Regulatory Independence, Investment and Political Interference: Evidence from the EU *

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Abstract

This paper examines the implications of "modern" regulatory governance - i.e. the creation of Independent Regulatory Authorities (IRAs) - for the capital investment decisions of a large sample of EU publicly traded regulated firms from 1994 to 2004. These firms provide massively consumed services, and this is why governments are particularly sensitive to regulatory decisions and outcomes. We therefore analyze and empirically investigate *i)* whether the inception of IRAs may reduce the time-inconsistency problems undermining company investment, and *ii)* whether governments' political orientation and residual state ownership interfere with investment decisions. We control for the potential endogeneity of the key institutional variables by drawing our identification strategy from the political economy literature.Our results show that regulatory independence has a positive impact on regulated firms' investment while private vs. state ownership is not significant. The executive's political orientation also matters, as company investment increases under more conservative and market-oriented governments, but the impact seems to reverse when the IRA is in place. Our evidence suggests that the interaction of politics with the functions of the IRA can undermine investment decisions whenever a formally independent regulator coexists with a strongly ideologically driven executive, as this is likely to introduce instability and uncertainty in the regulatory framework.

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1. Introduction

Since the early 1990's, the public utility sector in the European Union has gone through substantial structural reforms that include liberalization of the markets, privatization of state-owned utilities and the institution of independent agencies to regulate the provision of utility services. When evaluating the effect of these reforms, infrastructure investment is perhaps the most important economic dimension because of its impact on welfare and dynamic efficiency. On the one hand, public utilities typically deliver essential services through a network, which must be constantly maintained and upgraded to provide them in appropriate quantity and quality, and at reasonable prices. On the other hand, infrastructure investment is an acknowledged driving force of the economy and a major determinant of economic growth, often used as a counter-cyclical policy tool.[1] Guthrie (2006), for example, estimates that network industries, like energy, telecommunications, railways, airports, ports and water supply contribute, on average, 5% of the GDP of OECD countries, while gross fixed capital formation in these industries adds up to almost 15% of total investment in the non agricultural business sector.

The implementation of market liberalization, privatization, and of regulatory reforms, however, differ considerably across member states and industries, because the European Commission set the general framework and the guidelines while national governments set the pace of the process. The most important of these reforms is perhaps the institution of Independent Regulatory Authorities (IRAs) spurred by the European Commission to regulate the activity of network industries and to discipline the potential conflict of interest between the Government and state owned utilities.[2] In this paper we study how varying regulatory institutions and ownership patterns affect regulated firms' investment decision, contending that the establishment of Independent Regulatory Authorities has a positive influence on public utilities' investment and that this influence is entwined with the residual presence of state ownership and with the government's political stance about state intervention in the economy.

Why is regulatory independence so critical? When regulators are "not independent", the government can either directly force or indirectly influence them to ex-post modify their decisions, thus constraining their ability to commit to their regulatory policy. This lack of commitment leads to time-inconsistent decisions, undermining firms' investment incentives: if regulators ex post are induced to revise their decisions, capital expenditures in new infrastructure, typically large, specific and sunk, can be expropriated, or not fully recovered by the investing firm. Thus, uncertainty in the

[1]Using data on the telecoms market,Koutroumpis (2009) shows that the average impact of new investment in broadband networks 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 investment accounted for $28 billion of US GDP in 2006.

[2] The OECD describes IRAs as "one of the most widespread institutions of *modern* regulatory governance" (OECD, 2002).

regulatory policy negatively affects the firm's investment decisions. The rationale behind the creation of an independent authority lies in the attempt to insulate regulators from political interference aimed at influencing regulated firms' investment or employment decisions, particularly when the government has ownership stakes in the utility.[3] Institutions like central banks and IRAs, are typically designed to limit political interference and supposed to enhance regulators' credibility and commitment.[4] Therefore, the design of regulatory authorities, if credible, includes institutional arrangements that restrain the government from opportunistically expropriating the utilities' investments.

Utility sectors, however, are a special case of interest because the services they provide are massively consumed by the citizenry, and governments have the latitude to influence the pace of liberalization, privatization and regulatory reforms, in line with their political stance and objectives. This implies that politicians and interest groups in general will be particularly concerned about regulatory decisions that may affect the provision of utility services. Therefore, despite EU driven product market reforms, and even though an independent regulator exists, politicians may still try to pursue their partisan goals by interfering with (private and state owned) public utilities' decisions, as they strive to be reelected or simply because they want to achieve their own favorite policy outcome.

The degree of independence and the credibility of newly set up regulatory authorities are likely to depend on how much power Governments are willing to delegate. A regulatory agency can be provided with formalindependence or authority, i.e. with the right to decide on specified matters, but this *formal* authority not necessarily confers a *real* authority, that is the effective control over the decisions, thus limiting the *real* independence of the regulatory agency from politics. Aghion and Tirole (1997) present a theory of the allocation of formal and real authority within organizations which shows that an increase in the real authority (i.e. in delegation of powers) enhances the regulator's incentive and initiative to acquire the relevant information on the corresponding activity, but results in a loss of control by politicians. This causes a trade-off between loss of control and regulatory initiative that affects the degree of delegation from politicians to regulators and in turn the credibility and effectiveness of regulatory intervention.

[3] That politicians may be "bad regulators" is eloquently described by Stigler (1971, p. 3): "the political process defies rational explanation: 'politics' is an imponderable, a constantly and unpredictably shifting mixture of forces of the most diverse nature, comprehending acts of great moral virtue (the emancipation of slaves) and of the most vulgar venality (the congressman feathering his own nest)".

[4] Alesina and Tabellini (2008), studying the normative criteria that allocate tasks between politicians and bureaucrats, hold that regulation of public utilities is an example of "policies that lend themselves to bureaucratic delegation, since they pit special interests against those of consumers as a whole" (page 444). Perino (2010) shows that delegation unambiguously increases credibility, especially when new information affects the ex ante policy.

The complex nature of the link between independent regulation and politics motivates the following research questions, i.e. Does the creation of independent regulatory agencies affect public utilities' investment decisions, and do privatized and partially privatized firms respond differently? What is the interaction with politics? Does the IRA succeed in constraining political interference in public utilities' investment decisions? To answer these questions, we estimate an econometric model of EU regulated utilities' investment in which we take explicitly into account (i) the degree of independence of regulatory agencies, as it varies across sectors, countries and time; (ii) the degree of government's ownership of regulated utilities, as it changes over time and across firms, and (iii) the change in political orientation of national governments over time, as this may ultimately influence the regulatory climate to be either pro-firm or pro-consumers.[5] To measure regulatory independence we use two alternative variables: a dummy that equals 1 in the year the Independent Regulatory Agency (IRA) was set up and thereafter, and an index of formal regulatory independence (Gilardi, 2002 and 2005) which is based on key dimensions of the regulatory framework, such as the financial and organizational autonomy of the agency, the degree of accountability to the government and the parliament, the scope of regulatory competencies and the status of the agency head and of the members of management board. We focus on formal independence because, to our knowledge, no indexes exist that quantitatively measure actual (informal) independence of European regulators.[6]

Our paper belongs to the recent strand of the political economy literature that investigates the impact of either policy reforms or institutions on a variety of economic dimensions, addressing the potential endogeneity of reforms. One branch of this literature has a broad historical perspective to analyse how social and political institutions affect economic development.[7] Another strand investigates the micro-economic consequences of reforms. Among the others, Bertrand and Kramarz (2002) study the effect of labour market institutions on employment growth in France; Besley and Burgess (2004) investigate the impact of labour regulation reforms on the economic performance of manufacturing industry in India; Alesina*et al.* (2005) study the effect of product

[5] See Friedman (1962) and Alesina and Rosenthal (1995) for a general review of the impact of partisan politics and ideology on economic policies. Leftwing parties are rarely associated with market-oriented policies, while rightwing parties are more in favor of deregulation and less inclined to sustain consumers' interest than leftwing parties (see also Benoit and Laver, 2006). This insight is consistent with empirical evidence on the effect of government's ideology on fiscal policy suggesting that left-wing executives are more willing to increase taxation and public expenditure (size of the government) than right-wing one; see, among the others, Alesina*et al.* (1997), Perotti and Kontopoulos (2002), and Ticchi and Vindigni (2010).

[6] As long as we rely on existing indexes of *formal* independence, we mainly address the independence of regulators from executives and politicians rather than from the regulated firm's stakeholders. This issue is beyond the scope of the paper, as it implies that we deal with problems of lobbying and regulatory capture, for which the data in Europe are not available. For a survey on regulatory capture, see Armstrong and Sappington (2007).

[7] See, among the others, Persson and Tabellini (1999), Acemoglu, Johnson and Robinson (2001), Persson (2002), Aghion et al. (2010) and Tabellini (2010).

market reforms on liberalized sectors' aggregate investment. More recently, Aghion*et al.* (2009) study the impact of market entry on incumbent firms' innovation and productivity, while Da Rin*et al.* (2010) analyse the effect of changes in corporate income taxation on entrepreneurship and firm entry conditions. The focus of this paper is on firms' responses to institutional reforms, in that we look at the effect of an institutional change implemented by national governments, such as the set up of the IRA, on public utilities' investment decisions. To this aim we construct a firm-level panel dataset on 80 publicly traded EU utilities in energy, telecommunications, water and transport infrastructures covering more than 85% of quoted European utilities from 1994 and 2004, which we complement with country and sector specific variables to cover the regulatory framework and the political environment. We follow Acemoglu (2005) who illustrates why political institutions – in our case the IRA itself - should be treated as endogenous, and we use an identification strategy borrowed from the applied political economy literature to control for the potential endogeneity of the key institutional changes that may have affected public utilities in the time horizon under study – such as the establishment of the independent regulator, its relationship with politics, and the privatization process.

This paper departs from existing work in at least four directions. First, while most studies typically focus on utilities in developing countries, we test our models on a large panel of European firms. Europe is particularly interesting, but complex, due to its multidimensional institutional and political differences, and this complexity probably explains the limited number of studies on the impact of regulatory reforms in Europe. Second, although other papers do examine the relationship between regulatory framework or independence and investment, they do not consider its interactions with firm ownership and government partisanship. Third, in our econometric analysis, we use a structural model of investment, the Euler equation approach, which allows us to test whether the equilibrium level of investment changes when the regulator is independent and when the firm is partially owned by the state while also controlling for the impact of the Government's political orientation (i.e. pro-consumers versus pro-firm ideology). Four, we control for the potential endogeneity of the institutional variables included in the model. In fact, politicians may decide to establish an independent regulator because they seek to expand or modernize the country's infrastructure; politicians might thus decide to delegate some power in order to make the regulatory environment more stable, reduce the threat of hold up and provide stronger investment incentives to the regulated firms. By the same token, the decision to privatise a state-owned incumbent firm is also likely be influenced by the need of huge investments in the sector. We thus allow for the potential endogeneity of these variables and rely on instrumental variables techniques, using

alternative sets of instruments that capture characteristics of the political and financial institutions to identify the direction of the relationship between investment, independent regulation and politics.

Our results show that regulatory independence does matter for investment of regulated firms. More specifically, investment increases when an IRA is in place, or the more independent is the regulator, and this effect is independent of firm ownership as well as of the extent of market liberalization. Moreover, the government's political orientation does matter, as firm investment is found to increase under more conservative (pro-firm) governments, but this effect appears to revert if an IRA exists, and the higher is regulatory independence. On the one hand, our results suggest that the IRA provides regulated firms' investment decisions with a shield against political interference; on the other hand, the evidence suggests that the interaction of politics with the regulatory functions of the independent authorities can be detrimental when the political stance of the executive moves toward the extreme rightwing of the political spectrum. Our interpretation of this result is that the tension arising between intensely market-oriented governments and regulators, obviously bureaucrats whose task is to intervene to correct market failures, undermine firms' investment incentives.

The rest of the paper is organized as follows. In Section 2, we review the literature background. In Section 3, we describe the institutional context. In Section 4 we present our identification strategy and in Section 5 we describe the dataset and define the variables and the instruments. In Section 6, we present the econometric model and the estimation methodology while in Section 7 we present the results. Section 8 concludes.

2. Literature background

Regulated firms have to incur substantial investment expenditures to construct and operate network infrastructures. Since public utility services are used by a large portion of the population, their prices are an issue of public concern, and regulators might be urged by public pressure and politicians to revise regulated charges as soon as investment expenditures are sunk.

The importance of regulatory independence is closely associated to the problem of time-inconsistency in regulation, i.e. the well-known regulatory opportunism, or hold up, problem.[8] The theory shows that regulatory opportunism leads regulated firms to underinvest (Besanko and Spulber, 1992). Whenever regulators cannot commit to long-term regulated prices, they may have an incentive to reduce the regulated rates ex post – i.e. once the firm's investment is sunk - in order

[8] See, for example, Newbery (1999; Ch. 2) and the survey by Armstrong and Sappington (2007).

to benefit consumers at the expense of the firm's owners.[9] The view of an independent regulatory authority as the necessary condition for policy credibility is by Levy and Spiller (1994), who show that "independence" improves the regulators' ability to make long-term commitments to regulatory decisions and, as a consequence, that sunk investment is less likely expropriated ex post. Interestingly for our purposes, they also show that the credibility and effectiveness of a regulatory framework varies with a country's political and social institutions. [10]

State ownership is another institutional factor that must be taken into account when assessing the merits of economic reforms in the public utility sector. State-owned enterprises tend to be less cost-efficient because their managers obtain only a fraction of the benefits from cost-saving activities, face less stringent financial (soft-budget) constraints and are more likely influenced by politicians (Hart *et al*., 1997; Shleifer, 1998). Governments may in fact demand regulators to use the assets of state-owned utilities for policy objectives (e.g. to extend the universal service obligation or to provide the service in geographically disadvantaged areas) rather than to pursue profit maximization (Laffont and Tirole, 1991). Politicians' interference may thus impair the ability of regulators to commit. As shown by Bias and Perotti (2002), however, the costs of regulatory opportunism can be raised by encouraging "widespread" privatisation and fragmented ownership structures, where investors/voters may urge governments not to reduce shareholders' value through political interference in regulatory policy. Privatization may thus deliver benefits – in terms of commitment powers – similar to the establishment of an independent regulator, as in the seminal paper by Sappington and Stiglitz (1987), who also show that the promise not to intervene ex-post is more credible under private ownership.[11]

Laffont (1996) studies the implications of government's partisanship for the regulated firm's efficiency with a model in which the alternation in power of biased political principals exposes the firm to regulatory risk and this risk depends on the firm's ownership structure. He shows that, in the presence of partisan executives, the ownership structure of the firm can be used to influence the social welfare: with a privately-owned monopoly, the change from a pro-consumer to a pro-firm executive is likely to strengthen incentives in the firm, as regulators would be more inclined to adopt high powered incentives schemes.

[9] Building on this, Spiegel and Spulber (1994) show that firms can strategically use financial leverage and bankruptcy risk to discipline regulatory opportunism in order to shield investment incentives. Bortolotti, Cambini, Rondi and Spiegel (2010; BCRS hereafter) provide empirical evidence to the strategic relationship between debt and regulated rates.

[10]Further advantages of independent regulatory institutions include enhanced expertise, flexibility in decision-making and sector-specific knowledge that reduces asymmetric information problems. Altogether, these features promote stability and continuity of regulators' course of action, enhancing their credibility (Majone, 1997).

