Incentive Regulation and Investment: Evidence from European Energy Utilities

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Abstract

This paper investigates whether the form of regulation affects the investment decisions of a sample of EU energy utilities and whether this influence is sensitive to the firm's private vs. state ownership. We control for potential endogeneity of the regulatory regime as well as of the ownership status by using institutional, political and sectoral variables as instruments and we account for cross-country differences in energy fixed capital endowments. Our results show that investment rate is higher under incentive regulation than under rate of return regulation. We also find that investment rates at firms under incentive regulation are negatively related to the level of the X-factor. In contrast, when controlling for the endogeneity of ownership, we find that the positive relationship between private control and investment is no longer significant, suggesting that in European energy utilities regulation reduces the differences in firms' internal incentives.

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1. Introduction

Provision of energy services in adequate quality and quantity and at fair prices requires large amounts of investment that is both irreversible and risky. Investment in infrastructure, and their modernization, is crucial to both prices and quantities in the long run, because delayed investment can have enormous costs from the social point of view. One factor influencing investment decisions in energy industries is the regulatory policy adopted by national regulators. Despite the relevance of this issue, little empirical evidence exists, mostly focused on the U.S. and on telecommunications industry, that helps to understand the potentially effects of different regulatory mechanisms, i.e. incentive vs. rate or return regulation (Guthrie, 2006). This paper contributes to fill this gap by investigating whether the investment decisions of a sample of European energy utilities differ with the different regulatory regimes in place from 1997 to 2007.

European utilities are an interesting case to study because in the last decade most national governments profoundly reformed their public utility sectors, particularly energy and telecommunications. Former state monopolies were privatised and independent regulators were introduced, with the difficult task to liberalize the “markets” and therefore to choose, and implement, a form of regulation. After about ten years since the inception of National Regulatory Agencies (NRA), it is therefore important to document the evolution of the regulatory regimes and interventions in the energy utility sectors of the five largest EU economies as well as to study their implications for investment.

In this paper we investigate the relationship between regulatory regimes and investment, while controlling for the effect of firm ownership. We account for ownership because, despite the recent privatisation wave, many European energy utilities are still controlled by central or local governments, and because ownership is found to matter both for the relationship between regulators and regulated firms’ incentives to invest (Martimort, 2006) and for their financing decisions (Bortolotti, Cambini, Rondi, Spiegel, 2008). Our evidence is drawn from a small, but representative panel of electric and gas utilities in France, Germany, Italy, Spain and UK, for which we collected accounting and ownership data as well as detailed information on the regulatory schemes implemented by the NRAs. When liberalization was started, in the late ‘90s, many national agencies regulatory agencies abandoned rate of return regulation to implement incentive mechanisms such as price or revenue caps. Our dataset also includes yearly information on the regulatory tools, namely the weighted average cost of capital (WACC) and X-factor, at various regulatory hearings from 2000 to 2007. This allows us to investigate whether investment decisions are sensitive to changes in the regulatory variables.

We conduct our analysis by controlling for firms' ownership – since private firms may have more pronounced incentives to invest in cost reducing activities than in network expansion – as well as for the underlying energy demand, as captured by the manufacturing share of GDP and for existing energy supply – since countries with lower energy requirements, or better equipped countries, need to invest less in new infrastructure. These country specific factors also help us to make some conjectures about the type of investment the energy utilities may have chosen to carry out in our time horizon.

Since the observed investment variation as well as implemented regulatory regimes might both be due to unobserved factors related to the technological process or to the institutional context, we also consider the potential endogeneity of the regulatory regimes. To our knowledge, this is the first paper that investigates the relationship between regulatory mechanisms and investment for European energy utilities, which also controls for the influence of state vs. private ownership, of country structural characteristics, and for endogeneity of both regulatory intervention and ownership status. Another contribution of the paper is to analyze the sensitivity of investment to specific regulatory tools, i.e. the weighted average cost of capital (WACC) and the X factor.

We find that the investment decisions of energy utilities differ with the regulatory regimes, as firms under incentive regulation appear to invest more than firms under RoR. This result holds when we apply instrumental variable techniques that use institutional, political and sectoral variables as instruments for regulatory regimes, and when we apply the GMM estimator for dynamic panel data, which uses lags of all right-hand variables as instruments. We also find that private ownership is positively associated with higher investment rates, but this evidence appears less robust to instrumental variable estimation. Finally, we find that investment rates of EU energy utilities are negatively affected by the level of the X-factor and that the allowed cost of capital – the regulatory WACC – has a positive effect on energy utilities investment decisions, significantly so for those under rate of return and for the sub-sample of electric utilities.

The paper is organized as follows. Section 2 describes the literature. Section 3 describes the EU institutional and regulatory framework and the interventions between 1997 and 2007. Section 4 presents the data and the summary statistics for national energy indicators and firm level variables and Section 5 presents the results of the econometric analysis and the robustness checks. Section 6 concludes.

2. The literature

The theoretical framework for our analysis draws on the literature that studies the implications of different forms of regulation for capital investment decisions (Crew and Kleindorfer, 1996 and 2002; Vogelsang, 2002; Joskow, 2008). The famous Averch-Johnson (1962) effect indicates that a monopoly firm under RoR has an incentive to overinvest to expand its asset base, but fewer incentives to raise its productive efficiency.[1] Mainly to reduce managerial slack, regulators turned to alternative incentive mechanisms, like price- and revenue-cap or profit- and revenue-sharing, which are thought to provide powerful incentives to increase efficiency while leaving excess profits to the regulated operator.[2] In practice, the application of incentive regulation consists in the adoption of elements of traditional cost of service regulation and high-powered "fixed price" incentives.[3] Therefore, "*the implementation of price cap mechanisms is more complicated and their efficiency properties more difficult to evaluate than it is often implied*" (Joskow, 2008, p. 554).

The literature suggests that regulatory policies affect utilities' investment decisions differently, depending on the type of investment – either in cost reducing or in infrastructure (Armstrong and Sappington, 2006; Guthrie, 2006). Typically, regulatory interventions that deliver no extra profit to the firm (like in a rate of return regulation) deprive managers' incentives to invest in cost reduction. In contrast, if the firm's allowed revenues do not depend on realized cost savings (like in a price- or revenue- cap mechanism), the theory suggests that the incentives to invest in cost reducing activities become more pronounced[4]. A

[1] RoR regulation is a *cost plus mechanism* whereby regulators fix the rate of return the utility can earn on its assets. They set the price the utility can charge so as to cover all main operating costs and to allow it to earn a specified rate of return. The regulated price can then be adjusted upward (downward) if the firm starts making a lower (higher) rate of return.

[2] Incentive regulation is usually implemented as *price-* or *revenue-cap* mechanisms (Littlechild, 1983), through the application of *fixed-price contracts* (Armstrong and Sappington, 2007). Sappington (2002) is a comprehensive survey of incentive regulation mechanisms and instruments. Joskow (2008) surveys incentive regulation schemes as adopted in the energy industry.

[3] See also Liston (1993) for an earlier review of the differences and the similarities of the two regulatory mechanisms.

