Book Chapter

Investment and the Strategic Role of Capital Structure in Regulated Industries: Theory and Evidence

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1. Introduction

In the past 30 years, many countries around the world have fundamentally reformed their public utilities sector. Among other things, these reforms included a large scale privatization of state-owned utilities and the establishment of sector-specific Independent Regulatory Authorities (IRAs) to regulate them. In this paper, we provide a summary and synthesis of results from an on-going research project on the effect of privatization and the establishment of IRAs on the capital structure and investments of regulated firms and on regulated prices. In particular, we draw heavily on results from Bortolotti, Cambini, Rondi and Spiegel (2011; henceforth BCRS), Cambini and Rondi (2011a and 2011b) and Cambini and Spiegel (2011; henceforth CS), although we will also provide some new results on the interaction between the ownership structure of regulated utilities, their investment levels, and regulatory independence.

Our research is motivated in part by the fact that investments by regulated firms in infrastructure are crucial for the economy at large (see e.g., Guthrie 2006) and account for a significant fraction of GDP. For instance, in 2008, investments of public utilities in infrastructure accounted for 15.24% of GDP on average in the EU 15 countries that were members of the EU before the enlargement on 1st May 2004 (see the Appendix in CS for details). Another motivation for our research is the fact that at least in the EU, the structural reforms in the public utilities sector were accompanied by a substantial increase in the financial leverage of regulated utilities. This trend, coined the "dash for debt," has raised substantial concerns among policy markers. For instance, a joint study of the UK Department of Trade and Industry (DTI) and the HM Treasury argues that the "dash for debt" within the UK utilities sector from the mid-late 1990's "could imply greater risks of financial distress, transferring risk to consumers and taxpayers and threatening the future financeability of investment requirements" (DTI and HM Treasury, 2004, p. 6). Similar concerns were expressed by the Italian energy regulatory agency (see e.g., AEEG 2008, paragraph 22.13).

The paper is organized as follows: In Section 2 we briefly describe the relevant structural reforms in the EU. In Section 3 we present a theoretical model which we use to derive testable hypothesis regarding the leverage and investment levels of regulated firms, and the effect of leverage on regulated prices. Section 4 presents our empirical results. Concluding remarks are Section 5.

2. Structural reforms in the public utilities' sector in the EU

Until the early 1990's (or the early 1980's in the UK), public utilities in Europe were largely characterized by vertical integration, state monopoly, and public ownership. Regulated prices were mainly set to counterbalance the rise of inflation and utilities were often asked to absorb labor whenever unemployment increased. The result was ill-performing monopolies and inefficiencies (Megginson and Netter, 2001).

The structural reforms of the public utility sector in the EU were promoted by the European Commission through a series of Directives, aimed at redesigning the legal and regulatory framework in order to enhance cost efficiency, service quality, and encourage new investments. While the Commission was in favor of privatization of public utilities, the decision about the ownership structure of public utilities was left entirely in the hands of national governments. As of 2010, privatization of public utilities in the EU is far from complete; central and local governments still hold majority (and minority) ownership stakes in many regulated utilities.[4]

In order to regulate public utilities and avoid the government's potential conflict of interest in its dual role as an owner and a regulator, the European Commission has been promoting, since the mid 1980's, the delegation of regulatory tasks to Independent Regulatory Authorities (IRAs). These tasks typically involve price and quality standard setting, both at the retail and wholesale levels, the definition of entry conditions, and the setting technical rules for the usage of and access to existing infrastructures. Within this set of regulatory rules, utilities are free to make investment and financing decisions at their own discretion.

The implementation of structural reforms varies considerably across countries and sectors. The structural reforms are most advanced in the energy (electricity and gas) and telecommunication sectors. As Table 1 shows, sector-specific IRAs were established in all EU 27 countries and most firms are (at least partially) privatized. Yet, despite the reforms, many large utilities are still controlled by the government, particularly in France, Germany, Italy and Portugal, and especially so in the natural gas industry. The structural reforms are less developed in water supply and in transportation infrastructure (docks and ports, airports and freight motorways). With the exception of the UK, most water and transportation utilities are still controlled by central and local governments and still regulated directly by the state rather than by IRAs.[5]

The heterogeneity of institutional structure allows us to examine the effect of private- versus state-ownership and of regulatory independence on the capital structure and investment decisions of regulated firms and the effect of leverage on regulated prices. It is worth noting that a similar heterogeneity is present in many countries outside Europe. Table 2 reports relevant data for selected South American and East Asian countries.

3. The model

This section, which draws on CS, establishes a number of empirical predictions on the effect of regulatory independence and privatization on the capital structure and investments of regulated firms, and on the interaction between leverage and regulated prices. In Section 4 we will examine these predictions empirically. The interested reader is referred to CS for more details and for formal proofs.

3.1. The regulated firm and the rate setting process

Consider a regulated firm, which for simplicity faces a unit demand function. The willingness of consumers to pay, $V(k)$, is an increasing and concave function of the firm's investment, k. Consumers' surplus is given by $V(k)-p$, where p is the regulated price.

The regulated firm is partially owned by the state. The state's stake in the firm's equity is δ. To capture the effect of δ on the firm's behavior, we adopt the *managerially-oriented public enterprise* (MPE)

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

[5] Only recently, the energy IRAs in some new member states (Latvia and Lithuania) started regulating the water sector within a multi-sector regulatory model. And, from 2006, the German IRA (named *Bundesnetzagentun*) started regulating the railways sector.

approach, due to Sappington and Sidak (2003). The key assumption in this approach is that the (partially) state-owned firm's objective function is a weighted average of the firm's profits, π, and revenue, R, and given by $\delta R+(1-\delta)\pi$. Noting that $\pi = R-C$, where C is cost, we can rewrite the firm's objective function as $R-(1-\delta)C$. That is, the firm behaves as if it ignores a fraction δ of its cost. This reflects the idea that managers of MPEs often have considerable interest in expanding the scale or scope of their activities and expand the firm's budget and labor force either for political reasons or due to moral hazard and weak monitoring by the state.