[11] For a recent survey on the costs and benefits of privatization see Martimort (2006)

Very few empirical studies investigate the relationship among regulatory independence and investment and even less take firm ownership into account. Moreover, most of these studies look at the public utility sector in developing countries or at one individual sector. Gutiérrez (2003) finds, for telecom companies in Latin American and Caribbean countries from 1980 to 1997, that regulatory independence has a positive impact on the number of phone lines per capita. Cubbin and Stern (2005) show, for a panel of electric utilities in developing countries from 1980 to 2001, that the existence of an independent regulator is associated with higher generating capacity. Egert (2009), using industry level data from 13 OECD countries, shows that incentive regulation implemented jointly with an independent regulator has a sizeable positive impact on investment in network industries, though when taken separately the two variables do not display any significant effect.[12] The empirical evidence on the impact of firm's ownership on investment is mixed. Early studies by Megginson*et al.* (1994) and Boubakri and Cosset (1998) show, for a variety of countries and industries, that privatizations led to higher fixed investment and innovation.[13] More recently, Gupta (2005) finds that partial, but not full, privatization of Indian state-owned enterprises had a positive impact on privatized firms' investment from 1990 to 2000. Cambini and Rondi (2010) investigate the impact of regulatory regimes (incentive vs. cost-plus regulation), on energy utilities' investment in five EU countries (France, Germany, Italy, Spain and UK) in the decade 1997-2007 and find that firm ownership has no significant effect on investment. Finally, two empirical studies examine the role of both independent regulation and firm (public vs. private) ownership in fostering investments. Wallsten (2001) finds that the privatization of telecom providers in Latin America and Africa was positively related to larger investment in connection capacity and phone penetration, but only where an IRA exists. Li (2009), using data of 22 mobile carriers from 7 countries in the period 1995-2007, shows that regulatory independence is associated with higher mobile penetration and network expansion, higher technical efficiency, TFP growth and innovation and finds that the relationship is stronger when firms are privately-controlled. Notably, most of these studies do not control for the potential endogeneity of both regulatory independence and firm ownership[14], and none includes government's political orientation to control for direct government's interference over investment decisions.

Similarly to regulatory independence, competition may also, in principle, reinforce regulated firms' incentives to invest. The empirical evidence on the complementarity between competition

[12]Guasch*et al.* (2008) study the impact of regulatory independence in a different context. Using data from 307 transportation and water concession contracts in Argentina, Brazil, Chile, Colombia, and Mexico from 1989 to 2000, the authors find that the presence of an IRA lowered the probability of renegotiation by 5%-7.3%.

[13] See Megginson and Netter (2001) for a survey.

[14] Gupta (2005) and Cambini and Rondi (2010) are the only two studies, in our review, that deal with the potential endogeneity of privatization.

and regulation, however, is mixed. Ai and Sappington(2002), investigating the effect of incentive regulation for U.S. telecoms' investment between 1986 and 1999, find that its impact is substantial in settings where competition is more intense. Alesina*et al.* (2005) show, for a panel of 21 OECD countries from 1975 to 1996, that a lower intensity of product market regulation in non-manufacturing industries, hence a more competitive and open market, leads to higher aggregate investment at sectoral level.

Finally, political institutions also are likely to affect regulated firms' decisions. Shleifer and Vishny (1994, pp. 1022-1023) theoretically analyse the behaviour of private and public enterprises in situations where politicians try to influence firms to pursue political objectives. They show that "an important determinant of whether politicians want firms to be private or public is their ability to get tangible political benefits out of public ownership. The greater the independence of public firms from politicians, the less attractive is public ownership for politicians." Their framework, however, does not encompass the role of independent regulation and its interplay with political partisanship. Henisz and Zelner (2001) and Zelner and Henisz (2006) analyse and empirically investigate the impact of political institutions on regulated firms' investment. More specifically, Henisz and Zelner (2001) use telecommunications operators in 147 countries during the period 1960–1994, and find that the credibility of the political regime as measured by political institution variables (such as the presence of low and upper chambers, judiciary and some federal institutions, the effective systems of checks and balances, etc.) imposes stronger constraints on managers' discretion that positively affect investment. Zelner and Henisz (2006) use a panel of state-owned electric utilities from 78 countries (1970-1994) to investigate if veto powers and interest group pressure influence the annual rate of deployment of electricity generating capacity. In their view, state owned enterprises (SOEs) may be driven by political actors to undertake excessive investment projects (the so-called "white elephants") that provide targeted economic benefits to their constituencies. The empirical results support the hypothesis that the impact on electrical infrastructure investment by political institutions that constraint the behaviour of political actors varies with the level of interest group competition (households vs. industrial users) faced by electric utilities.[15]

[15] A recent strand of the literature studies the institutional design of public organizations and the extent to which public officials – like regulators and judges - are subject to accountability. Besley and Coate (2003), for the US electric power industry, find that the way commissioners are selected - either appointed by the government or elected by citizenry - affects the regulatory outcomes: in States where regulators are elected, prices are lower, but investments are also lower than in states where they are appointed by the government. This result suggests that being subject to (re-)election makes regulators more inclined to follow public opinion than if they were appointed and therefore to pursue short-term rather than long-term goals. Guerriero (2010), who also examines the US electric power industry, investigates the determinants of the adoption of incentive regulation from 1982 to 2002, and finds that "performance based regulation" is more likely to be adopted in states where regulators are elected, political competition is less harsh, and regulatory resources are more abundant. In Europe, where regulators are typically appointed by the Government, this type of analysis cannot be conducted.

The recent empirical literature on regulation and politics focuses on how both the ideology of the government and the political system affect market reforms in regulated industries. Li and Xu (2002) investigate the political economy of privatisation and competition in the fixed telephone sector in 45 countries from 1990 to 1998. They show that democratic countries with a strong presence of pro-reform and pro-market interest groups are more likely to privatise firms and liberalize markets than less democratic governments. Gilardi (2005) finds that in West European countries the need to improve credible commitment when privatising and liberalising increases the likelihood that and IRA will be established and this likelihood increases with political uncertainty, i.e. with higher risk of a government being replaced by a coalition of different preference (pro-firm vs. pro-consumer). Duso and Seldeslachts (2010), using data from the mobile telecom industry of 24 OECD countries in the period 1991-1997, show that executives more in favour of de-regulation and smaller welfare states speed up market entry while pro-regulation governments, which co-exist with strong incumbents, slows down liberalization. Finally, Potrafke (2010), using data for 21 OECD countries from 1975 to 2003, finds that the government's ideology has a strong influence on the deregulation process, specifically that a rightwing and market-oriented political orientation is a driving force of product market deregulation and privatization.[16]

All these studies show that regulatory institutions and market reforms are influenced by political decisions according to the specific social and political goals of the government in charge. This evidence suggests that the decision to delegate specific powers to an independent authority, as well as the decision to privatize regulated utilities may be endogenous. To the best of our knowledge, our study is the first one in the recent literature on political economy of regulation that allows for the potential endogeneity of both the existence of independent regulation and the residual state ownership. To this aim we borrow from the recent literature on political economy and use characteristics of the political, legal and financial institutions to instrument potentially endogenous variables.

3. Two decades of regulatory reforms in the EU

Until the early Nineties, public utilities in Europe, with the only UK exception, were largely characterized by vertical integration, state monopoly and public ownership. Ministries, governmental committees and local governments were in charge of regulating the public utility sector, setting tariffs and imposing quality standards. In that period regulation was viewed more as a

[16] This result is consistent with previous findings by Bortolotti*et al.*(2003), while Boubakri *et al.* (2010), using 221 privatised firms in 27 emerging countries, find that political constraints, but not political ideology, are important determinants of residual state ownership in privatised firms.

sort of "political negotiation" among the utilities and the Ministry itself rather than as an instrument to create competitive conditions while amending market failures. Regulated rates were mainly set to counterbalance the rise of inflation while utilities were often asked to absorb labour units whenever unemployment increased. The result of this “un-incentive regulation” was ill performing monopolies and inefficiency (Megginson and Netter, 2001).

The European Commission issued various Directives to prompt national reforms that redesigned the legal and regulatory frameworks in order to raise efficiency, service quality, and spur infrastructure investment within EU member states. The public utility sector was therefore gradually liberalized with the involvement of private investors in the ownership and control of assets. The Commission, however, though in favour of privatisation, left the decision about utilities’ ownership structure entirely in the hands of national governments. As of 2010, privatization of public utilities within EU member states is far from complete, and central and local governments still hold majority and minority ownership stakes in many regulated utilities.[17]

In order to regulate the provision of utility services and to avoid the potential conflict of interest between the Government and state owned utilities, the European Commission promoted the delegation of regulatory competencies to independent authorities, entitled to act on the behalf of the central government, but outside of any state department or ministry. The new regulatory body ought to operate with their own specialized staff and with specific and detailed tasks, independently of ministries or government departments. The European Commission especially urged national governments to establish formally independent regulators within country- wide sectors like energy and telecommunications, leaving, however, the decision about the definition and the scope of the delegated powers to national executives. Typically, delegated regulatory tasks involve price setting decisions, both at retail and wholesale level - whenever access to essential facility is needed to develop market competition -, the definition of entry conditions, the imposition of quality standards and all the technical rules to use or access to existing infrastructures. Within this set of regulatory rules, utilities are free to make their own decisions about investments and their financing.

National authorities implemented a variety of regulatory mechanisms that differ across countries and sectors and change over time, so that the inception of the IRA cannot be related to the adoption of a specific scheme. These range from the typical cost-plus (rate of return) to incentive-based schemes, either in the form of price or revenues caps or through yardstick competition. Within telecommunication sectors, for example, all regulators have shifted– over time - from cost-plus to price cap as far as retail services are concerned, but mostly still apply cost-plus regulation to wholesale charges. In the energy sector, some countries (the UK, for example) adopted incentive

[17] See Bortolotti and Faccio (2009) for a recent analysis.

mechanisms while some others switched from rate of return to incentive based pricing (like Italy and Spain), and some (like Germany and France) rely only on cost-plus mechanisms.[18] As for water supply, regulators (where existing, like in the UK) apply yardstick competition to set water tariffs, while some (but not all) freight roads operators shifted from cost-plus to price cap schemes.

To summarize, the implementation of liberalization reforms varies considerably across countries and sectors. It is most advanced in the telecom industry where independent regulatory agencies (IRA) have been established in virtually all member states and most of the companies are (at least partially) privatized. Market liberalization is also quite advanced within the energy sector, where the majority of electric and gas utilities is regulated by an IRA. However, many large utilities are still controlled by the government, particularly in France, Germany, Italy and Portugal and especially so in the natural gas industry. In contrast, structural reforms are lagging behind in water supply and in transportation infrastructure (docks and ports, airports and freight motorways). With the exception of the U.K., most water and transportation utilities are still controlled by central and local governments and still subject to regulation by ministries or by other branches of the government rather than by IRAs.

4. Estimating Public Utilities' Investment with Independent Regulation, Politics and Mixed-Ownership

In this section we address the identification issues that arise when the purpose is to estimate the impact of regulatory independence on regulated firms' investment, while taking government's (partial) ownership and political orientation into account. As explained in the literature review in Section 2, the theory shows that regulatory lack of commitment and time inconsistency undermine firm investment incentives, and also that the discipline of regulatory opportunism is expected to restore the incentives to investment and to alleviate the hold up problem. As suggested by the institutional changes occurred in EU member states (Section 3), the positive answer to this normative problem is the introduction of independent regulatory agencies, with an institutional design that should ensure the task of insulating regulators from politicians who may undermine their commitment. Therefore, ideally, *independent* regulatory agencies are expected to soften the lack of commitment problem, the more so the more independent the regulator is from the government. From the empirical point of view, the main challenge is that "lack of commitment", or the "threat of hold up due to regulatory opportunism", is not observable and cannot be measured. However, if

[18] For further information on the evolution of regulatory schemes in telecoms and energy sectors, see OECD (2006) and Cambini and Rondi (2010), respectively.

lack of commitment has a negative effect on investment, then its discipline should display a positive effect on investment. Therefore our empirical strategy is to rely on the existence of an independent regulatory agency, or on the degree of independence of the agency, to estimate the effect of curbed opportunism on investment. For this reason, however, the presence, or the degree of independence, of the IRA, is likely to be endogenous to the investment decision, given that the decision to set up an IRA itself is closely related to the lack of commitment problem and probably motivated by the intent of disciplining the potential regulatory opportunism and so to reassure the firm that investment rents will not be expropriated as soon as investment expenditures are sunk. This likely[19]endogeneity is an identification problem that we tackle by exploiting major institutional features that differ across countries, sectors and over time as well as by using appropriate instrumental variable methods.

The second challenge we face is the link between politics, the IRA and firm investment, since the decision to set up an independent regulatory agency is likely to be political. As long as politics *indirectly* influences public utilities' investment through the IRA, it provides a suitable instrument for IRA. However, politics may also have a *direct* effect on investment, to the extent that it promotes and mould infrastructure investment (think of the decision to set up nuclear or photovoltaic, or wind-power energy plants; to deploy a broadband telecom network, to expand the motorway or the railway transportation system, etc.) as well as the choice of the technology (labour- or capital-intensive). In our preferred specification, politics enters linearly and interactedly with the IRA to test whether the impact of the IRA on investment changes with Government's political orientation.

Finally, the direct effect of politics on investment decisions is likely to be stronger if the government holds ownership stakes in regulated firms, and the larger the stake, the stronger the effect. So our empirical models extend to control for the direct vs. indirect effects of politics while also accounting for the presence of government, as an investor, in regulated utilities.

To summarize our econometric methodology, we test the impact of the presence of the IRA on regulated utilities' investment decisions (as said, this may be viewed as the inverse test of the effect of lack of commitment), first assuming it is a strictly exogenous variable and subsequently accounting for its potential endogeneity by relying on internal (i.e. lags of the IRA) and external instruments. We start with politics, measured by an index of the political orientation of the executive in charge, as an excluded instrument for IRA to allow for politics influencing indirectly public utilities' investment through the decision to set up the IRA. We then account for the *direct* effect of politics by including the political orientation index among the regressors, and, because the

[19] As explained in section 3, the decision to set up independent regulatory authorities was promoted by the European Commission, but the timing of the inception and the latitude of the delegated tasks were left to national governments.

effect of the IRA is likely to vary with government's political orientation, we enter these variables linearly and with an interaction. We similarly proceed with government's ownership, first using our ownership variable, a continuous measure of the Government's ultimate control rights, as an excluded instrument and then including it as a regressor, both standalone and interacted with IRA. Because the Government's decision to fully or partly privatise the regulated utilities may also be endogenous to the decision to spur utilities' investments, we allow for endogeneity of this control variable. For robustness, we use various sets of institutional and political variables to perform a number of tests of our preferred specifications.

5. Data and Variable Definitions

For the empirical analysis we use an unbalanced panel of 80 publicly traded utilities and transportation infrastructure operators from EU 15 founding member states, tracked from 1994 to 2004. The data covers firms that are either regulated by independent regulatory agencies or by ministries, governmental committees, or local governments, and with various degrees of state ownership. The sectors covered by our data include electricity and natural gas (both distribution and transmission), water supply, telecommunications, freight roads concessions, ports, and airports. In all, we have 37 firms that engage in electricity and gas (distribution and transport), 12 water supply companies, 15 fixed telecom incumbent operators, 6 freight roads concessionaires, and 10 transportation infrastructure operators (airport, ports and docks). Our sample is not large but representative, as it covers more than 85% of publicly listed European utilities that in the period 1994-2005 can be tracked for at least five consecutive years.