[4] Cabral and Riordan (1989) theoretically show that investment in cost reduction is higher under price cap than under rate of return. Biglaiser and Riordan (2000) study the dynamics of regulation and show that under price cap, investment in cost reducing is likely to occur in the early years not in the later years of the regulatory cycle. Moreover, price-cap regulation leads to more efficient capital replacement decisions than RoR regulation. More recently, Roques and Savva (2009) find that a relatively high price cap can speed up investment in cost reduction compared to an unregulated industry, while a stringent price cap acts as a

complicating factor, however, is that investment incentives operate differently whether they relate to infrastructure or to cost reducing activities. Rate of return regulation is thought to provide firms with strong incentives to develop new infrastructure since the rate of return on the asset base is guaranteed and the risk faced by the firm considerably reduced. On the contrary, price cap mechanisms may weaken the incentive to invest in new infrastructure, especially when the regulatory lags are shorter than the life of the assets, due to regulatory opportunism.[5]

The literature also finds that firm ownership affects investment incentives. Martimort (2006) shows that contract incompleteness and, more specifically, the limits to regulatory commitment and state control, may affect the decision to privatize the utility and its ex post performance. On the one hand, the promise not to intervene ex post is more credible under private production than under state ownership, and private firms are thus expected to invest more, because regulatory commitment is (supposed to be) more pronounced (Sappington and Stiglitz, 1987).[6] On the other hand, private ownership may provide managers with stronger incentives to invest in cost reducing activities that secure larger benefits and higher (implicit or explicit) rewards. However, although the theory predicts that private ownership boosts investment incentives, we found no empirical evidence on this issue within the European energy industry.

The relationship between regulation and investment has received much attention by economic theory, but the empirical evidence is scant and mostly focussed on US regulated utilities. Specifically, there is little systematic analysis of the effects of the application of incentive regulation mechanisms for public utilities' investment, and for energy firms in particular. Greenstein *et al.* (1995) and Ai and Sappington (2002) investigate the impact of incentive regulation for U.S. telecoms and show that price cap regulation accelerates network modernization, i.e. encouraging investment mainly for cost reducing purposes. Newbery and Pollitt (1997) and Domah and Pollitt (2004) show that UK regional electricity distribution companies increase their productivity and service quality after the introduction of incentive regulation. Estache and Rodriguez-Pardina (1998), Rudnik and Zolezzi (2001),

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disincentive for investment. Similarly results are obtained by Nagel and Rammerstorfer (2008) showing that a too restrictive regulator, who sets more binding price cap, can force firms to reduce investments in cost reduction.

[5] Lyon and Mayo (2005), using data for the US electricity market during the period 1970-1991, find evidence of regulatory opportunism by US regulators only for investment in nuclear technology, but not for other electric technologies.

[6] See also Henitsz and Zelner (2001) for an empirical analysis of the role played by institutional environment, political constraints and public ownership for telecommunication investment.

and Pollitt (2004) focus on the impact of incentive regulation on labour productivity of electric distribution companies operating in developing countries. However, none of these studies investigate the interaction between investment and regulatory regimes and how ownership issue affects this relationship.

3. Regulatory framework and interventions in Europe

Energy utility sectors in Europe are regulated either via a rate-of-return or via incentive regulation. Over the past decade the price cap approach has become increasingly successful if compared to RoR regulation, especially after the introduction of liberalization and privatization reforms.

The milestone legislation introducing market liberalization is European Commission Directive 96/92 for the electricity, followed by EC Directive 98/30 for the gas market. The purpose of these directives was to introduce competition in generation/production and distribution, as well as to vertically separate the different segments in the energy value chain. EC Directives also established National Regulatory Agencies whose purpose is to ensure non-discrimination, effective competition and regulation of the wholesale and retail charges. However, the Directives did not impose any mandatory rule on the form of regulatory schemes and delegated the choice of the most appropriate regulatory regime to each NRA. To date, most of the NRAs implemented, and actually adopted, fixed-price mechanisms, mainly *revenues cap*, while only a few implemented RoR regulation.

With respect to ownership issues, the Commission left the decision about whether privatise or not entirely in the hands of national governments. In most EU countries, privatisations started in the early Nineties with the sale of non-majority stakes and by the end of the decade the process was suspended and was not resumed in the years 2000s.[7] As a result, central and local governments still hold majority or controlling stakes in many European energy utilities.

To study the investment behaviour of energy utilities under different regulatory regimes we constructed panel data for 23 energy companies from five EU member states - France, Germany, Italy, Spain, and UK - matching firm level variables with regulatory data, national economic indicators and energy statistics. Incentive regulation is currently in place in Italy, Spain and UK, mostly in the form of revenue caps, but Italy and Spain switched

[7] Bortolotti and Faccio (2008) show that, as of 2000, governments controlled 62,4% of privatized firms. From that year onwards no significant progress in privatizations has been carried on in Europe.

from RoR to cap regulation over the period (see Table 1). RoR schemes apply in France and Germany, but both countries are expected to introduce incentive regulation in 2009.[8]

We now briefly describe the evolution of the regulatory regimes and of the regulatory tools for our sample countries and period. In Italy, the national authority, *Autorità per l'Energia Elettrica e il Gas* (AEEG), switched from RoR to incentive regulation in 2000 in both electricity and gas, opting for a mechanism consisting of a mix of price and revenue cap that applies, respectively, to the commodity and to the capacity components. In 2003, the regulator raised the WACC for the electricity TSO from 5.6% to 6.66% and reduced the X factor from 4% to 2.4%. Within electricity distribution, both the WACC and the cap were also reduced, the former from 7.4% to 6.85% and the latter from 4% to 3.5%. The WACC rates for gas industry were set, in 2000, at 9.1% in transmission and 8.8% in distribution and were reduced in 2006 to 6.7% and 7.5%, respectively. Similarly to Italy, Spain switched from RoR to incentive regulation in the late nineties in electricity and in the early 2000s in gas industry. The *Comisiòn Nacional de Energìa* (CNE) adopted a revenue cap mechanism for electricity in 1998, for gas distribution in 2001 and for gas transmission in 2002. In 2001, the regulator set the WACC of gas distribution at 8.25%, and did not change it thereafter, and the WACC of gas transmission at 6.7%, and, in 2007, raised it to 9.7%. The WACC for electricity transmission increased from 4 to 6% in 2002.[9] In the UK, the *Office of the Gas and Electricity Markets* (OFGEM) has been applying incentive regulation since the mid Eighties. Within gas transmission and distribution, the WACC and the X factor were set at 6.25% at 2%, respectively, and did not change over the period. Within electricity transmission, the WACC was 6.25% in 2001 and 6.90% in 2007, while the X factor was reduced from 3% to 2%. The WACC for electricity distribution was raised from 6.5% to 6.9%, while the X factor was 3% until 2005 and then was set to zero.