Firm level accounting data have been collected from *Worldscope*. Our dependent variable is the investment to capital stock ratio (I/K). In the econometric analysis we use the ratio of capital expenditures to capital stock at the replacement value.[20] Other key variables of the investment equations are the operating cash flow to capital stock ratio (Π/K), the output (sales) to capital stock

[20] The accounting data from *Worldscope* only include historic cost valuations of fixed assets, which usually bear little relation to current replacement cost of long-lived fixed capital assets. Hence, we calculate the replacement cost of the capital stock using the perpetual inventory formula: $p_{t+1}K_{t+1} = p_tK_t(1-\delta)(p_{t+1}/p_t) + p_{t+1}I_{t+1}$, where p_t is the country-specific implicit price deflator for gross capital formation in period t sourced by the OECD, K_t is the fixed capital stock in period t, I_t is the investment flow in period t, and δ is the depreciation rate. We derived the sector specific depreciation rates from Bureau of Economic Analysis estimates reported in "Rates of Depreciation, Service Lives, Declining Balance Rates, and Hulten-Wykoff Categories" and used 4.4% for energy, gas and water supply, 3% for freight roads concessionaires, 8% for telecommunications, and 4.5% for ports and airports. To obtain the starting values for the perpetual inventory formula, we assumed that replacement-cost valuations are equal to historic-cost valuations for the earlier available capital stock data (usually 1994). Whenever a major acquisition or divestiture may cause a major discontinuity in the investment rate series, we split the firm's time-series into two units accounting for the period "before" and "after" the event, provided that the split unit has at least five consecutive observations.

ratio (Y/K), and the financial debt to capital stock ratio (D/K). Table 1 summarizes the descriptive statistics of the main variables used in the analysis, for the full sample, the two sub-samples of firm-year observations when the IRA does, and does not exist.

To indicate ownership, we employ a continuous variable constructed by Bortolotti and Faccio (2009), which uses the weakest link approach to measure the government's ultimate control rights (*Government UCR*).[21] Within our sample, 21 firms changed their ownership status from state controlled to privately-controlled (i.e. the government has less than 50% of the ultimate control rights).

All firms operate in regulated sectors, i.e. where entry and prices are subject to regulatory oversight either by a government committee or by an *Independent Regulatory Agency* (IRA). In order to study the effect of regulatory independence on firms' investment decisions, we use an IRA dummy that is equal to 1 in all years in which the firm was subject to regulation by an IRA, and 0 otherwise. The IRA dummy was constructed using data and information on IRAs' inception dates taken from Gilardi (2002 and 2005) for the energy and telecommunications sectors in which IRAs already exist in all countries in our sample. We complemented this data by drawing from additional sources information about the presence of IRAs within freight roads, airports, port and docks, and water supply. As mentioned in Section 3, we found that only the water industry in the UK has an independent regulatory agency. As an alternative to the IRA dummy, we use the Index of formal *Regulatory Independence* (see Gilardi 2002, 2005), which allows us to control for differences in the regulatory environment across countries and sectors where the IRA exists.[22] This index is obtained by taking the average of five key dimensions of the regulatory framework: (i) the status of the agency head (for example, term of office and appointment and dismissal procedure), (ii) the status of the members of management board, (iii) relationship with government and parliament, (iv) financial and organizational autonomy, and (v) regulatory competencies.It goes from 0 (no independence) to 1 (full independence). The index is time invariant and is not available for water utility sector and for transportation infrastructure, where the IRA does not exist. Regulatory independence varies considerably across European countries and sectors. In telecommunications, Austria, Ireland, Portugal, and the U.K. appear to have the most independent regulators, while Belgium and Germany have the least independent regulators. In electric and gas, Austria, Belgium, and Italy appear to have the most independent regulators, while Spain seems to have the least

[21] See La Porta, Lopez-de-Silanes, and Shleifer (1999), Faccio and Lang (2002). According to this approach, the UCR of the state is simply equal to the minimum ownership stake along the control chain (i.e., the weakest link). In BCRS (2010) a dichotomous dummy variable captures the public vs. private control status.

[22] To our knowledge, Gilardi's Index is the only one covering all sectors regulated by an IRA across EU member states. Edwards and Waverman (2006) and Larsen *et al.* (2006) constructed sector- specific indexes that assess the degree of formal independence for European countries' telecommunications and electricity markets, respectively.

independent regulators and Germany does not have an IRA dedicated for energy sectors. When we use the Gilardi index as a substitute of the IRA dummy in the econometric analysis, we estimate our models on the sub-sample of regulated firms operating in sectors with an IRA. This enables us to add one dimension to our analysis, namely that a test of the impact of the *degree* of regulatory independence on the investment decisions of firms subject to IRA.

The *Political Orientation* Index is a continuous and time-variant measure of the government's political stance, i.e. from leftwing to rightwing, and under reasonable assumptions, can be used to capture whether the government in charge is more pro-firm (supposedly right-wing) or pro-consumer (left-wing). The index ranges from 0 (extreme left wing) to 10 (extreme right wing) and is equal to a weighted average of scores given in expert surveys supporting government (see Huber and Inglehart, 1995, and Bortolotti and Faccio, 2009). Insofar as governments interfere with the decision to establish an IRA or with the regulator's agenda (so that the regulator is ultimately *less* independent), *Political Orientation* may also be a proxy of the regulatory climate. The data in Table 1 show that the average index is 5.662, while the minimum is 3.665 (corresponding to the German government led by Gerard Schroeder in the years 2003 and 2004) and the maximum is 8.025 (assigned to the Italian executive led by Berlusconi from 2002 to 2004), indicating that the distribution of observations is more skewed towards the right.[23] In Appendix 1 we report, for each country, the political orientation of the executives in charge when the IRAs in the energy and telecommunications sectors were established. The table shows that IRAs became operative when the government in charge was right-wing or center-right in 17 cases out of 28, and in 6 out 28 cases when the government was left-wing or center-left. This anecdotal evidence reveals that the pattern of the data is sufficiently heterogeneous, though it seems that the IRA is more likely to be set up by conservative governments. It is also true, however, that if IRAs tend to be set up in the wake of privatization programs then a hypothetical link "rightwing executive-IRA" may in fact conceal a more complex "rightwing executive-privatizations-IRA" link. This is a three-way relation that further justifies our choice to adopt an estimation strategy that allows for the interactions of independent regulation, mixed-ownership and political orientation.

In our analysis we allow for the likely endogeneity of the decision to establish an IRA, and of the IRA's degree of formal independence by instrumenting the IRA dummy (or the *Regulatory independence index*). We also allow for the potential endogeneity of residual state ownership by instrumenting *Government UCR*. We obtain external instruments by exploiting country features that

[23] In fact, the inter-quartilic distribution of the *Political Orientation Index* shows that the first quartile is at 4.43, the median is at 5.27 and the third quartile is at 7.44, indicating a fat tail towards the center-left and a thinner (and longer) tail towards the right wing of the political spectrum.

may help gauging the degree of accountability of country institutions, the probability that policy reforms and political decisions may be (more or less easily) reverted, and the extent to which property rights are effectively protected.

The *Investor Protectionindex* is the "anti-director rights" index developed by La Porta*et al.* (1999) and updated by Pagano and Volpin (2005). The index is time-varying and goes from 0 to 7 as shareholders' rights become more and more protected. We use this variable to proxy for the extent of protection and enforcement of property rights. Countries where investor protection and property rights are strongly protected are likely to have more credible institutions since, for example, liability rules are clearer, disclosure and accountability requirements are tighter, risk of expropriation and likelihood of contract repudiation by the government are smaller.

To control for characteristics of institutional and political systems that may influence the decision to privatize utilities and to introduce the IRAs, we use the *Political Orientation index* (see above) and the *Political Institutional Gallagher Index of Disproportionality*, an index of political fragmentation that allows a categorization of countries based on a majoritarian -consensual dimension and a measure of government stability and of the veto-power of minority parties (Gallagher, 1991, updated by Bortolotti and Pinotti, 2008). The index is continuous and time varying; it equals zero when the apportionment of parliamentary seats is exactly proportional to electoral results, and it increases as disproportionality increasestoward a majoritarian system. As argued in Henisz (2000), when political fragmentation is high, policies are adjusted less often because reforms are more likely to be blocked within a multi-party system and coalition governments, as the number of independent institutional actors with potential veto power increases. This implies that within a fragmented political system, politicians are less able to interfere with regulatory decisions, and the regulator should be – at least in principle - more independent.[24]

To complement our analysis we also use a set of variables taken from the World Bank database on Political Institutions, which has been extensively used in the political economy literature (see, for example, Bertrand and Kramarz, 2002; Aghion*et al.*, 2009; Da Rin*et al.* 2010).[25] Here is the list of variables used as instruments. The index of *Government Stability* is a time-varying survey-based measure that assesses both the government's ability to carry out its declared program, and its ability to stay in office. It ranges from 0 (low stability) to 1 (high stability). Insofar

[24] In fact, while proportional parliamentary regimes lead to multy-party systems and, therefore, to coalition governments, majoritarian ones lead to the formation of two-party systems where the executive power is typically concentrated in the hands of the prime minister. This implies that, in a system characterized by a unified government, control over bureaucrats will be stronger than in systems characterized by a divided government (Alesina and Rosenthal, 1996). Therefore, the probability of observing more independent agencies is higher in systems characterized by divided governments (Spiller and Urbiztondo, 1994; Spiller, 2004).

[25] For a detailed description of the variables in the World Bank database, see Beck *et al.* (2001).

as the executive is more stable and less subject to veto powers, lack of commitment and time inconsistency are likely to be less of a problem. *EXERLC* is a time-varying variable equal to 1 when the executive is leftwing, 2 when it is centre, and 3 when it rightwing and can be used as an alternative to the index of *Political Orientation*. *Election date* is a dummy variable that is equal to 1 if there was an executive election in that year. Finally, *Checks & Balances* is a time-varying index that measures the number of veto powers in a political system according to specific legislative and executive indexes of electoral competitiveness. Appendix A2 reports descriptive statistics for the political and legal institutional variables we use in the empirical analysis. The next section illustrates the model of fixed capital investment we use to test our hypotheses, the various specifications we estimate and the econometric methodology.

6. Econometric Model and Estimation Methods

For an empirical model of investment to be tested on firm panel data, we turn to the Euler equation approach, introduced by Abel (1980) and developed by Bond and Meghir (1994). The Euler equation derives from the first-order conditions for the optimal capital stock and therefore describes the optimal path of firm investment. It is not an investment rule where investment is a function of predetermined or exogenous variables but, rather, a structural relation between investment rates in successive periods as derived from dynamic optimization in the presence of symmetric and quadratic adjustment costs that take the form of foregone production. The advantage of the Euler equation model of company investment is that it captures the influence of current expectations of future profitability on current investment decisions without having to rely on stock market valuations of the firm as in the usual Q model approach, an attractive feature because, with partially privatized, regulated utilities, stock market valuations are likely to be less reliable and lead to larger measurement errors.

To obtain an empirical model, the firm is assumed to maximize the present discounted value of current and future net cash flows. Let L_{it} denote variable factor inputs, w_{it} the price of variable factors, p_{it} the price of output, I_{it} fixed investment, K_{it} the capital stock, p^I_{it} the price of investment goods, ρ_{t+j} the nominal discount factor between period t and period $t+j$, δ the rate of depreciation, $F(K_{it}, L_{it})$ the production function and $G(I_{it}, K_{it})$ the adjustment cost function and $E_t(.)$ the

expectation operator conditional on information available at t.[26] The firm solves the following optimization problem:

$$\text{Max } E_t[\Sigma_{j=0}\rho_{t+j}\Pi(K_{it+j}, L_{it+j}, I_{it+j}] \quad (1)$$

$$\text{s.t.} K_{it} = (1-\delta) K_{it-1} + I_{it}$$

where $\Pi_{it} = p_{it}F(K_{it}, L_{it}) - p_{it}G(I_{it}, K_{it}) - w_{it}L_{it} - p^I_{it}I_{it}$. The Euler equation characterizing the optimal investment path relates the marginal adjustment costs in adjacent periods and can be written as follows:

$$-(\partial\Pi/\partial I)_{it} = -(1-\delta)\rho_{t+1}E_t(\partial\Pi/\partial I)_{it+1} + (\partial\Pi/\partial K)_{it}$$

The symmetric adjustment cost function for the capital stock can be described by $G(I_{it}, K_{it}) = b/2\,[(I/K_{it} - c)]^2 K_{it}$, where b reflects the importance of adjustment costs and c is the "normal" rate of gross investment. Since we are dealing with imperfect market structures characterized by non constant returns to scale – i.e. natural monopolies or imperfectly competitive markets with dominant firms subject to regulatory agencies with the tasks of regulating, among the others, prices, entry and access to the network - the output price p_{it} is assumed to depend on the output, with a constant price elasticity of demand (ε)[27]. We therefore introduce the output to capital ratio $(Y/K)_{it}$ to account for imperfect competition in the market (see also Schiantarelli and Georgoutsos, 1990).

The Euler equation can then be expressed as:

$$(I/K)_{it} - \gamma_1(I/K)^2_{it} = \gamma_2 E_t(I/K)_{it+1} + \gamma_3[(\Omega/K)_{it} - J_{it}] - \gamma_4(Y/K)_{it} + \alpha \quad (2)$$

where $\Omega_{it} = p_{it}F(K_{it}, L_{it}) - p_{it}G(I_{it}, K_{it}) - w_{it}L_{it}$ is the gross operating profit and J_{it} is the real user cost of capital (with $J_{it} = (p^I_{it}/p_{it})\{1-(1-\delta)\rho_{t+1}p^I_{it+1}/p^I_{it}\}$), while the coefficients γ_1, γ_2, γ_3 and γ_4 can be shown to be positive.

To implement this model, the unobserved $E_t(I/K)_{it+1}$ is replaced by the realized $(I/K)_{it+1}$ plus a forecast error, and the $(I/K)_{it+1}$ term is then moved to the left-hand side to obtain an econometric model that is linear in variables. Finally, the cost of capital term can be replaced by time and firm

[26] Our concise exposition of the Euler equation approach closely follows Bond and Meghir (1994) and Bond, Elston, Mairesse and Mulkay (2003).

[27] This is in line with the so-called Ramsey prices, which represent the second-best solution that a benevolent regulator should implement in a regulated setting. According to this pricing rule, prices are inversely related to the degree of demand elasticity. See also Armstrong and Sappington (2007).

specific effects. Time dummies also control for common macro shocks. The empirical specification that we estimate then takes the form:

$$(I/K)_{it+1} = \beta_1(I/K)_{it} - \beta_2(I/K)^2_{it} - \beta_3(\Pi/K)_{it} + \beta_4(Y/K)_{it} + d_{it+1} + \eta_i + \nu_{it+1} \quad (3)$$

Where Π/K is rate of operating cash flow to capital stock, Y/K is the sales to capital stock ratio, η_i. are firm specific effects, d_{it+1} are the time dummies and ν_{it+1} is the expectational error.[28] It can be shown that $\beta_1 \geq 1$ and $\beta_2 \geq 1$, while $\beta_3 > 0$ under the null hypothesis of perfect capital markets and when internal and external sources of funds are perfect substitutes. The coefficient β_4 is positive under imperfectly competitive markets or when the company is facing increasing return to scale. In our setting, while it is true that utilities typically face non-constant returns to scale, they are also subject to price regulation and one goal of regulation is to ensure that the behaviour of public utilities is similar to that of firms operating in a competitive environment and that prices are aligned to marginal costs. Moreover, the demand of public utility services is typically price inelastic, hence $\varepsilon < 1$. Hence, even though the utilities markets are imperfect, the sign of the coefficient β_4 might become ambiguous in a regulated setting as the two effects might compensate each other.

An attractive feature of the Euler equation approach is that equation (3) can be extended also to debt as a source of investment finance (Bond and Meghir, 1994). The model assumes that the rate of interest paid by the firm on debt finance may be an increasing function of debt issued, a situation that occurs whenever the firm faces a bankruptcy risk, because the probability of bankruptcy is an increasing function of the amount of the debt outstanding. This allows us to test for the impact of bankruptcy risk and financial distress on regulated utilities' investment, a feature that Spiegel and Spulber (1994) find to be of key importance if capital structure is strategically used to influence regulated rates. It can be shown that the augmented Euler equation for capital stock can be written as:

$$(I/K)_{it+1} = \beta_1(I/K)_{it} - \beta_2(I/K)^2_{it} - \beta_3(\Pi/K)_{it} + \beta_4(Y/K)_{it} + \beta_5(D/K)^2_{it} + d_{it+1} + \eta_i + \nu_{it+1} \quad (3bis)$$

where D/K is the financial debt to capital stock ratio. The additional term $(D/K_{it})^2$ thus controls for the non-separability between investment and financial decisions. The sign on the debt coefficient, β_5, is expected to be negative if bankruptcy costs exist, and zero if there are no bankruptcy costs and debt and investment decisions are separable. The negative coefficient reflects that the expected cost

[28] It is possible to show that $\beta_1 = (1+c\nu)/\psi$; $\beta_2 = (1+\nu)/2\psi$; $\beta_3 = \mu/b\psi$, and $\beta_4 = (\mu - \nu)/(b\psi)$, where $\psi = \rho_{t+1}(1-\delta)(p_{it+1}/p_{it})$ is treated as constant, $\mu = (1 - 1/\varepsilon)$ is the mark up coefficient in an imperfect market; and ν is the returns to scale of the gross production function.

of borrowing is not independent of the probability of bankruptcy and also that the probability of bankruptcy decreases as the firm size increases for a given level of debt.

As described in Section 4, the main purpose of our test is to investigate the implications of independent regulation for the investment policy of regulated firms when residual state ownership and government's political orientation can both influence investment, either indirectly (through the IRA) or directly. We thus add three variables, in turn, to the Euler equation for investment: the dichotomous *IRA* dummy which is equal to 1 if firm *i* was subject to regulation by an IRA in year *t* and is equal to 0 otherwise, *Government UCR*$_{it}$, the ultimate control rights held by the Government, and the *Political Orientation Index*$_{it}$, to measure the political stance of the government. The latter two variables are used first as instruments and then included as regressors in the equation, since they are likely to display a direct additional effect on investment and would therefore be invalid instruments, leading to biased estimates.[29] We therefore estimate the following reduced-form empirical model in which we add, one at the time, the institutional variables:

$$\begin{aligned}(I/K)_{it} = \beta_0 + \beta_1 (I/K)_{it-1} + \beta_2 (I/K)^2_{it-1} + \beta_3 (\Pi/K)_{it-1} + \beta_4 (Y/K)_{it-1} + \\ + \alpha_1 IRA_{it} + \alpha_2 GovernmentUCR_{it} + \alpha_3 PolOrient_{it} + \eta_i + d_t + \varepsilon_{it},\end{aligned} \tag{4}$$

We then investigate whether the impact of independent regulation varies with the residual state ownership and the executive's political orientation, by including the interactions of *IRA* with *Government UCR* and with *Political Orientation*:

$$\begin{aligned}(I/K)_{it} = \beta_0 + \beta_1 (I/K)_{it-1} + \beta_2 (I/K)^2_{it-1} + \beta_3 (\Pi/K)_{it-1} + \beta_4 (Y/K)_{it-1} + \\ + \alpha_1 IRA_{it} + \alpha_2 GovernmentUCR_{it} + \alpha_3 PolOrient_{it} + \\ + \alpha_4 GovernmentUCR_{it} * IRA_{it} + \alpha_5 PolOrient_{it} * IRA_{it} + \eta_i + d_t + \varepsilon_{it},\end{aligned} \tag{5}$$

Our third specification adds the squared debt to capital term to test for the presence of bankruptcy costs:

$$\begin{aligned}(I/K)_{it} = \beta_0 + \beta_1 (I/K)_{it-1} + \beta_2 (I/K)^2_{it-1} + \beta_3 (\Pi/K)_{it-1} + \beta_4 (Y/K)_{it-1} + \beta_5 (D/K)^2_{it-1} + \\ + \alpha_1 IRA_{it} + \alpha_2 GovernmentUCR_{it} + \alpha_3 PolOrient_{it} + \\ + \alpha_4 GovernmentUCR_{it} * IRA_{it} + \alpha_5 PolOrient_{it} * IRA_{it} + \eta_i + d_t + \varepsilon_{it},\end{aligned} \tag{6}$$

[29] See the discussion on the identification and selection of instruments in Acemoglu (2005) and in Aghion*et al.* (2009).

To investigate the role of independent regulation we also rely on the index of formal *Regulatory Independence* (see Gilardi, 2005), which we use as an alternative to the IRA dummy. This index is time invariant and available only for sectors/countries where the IRA is present (electricity and gas industry, telecommunications and, for the UK only, water supply). It thus allows us to control for differences in the regulatory environment across countries and across sectors that cannot be captured by a dichotomous dummy, and also to pin down the effect that varying degrees of regulatory independence have on the investment of the sub-sample of utilities that are actually subject to an IRA.

When we estimate the models with the interacted terms (4 and 5), we can calculate, for any given value of *Government UCR* and of *Political Orientation*, the total effect of the presence of the IRA as $\partial(I/K)/\partial IRA = \alpha_1 + \alpha_4 * Government\ UCR + \alpha_5 * PolOrient$,conditional on different patterns of ownership and partisanship. The coefficient α_1 thus measures the (limit) effect of the IRA on investment as both the Government's shareholding and the Political Orientation indexes go to zero, i.e., the effect of IRA on investment for fully privately controlled firms and when the government in charge is (extreme) leftwing. The coefficient α_2 measures the direct effect of state ownership while the coefficient α_3 measures the direct effect of political orientation of the executive. Finally, the coefficient α_4 measures how the effect of IRA varies with ownership (from fully public to fully private) while the coefficient α_5 measures how the effect of IRA differs as political orientation shifts from left to right. The interaction terms *Government UCR*IRA* and *Political orientation*IRA* thus estimate whether the impact of the IRA on investment is different across state- and privately-controlled utilities, and different across utilities under left- and right-wing governments, respectively. For all estimated equations, we report the results of tests of significance of the sum of the coefficients in order to assess the partial effects of political orientation and state ownership, conditional on the presence of the IRA.

To estimate a dynamic investment equation using panel data, the endogeneity problems affecting both the firm level variables in the baseline investment equation and the regulatory independence variables suggest that we use the Arellano and Bond (1991) and Arellano and Bover (1995) linear generalized method of moments (GMM) estimator, which is especially designed for models where the lagged dependent variable is included and some of the regressors are potentially endogenous. More specifically, we use the dynamic System-GMM estimator developed by Arellano and Bond (1991) and Blundell and Bond (1998), which deals with situations where the lagged dependent variable is persistent and the lagged levels of the dependent variables are weak instruments. This model estimates a system of level and first-differenced equations and uses lags of

first-differenced variables as instruments for equations in levels and lags of variables in levels as instruments for equations in first-differences. In addition to internal instruments, i.e. lags of variables in the estimating equation, we use two sets of external instruments, i.e. the institutional variables described in Section 5. For the validity of the GMM estimates it is crucial, however, that the instruments are exogenous. We therefore calculate the two-step Sargan-Hansen statistic under the null of joint validity of the instruments and report the resulting p-values in all tables. Since the Sargan-Hansen test may be weakened if there are too many instruments (with respect to the number of observations), we follow a conservative strategy and use no more than three (but mostly two) lags of the instrumenting variables. We also test the overidentifying restrictions in the specifications where we experiment with a variety of external instruments, and calculate the Difference-in-Hansen test of exogeneity of individual instruments to guide our choice of instruments. Finally, we report the Arellano and Bond (1991) autocorrelation test to control for first order and second order correlation in the residuals. In fact, if AR(2) is detected, instruments dated t-2 are invalid and only instruments dated t-3 and earlier can be used. Standard errors are robust to heteroskedasticity and arbitrary patterns of autocorrelations within individuals.

7. Results

Tables 2 – 8 report the estimates of the Euler equation models for regulated firms' optimal capital accumulation. To evaluate the impact of the regulatory independency we use the *IRA* dummy in Tables 2, 3, and 4 and the index of formal *Regulatory Independence* in Table 5 (see Equations 4 and 5). In Table 4, we add the squared debt term that allows us to test for the presence of bankruptcy costs (see Equation 6). Tables 6, 7, and 8 report the results of the robustness analysis.

7.1 The Baseline Model

We start by reporting in Table 2 the estimates of simple fixed effects regressions with time and firm dummies, and then proceed by removing – more plausibly - the exogeneity assumptions for the firm variables in the investment model. In the next section we will address the endogeneityofthe IRA dummy, the residual state ownership and the government's political orientation.[30]

The fixed effects results in Columns (1) – (3) show that the coefficients on the lagged investment and lagged investment squared terms have the right sign and are always significant. The

[30] GMM estimation of dynamic panel data models is in line with what Bertrand, Duflo and Mullainathan (2004) suggest adopting when the main purpose is to identify the effects of specific policy interventions or treatment. Bertrand *et al.* raise several concerns about the validity of differences-in-differences estimates as obtained by using OLS on panel data, which tend to over-reject the null hypothesis of no effect because of serial correlation problems.

coefficient on the output to capital stock ratio is positively signed, but insignificant in all columns. As suggested in Section 6, this is probably due to the combined effects of imperfect competition in a regulated environment and inelastic demand of public utility services that may compensate each other and lead to an insignificant or even negative coefficient. All estimated models, however, show the same inconsistency with one theoretical assumption of the Euler investment equation, namely the positive and significant coefficient of the cash flow term. Since the cash flow was predicted to have a negative and significant coefficient, this result suggests the presence of imperfections in the capital markets such as information asymmetries or incentive problems (see Bond and Meghir, 1994, and the literature reviewed by Hubbard, 1998). In Columns (4)-(6), we report the GMM-System estimates of our baseline model, when we allow for the potential endogeneity of the firm variables in the investment equation, but still assume that *IRA*, *Government UCR* and *Political Orientation* are exogenous. The results are similar to those in columns (1)-(3). The main difference is that the point estimates of both (I/K) and $(I/K)^2$ are now closer to 1 in absolute value as predicted by the theory (as before, t-tests on the point estimates cannot reject the hypothesis that the coefficients are one). This suggests that the investment dynamics implied by the theory is supported by the data. Moreover, the coefficient on the cash flow term is positive and insignificant, which is still indicative of imperfections in the capital markets.

We now turn to our main variable of interest, the *IRA* dummy. We find that the coefficient on the lagged IRA term is positive and significant in all columns. This result indicates that the level of investment is higher when an independent regulatory agency exists, consistently with theory showing that regulatory independence enhances the investment incentives of regulated utilities (Levy and Spiller, 1994). We then add *Government UCR* to test the hypothesis that state ownership has a direct effect on the investment decisions of regulated firms. The direction of this influence, however, is ambiguous because privately-owned utilities are thought to have stronger incentives to invest (see, for example, Sappington and Stiglitz, 1987; Martimort, 2006), but state-owned utilities might be used by politicians to carry out "white elephants" expenditure programs for their own political benefits (see Zelner and Henisz, 2006). Our results reflect this ambiguity, as the coefficient on *Government UCR* is not significantly different from zero.[31] Finally, we include the Government's *Political Orientation* Index. As discussed in Section 4, politics may display both a direct effect on regulated firms' investment and an indirect effect (via the decision to establish the

[31] The lack of significance of the ownership variable is consistent with empirical evidence in Cambini and Rondi (2010) who show that the investment rates of private and state-owned energy utilities in Italy, Spain, France, Germany and UK from 2000 to 2007 do not significantly differ.

IRA). We find that the coefficient on political orientation is negative – suggesting that utilities invest more under leftwing executives -, but insignificant.[32]

In the next section we will consider the indirect influence of politics by using political orientation as an instrument for the IRA.

7.2 GMM estimates addressing the potential endogeneity of institutional variables

In Section 4 we discussed how independent regulatory agencies are likely to be set up because lack of commitment due to political interference may undermine investment incentives, a reason that makes the presumed exogeneity of the IRA rather suspect. Moreover, the decision itself to set up an IRA may interact both with the residual state ownership in the public utility and with the executive's political stance. In the next regressions, therefore, we allow for the potential endogeneity of the *IRA* and, in turn, of *Government UCR* and *Political Orientation*, and we also investigate the implications of their interrelations for regulated firms' investment decisions.

Table 3 reports the results when all the variables are treated as endogenous and instrumented with their own lags as well as with external variables. We control the validity of the instruments with the Sargan-Hansen test of all the over-identifying restrictions and with the Difference-in-Hansen test of exogeneity of individual instruments, which we report at the bottom of each column. In Column (1), the lagged *IRA* variable is instrumented with its own second order lag, *Political Orientation*, lagged once and twice, and *Government UCR*, lagged twice, because the (t-1) lag was rejected as an invalid instrument by the Difference-in-Hansen test. The set of external instruments includes the *Investor Protection* and the *Disproportionality* Indexes. The former gauges the extent to which the law protects and enforces investors' rights and is meant to proxy for the credibility of domestic institutions. The latter measures the fragmentation of the political system, and is meant to seize the power of politicians' to interfere with the regulator (see Section 5).

The results show that the IRA dummy enters with a positive and significant coefficient, confirming the positive effect of independent regulation on regulated firms' investment decisions. The Sargan-Hansen test does not reject the validity of the instrument set, but the Diff-in-Hansen test rejects *Government* UCR_{t-1} as an invalid instrument. We therefore include it in the regression in Column (2). The coefficient of *Government* UCR_{t-1} is positive, suggesting that state owned utilities invest more than privately-owned ones, but the p-value is 0.21, hence not significant at the

[32] For robustness, we re-estimate the fixed effect model with standard errors clustered by sectors rather than by firms, and find that the IRA dummy remains highly significant while the negative coefficient on *Political Orientation* turns almost significant (with a p-value of 0.138). Results are available on request.

conventional levels. In Column (3) we thus test if *Government UCR* displays a direct effect on investment, conditional on the presence of the IRA.[33] We find that neither the linear nor the interacted terms are significant. The interaction is positively signed, suggesting that, when the IRA exists, state-owned utilities increase their investment, but the p-value is 0.23, again below standard levels of significance. More importantly, the IRA coefficient has turned insignificant (the p-value is 0.194), hinting at some misspecification in the identification of relationship between IRA and Government ownership. In particular, we notice that *Political Orientation*is now found to be an invalid instrument, and this leads us to include this instrument in the regression. In Column (4), we find that the coefficient on the IRA dummy is highly significant again (p-value is 0.03), though both *Government UCR* and *Political Orientation* are insignificant. The Sargan and the Diff-in-Hansen tests show that instruments are valid, both jointly and individually.