In France, the *Commission de Régulation de l'Energie* (CRE) set the rate of return on capital for the regulatory asset base (RAB) at 7.25% for both gas and electric transmission in the year 2000 and did not change thereafter. The rate of return within electricity distribution was 6.50% in the period 2001-2002 and 7.25% later on. Within gas distribution, the WACC followed an opposite trend, from 7.25% to 6.75%. In Germany, the mechanism in place is a *cost-plus* structure, where the allowed rate-of-return is the same in all segments of the energy

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[8] In Germany, the evolution from RoR regulation to an incentive mechanism follows inception of the Energy Regulatory Authority, named *Bundesnetzagentur*

[9] Unfortunately, although we checked in various sources, we were not able to reconstruct the values for the WACC applied to electricity distribution in Spain.

market and is generally negotiated between the Government and the regulated companies. The rate of return was 6.50% until the end of 2006 and then increased to 7.91% at the end of 2007.

Overall, the evolution of the allowed rates of return and of the X factors suggests that the regulatory policy in the five countries became somewhat looser over time, particularly toward to the end of the period, as regulators increased the WACC and reduced the X in most countries.

4. The Data and descriptive statistics

Country characteristics of the energy supply and demand may affect regulatory policies as well as firms' investment decisions. We thus begin this section by presenting Eurostat and OECD national indicators that allow us to compare the main structural differences among the five countries in our sample.[10] Table 1 (Panel B) presents national statistics by country while Table 2 sorts them by regulatory regime and tests the statistical significance of mean differences across incentive and rate of return regulation. The first set of structural indicators documents the country specific energy supply, as measured by *total primary energy supply per unit of GDP*, the underlying energy demand as proxied by the *share of GDP accounted for by manufacturing industry*, and *energy dependence*, i.e. the extent to which an economy relies upon imports in order to meet its energy needs. We note that whereas energy supply is higher in Germany and France, two RoR countries, the underlying demand for energy seems to be highest in Germany, but also in Italy, which switched to cap regulation around the year 2000. When we compare across the two regimes we find that both energy supply and underlying demand are higher under RoR regulation, although the mean difference for the latter is only significant at the 10% level. This suggests that energy infrastructure (broadly defined to include all types of energy resources and generations) is more developed in countries where RoR is in place, consistently with the view that RoR leads to large investment in infrastructures (Guthrie, 2006).[11] Turning to *energy dependence*, we find that it is highest in Italy and lowest in the UK, both regulated by

[10] We thank an anonymous referee for suggesting this analysis.

[11] Unfortunately, we were not able to find specific infrastructure data covering both electricity and gas and all countries for all the entire period. For example, using data sourced by UCTE (*Union of the Coordination of Transmission of Electricity*), we collected information on electrical infrastructures (length of electrical circuits at 220, 400 and 750 kV in km, number and capacity of network transformers at different nodes, available ae www.ucte.org) for all countries, but not for the UK. This data confirm that network infrastructure investments in countries with RoR are significantly higher than in countries with incentive regulation. We also find that these variables are highly correlated with the structural indexes described in Table 1.

incentive mechanisms, and this may explain why the mean difference across regimes is insignificant. Leaving UK out due to its North Sea oil reserves, the two RoR countries, France and Germany (both employing nuclear energy) appear much less energy dependent than Italy and Spain.

The second set of indicators describes price indexes, namely the *Energy consumer price index*, and the *gas* and *electricity prices* charged to final consumers. We find that both the energy price index and the electricity price appear significantly higher under incentive regulation than under rate of return. But if we look at national data we find quite heterogeneous trends and situations within both regimes, as the highest electricity prices in Italy somewhat compensate the lower prices in UK, while relatively lower prices in France compensate relatively higher prices in Germany.

In sum, the overview of national indicators suggests that infrastructure investment appears larger under RoR regulation than in countries where incentive regulation is in place. On the other hand, the data also show that incentive regulated countries, like Italy and Spain, exhibit high energy dependence and high energy prices. This suggests that the choice of the regulatory regime might be influenced by the need to guarantee more efficient supply and lower retail prices. As a consequence, the choice of the form of regulation might itself be endogenous. In the empirical estimations we will take this possibility into account.

Finally, we turn to firm level data. We constructed an unbalanced panel of 23 energy utilities operating in electricity and/or gas transmission and distribution: 13 are transmission service operators (TSO), 5 are vertically integrated and 5 are horizontally integrated, i.e. operate in both electric and gas distribution.[12] If we break down the sample by form of regulation and ownership, 13 utilities are regulated with incentive mechanisms and 4 by rate of return throughout the period, while 6 (four Italian and two Spanish) switched from RoR to incentive regulation. Ten firms are privately controlled and thirteen are publicly controlled.[13] Table 3 reports the list of firms by country and sector.

[12] We used the largest fraction of sales revenues as a criterion to assign horizontally integrated firms to either the electricity or the gas industry. The panel is unbalanced because due to privatization, de-mergers from former state monopolies and re-organization of local utilities, several firms were incorporated in 2000-2001 (for example, Snam Rete Gas, Terna, Enagas, CE Electric). Therefore, for these utilities, the accounting data are not available for the entire period. In sum, 11 firms cover the period from 1997 to 2007, 12 firms from 2000 to 2007, 6 firms switched from RoR to incentive regulation.

[13] None of these firms changed the ownership status during the sample period. Firms that are privately controlled (mainly the UK and Spanish utilities) were privatized in the mid of Nineties. A firm is “privately-controlled” if the state holds less than 30% of the ultimate control rights (see Bortolotti, Cambini, Rondi and Spiegel, 2008 for further details on the construction and sources for this variable).

Although we just have 23 firms, our sample is largely representative of the energy utility sector in each country. In Italy, Terna and Snam Rete Gas are TSOs for electricity and gas transmission, respectively; the other Italian utilities in the dataset jointly cover approximately 90% of electric and gas distribution. In France, Electricitè de France (EDF) and Gaz de France (GDF) are (near) monopolists in their sectors. In Germany, E.On and RWE cover about 60-70% of the electricity and gas markets.[14] In Spain, Red Electrica Espana and Enagas are TSO for electricity and gas transmission. Gas Natural is the incumbent in gas distribution, with a share of 80% of the market, while Endesa, Union Ferosa and Iberdrola cover almost 100% of the retail market for electricity distribution. Finally, in the UK, National Grid is the TSO for both gas and electricity and has more than 50% of the market for gas distribution, while Scottish Power, Scottish and Southern Energy and CE Electric together cover approximately 35-40% of the market for retail electricity.

Table 4 presents descriptive statistics for the accounting and financial variables we use in the empirical analysis. The key variable is the investment rate, which we measure by the ratio of capital expenditure to total assets. We break down the sample firms by form of regulation (Panel B) and ownership (C) and report the results of mean differences tests for all variables. The mean differences in both panels are mostly statistically significant. Though smaller in size, firms under incentive regulation report higher investment rates and higher profitability (measured by operating cash flow to total assets) than firms subject to RoR. We also note that firms under RoR are typically state-controlled. When we look at mean differences across ownership, we find that privately controlled firms exhibit significantly higher investment and profitability rates.

We conclude looking at regulatory variables. On average, WACC rates appear very similar for utilities under incentive and RoR regulation, but significantly different across ownership, as privately controlled firms appear to be allowed significantly lower rates of return than state-controlled firms. Also the X factors are different across ownership, as the typical value of the X is significantly larger for state-controlled than for private firms. The higher X factor for state-controlled utilities can be viewed as a regulatory strategy to induce higher efficiency and reduce managerial slack.

[14] It is worth noting that most of German energy utilities are not listed and it is therefore very difficult to find reliable and comparable data on financial and economic variables.

5. Empirical Analysis

The purpose of the econometric analysis is to examine whether the investment decisions of a sample of European energy utilities from 1997 to 2007 change with the regulatory scheme in place, while also controlling for potential differences in country structural indicators and firm ownership. Then we also investigate whether, and how, investment is sensitive to changes in the regulatory tools, i.e. the X factor and the WACC. Tables 5 and 6 report the results.

We derive our investment model from the microeconometric literature on company investment[15] which suggests to include the *lagged investment ratio* to account for capital stock adjustment, *demand growth*, as measured by the log difference of firm sales, to account for accelerator effects, the lagged *long-term interest rate* to control for the cost of capital, and the lagged *cash flow to total assets* to account for capital markets imperfections and asymmetric information problems that may cause investment decisions to be constrained by the amount of internal funds. Moreover, because the underlying demand of energy as well as the level of infrastructure in the energy industry may also affect firm investment decisions, we include two country-level variables, i.e. the share of GDP generated by manufacturing industry and, alternatively, the energy supply per GDP, and we lag them one period to reduce reverse causality problems.

In principle, if the underlying energy demand affects firm investment decisions, the *Manufacturing Share of GDP* should enter with a positive coefficient. Similarly, if a country is endowed with large infrastructure securing abundant energy supply, utilities are less likely to invest in new capital formation and a negative coefficient on *Energy Supply per GDP* is expected. Of course if both fail to affect the capital stock accumulation, then we may suppose that investment decisions are driven by alternative motivations, such as cost reducing and profitability-enhancing purposes, and therefore that the investment delivered is more likely intensive than extensive.

To this specification we then add a dummy for the regulatory scheme in place in the sector/country where the utility operates and a dummy for the utility's ownership status. Therefore, *Incentive Regulation* is a dummy equal to 1 when the utility is under a price or

[15] See, for example, Hubbard (1998) for a comprehensive survey of company investment models estimated with panel data, Fazzari, Hubbard and Petersen (1988), for a seminal contribution, and Lyon and Mayo (2005), for an application to the US electric utility industry.

revenue cap regime and *Private Control* is a dummy equal to 1 when the utility is privately controlled (that is where the government holds an equity share less than 30%). Our baseline specification is as follows:

$$IK_{it} = \alpha_0 + \alpha_1 IK_{it-1} + \alpha_2 \Delta LogSales_{it} + \alpha_3 CFK_{it-1} + \alpha_4 IncentiveRegulation_{it} + \alpha_5 PrivateControl_{it} + \beta_1 ManufacturingShare_{jt-t} + \beta_2 InterestRate_{jt-t} + \mu_i + \delta_t + \varepsilon_{it} \quad [1]$$

where the dependent variable is the investment rate, IK_{it}, defined as the capital expenditure to total assets ratio, μ_i denotes the firm dummies, δ_t denotes the time-specific dummies, *i*, *j* and *t* are the firm, country and year subscripts, and ε_{it} is the error term.

Before turning to the empirical results, we briefly consider the estimation strategy. Because 6 out of 23 utilities switch from RoR to incentive regulation, while the remaining firms operate under the same country specific regulatory regime throughout the sample period, this feature reduces, for the incentive regulation dummy, the usual heterogeneity across firms and time, which is itself a main advantage of panel data analysis. We thus start with a simple OLS estimator (i.e. pooling all firm-year observations) to which we add year dummies to control for common time effects due to the business cycle. On the other hand, the investment decision is highly idiosyncratic and influenced by firm-specific invariant factors and is therefore usually investigated within a firm fixed-effects framework. We thus continue with the fixed effect model by including firm as well as time specific effects.[16] Finally, we turn to instrumental variable estimation to address potential endogeneity of the regulatory regime and of the ownership status.

The OLS estimates in column (1) of Table 5 show that the standard control variables in the investment equation enter significantly and with the expected sign. The positive coefficient on sales growth is consistent with the presence of accelerator effects, while the positive cash flow coefficient suggests that capital market imperfections may constrain investment decisions to the internal funds available to the firm. The long-term interest rate is not significantly different from zero, probably because is absorbed by the year dummies. When we look at our proxy of the underlying energy demand, *Manufacturing Share of GDP*,

[16] To control for potentially unaccounted country effects, we estimated a random effects model (RE), which allows to include country and sector dummies that in the fixed effects model cannot be estimated because they are perfectly collinear with firm fixed effects. However, in the RE model the firm effects are part of the error term by construction and it is thus crucial that the regressors are not correlated with the error term. We tested this restriction with the Hausman specification test, but the results of the test pointed toward the fixed-effects model.

we notice that the coefficient is also not significantly different from zero. In column (2), we add the regulatory and ownership regimes and find that both dummies are positive and significant, suggesting that investment at energy utilities under *Incentive Regulation* is higher than at utilities under rate of regulation, and that investment at privately controlled firms is higher than at state controlled firms.[17] Columns (3) and (4) report the results when we account for firm specific fixed effects. The results are quite similar. The coefficient on *Manufacturing Share of GDP* is positive but, again, insignificant, while the *Incentive Regulation* and the *Private Control* dummies remain positive and significant.[18]

Columns (5)-(8) address the potential endogeneity of the regulatory regime choice, as many national authorities, such as Italy and Spain, shifted from RoR to incentive regulation when the energy markets were liberalized, and of firm ownership, as many utilities were privatized in the past decades. Endogeneity of the regulatory regime may derive from the decision to opt for rate of return or incentive regulation whenever the government/regulator thinks that either larger infrastructure to face growing energy demand or more cost reducing investment is needed. Endogeneity of ownership may derive from the government's decision to privatize firms that were in healthier financial situation and therefore more able and ready to fulfil investment programs than a fiscally constrained government.[19] We employ two instrumental variable methods to deal with potential endogeneity problems. First, we use the two-stage least squares instrumental variable method, and, following Ai and Sappington (2002), we choose our instruments among a set of institutional, sectoral and political variables.[20] Second, we use the Generalised Method of Moments proposed by Arellano and Bond (1991) and Blundell and Bond (1998), which is especially designed for dynamic models where right-hand variables, including the lagged dependent variable, are not strictly exogenous. GMM estimation also deals with the dynamic panel bias that arises when the lagged dependent variable may be correlated with the error term even when the firm fixed

[17] To further control the robustness of the coefficient on the incentive regulation dummy, we estimated several specifications such as OLS with country and time dummies, OLS with sector and time dummies and OLS with time dummies and country dummies interacted with sector dummies. In all regressions, *Incentive Regulation* keeps its sign and significance whereas the *Private Control* dummy is often insignificant. We do not report the results for reason of space, but they are available on request.

[18] In the working paper version (Cambini, Rondi and Di Renzo, 2009), we included two OECD indexes constructed by Conway and Nicoletti (2006) to control for the regulatory and competitive environment: the extent of *Market Entry* for the Electricity and the Gas industries and the degree of *Vertical Integration*. Neither *Market Entry* nor *Vertical Integration* was a significant determinant of the investment rate.