We now address the lack of significance of *Government UCR* and *Political Orientation* by examining their interrelations with the IRA. If one recalls that IRAs in Europe were prompted by the EU Commission to limit political interference on state controlled utilities, then the empirical question now is whether the impact of residual state ownership and politics has changed conditional on the presence of the IRA. In other words, the presence of an IRA is expected to capture a "more" credible, or "less" opportunistic regulatory environment, but the investment-enhancing impact of the IRA might still differ with different levels of state ownership, or depending on the political stance of the executive. To check these interrelated effects we add two multiplicative terms to our main specification: *Government UCR*IRA* and *Political Orientation*IRA*. In Column (5) we report the results, which confirm the positive and significant impact the IRA has on regulated firms' investment, but also show that both *Government UCR* and its interaction with IRA are insignificant. More interestingly, we find that both the standalone *Political Orientation* variable and its interaction with IRA are significant, thus suggesting that the direct effect of political orientation on investment is different conditional on the presence of the IRA. The former is positively signed, suggesting that regulated firms tend to increase their investment when the executive is rightwing (the index is high), hence, in principle, more market-oriented and rather pro-firm than pro-consumer, while the latter is negatively signed, an indication that the positive effect of rightwing executives (or, alternatively, of the IRA) on investment shrinks when the IRA exists (or, when the government is very conservative). Both the Sargan-Hansen and the Difference-in-Hansen tests for individual instruments cannot reject the orthogonality conditions.[34]

[33] For example, Edwards and Waverman (2006) find, for the EU telecommunication industry, that wholesale charges are higher when the public telecom operator (PTO) is state-owned, but decrease when the state-owned PTO is subject to an IRA.

[34] We experimented with specifications including the linear and interacted *Government UCR* terms only in the instrument set and not in the regressions, and we found that the results on *Political Orientation* remain unchanged. We

Because the significant interaction between the *IRA* dummy and *Political orientation* hints at negative spillovers on regulated utilities' investment, we focus on the marginal effects of IRA and political orientation on firms' investments, and also report them graphically. While the positive α_1 and α_3 coefficients imply that utilities tend to invest more when the IRA exists and when the government is conservative, the negative α_5 coefficient suggests that the change in investment is less pronounced if the government is rightwing and the IRA is in place. If we test the significance of the sums of the coefficients (reported at the bottom of Column (5) in Table 3), we find that the sum of $\alpha_1 + \alpha_5 = 0.062$ is significantly different from zero while the sum $\alpha_3 + \alpha_5 = -0.006$ is insignificantly different from zero. The lack of significance of $\alpha_3 + \alpha_5$ is an indication that the presence of the IRA has a curbing effect on the executive's political interference (which is *per se* statistically weaker than the effect of the IRA) with regulated firms' investment. And this is consistent with the EU Commission's expectations when the independent regulatory authorities were set up. However, symmetrically, the significance of the $\alpha_1 + \alpha_5$ sum suggests that political interference by the government may weaken, and even revert, the positive influence of the IRA on investment for extreme values of *Political Orientation*, a result we interpret below.

To illustrate how the impact of *Political Orientation* on firm investment changes conditional on the presence of the *IRA*, in Figure 1, we plot the partial effect of the sum: $\alpha_3 + \alpha_5$**IRA* and the corresponding 95% confidence intervals based on the estimated coefficients in Column (5). The figure shows that the increase in investment experienced by firms under rightwing governments vanishes when the IRA is in place. If the IRA exists (i.e. when the dummy is one), the total effect of *Political Orientation* is summarized by the statistically insignificant sum of the point estimates: +0.007 – 0.013 = -0.006, indicating that the effect of the IRA offsets the effect of political interference. Figure 2 plots the partial effect of the IRA conditional on the executive's political orientation (i.e. the sum $\alpha_1 + \alpha_5$**Political Orientation).* We notice that the positive effect of IRA on investment shrinks as the political orientation index increases, i.e. as the government becomes increasingly rightwing, and rightwing executives are typically viewed as. ideologically more in favour of downsizing state intervention in the economy and of limiting the bureaucrats/regulators intervention in markets and industries (see among the others, Alesina and Rosenthal, 1995, and

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also re-estimated all the specifications in Table 3 adding industry dummies both as regressors and as instruments, and found that all the results are confirmed. However, we prefer to exclude the industry dummies because the instrument count would outnumber individuals in the panel, and this may weaken the Sargan/Hansen test (Roodman, 2006). Results are available on request. We further checked these results by re-estimating columns (1), (4) and (5) with the GMM-first difference estimator, which uses (lags of) variables in levels to instrument differenced variables and is therefore less efficient (due to the weak instrument problem, see Blundell and Bond, 1998). The results are reported in the Appendix A3 and very similar to those obtained with the GMM-System estimator. In particular the *IRA* dummy is positive and highly significant, the *Political Orientation* index is positive and not far from significance (the p-value is 0.135) and the *Political Orientation***IRA* interaction is negative and significant.

Benoit and Laver, 2006). We can calculate the effect at the average value of the political orientation index, which is 5.662 (see Table 1) and we find that the investment increase is still around 1% (0.84%). As the political ideology of the executives becomes more and more conservative (when the index ranges between 0.082/0.013=6.308 and the maximum value 8.025), the effect turns negative.[35] This result suggests that under highly conservative governments, the conflicts between the objective functions of the regulator (which is a weighted average of consumer surplus and firm profits) and of the rightwing executive (which is likely biased towards pro-firm objectives) is so strong that the institutional and regulatory environment becomes more uncertain and the probability of time inconsistence grows very high. The diverging goals of politicians – on one side - and bureaucrats/regulators – on the other side – may thus generate negative spillovers that eventually undermine investment incentives.[36] Apparently, then, our results suggests that the presence of an IRA succeeds in restraining political interference with regulated firms' investment decisions, but only up to a point, that is only if the beliefs, or the political views, behind the executive in charge are not in sheer contrast with the institutional principles behind the creation of the IRA itself.

We then turn to the model that adds the squared debt to capital stock ratio (see equation (6)). The results are in Table 4. The point estimate of the coefficient on the debt term has the expected negative sign and is significant in all columns, suggesting that, for our sample of regulated utilities, the investment and financing decisions are not separable due to the presence of deadweight costs associated to bankruptcy. This result is consistent with the idea of a strategic use of leverage that, through the bankruptcy threat, may induce the regulator not to reduce ex-post regulated rates (as shown in BCRS, 2010), so as to allow the regulated firm to follow the optimal investment path. The remaining results, including the highly significant coefficient of the IRA dummy, confirm the previous findings in Table 3.

[35] If we match the index values and the executives in charge in that range, we find the Governments led by Kohl in Germany, from 1994 to 1997 (the value of the index is 6.69), in Spain by Aznar from 1997 to 2003 (7.5), in the UK by John Major in 1994-1996 (7.8); in France by Chirac in 2003-2004 (7.8); in Denmark by Anders Rasmussen since 2002 (7.98), and in Italy by Berlusconi from 2002 to 2004 (the maximum value of the index: 8.025). The minimum value, 3.665, is assigned to the German executive led by Gerard Schroeder in the period 2002-2004.

[36] In Appendix A4 we re-estimate the specification in Column (4) to investigate the impact of political orientation for the sub-sample of firms and sectors where the IRA is in place. If the results above are confirmed, we should find that investment decreases as the *Political Orientation Index* increases, i.e. a negative and significant coefficient on political orientation. The estimates in Column (1) of Table A4 confirm that when the IRA exists, investments decrease as the government becomes more and more rightwing. In Column (2), as an alternative to the *Political Orientation Index* we use the World Bank index *EXERLC*, and find similar results. The same analysis with the sub-sample of firms/sectors without an IRA cannot be conducted because the number of observations is too small to apply the GMM-system estimator.

7.3 Results with the index of formal regulatory independence

Our next step is to replace the IRA dummy with the *Regulatory IndependenceIndex* (Gilardi, 2002, 2005), which graduates the formal level of regulatory independence from 0 (no independence) to 1 (full independence). Although the index is time invariant, by using a continuous variable, instead of a dummy, we can account for differing levels of regulatory independence across countries and sectors in which an IRA exists. This also implies that we perform our tests only on utilities which operate in sectors where an IRA exists, i.e. the electrical and gas industry and telecommunications in most countries, after the IRA was set up (see Section 5). We estimate the specifications in Columns (1), (4) and (5) of Table 3 using the *Regulatory Independence* Index, and report the results in Table 5. The results confirm the positive effect of regulatory independence on investment and the negative externality of political interference. The coefficient on the *Regulatory Independence* Index is positive and significant, suggesting that the higher the (formal) regulatory independence the higher the investment while the positive coefficient on the linear *Political Orientation* variable turns significant when we include the interacted term (Column (3)). Again the results suggest that the positive effect of pro-firm (conservative) governments on utilities' investment weakens and ultimately reverts, as regulators become more independent. The main difference from the results in Table 3 is that *Government UCR* now enters significantly, both linearly and interactedly with the IRA. The negative α_2 coefficient suggests that the larger is the Government's stake the lower is investment, but the positive α_4 coefficient on the interacted term suggests that the effect of Regulatory Independence is to increase state-owned utilities' investment. The positive sign could be driven by the fact that the sample of firms where the *Regulatory Independent* Index exists includes many energy utilities, which is where state shareholdings tend to be largest, especially in the gas industry. Overall, the results with the index of *Regulatory Independence* for the subsample of utilities that became subject to an IRA confirm the results we obtained using the IRA dichotomous dummy for the full sample.

7.3 Robustness: Political institutions and competition

In Section 7.2, we handled the potential endogeneity of independent regulation to utilities' investment by instrumenting the *IRA* dummy with the *InvestorProtection* and *Disproportionality* Indexes and by treating *Government UCR* and *Political Orientation* first as excluded instruments and then as regressors as well as instruments. In this section we check the robustness of our results by using an alternative set of instruments, which capture additional features of the political institutional environment and sourced from the World Bank's Database of Political Institutions (see

Section 5). Some of the variables seize the relationship between the IRA and the political environment. For example, if the decision to establish the IRA is politically motivated, then the *Election Date dummy* may capture a change in the executive that may have lead to the institution of the IRA. Because delegation is thought to be credible only when it cannot be revoked easily and the political system constraints executive discretion[37], the *Checks & Balances Index* is used to capture the credibility of regulatory independence. Other institutional characteristics are used to proxy the variables in the original specification. The time-varying index of *Government Stability* is another proxy for commitment and credibility, while the *EXERLC* index, which is 1 when the executive is leftwing, 2 when it is centre, and 3 when it rightwing may be used to instrument the political orientation index. *EXERLC* varies over time like the *Political Orientation* index, but is less refined in graduating nuances in the partisanship of executives.

Table 6 reports System-GMM estimates of the investment equation where the external variables described above are the only instruments for the IRA dummy (hence no lags of IRA are included as instruments, nor the *Investor protection* and *Disproportionality* Indexes, as in the previous tables). In Column (1) of Table 6, the estimated coefficient on the *IRA* dummy is positive and significant and its magnitude is similar to estimates in Table 3. In Columns (2) we include firm ownership and political orientation in the regression, while in Column (3) we add the interacted terms. The instrument set does not include the lags of the *IRA* dummy, nor lags of Government UCR or of the *Political Orientation* Index. Again the results are very similar to those in Table 3 and confirm the positive impact of independent regulation on regulated firms' investment and the disciplining of political interference by the IRA.

Even though the Sargan and the Diff-in-Hansen tests have never, to this point, rejected the validity of our instruments, we perform an additional robustness test of the identifying assumptions (see for example Tabellini, 2010) and check the validity of the subset of excluded instruments by including them directly in the regressions. If we are correct in excluding them, then they should display no direct effect on investment, and the estimated coefficient on IRA ought to remain statistically significant. The results are in Table 7. In Columns (1) and (2), we include *Investor Protection* and *Disproportionality* and in Columns (3) and (4) we include the entire set of World Bank political institutions variables (that we used to instrument IRA in Table 6).

The results confirm the validity of our identification strategy. In Columns (1) and (2), *Investor Protection* and *Disproportionality* are insignificant while the *IRA* dummy remain highly significant. The World Bank variables are also insignificant, except for *Government Stability*, which enters in Column (3) with a p-value of 0.087, but is insignificant in the specification with the

[37] This is a quite robust result of the literature on central banks independence; see Keefer and Stasavage (2003).

interacted terms. *IRA* is always significant and the size of the coefficients is similar in all columns and also similar throughout the tables. Moreover, *Political Orientation* is positive and significant in column (2) and the IRA dummy as well as its interaction with political orientation remains negative and significant.

Last but not least, we explore the effect of liberalization reforms since investment decisions of incumbent regulated firms might in fact be influenced by the degree of market competition, which, in turn, is likely to be affected by the intensity of liberalization and deregulation. In order to capture the extent of liberalization of a variety of sectors and countries, we use an index we derive from the OECD International Regulation database (Conway and Nicoletti, 2006). The index is an average of several indicators which vary from 0 to 6 (lower numbers indicate a greater degree of openness) and reflects entry barriers,[38] the vertical structure of the market, the state ownership in firms that operate in the relevant sector, the market share of the dominant player(s), and the presence of regulatory controls on retail prices and specific guidelines for its implementation. We eliminate the state ownership component from the index, because we already have a well-defined ownership variable, and recalculate the average over the remaining OECD sub-indicators (market entry, vertical integration and market structure). As in the original OECD index, high values of the index are associated with low degrees of liberalization. In Table 8, we add the new variable, which we label *OECD Liberalization Index*, to the usual specification with the *IRA* dummy in Column (1). In Column (2) we test its interaction with IRA, and in Column (3) we include *Government UCR* and *Political Orientation*, and test the robustness of the *Political Orientation*IRA* interaction. Notably, the index does not exist for infrastructure industries such as ports and airports, and water supply, so we run the regressions for the subsample of firms operating in energy, telecom, and freight roads.

Although it is reasonable to predict that features like access conditions and the degree of vertical separation of the incumbents might influence investment decisions of the regulated firm, the results in Columns (1) and (2) show that the coefficient of *OECD Liberalization Index* is insignificant. However, when we take into account the political stance of the government, i.e. the *Political Orientation* variable, we find that the *Liberalization Index* turns negative and almost significant (the p-value is 0.117), suggesting that as long as liberalization moves on and markets become more open and competitive, regulated firms are more likely to increase their investments. This result is consistent with Alesina*et al.* (2005) who, using the above indexes, find that deregulation and liberalization spur investment in non-manufacturing sectors in OECD countries. Furthermore, since the *Liberalization Index* is significant only when we control for the

[38] Low values of the entry barriers indicators are associated with competition in all segments of the relevant sector and with vertical separation between downstream and upstream firms, while high values are associated with the existence of a vertically integrated legal monopoly.

government's political orientation, this result is in line with Duso and Seldeslachts (2010) and Potrafke (2010), who find that political partisanship is a driving force of product market deregulation within OECD countries. Comfortingly, the IRA dummy is always significant, as well as its interaction with Political Orientation, confirming that our main results are robust when we control for the intensity of market liberalization.

8. Conclusions and Implications

Over the last 20 years, in many European countries, regulatory competencies have been delegated to independent authorities mainly to reduce potential conflicts of interests that surface when politicians directly or indirectly control companies providing essential services for citizens. The expectation was that this new institutional arrangement would improve the credibility of the regulatory commitments and positively affect public utilities' investment spending. Notwithstanding this, politicians can still influence the regulatory policy following their partisan interests, and government intervention might especially intensify when utilities are (totally or partially) controlled by the State and market liberalization is incomplete. Regulatory independence, government's political orientation and residual state ownership are thus institutional features that separately and interactedly may affect investment spending in the public utility sector, which is acknowledged as a driving force of economic growth.

This paper investigates the investment decisions of a large panel of publicly traded European regulated firms from 1994 to 2004, taking the changing institutional environment into account, namely: (i) varying degrees of independence of regulatory agencies across different sectors; (ii) varying degrees of state ownership within regulated public utilities, and (iii) the government's political orientation, in that executives may ultimately influence the regulatory climate to be either pro-firm or pro-consumers. Motivated by the recent strand of applied political economy literature, we address the potential endogeneity of these institutional variables and rely on instrumental variables techniques (GMM-difference and GMM-system estimators) and alternative sets of instruments to identify the direction of the relationship between investment, independent regulation and politics.

Our results show that when an Independent Regulatory Agency is in place, or when the regulator is more independent, investment does increase. This evidence implies that the gradual introduction of *modern* regulatory governance (OECD, 2002) in Europe contributes to a more credible and stable environment that, as predicted by the theory, strengthens the regulated firms' investment incentives and generates positive effects on the economy as a whole.

As regulatory reforms were implemented in Europe, however, firm privatisation and market liberalization were also in progress. Although both processes are still incomplete, our findings do not support a significant difference between the investment of privately controlled and partially privatised utilities, showing instead that market liberalization has a positive (albeit weak) influence on regulated firms' investment, in line with recent evidence by Alesina*et al*. (2005).

Finally, our results show that politics still affect firm behaviour. Delegation to bureaucrats – to IRAs in our case - is preferable, from the normative point of view, when time inconsistency and short-termism may influence the decision process, or if vested interests have large stakes in the policy outcomes, as in the case of regulated utilities. However, from the positive point of view, politicians may not be willing to fully delegate policy powers to bureaucrats (Alesina and Tabellini, 2008). Incomplete delegation thus implies that a *formally* independent regulatory authority might not *per se* be the sufficient condition to create a more stable, less opportunistic regulatory environment, as long as politicians wish to retain some policy tools that they may use to make their re-election more likely (political rent-seeking) even at the cost of making the regulatory environment less stable and more uncertain. What are the implications for investment?

Our results shows that both formal regulatory independence and (rightwing) political orientation of the executive have a positive effect on investment, but also that the interaction between the two generates a negative spillover (the negative α_5 coefficient). Our interpretation of this negative spillover is that a conflict of policy objectives may arise whenever a formally independent regulator coexists with a strongly ideologically driven executive, as this is likely to introduce instability and uncertainty in the regulatory framework. The net effect of this conflict would be to undermine the investment incentives of the regulated firm. We find that this tension is more likely to surface when the government is very conservative, i.e. typically less in favour of state intervention and regulation, and more inclined to reduce the size and scope of government, to pursue deregulation and to restrict administrative interventions in the market, such as those carried out by independent agencies or authorities. In contrast, regulators are obviously bureaucrats, whose given task is to define rules conducive to enhance market competition and protect consumers. In sum, we find that these opposite attitudes interfere with each other and generate regulatory uncertainty that undermine firm's investment decisions.

Entering the black box of the relationship between regulators and politicians, while controlling for the direct government's ownership of the firm, is surely an interesting political economy question that deserves further investigations.

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Table 1 - Summary statistics

Panel A: Full sample 1994-2004

Variable	Mean	Std. Dev.	Min	Max	No. Obs
Real Sales (in millions of 2005 dollars)	96,876.18	148,345.30	79.87	802,264.60	720
Real Total Asset (in millions of 2005 dollars)	207,465.30	320,829.70	297.02	1,562,157	720
Investment Rate	0.111	0.072	0.000	0.674	703
Cash flow to Capital Stock	0.135	0.102	- 0.940	0.871	719
Sales to Capital Stock	0.742	0.804	0.020	6.191	684
Debt-to-Capital Stock	0.212	0.304	0.000	3.356	719
Independence Regulatory Agency dummy	0.585	0.493	0	1	720
Index of Regulatory Independence	0.618	0.114	0.36	0.83	421
Government's UCR	0.344	0.357	0	1	720
Political Orientation	5.662	1.481	3.665	8.025	720

Panel B: Firms subject to an IRA

Variable	Mean	Std. Dev.	Min	Max	No. Obs
Real Sales (in millions of 2005 dollars)	93,213.56	133,725.90	355.70	802,264.60	421
Real Total Asset (in millions of 2005 dollars)	207,363.90	301,776.60	1,084.65	1,553,495	421
Investment Rate	0.114	0.071	0.008	0.673	408
Cash flow to Capital Stock	0.133	0.098	- 0.940	0.498	420
Sales to Capital Stock	0.730	0.863	0.020	6.191	403
Debt-to-Capital Stock	0.237	0.343	0.000	3.356	420
Independence Regulatory Agency dummy	1	0	0	1	421
Index of Regulatory Independence	0.618	0.114	0.36	0.83	421
Government's UCR	0.285	0.341	0	1	421
Political Orientation	5.744	1.490	3.665	8.025	421

Panel C: Firms without an IRA

Variable	Mean	Std. Dev.	Min	Max	No. Obs
Real Sales (in millions of 2005 dollars)	102,033.30	166,872.60	79.869	752,871.10	299
Real Total Asset (in millions of 2005 dollars)	207,608.20	346,404.50	297.017	1,562,157	299
Investment Rate	0.107	0.073	0.000	0.537	295
Cash flow to Capital Stock	0.138	0.107	- 0.561	0.871	299
Sales to Capital Stock	0.758	0.709	0.093	4.670	281
Debt-to-Capital Stock	0.177	0.234	0.000	1.847	299
Government's UCR	0.402	0.368	0	1	299
Political Orientation	5.545	1.464	3.665	8.025	299

Table 2 –Investment Euler Equation with Independent Regulatory Agency dummy, Government's Ownership and Political Orientation

The dependent variable (*I*/*K*) is the investment rate measured as the ratio between capital expenditures and capital stock at replacement value. *ΠI*/*K* is the ratio between operational cash flow and the capital stock at replacement value. *Y*/*K* is the sales to capital stock (at replacement value) ratio. *IRA* is a dummy equal to 1 if an independent regulatory agency (IRA) is in place and equal to 0 otherwise. *Government's UCR* measures the ultimate control rights held by the government. *Political orientation* measures the government's political stance. Fixed effects estimates in columns (1)-(3). Dynamic panel-data estimation, one-step system GMM estimates in columns (4)-(6). Lagged values of right-hand variables used as instruments: lagged levels are used in first-differences equations and lags of first-differenced variables are used in levels equations. All regressions include year dummies both as regressors and as instruments. Standard errors in parentheses are robust to heteroschedasticity and to within group serial correlation.AR(1) [AR(2)] tests the null hypothesis of no first-order [second-order] correlation in the differenced residuals. The Sargan-Hansen statistic tests the null hypothesis that the over-identifying restrictions are valid. ***, **, * denote significance of the coefficients at 1%, 5% and 10%.

I/K_t	**Fixed effects**			**GMM-System (IRA dummy, Gov. UCR and Political Orientation as exogenous variables)**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
$(I/K)_{t-1}$	0.601***	0.600***	0.603***	0.910***	0.904***	0.901***
	(0.095)	*(0.095)*	*(0.092)*	*(0.148)*	*(0.147)*	*(0.145)*
$(I/K)^2_{t-1}$	-0.767***	-0.765***	-0.773***	-1.021***	-1.021***	-1.015***
	(0.181)	*(0.181)*	*(0.177)*	*(0.249)*	*(0.247)*	*(0.247)*
$(\Pi/K)_{t-1}$	0.113**	0.113**	0.111**	0.037	0.036	0.037
	(0.051)	*(0.051)*	*(0.050)*	*(0.033)*	*(0.034)*	*(0.033)*
$(Y/K)_{t-1}$	0.012	0.012	0.015	0.002	0.002	0.002
	(0.013)	*(0.013)*	*(0.013)*	*(0.004)*	*(0.004)*	*(0.004)*
IRA Dummy$_{t-1}$ (α_1)	0.021**	0.021**	0.026**	0.009**	0.010**	0.011**
	(0.010)	*(0.010)*	*(0.011)*	*(0.004)*	*(0.004)*	*(0.004)*
Government UCR$_{t-1}$ (α_2)	-	*0.006*	0.001	-	0.008	0.007
	-	*(0.016)*	*(0.017)*	-	*(0.006)*	*(0.006)*
Political Orientation$_{t-1}$ (α_3)	-	-	-0.003	-	-	-0.003
	-	-	*(0.002)*	-	-	*(0.002)*
Firm dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
R squared within	0.242	0.243	0.246	-	-	-
F-test (p-value)	12.93 (0.00)	12.11 (0.00)	11.77 (0.00)	-	-	-
Arellano-Bond test for AR(1) *(p-value)*	-	-	-	0.001	0.001	0.001
Arellano-Bond test for AR(2) *(p-value)*	-	-	-	0.624	0.618	0.612
Sargan-Hansen test *(p-value)*				0.366	0.321	0.332
N. Firms [N. Obs.]	80[582]	80[582]	80[582]	80[582]	80[582]	80[582]

Table 3 – GMM System Estimates of the Investment Euler Equation where IRA dummy, Ownership and Government's political orientation are endogenized

(*I/K*), *(ΠI/K*), (*Y/K),IRA* dummy, *Government's UCR* and *Political orientation* are defined in Table 2. Dynamic panel-data estimation, one-step system GMM estimates. All regressions include year dummies both as regressors and as instruments.*Government UCR* $_{t-1}$**IRA* and *Political Orientation* $_{t-1}$**IRA* are instrumented with their lags. *Investor Protection* and *DisproportionalityIndexes* are defined in Section 5. Standard errors in parentheses are robust to heteroschedasticity and to within group serial correlation.AR(1) [AR(2)] tests the null hypothesis of no first-order [second-order] correlation in the differenced residuals. The *Sargan-Hansen* statistic tests the null hypothesis that the over-identifying restrictions are valid. The *Difference-in-Hansen* statistics tests the exogeneity of subsets or individual instruments. ***, **, * denote significance of the coefficients at 1%, 5% and 10%.

I/K_t	(1)	(2)	(3)	(4)	(5)
$(I/K)_{t-1}$	0.972***	0.961***	0.866***	0.958***	0.961***
	(0.118)	*(0.118)*	*(0.132)*	*(0.119)*	*(0.119)*
$(I/K)^2_{t-1}$	-1.205***	-1.199***	-1.060***	-1.193***	-1.210***
	(0.168	*(0.168)*	*(0.190)*	*(0.169)*	*(0.170)*
$(\Pi/K)_{t-1}$	-0.015	-0.017	-0.036	-0.016	-0.006
	(0.032)	*(0.033)*	*(0.034)*	*(0.034)*	*(0.029)*
$(Y/K)_{t-1}$	0.004	0.004	0.005	0.004	0.003
	(0.004)	*(0.004)*	*(0.005)*	*(0.005)*	*(0.004)*
IRA Dummy$_{t-1}$ (α_1)	0.012*	0.013**	0.010	0.013**	0.082**
	(0.005)	*(0.006)*	*(0.007)*	*(0.006)*	*(0.033)*
Government UCR $_{t-1}$ (α_2)	-	0.009	-0.005	0.009	0.007
	-	*(0.007)*	*(0.010)*	*(0.008)*	*(0.010)*
Political Orientation $_{t-1}$ (α_3)	-	-	-	-0.001	0.007*
	-	-	-	*(0.003)*	*(0.004)*
Government UCR $_{t-1}$*IRA (α_4)	-	-	0.025	-	0.006
	-	-	*(0.021)*	-	*(0.019)*
Political Orientation $_{t-1}$*IRA (α_5)	-	-	-	-	-0.013**
	-	-	-	-	*(0.006)*
P-value test on $\alpha_1 + \alpha_4 = 0$	-	-	0.056	-	0.014
P-value test on $\alpha_1 + \alpha_5 = 0$	-	-	-	-	0.008
P-value test on $\alpha_3 + \alpha_5 = 0$	-	-	-	-	0.166
Arellano-Bond test for AR(1) *(p-value)*	*0.004*	*0.004*	*0.004*	*0.004*	*0.003*
Arellano-Bond test for AR(2) *(p-value)*	*0.86*	*0.855*	*0.836*	*0.864*	*0.993*
Sargan-Hansen test (p-value)	0.363[70]	0.246[67]	0.309[59]	0.233[66]	0.223[66]
Internal Instruments	Difference-in-Hansen tests *(p-value)*				
IRA Dummy$_{t-2}$	*0.136*	*0.213*	*0.521*	*0.317*	*0.852*
Government UCR $_{t-2}$	-	*0.216*	*0.698*	*0.295*	*0.588*
Political Orientation $_{(t-2)}$	-	-	-	*0.246*	*0.440*
External and Excluded Instruments					
Government UCR	*0.573*	-	-	-	-
Political Orientation	*0.957*	*0.891*	*0.065*	-	-
IP - Investor Protection	*0.819*	*0.937*	*0.912*	*0.789*	*0.587*
D - Disproportionality	*0.461*	*0.278*	*0.903*	*0.372*	*0.162*
N. Firms [N. Obs.]	80[521]	80[521]	80[521]	80[521]	80[521]

Table 4 – GMM System Estimates of the Investment Euler Equation with Debt

(*I/K*), *(ΠI/K*), (*Y/K)IRA* dummy, *Government's UCR* and *Political orientation* are defined in Table 2. (*D/K)* is the ratio of financial debt to capital stock at replacement value. Dynamic panel-data estimation, one-step system GMM estimates. All regressions include year dummies both as regressors and as instruments. *Government UCR* $_{t-1}$**IRA* and *Political Orientation* $_{t-1}$**IRA* are instrumented with their lags. *Investor Protection* and *DisproportionalityIndexes* are defined in Section 5. Standard errors in parentheses are robust to heteroschedasticity and to within group serial correlation.AR(1) [AR(2)] tests the null hypothesis of no first-order [second-order] correlation in the differenced residuals. The *Sargan-Hansen* statistic tests the null hypothesis that the over-identifying restrictions are valid. The *Difference-in-Hansen* statistic tests the exogeneity of subsets or individual instruments. ***, **, * denote statistical significance at 1%, 5% and 10%.