[19] We thank one referee for suggesting to develop this issue.

[20] The correlation matrix in the Appendix, Table A1 shows the partial correlations between the instruments and the instrumented variable as well as between the instruments and the dependent variable. The Table shows that the chosen instruments are uncorrelated with the dependent variable and correlated with the endogenous variable.

effects are wiped out by first-differencing. Our GMM estimates employ *t-2* and *t-3* lags of the dependent variable and of other non-strictly exogenous regressors, such as the cash flow to total asset, and the regulatory dummy, and the *t-2* lag of the sales growth, the manufacturing share of GDP and of the ownership dummy. All regressions include firm and time specific fixed effects.

In columns (5)-(6) we report the results from 2SLS estimation. In column (5), the instrumented variable is the incentive regulation dummy, and the private control dummy is excluded, while in column (6) we include, and instrument, both the regulatory and the ownership regimes.[21] Comparing with the previous results, we find that *Incentive Regulation* dummy remains positive and significant in both columns, while the *Private Control* variable becomes insignificant when we control for endogeneity. The GMM results in columns (7) and (8) are quite similar. The *Incentive Regulation* coefficient keeps its sign and significance, but not the Private Control dummy, supporting the view that within the estimation period from 1997 to 2007, and controlling for the underlying energy demand, and for potential differences due to private vs. public ownership, the European energy utilities under incentive regulation reported higher investment rates than their counterparts under rate of return regulation.

Table A2 in the Appendix reports the estimates of the investment model [1] where we replace *Manufacturing Share of GDP* with *Energy Supply per GDP* to account for the impact that the available energy infrastructure may exert on the decision to whether or not expand the network. We find that the results are very similar to our findings in table 5 (columns (4), (6), and (8)) as the positive coefficient on Incentive Regulation is always significant while the Private Control dummy becomes insignificant when we control for potential endogeneity of the ownership variable. We note that *Energy Supply per GDP* enters with the expected negative sign, although its coefficient is never statistically significant.

The evidence that incentive regulation has spurred investment more than rate of return is not entirely consistent with the conventional view that cost-of-service may even induce

[21] In column (5), the instrument set includes the OECD index of *Market Entry*, *Political Orientation*, and a sector dummy. *Market Entry* reflects the terms and conditions of third party access and the degree of market openness at wholesale and retail level in the Electricity and the Gas industries. Market entry is an index of market liberalization rather than an index of regulation, since it measures the possibility of entry by new firms into the energy market. *Political orientation* is an index ranging from 0 (extreme left wing) to 10 (extreme right wing) and is computed as the weighted average of the right-left political orientation scores of the parties forming the executive branch of government (see Bortolotti and Faccio, 2008). Higher values of the political orientation index are typically associated with more pro-firm regulation. In column (6) we add an index of energy dependence and a dummy that identifies whether the firm originates from a country under the Common Law legal system, which is typically associated with stronger investor protection, hence more favoured by private investors.

firms to overinvest (see Section 2). However, the literature (see, for example, Armstrong and Sappington, 2006; Guthrie, 2006) has also advanced that different regulatory regimes may display different effects on different types of investment and, specifically, that incentive regulation is more appropriate to spur cost-reducing (intensive) investment while RoR regulation is more conducive to infrastructure (extensive) investment.[22] Ideally, to sort out the implications of alternative regimes, we ought to consider which type of investment the utilities delivered in the time span under scrutiny, but unfortunately our data do not allow us to do so. Notwithstanding this, the positive and significant coefficient on the incentive regulation dummy, joint with the lack of significant influence by the underlying energy demand or the actual energy supply, suggest that, in the period 1997-2007, the investment decisions of European energy utilities under incentive regulation were more likely motivated by cost reducing and efficiency-enhancing rather than by capacity expansion goals.

In Table 6, we study the energy utilities' investment behaviour more in depth by introducing two regulatory variables, the *Weighted Average Cost of Capital* (WACC) and the *X-factor* that the NRAs set up from 2000 to 2007 (as the liberalization process in most countries began in 1997-99, and the regulatory variables became available only from 2000). Regulatory rates differ across electricity and gas operators, countries and over regulatory lags (in section 3 we describe their evolution over time).

In column (1), the results for the full sample of RoR and incentive regulated utilities show that the Weighted Average Cost of Capital enters with a positive but insignificant coefficient. As the WACC is thought to be the main direct regulatory tool for companies operating under cost of service, we dig into it a bit further by estimating the same specification for the RoR sub-sample. With only 31 firm-year observations we do not report the results, but nonetheless register that the WACC enters with a positive and significant coefficient (p-value = 9.3%; the results are available on request), consistent with the idea that utilities tend to increase their investment the higher is the allowed rate of return.

The remaining columns focus on firms under incentive regulation. In column (2) we find that capped utilities are less sensitive to the allowed rate of return. In column (3) we experiment with the *Change in WACC* because the variation in the cost of capital may affect investment in a way similar to the *X factor*, i.e. through a *change* in the price (while the *level*

[22] This view is consistent with Vogelsang (2006), who studies the relationship between the length of regulatory cycles and investment when performance-based regulation is applied to electric transmission and finds that, in the short run, productivity-enhancing objectives can be achieved by using cap mechanisms, such as profit sharing schemes. On the contrary, infrastructure investment incentives should be based on rate-of-return regulation with a "used and useful" criterion because they imply long-term adjustments.

of the WACC is expected to affect the *level* of the price). We find that the coefficient is positively signed, though again insignificant. In column (4) we explore the role of the X-factor. The results show that the coefficient on the X-factor is negative and highly significant, indicating that, under more (less) stringent regulatory schemes, European energy utilities tend to curb (increase) their investment. Our interpretation is that an increase (cut) in the X factor reduces (increases) the ex post expected return of the cost reducing investment and cash flow, curbing the investment decision. However, the tightness of regulation may be itself endogenous, reflecting the (social) desirability of the investment decision, the political stance of the government and regulatory opportunism. In other word, the regulator might allow higher rates when more investment is needed (or viceversa), and then may (or may not) increase the X (thereby reducing the price) as soon as the investment is sunk. Or the regulator might raise the X because the investment was delivered more cheaply than had been initially expected so that the price can be reduced without harming the utility. In this case the change in the X would not be the cause, but the consequence of the investment. To address this delicate issue, we rely on instrumental variable techniques. In column (5) and (6) we present the 2SLS and GMM estimates of our investment model for the sub-sample of incentive regulated utilities extended to regulatory tools. The instrument set for the 2SLS estimation includes variables measuring the institutional, sectoral and political environment while the GMM estimator uses, as in Table 5, only lags of the right-hand side variables as instruments. The estimated coefficient on the X factor keeps its negative sign and is always significant whether we use 2SLS or the GMM estimators, suggesting that the negative relationship between the X and the investment rate is robust when we account for potential endogeneity of the X setting by the regulator. However our results also show that, similarly to Table 5, when we control for reverse causality of ownership, the private control dummy becomes insignificant.

The last piece of evidence refers to the sub-sample of 15 electric utilities, of which we study the investment behaviour in relation to the changes in regulatory variables.[23] We report the results in the Appendix (Table A3). We find that, in spite of the small size of the sample, the estimated coefficients are well defined and significant. The WACC always enters positively and significantly, both for the full sample (Column (1)) and for the electric utilities under incentive regulation. The X factor is negatively and significantly related with the investment rate, also when we apply the instrumental variables methods to control for

[23] Due to small sample problems we do not report the results for the five gas utilities.

potential endogeneity of the X setting. Overall, the sharper results on the electric utilities confirm that investment decisions respond to regulatory interventions quite consistently with their predicted policy impact.

6. Conclusions

The European and U.S. energy sectors differ in many respects. Regulation and market reforms promoting liberalization were only introduced in the late 1990s and are still in their early phase. In addition, despite the privatisation wave, private ownership and control of energy utilities is still the exception rather than the rule. Therefore, it is important to gauge the effectiveness of regulatory interventions in Europe in this decade and to do so by taking ownership into account. This paper investigates whether investment decisions of European energy utilities differ from 1997 to 2007 with the regulatory regimes, accounting for cross-country structural differences as well as for potential endogeneity of the regulatory scheme and firm ownership.

The econometric analysis shows that firm investment is higher under incentive regulation and that, consistently with the theory, incentive regulated investment is negatively related to the level of the X factor set by the NRA. The responsiveness of investment to incentive regulation and to cash flow and the lack of significance of the proxies for country energy supply and demand suggest that the type of investment delivered in the early years of regulation and liberalization was more likely aimed at enhancing efficiency and profitability than at expanding infrastructure capacity. We also find that the expected positive effect of the WACC on firms' investments only surfaces when we focus the analysis on the sub-sample of electric utilities.

These results are robust to instrumental variable techniques that employ either institutional, political and indexes that describe the regulatory environment or lagged regressors as instruments. In contrast, when we control for the potential endogeneity of ownership, the positive relationship between private control and investment is no longer significant. This suggests that the expected effects of privatization on investment of European energy utilities have so far not materialized, and, rather, that regulation seems to create an environment which somewhat reduces the differences between private and public incentives to invest .

Just because the time range we cover has witnessed the first steps of regulation and liberalization, further investigation is needed. Our results are suggestive of two directions for future research. The first one digs into ownership and control of energy utilities, as the preliminary evidence that investment is higher at privately controlled firms was not robust when we controlled for endogeneity. This issue could be investigated by including managerial incentive compensations, though difficult to find, in an effort to identify potential sources of differences in the behaviour of private and public managers. The second extension is the analysis of the potential complementarity between incentive regulation and competition. European energy utilities entered into a regulated environment while shifting not only from public to (partially) private ownership, but also from quasi-monopoly to (still very incomplete and imperfect) competition. This may explain why newly settled regulators have chosen efficiency-enhancing incentive regulation, and obtained – as shown by our results – that utilities opted for cost reducing investment. From now on, the usual trade-off between social and private interests, that is between efficiency and social welfare related investment, is likely to become the next priority in the agenda, and this is why it will be important to focus on the interrelations between incentive regulation and competition as it gradually strengthens within European energy utilities.

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Table 1– Descriptive statistics of economic and energy indicators by country

Mean values from 1997 to 2007 (Sources: Eurostat, OECD)

			Panel A		
Regulatory Regimes	**France**	**Germany**	**Italy**	**Spain**	**UK**
Electricity	RoR	RoR	RoR* Incentive Regulation	RoR** Incentive Regulation	Incentive Regulation
Gas	RoR	RoR	RoR* Incentive Regulation	RoR*** Incentive Regulation	Incentive Regulation
			Panel B		
Structural Indicators					
Manufacturing Share of GDP [a]	0.146	0.228	0.195	0.168	0.156
Energy Supply per GDP [b]	0.169	0.159	0.120	0.143	0.147
Energy Dependence [c]	50.943	60.784	85.152	78.302	-2.222
Price Indexes					
Energy price [d]	103.750	112.905	106.359	107.016	105.925
Gas price [e]	9.195	10.028	9.970	10.666	7.300
Electricity price [f]	0.092	0.129	0.151	0.090	0.099
Long term Interest rate (%)	4.482	4.385	4.634	4.447	5.050

Notes:

* Up to 1999
** Up to 1997
*** For gas distribution up to 2001, for gas transmission up to 2002
[a] Value added of manufacturing divided by total GDP, current prices. Source: OECD.
[b] Total primary energy supply per unit of GDP (Toe per thousand 2000 US dollars of GDP calculated using PPP). Source: OECD.
[c] Percentage - The indicator is calculated as net imports divided by the sum of gross inland energy consumption. Source: Eurostat
[d] Energy Consumer Price Index (year 2000 = 100). Source: OECD
[e] Euro per Giga Joule. Source: Eurostat
[f] Euro per kWh. Source: Eurostat

Table 2 – Descriptive statistics of national economic and energy indicators by regulatory regime

Mean values from 1997 to 2007 (Sources: Eurostat, OECD)

Description variable	*Incentive Regulation*		*Rate of return regulation*		Mean diff.
	Mean	Std. dev	Mean	Std Dev	Sign.
Structural Indicators					
Manufacturing Share of GDP	0.176	0.022	0.183	0.038	*
Energy Supply per GDP	0.133	0.013	0.156	0.018	***
Energy Dependence	62.685	41.261	61.012	11.639	-
Price Indexes					
Energy price	107.989	12.068	103.368	14.755	**
Gas price	9.259	1.925	9.664	1.724	-
Electricity price	0.120	0.029	0.112	0.026	*
Long term Interest rate	4.618	0.695	4.655	0.748	-
Regulatory Variable					
WACC	0.071	0.001	0.070	0.001	-
X factor	0.025	0.016			

***, **, * denote significance at 1%, 5% and 10%. See notes to Table 1.

Table 3 - Firms' sample (1997-2007)

		TRANSMISSION	DISTRIBUTION
ELECTRICITY	**Italy**	Terna (TSO)	Enel, AEM Milano ASM Brescia, Iride, Hera, ACEA
	Spain	Red Electrica (TSO)	Endesa, Iberdrola, Union Ferosa
	UK	National Grid (TSO)	Scottish Power, CE Electric, Scottish and Southern Energy
	France	EDF	EDF
	Germany	E.On, RWE	E.On, RWE
GAS	**Italy**	Snam Rete Gas (TSO)	AEM Milano, ASM Brescia Italgas, Hera
	Spain	Enagas	Gas Natural
	UK	National Grid	National Grid
	France	Gaz de France	Gaz de France
	Germany	E.On (Ruhrgas), RWE	E.On (Ruhrgas), RWE

Table 4 - Descriptive statistics

Panel A - Full sample

Variable	Mean	Std. Dev.	Min	Max	No. Obs.
Capex to total asset	0.067	0.032	0.013	0.209	211
Log of sales	3.625	0.655	2.423	4.905	220
Cash Flow to total asset	0.087	0.041	0.001	0.286	218
Private control	0.427	0.496	0	1	222
Incentive Regulation	0.702	0.458	0	1	222
Regulatory variables					
WACC	0.070	0.008	0.040	0.097	160
X Factor	0.025	0.016	0.000	0.050	134