I/K_t	**(1)**	**(2)**	**(3)**
$(I/K)_{t-1}$	0.939***	0.933***	0.944***
	(0.117)	*(0.118)*	*(0.117)*
$(I/K)^2_{t-1}$	-1.142***	-1.143***	-1.171***
	(0.157)	*(0.161)*	*(0.163)*
$(\Pi/K)_{t-1}$	0.003	- 0.005	-0.004
	(0.039)	*(0.041)*	*(0.038)*
$(Y/K)_{t-1}$	0.005	0.005	0.004
	(0.004)	*(0.005)*	*(0.004)*
$(Debt/K)^2_{t-1}$	-0.005***	-0.004***	- 0.005***
	(0.002)	*(0.002)*	*(0.002)*
IRA Dummy$_{t-1}$ (α_1)	0.012**	0.015**	0.081**
	(0.005)	*(0.006)*	*(0.035)*
Government UCR $_{t-1}$ (α_2)	-	0.008	0.011
	-	*(0.008)*	*(0.011)*
Political Orientation $_{t-1}$ (α_3)	-	-0.001	0.007*
	-	*(0.003)*	*(0.004)*
Government UCR $_{t-1}$* IRA (α_4)	-	-	-0.001
	-	-	*(0.018)*
Political Orientation $_{t-1}$* IRA (α_5)	-	-	-0.012*
	-	-	*(0.006)*
P-value test on $\alpha_1 + \alpha_4 = 0$	-	-	0.018
P-value test on $\alpha_1 + \alpha_5 = 0$	-	-	0.017
P-value test on $\alpha_3 + \alpha_5 = 0$	-	-	0.192
Arellano-Bond test for AR(1) *(p-value)*	0.003	0.003	0.003
Arellano-Bond test for AR(2) *(p-value)*	0.757	0.771	0.868
Sargan-Hansen test *(p-value)*	0.304[67]	0.226[65]	0.202[65]
Internal Instruments	Difference-in-Hansen tests *(p-value)*		
IRA Dummy$_{t-2}$	*0.630*	*0.479*	*0.181*
Government UCR $_{t-2}$	-	*0.771*	*0.208*
Political Orientation $_{(t-2)}$	-	*0.336*	*0.276*
External and Excluded Instruments			
Government UCR	*0.707*	-	-
Political Orientation	*0.693*	-	-
IP - Investor Protection	*0.227*	*0442*	*0.328*
D - Disproportionality	*0.958*	0.933	0.759
N. Firms [N. Obs.]	80[521]	80[521]	80[521]

Table 5 – GMM System Estimates of the Investment Euler Equation with Formal Regulatory Independence Index

(*I/K*), *(Π/K*), (*Y/K)IRA* dummy, *Government's UCR* and *Political orientation* are defined in Table 2. *Regulatory Independence* is an index of formal regulatory independence (Gilardi, 2005). Dynamic panel-data estimation, one-step system GMM estimates. All regressions include year dummies both as regressors and as instruments. *Government UCR $_{t-1}$*IRA* and *Political Orientation $_{t-1}$*IRA* are instrumented with their lags. *Investor Protection* and *DisproportionalityIndexes* are defined in Section 5. Standard errors in parentheses are robust to heteroschedasticity and to within group serial correlation.AR(1) [AR(2)] tests the null hypothesis of no first-order [second-order] correlation in the differenced residuals. The Sargan-Hansen statistic tests the null hypothesis that the over-identifying restrictions are valid. The *Difference-in-Hansen* statistics tests the exogeneity of subsets or individual instruments. ***, **, * denote significance of the coefficients at 1%, 5% and 10%.

I/K_t	**(1)**	**(2)**	**(3)**
$(I/K)_{t-1}$	0.753***	0.774***	0.735***
	(0.131)	*(0.138)*	*(0.135)*
$(I/K)^2_{t-1}$	-0.906***	-0.978***	-0.903***
	(0.180)	*(0.194)*	*(0.179)*
$(\Pi/K)_{t-1}$	0.091	-0.027	0.204**
	(0.075)	*(0.071)*	*(0.103)*
$(Y/K)_{t-1}$	-0.003	-0.004	-0.002
	(0.003)	*(0.005)*	*(0.004)*
Regulatory Independence Index$_{t-1}$ (α_1)	0.060*	0.181**	0.370**
	(0.037)	*(0.071)*	*(0.182)*
Government UCR $_{t-1}$ (α_2)	-	-0.009	-0.158**
	-	*(0.013)*	*(0.079)*
Political Orientation $_{t-1}$ (α_3)	-	-0.003	0.038**
	-	*(0.005)*	*(0.017)*
Government UCR $_{t-1}$* Regulatory Independence (α_4)	-	-	0.275**
	-	-	*(0.135)*
Political Orientation $_{t-1}$* Regulatory Independence (α_5)	-	-	-0.072**
	-	-	*(0.031)*
P-value test on $\alpha_1 + \alpha_4 = 0$	-	-	0.008
P-value test on $\alpha_2 + \alpha_4 = 0$	-	-	0.041
P-value test on $\alpha_1 + \alpha_5 = 0$	-		0.049
P-value test on $\alpha_3 + \alpha_5 = 0$	-		0.028
Arellano-Bond test for AR(1) *(p-value)*	0.033	0.023	0.031
Arellano-Bond test for AR(2) *(p-value)*	0.622	0.908	0.339
Sargan-Hansen test *(p-value)*	0.453[40]	0.590[43]	0.548[31]
Internal Instruments	Difference-in-Hansen tests *(p-value)*		
Regulatory Independence Index$_{t-2}$	*0.15*	*0.241*	*0.274*
Government UCR $_{t-2}$	-	*0.416*	*0.428*
Political Orientation $_{t-2}$	-	*0.638*	*0.147*
External and Excluded Instruments			
IP - Investor Protection	*0.752*	-	-
D- Disproportionality	-	*0.457*	*0.119*
N. Firms [N. Obs.]	53[261]	53[286]	53[261]

Table 6 – Robustness Analysis: Political Institutions as External Instruments

(*I/K*), *(ΠI/K*), (*Y/K),IRA* dummy, *Government's UCR* and *Political orientation* are defined in Table 2. Dynamic panel-data estimation, one-step system GMM estimates. All regressions include year dummies both as regressors and as instruments.*Government UCR* $_{t-1}$**IRA* and *Political Orientation* $_{t-1}$**IRA* are instrumented with *Government UCR*$_{t-1}$**Government Stability*$_{t-2}$ and EXERLC$_{t-2}$**Government Stability*$_{t-2}$, respectively. The World Bank political institutions instruments include: *Government Stability, Checks & Balances,Election Date*, and *EXERLC*, as defined in Section 5. Standard errors in parentheses are robust to heteroschedasticity and to within group serial correlation.AR(1) [AR(2)] tests the null hypothesis of no first-order [second-order] correlation in the differenced residuals. The Sargan-Hansen statistic tests the null hypothesis that the over-identifying restrictions are valid. The *Difference-in-Hansen* statistics tests the exogeneity of subsets or individual instruments. ***, **, * denote significance of the coefficients at 1%, 5% and 10%.

I/K_t	**(1)**	**(2)**	**(3)**
$(I/K)_{t-1}$	0.942***	0.926***	0.915***
	(0.127)	*(0.127)*	*(0.125)*
$(I/K)^2_{t-1}$	-1.154***	-1.141***	-1.161***
	(0.180)	*(0.181)*	*(0.186)*
$(\Pi/K)_{t-1}$	-0.006	-0.006	-0.001
	(0.031)	*(0.032)*	*(0.029)*
$(Y/K)_{t-1}$	0.003	0.002	0.003
	(0.004)	*(0.004)*	*(0.004)*
IRA Dummy$_{t-1}$ (α_1)	0.012***	0.014***	0.120**
	(0.004)	*(0.005)*	*(0.052)*
Government UCR $_{t-1}$ (α_2)	-	0.009	-0.011
	-	*(0.006)*	*(0.011)*
Political Orientation $_{t-1}$ (α_3)	-	-0.002	0.010*
	-	*(0.002)*	*(0.006)*
Government UCR $_{t-1}$* IRA (α_4)	-	-	0.039*
	-	-	*(0.022)*
Political Orientation $_{t-1}$* IRA (α_5)	-	-	-0.021**
	-	-	*(0.009)*
P-value test on $\alpha_1 + \alpha_4 = 0$	-	-	0.003
P-value test on $\alpha_2 + \alpha_4 = 0$	-	-	0.041
P-value test on $\alpha_1 + \alpha_5 = 0$	-	-	0.021
P-value test on $\alpha_3 + \alpha_5 = 0$	-	-	0.007
Arellano-Bond test for AR(1) *(p-value)*	*0.004*	*0.004*	*0.003*
Arellano-Bond test for AR(2) *(p-value)*	*0.835*	*0.852*	*0.819*
Sargan-Hansen test *(p-value)*	0.516[71]	0.445[69]	0.296[65]
	Difference-in-Hansen tests *(p-value)*		
External and Excluded Instruments			
Government UCR $_{t-2}$	*0.840*	-	-
Political Orientation $_{t-2}$	*0.230*	-	-
WB Political Institutions	*0.907*	*0.571*	*0.903*
N. Firms [N. Obs.]	80 [521]	80 [521]	80 [521]

Table 7 – Robustness: Further checks on the Validity of External Political and Legal Instruments

(*I/K*), *(ΠI/K*), (*Y/K),IRA* dummy, *Government's UCR* and *Political orientation* are defined in Table 2. Dynamic panel-data estimation, one-step system GMM estimates. All regressions include year dummies both as regressors and as instruments.*Government UCR* $_{t-1}$**IRA* and *Political Orientation* $_{t-1}$**IRA* are instrumented with their lags. *Investor Protection*, *DisproportionalityIndexes*, *Election Date*, *Government Stability* and *EXERLC* are defined in Section 5. Standard errors in parentheses are robust to heteroschedasticity and to within group serial correlation.AR(1) [AR(2)] tests the null hypothesis of no first-order [second-order] correlation in the differenced residuals. The Sargan-Hansen statistic tests the null hypothesis that the over-identifying restrictions are valid. The *Difference-in-Hansen* statistics tests the exogeneity of subsets or individual instruments. ***, **, * denote significance of the coefficients at 1%, 5% and 10%.

I/K_t	(1)	(2)	(3)	(4)
$(I/K)_{t-1}$	0.965***	0.963***	0.997***	0.947***
	(0.118)	*(0.114)*	*(0.130)*	*(0.138)*
$(I/K)^2_{t-1}$	-1.212***	-1.221***	-1.250***	-1.189***
	(0.172)	*(0.169)*	*(0.183)*	*(0.203)*
$(\Pi/K)_{t-1}$	-0.006	0.001	-0.011	-0.004
	(0.030)	*(0.027)*	*(0.033)*	*(0.031)*
$(Y/K)_{t-1}$	0.003	0.003	0.003	0.001
	(0.004)	*(0.004)*	*(0.004)*	*(0.004)*
IRA Dummy$_{t-1}$ (α_1)	0.013**	0.076**	0.014**	0.073**
	(0.006)	*(0.030)*	*(0.007)*	*(0.033)*
Government UCR $_{t-1}$ (α_2)	0.012	0.008	0.005	-0.007
	(0.010)	*(0.011)*	*(0.009)*	*(0.012)*
Political Orientation $_{t-1}$ (α_3)	0.000	0.008**	-0.006	-0.002
	(0.003)	*(0.004)*	*(0.006)*	*(0.005)*
Government UCR $_{t-1}$* IRA (α_4)	-	0.010	-	0.021
	-	*(0.019)*	-	*(0.020)*
Political Orientation $_{t-1}$* IRA (α_5)	-	-0.012**	-	-0.012**
	-	*(0.005)*	-	*(0.006)*
Investor Protection $_{t-1}$	0.0005	0.0003	-	-
	(0.003)	*(0.003)*	-	-
Disproportionality $_{t-1}$	0.0003	0.0002	-	-
	(0.0003)	*(0.0003)*	-	-
GovernmentStability $_{t-1}$	-	-	0.014*	0.011
	-	-	*(0.008)*	*(0.008)*
EXERLC $_{t-1}$	-	-	0.007	0.009
	-	-	*(0.005)*	*(0.007)*
Checks& Balance $_{t-1}$	-	-	0.007	0.002
	-	-	*(0.002)*	*(0.003)*
Election Date $_{t-1}$	-	-	-0.009	-0.009
	-	-	*(0.09)*	*(0.009)*
P-value test on $\alpha_1 + \alpha_4 = 0$	-	0.014	-	0.014
P-value test on $\alpha_1 + \alpha_5 = 0$	-	0.011	-	0.025
P-value test on $\alpha_3 + \alpha_5 = 0$	-	0.226	-	0.067
Arellano-Bond test for AR(1) *(p-value)*	*0.003*	*0.003*	*0.004*	*0.004*
Arellano-Bond test for AR(2) *(p-value)*	*0.871*	*0.998*	*0.849*	*0.677*
Sargan-Hansen test *(p-value)*	0.201[64]	0.325[65]	0.459[64]	0.359
N. Firms [N. Obs.]	80 [521]	80 [521]	80[521]	80[521]

Table 8 – Robustness: Controlling for Competition Effects

(*I/K*), *(ΠI/K*), (*Y/K*),*IRA* dummy, *Government's UCR* and *Political orientation* are defined in Table 2. The *OECD Liberalization Index* is a revised version of the OECD Index of Product Market Regulation by Conway and Nicoletti (2006). Dynamic panel-data estimation, one-step system GMM estimates. All regressions include year dummies.*OECD Liberalization* $_{t-1}$**IRA* and *Political Orientation* $_{t-1}$**IRA* are instrumented with their lags. *Investor Protection* and*DisproportionalityIndexes* are defined in Section 5. Standard errors in parentheses are robust to heteroschedasticity and to within group serial correlation.AR(1) [AR(2)] tests the null hypothesis of no first-order [second-order] correlation in the differenced residuals. The Sargan-Hansen statistic tests the null hypothesis that the over-identifying restrictions are valid. The *Difference-in-Hansen* statistics tests the exogeneity of subsets or individual instruments. ***, **, * denote significance of the coefficients at 1%, 5% and 10%.