Panel B – Regulation – Incentive and RoR

Variable	Mean diff. Sign.	**Incentive Regulation**			**RoR**		
		Mean	Std. Dev.	No. Obs.	Mean	Std. Dev.	No. Obs.
Capex to total asset	***	0.071	0.033	153	0.057	0.026	58
Log of sales	***	3.423	0.527	154	4.096	0.685	66
Cash Flow to total asset	***	0.095	0.037	153	0.068	0.044	65
Private control	***	0.506	0.501	156	0.242	0.431	66
Regulatory variables							
WACC	-	0.071	0.009	121	0.070	0.005	39
X Factor		0.025	0.016	134	-	-	-

***, **, * denote significance at 1%, 5% and 10%

Panel C – Ownership Private and Public

Variable	Mean diff. Sign.	Private			Public		
		Mean	Std. Dev.	No. Obs.	Mean	Std. Dev.	No. Obs.
Capex to total asset	***	0.074	0.030	93	0.062	0.032	118
Log of sales	-	3.684	0.556	93	3.582	0.718	127
Cash Flow to total asset	**	0.098	0.040	93	0.078	0.039	125
Incentive regulation	***	0.831	0.376	95	0.606	0.490	127
Regulatory variables							
WACC	**	0.068	0.008	55	0.072	0.008	105
X Factor	***	0.013	0.011	61	0.035	0.010	73

***, **, * denote significance at 1%, 5% and 10%

Table 5 – Investment Decisions, Regulatory Regimes and Ownership of European Energy Utilities

Investment rate	**OLS**		**Fixed effects estimate**		**2SLS Estimation**		**One-step difference GMM**	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Investment Rate $_{t-1}$	0.487***	0.458***	0.204***	0.181**	0.182**	0.160*	0.337***	0.341***
	(0.089)	*(0.094)*	*(0.068)*	*(0.072)*	*(0.072)*	*(0.082)*	*(0.106)*	*(0.106)*
ΔLog of Sales $_t$	0.052***	0.048***	0.064***	0.066***	0.063**	0.064**	0.155***	0.150***
	(0.017)	*(0.017)*	*(0.023)*	*(0.024)*	*(0.026)*	*(0.025)*	*(0.051)*	*(0.049)*
Cash Flow to Total Asset $_{t-1}$	0.159**	0.124*	0.168**	0.151*	0.146*	0.177**	0.146	0.152
	(0.069)	*(0.066)*	*(0.075)*	*(0.075)*	*(0.084)*	*(0.083)*	*(0.168)*	*(0.166)*
LT Interest Rate $_{t-1}$	0.003	-0.004	0.011	0.015	0.014	0.022*	-	-
	(0.006)	*(0.007)*	*(0.009)*	*(0009)*	*(0.009)*	*(0.012)*	-	-
Manufacturing Share of GDP $_{t-1}$	-0.061	-0.026	0.136	0.046	0.023	0.226	-0.275	-0.329
	(0.062)	*(0.053)*	*(0.216)*	*(0.304)*	*(0.345)*	*(0.312)*	*(0.800)*	*(0.831)*
Incentive Regulation Dummy$_t$	-	0.009**	-	0.022*	0.026*	0.038**	0.037*	0.038*
	-	*(0.004)*	-	*(0.012)*	*(0.014)*	*(0.015)*	*(0.012)*	*(0.021)*
Private Control Dummy$_t$	-	0.007*	-	0.033***	-	0.052	-	0.022
	-	*(0.004)*	-	*(0.004)*	-	*(0.136)*	-	*(0.015)*
Arellano-Bond test for AR(1) (p-value)	-	-	-	-	-	-	0.016	0.015
Arellano-Bond test for AR(2) (p-value)	-	-	-	-	-	-	0.482	0.512
Hansen χ^2 test of overid. restrictions (p-value)	-	-	-	-	-	-	0.995	0.999
R squared (within)	0.459	0.481	0.252	0.299	0.608	0.623	-	-
F-test (p value)	-	-	0.00	0.00	0.00	0.00	-	-
N. Firms [N. Obs.]	186 [23]	186 [23]	186 [23]	186 [23]	186 [23]	182 [23]	138 [23]	138 [23]

OLS, Fixed-effects and I.V. estimates. All regressions include year dummies. Columns (3)-(8) also include firm dummies. The instruments used to 2SLS and GMM estimations are described in footnote 22 while the correlation matrix is in Table A1. Standard errors in parentheses are robust to heteroschedasticity and to within group serial correlation. ***, **, * denote significance at 1%, 5% and 10%.

Table 6 – Investment Decisions of EU Energy Utilities and Regulatory Variables (WACC and X Factor)

Investment rate	Full sample	Firms Under Incentive Mechanisms			Incentive Regulation	
					2SLS Estimation	One-step difference GMM
	(1)	(2)	(3)	(4)	(5)	(6)
Investment Rate $_{t-1}$	0.136	0.141	0.187	0.117	0.063	0.188***
	(0.115)	*(0.117)*	*(0.130)*	*(0.085)*	*(0.123)*	*(0.058)*
ΔLog of Sales$_t$	0.057**	0.070**	0.072**	0.062***	0.067**	0.168*
	(0.024)	*(0.031)*	*(0.032)*	*(0.011)*	*(0.029)*	*(0.098)*
Cash Flow to Total Asset $_{t-1}$	0.143**	0.148*	0.133	0.166**	0.185***	-0.257
	(0.069)	*(0.082)*	*(0.102)*	*(0.067)*	*(0.071)*	*(0.246)*
Manufacturing Share of GDP $_{t-1}$	-0.187	-1.478	-0.774	-1.063	-0.469	0.014
	(0.314)	*(0.939)*	*(1.391)*	*(0.964)*	*(1.141)*	*(1.602)*
Private Control Dummy$_t$	0.028***	0.031***	0.033***	0.036***	0.090	0.152
	(0.004)	*(0.007)*	*(0.006)*	*(0.005)*	*(0.072)*	*(0.120)*
Incentive Regulation Dummy$_t$	0.059***	-	-	-	-	-
	(0.007)	-	-	-	-	-
WACC$_t$	0.782[a]	0.385	-	-	-	-
	(0.473)	*(0.448)*	-	-	-	-
Change in WACC$_t$	-	-	0.257	-	-	-
	-	-	*(0.225)*	-	-	-
X Factor$_t$	-	-	-	-0.676**	-1.280*	-2.652**
	-	-	-	*(0.269)*	(0.738)	(0.999)
Arellano-Bond test for AR(1) (p-value)	-	-	-	-	-	0.036
Arellano-Bond test for AR(2) (p-value)	-	-	-	-	-	0.285
Hansen χ^2 test of overid. restrictions (p-value)	-	-	-	-	-	0.999
R squared (within)	0.311	0.312	0.316	0.349	0.595	-
F-test (p value)	118.26 (0.00)	3.46 (0.00)	321.5 (0.00)	11.03 (0.00)	14.07 (0.00)	-
N. Firms [N. Obs.]	143 [20]	112 [16]	104 [16]	126 [19]	124 [19]	100 [19]

[a] P value = 0.115

Fixed-effects in columns (1)-(4) and I.V. estimates in columns (5) and (6). All regressions include firm and year dummies. The instruments used to 2SLS and GMM estimations are described in footnote 22 while the correlation matrix is in Table A1. Standard errors in parentheses are robust to heteroschedasticity and to within group serial correlation. ***, **, * denote significance at 1%, 5% and 10%.

Appendix A1 – Correlations Matrix

	Investment Rate	*Incentive Regulation*	*Private Control*	*X Factor*	*Manufacturing Share of GDP*	*Energy Supply per GDP*	*Energy Dependency*	*Political Orientation*	*Entry Regulation*	*Common Law legal origin*
Investment Rate	1.000									
Incentive Regulation	0.208***	1.000								
Private Control	0.189***	0.244***	1.000							
X Factor	-0.253***	-	-0.732***	1.000						
Manufacturing Share of GDP	-0.069	-0.130*	-0.305***	0.718***	1.000					
Energy Supply per GDP	-0.077	-0.582***	0.251***	-0.645***	-0.279***	1.000				
Energy Dependency	0.004	0.024	-0.467***	0.210**	0.395***	-0.510***	1.000			
Political Orientation	-0.002	0.218***	-0.380***	0.518***	-0.061	-0.371***	0.464***	1.000		
Market Entry	0.070	-0.575***	-0.257***	0.181**	0.292***	0.140**	0.183***	-0.230***	1.000	
Common Law legal origin	0.085	0.310***	0.550***	-0.217**	-0.361***	0.1680**	-0.908***	-0.414***	-0.311***	1.000

Data Sources

Structural Indexes

- EUROSTAT (http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/main_tables)
- OECD Factbook 2009: Economic, Environmental and Social Statistics (ISBN 92-64-05604-1)

Political Orientation

- Bortolotti B. and M. Faccio (2008), "Government Control of Privatized Firms," Forthcoming in *Review of Financial Studies*

Sectoral Indexes of Market regulation: intensity of market regulation and market liberalization

- OECD International Regulation database: Conway and Nicoletti (2006), "Product Market Regulation in Non-Manufacturing Sectors in OECD Countries: Measurement and Highlights," OECD Economics Department Working Paper, http://www.oecd.org/eco/pmr

Appendix A2 – Investment, Regulation and Ownership with Energy Supply Structural Indicator

Investment rate	**Fixed effects estimate**	**2SLS Estimation**	**One-step difference GMM**
	(1)	**(2)**	**(3)**
Investment Rate $_{t-1}$	0.182**	0.168**	0.288***
	(0.070)	*(0.075)*	*(0.104)*
ΔLog of Sales $_t$	0.073***	0.069**	0.174***
	(0.025)	*(0.026)*	*(0.054)*
Cash Flow to Total Asset $_{t-1}$	0.154*	0.168*	0.050
	(0.076)	*(0.085)*	*(0.102)*
LT Interest Rate $_t$	0.009	0.014	-
	(0.011)	*(0.009)*	-
Energy Supply per GDP $_{t-1}$	-0.813	-0.768	- 0.706
	(0.576)	*(0.698)*	*(1.197)*
Incentive Regulation Dummy$_t$	0.027**	0.043**	0.031*
	(0.013)	*(0.019)*	*(0.018)*
Private Control Dummy$_t$	0.035***	0.019	0.001
	(0.005)	*(0.109)*	*(0.129)*
Arellano-Bond test for AR(1) (p-value)	-	-	0.026
Arellano-Bond test for AR(2) (p-value)	-	-	0.261
Hansen χ^2 test of overid. restrictions (p-value)	-	-	0.999
R squared (within)	0.315	0.660	-
F-test (p value)	90.31 (0.00)	-	-
N. Firms [N. Obs.]	186 [23]	158 [23]	138 [23]

Fixed-effects and I.V. estimates. All regressions include firm and year dummies. The instruments used to 2SLS and GMM estimations are described in footnote 22 while the correlation matrix is in Table A1. Standard errors in parentheses are robust to heteroschedasticity and to within group serial correlation. ***, **, * denote significance at 1%, 5% and 10%.

Appendix A3 – Investment and Regulatory Variables in Electric Industry

	Full sample	2SLS Estimation	Incentive Regulation Fixed effects			Incentive Regulation 2SLS	Incentive Regulation GMM
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Capex to Total Assets$_{t-1}$	0.125	- 0.000	0.117	0.172	0.156	0.038	0.223**
	(0.125)	*(0.153)*	*(0.150)*	*(0.148)*	*(0.108)*	*(0.152)*	*(0.105)*
ΔLog of Sales$_t$	0.038***	0.078**	0.041**	0.041**	0.033**	0.074**	0.036**
	(0.013)	*(0.031)*	*(0.016)*	*(0.017)*	*(0.012)*	*(0.038)*	*(0.015)*
Cash Flow to Total Asset$_{t-1}$	0.144*	0.119*	0.154	0.156	0.181**	0.203***	-0.082
	(0.080)	*(0.068)*	*(0.099)*	*(0.111)*	*(0.085)*	*(0.079)*	*(0.149)*
Manufacturing Share of GDP$_{t-1}$	-0.455	*-0.337*	-0.727	-1.271	-0.301	-0.137	2.201
	(0.351)	*(0.266)*	*(1.352)*	*(1.482)*	*(1.250)*	*(1.443)*	*(1.850)*
Private Control Dummy$_t$	0.030***	0.062	0.030***	0.036***	0.037***	0.098	0.114
	(0.004)	*(0.045)*	*(0.005)*	*(0.006)*	*(0.006)*	*(0.064)*	*(0.093)*
WACC$_t$	1.608**	4.059*	1.713**	-	-	-	-
	(0.657)	*(1.943)*	*(0.597)*	-	-	-	-
Change in WACC$_t$	-	-	-	0.917*	-	-	-
	-	-	-	*(0.524)*	-	-	-
X Factor$_t$	-	-	-	-	-0.749**	-1.545*	-1.423**
	-	-	-	-	*(0.275)*	*(0.942)*	*(0.550)*
R squared (within)	0.408	0.582	0.412	0.389	0.397	0.526	-
F-test (p value)	969.70 (0.00)	-	582.77 (0.00)	635.94 (0.00)	269.85 (0.00)	11.10 (0.00)	-
Arellano-Bond test for AR(1) (p-value)	-	-	-	-	-	-	0.009
Arellano-Bond test for AR(2) (p-value)	-	-	-	-	-	-	0.496
Hansen χ^2 test (p-value)	-	-	-	-	-	-	0.999
N. Firms [N. Obs.]	102 [15]	107[15]	81 [12]	81 [12]	96 [15]	100 [15]	69[15]

Fixed-effects and IV estimates. All regressions include firm and year dummies. The instruments used to 2SLS and GMM estimations are described in footnote 22 while the correlation matrix is in Table A1. Standard errors in parentheses are robust to heteroschedasticity and to within group serial correlation. ***, **, * denote significance at 1%, 5% and 10%.