I/K_t	(1)	(2)	(3)
$(I/K)_{t-1}$	0.822***	0.800***	0.758***
	(0.084)	*(0.095)*	*(0.111)*
$(I/K)^2_{t-1}$	-1.021***	-0.989***	-0.954***
	(0.137)	*(0.149)*	*(0.146)*
$(\Pi/K)_{t-1}$	0.138**	0.138**	0.165**
	(0.063)	*(0.064)*	*(0.084)*
$(Y/K)_{t-1}$	-0.004	-0.004	-0.003
	(0.003)	*(0.003)*	*(0.006)*
IRA Dummy$_{t-1}$	0.019**	0.020*	0.132**
	(0.009)	*(0.011)*	*(0.056)*
OECD Liberalization Index $_{t-1}$	0.001	-0.0003	-0.006[1]
	(0.004)	*(0.002)*	*(0.003)*
OECD Liberalization Index $_{t-1}$* IRA	-	0.0001	- 0.0001
	-	*(0.004)*	*(0.004)*
Political Orientation $_{t-1}$	-	-	0.013
	-	-	*(0.008)*
Government UCR $_{t-1}$	-	-	0.016
	-	-	*(0.013)*
Political Orientation $_{t-1}$* IRA	-	-	-0.021**
	-	-	*(0.009)*
Arellano-Bond test for AR(1) *(p-value)*	*0.025*	*0.024*	*0.021*
Arellano-Bond test for AR(2) *(p-value)*	*0.492*	*0.499*	*0.245*
Sargan-Hansen test *(p-value)*	0.441 [48]	0.400 [34]	0.609 [35]
Internal Instruments	Difference-in-Hansen tests *(p-value)*		
IRA Dummy$_{t-2}$	*0.728*	*0.891*	*0.732*
OECD Liberalization Index $_{t-2}$	*0.785*	*0.574*	*0.213*
Government UCR $_{t-2}$	-	-	*0.569*
Political Orientation $_{t-2}$	-	-	*0.501*
External Instruments			
IP - Investor Protection	*0.950*	*0.749*	*0.298*
D- Disproportionality	*0.655*	*0.491*	*0.956*
N. Firms [N. Obs.]	57[307]	57[307]	57[307]

[1] P-value = 0.117

FIGURE 1 - MARGINAL EFFECT OF POLITICAL ORIENTATION ON *IK* AS THE IRA IS SET IN PLACE

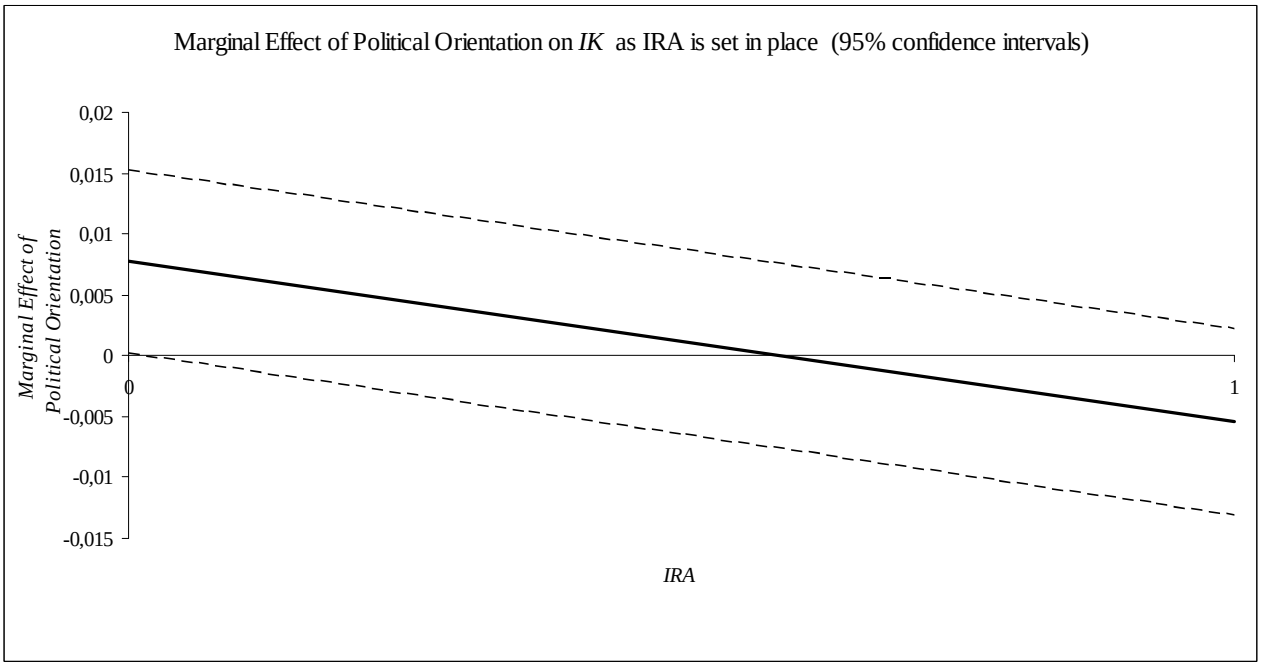
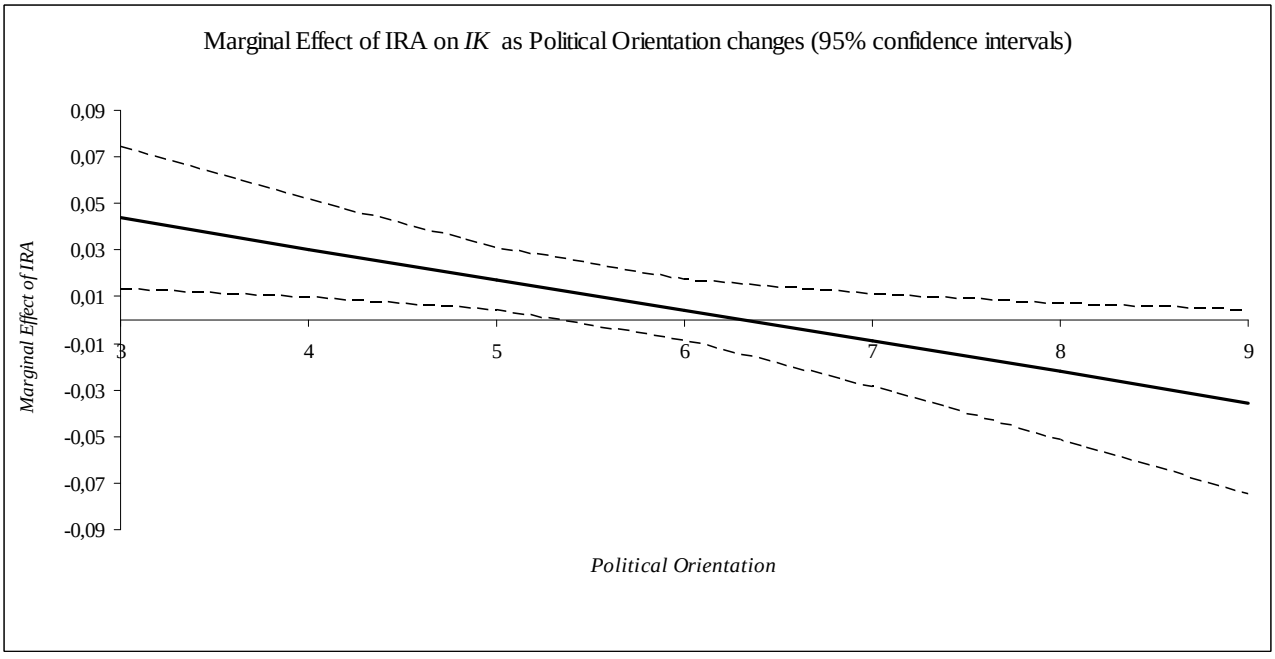


FIGURE 2 - MARGINAL EFFECT OF IRA ON *IK* AS POLITICAL ORIENTATION SHIFTS FROM LEFT TO RIGHT[2]



[2] We report values only for the range of variation of the *Political Orientation* variable, i.e. [3.665 – 8.025]. Note that the 80% of observations belongs to the range [4 – 7.71].

Appendix A1 – Establishment of an Independent Authority and Government's Political Orientation

	Energy		Telecom	
Country	**Date of establishing an energy IRA**	**Leading Party/Coalition and political orientation of the Government when the IRA is established**	**Date of establishing a Telecom IRA**	**Leading Party/Coalition and political orientation of the Government when the IRA is established**
Austria	2000	Social Democratic Party run by Franz Vranitzky *Executive Or.:* Right	1997	Social Democratic Party run by Franz Vranitzky *Executive Or.:* Right
Belgium	1999	Dutch Christian Social Coalition run by Jean-Luc Dehaene *Executive Or.:* Center	1991	Dutch Christian Social Coalit run by Wilfred Martens *Executive Or.:* Center
Denmark	1999	Social Democratic Party run by PoulNyrup Rasmussen *Executive Or.:*Left	2002	Liberal Party of Denmark run by Anders Fogh Rasmussen *Executive Or.:* Right
Finland	1995	Centre Party run by EskoAho *Executive Or.:* Center/Right	1987	Social Democratic Party run by KaleviSorsa *Executive Or.:* Center/Right
France	2000	Socialist Party run by Lionel Jospin *Executive Or.:* Left	1996	Rally for the Republic run by Alain Juppe *Executive Or.:* Right
Germany	2006	CDU/CSU run by Angela Merkel *Executive Or.:* Right	1996	CDU/CSU run by Helmut Kohl *Executive Or.:* Right
Greece	2000	Pan-Hellenic Movement run by Costas Simitis *Executive Or.:* Center/Left	1992	New Democracy run by Constantine Mitsotakis *Executive Or.:* Right
Ireland	1999	Fianna Fail-Labour run by Bertie Ahern *Executive Or.:* Center/Right	1997	Fianna Fail-Labour run by Albert Reynolds *Executive Or.:* Center/Right
Italy	1996	Technical (Non-partisan) govn.'t run by LambertoDini *Executive Or.:* Center	1997	Socialist Party run by Romano Prodi *Executive Or.:* Center/Left
Netherlands	1998	Labour Party run by William Kok *Executive Or.:* Center/Right	1997	Labour Party run by William Kok *Executive Or.:* Center/Right
Portugal	1995	Social Democratic Party run by AnibalCavaco Silva *Executive Or.:* Right	2001	Socialist Party run by Antonio Gutteres *Executive Or.:* Left
Spain	1998	Popular Party run by Jose Aznar *Executive Or.:* Right	1996	Socialist Party run by Felipe Gonzales *Executive Or.:* Left
Sweden	1998	Social Democratic Labour Party run by GöranPersson *Executive Or.:* Left	1992	Moderate Party run by Carl Bildt *Executive Or.:* Right
UK	1989	Conservative Party run by Margaret Thatcher *Executive Or.:* Right	1984	Conservative Party run by Margaret Thatcher *Executive Or.:* Right

Appendix A2 – Summary Statistics for Political and Legal Institutional Variables

Variable	Mean	Std. Dev.	Min	Max	No. Obs
Investor Protection	3.826	1.216	1	5	720
Disproportionality Index	10.527	8.222	0.428	33.739	720
Government Stability	0.156	0.320	0	1	720
EXERLC	1.960	0.942	1	3	720
Election Date	0.029	0.168	0	1	720
Checks & Balances	3.874	0.975	2	7	720
OECD Liberalization Index	2.708	2.042	0	6	521

Appendix A3

Robustness Analysis: GMM-difference Estimates of the Investment Euler Equation

(*I/K*), *(ΠI/K*), (*Y/K),IRA* dummy, *Government's UCR* and *Political orientation* are defined in Table 2. Dynamic panel-data estimation, one-step first-differences GMM estimates. All regressions include year dummies.*Government UCR* $_{t-1}$**IRA* and *Political Orientation* $_{t-1}$**IRA* are instrumented with their lags. *Investor Protection* and *DisproportionalityIndexes* are defined in Section 5. Standard errors in parentheses are robust to heteroschedasticity and to within group serial correlation.AR(1) [AR(2)] tests the null hypothesis of no first-order [second-order] correlation in the differenced residuals. The *Sargan-Hansen* statistic tests the null hypothesis that the over-identifying restrictions are valid. The *Difference-in-Hansen* statistics tests the exogeneity of subsets or individual instruments. ***, **, * denote significance of the coefficients at 1%, 5% and 10%.

I/K_t	(1)	(2)	(3)
$(I/K)_{t-1}$	1.183***	1.014***	1.124***
	(0.252)	*(0.195)*	*(0.259)*
$(I/K)^2_{t-1}$	-1.467***	-1.240***	-1.411***
	(0.370)	*(0.259)*	*(0.378)*
$(\Pi/K)_{t-1}$	0.002	0.054	-0.010
	(0.103)	*(0.088)*	*(0.082)*
$(Y/K)_{t-1}$	0.019	0.009	0.015
	(0.020)	*(0.020)*	*(0.019)*
IRA Dummy$_{t-1}$ (α_1)	0.077*	0.068**	0.244***
	(0.042)	*(0.034)*	*(0.094)*
Government UCR $_{t-1}$ (α_2)	-	0.061	0.066
	-	*(0.052)*	*(0.106)*
Political Orientation $_{t-1}$ (α_3)	-	-0.009	0.007
	-	*(0.007)*	*(0.010)*
Government UCR $_{t-1}$* IRA (α_4)	-	-	-0.103
	-	-	*(0.097)*
Political Orientation $_{t-1}$* IRA (α_5)	-	-	-0.018*
	-	-	(0.010)
P-value test on $\alpha_1 + \alpha_5 = 0$	-	-	0.010
P-value test on $\alpha_3 + \alpha_5 = 0$	-	-	0.233
Arellano-Bond test for AR(1) *(p-value)*	*0.001*	*0.002*	*0.001*
Arellano-Bond test for AR(2) *(p-value)*	*0.779*	*0.801*	*0.894*
Sargan-Hansen test *(p-value)*	0.327 [47]	0.190 [59]	0.441 [44]
Internal Instruments	Difference-in-Hansen tests *(p-value)*		
IRA Dummy$_{t-2}$	*0.772*	*0.529*	*0.753*
Government UCR $_{t-2}$	-	*0.578*	*0.498*
Political Orientation $_{t-2}$	-	*0.897*	*0.659*
External Instruments			
IP - Investor Protection	*0.177*	-	-
D- Disproportionality	*0.920*	*0.547*	*0.324*
N. Firms [N. Obs.]	79[435]	79[435]	79[435]

Appendix A4

Robustness Analysis: The impact of Politics in firms regulated by an IRA

(*I/K*), *(ΠI/K*), (*Y/K),Government's UCR* and *Political orientation* are defined in Table 2. *EXERLC* is a measure of political stance of the executive and is equal to 1 when the executive is leftwing, 2 when it is centre, and 3 when it rightwing. Dynamic panel-data GMM-System estimation. All regressions include year dummies. Standard errors in parentheses are robust to heteroschedasticity and to within group serial correlation.AR(1) [AR(2)] tests the null hypothesis of no first-order [second-order] correlation in the differenced residuals. The *Sargan-Hansen* statistic tests the null hypothesis that the over-identifying restrictions are valid. The *Difference-in-Hansen* statistics tests the exogeneity of subsets or individual instruments. ***, **, * denote significance of the coefficients at 1%, 5% and 10%.

$\mathbf{I/K_t}$	**(1)**	**(2)**
$(I/K)_{t-1}$	0.830***	0.766***
	(0.158)	*(0.114)*
$(I/K)^2_{t-1}$	-1.057***	-0.928***
	(0.222)	*(0.148)*
$(\Pi/K)_{t-1}$	0.106	0.174**
	(0.069)	*(0.086)*
$(Y/K)_{t-1}$	0.001	-0.004
	(0.003)	*(0.003)*
Government UCR_{t-1}	0.015	0.006
	(0.012)	*(0.013)*
Political $Orientation_{t-1}$	-0.006*	-
	(0.003)	-
$EXERLC_{t-1}$	-	-0.011*
	-	*(0.006)*
Arellano-Bond test for AR(1) *(p-value)*	*0.013*	*0.030*
Arellano-Bond test for AR(2) *(p-value)*	*0.769*	*0.607*
Sargan-Hansen test *(p-value)*	0.446 [51]	0.441 [44]
Firms [N. Obs.]	55[306]	53[261]