To model the firm's choice of capital structure, we assume that the firm issues debt with face value D, which it needs to cover from its operating income. Due to random cost shocks (e.g., fluctuating energy prices), the firm's cost of production, c, is random and is distributed uniformly over the interval $[0, \bar{c}]$, where $\bar{c} < V(0)$. If the firm's operating income $p–c$, is insufficient to cover D in full, the firm incurs a fixed cost of financial distress T. Using $\phi(p,D)$ to denote the probability of financial distress, the total expected cost of the firm is $C = \frac{\bar{c}}{2} + \phi(p,D)T$, where,

$$\phi(p,D) = \begin{cases} 0 & D+\bar{c} \le p, \\ 1-\dfrac{p-D}{\bar{c}} & D \le p < D+\bar{c}, \\ 1 & p < D. \end{cases} \tag{1}$$

Intuitively, as long as $D+\bar{c} \le p$, the firm can always pay D in full, so $\phi(p,D) = 0$. When $p < D$, the firm cannot pay D in full even when $c = 0$, so $\phi(p,D) = 1$. For intermediate cases, $\phi(p,D)$ is increasing with D and decreasing with p.

We follow Dasgupta and Nanda (1993) and Spiegel (1994) and Spiegel and Spulber (1997) by assuming that the regulator chooses the regulated price, p, to maximize a social welfare function defined over consumers' surplus, $V(k)$-p, and the firm's objective function. In line with Levy and Spiller (1994), Gilardi (2002), and Edwards and Waverman (2006), we will assume that a greater degree of regulatory independence improves the regulators' ability to make long-term commitments to regulatory policies.

Specifically, we assume that before the firm invests, the regulator commits with probability ρ to take into account the ex ante objective function of the firm, which includes k, and hence sets p by maximizing the ex ante social welfare function

$$\left(V(k)-p\right)^{\gamma}\left(p-(1-\delta)C-k\right)^{1-\gamma}, \tag{2}$$

where $\gamma \in (0,1)$ captures the degree to which the regulator is pro-consumer. However, with probability $1-\rho$, the regulator behaves opportunistically and once k is sunk, he chooses p to maximize the ex post social welfare function which ignores k,

$$\left(V(k)-p\right)^{\gamma}\left(p-(1-\delta)C\right)^{1-\gamma}. \tag{3}$$

Hence, the parameter ρ captures the regulator's ability to make long-term commitments and therefore serves as our measure of regulatory independence, with larger values of ρ indicating a greater degree of independence.

3.2. The sequence of events

The game evolves in two stages. In stage 1, the firm chooses k and issues debt with face value D in a competitive capital market. If the funds raised by issuing D exceed k, the firm pays the excess funds as a dividend. If the funds raised by issuing D fall short of k, the firm raises additional funds by issuing equity; to simplify matters, we assume that in this case the state participates in the equity issue to maintain its original stake δ. In stage 2, given k and D, the regulator sets the regulated price p. Finally, the firm's cost c is realized, output is produced, and payoffs are realized.

3.3. The regulated price

In stage 2, the regulator sets p to maximize either (2) or (3). Let I be an indicator function which equals 1 with probability ρ (the regulator keeps his commitment to take k into account) and equals 0 with probability 1-ρ (the regulator behaves opportunistically and ignores k when he sets p). Then, the regulator's objective function can be written compactly as

$$\left(V(k)-p\right)^{\gamma}\left(p-(1-\delta)C-Ik\right)^{1-\gamma}. \tag{4}$$

Maximizing (4) with respect to p, yields the following regulated price:

$$p^*(D,k,I)=\begin{cases} D_1(k,I)+\bar{c} & D\le D_1(k,I) \\ D+\bar{c} & D_1(k,I)<D\le D_2(k,I) \\ D_1(k,I)+\bar{c}+M(D,I) & D_2(k,I)<D\le D_3(k,I) \\ D_1(k,I)+\bar{c}+\gamma(1-\delta)T & D>D_3(k,I) \end{cases} \tag{5}$$

where $D_1(k,I)\equiv(1-\gamma)V(k)+\gamma(1-\delta)\frac{\bar{c}}{2}+\gamma Ik-\bar{c}$, $M(D,I)\equiv\dfrac{\gamma(1-\delta)\frac{T}{\bar{c}}\left(D+(1+\delta)\frac{\bar{c}}{2}-Ik\right)}{1+(1-\delta)\frac{T}{\bar{c}}}$,

$D_2(k,I)\equiv\dfrac{D_1(k,I)\left(1+(1-\delta)\frac{T}{\bar{c}}\right)+\gamma(1-\delta)\frac{T}{\bar{c}}\left((1+\delta)\frac{\bar{c}}{2}-Ik\right)}{1+(1-\gamma)(1-\delta)\frac{T}{\bar{c}}}$, and $D_3(k, I)$ is smaller than the value of D for which $D_1(k,I)+\bar{c}+M(D,I)=D$. Notice that $p^*(D,k,I)$ is (weakly) increasing with D and with I.

3.4. The choice of capital structure

Assuming that the capital market is perfectly competitive, the market value of new equity and debt is exactly equal in equilibrium to their expected return. Let $\phi^*(D,k,I) \equiv \phi^*(p^*(D,k,I),D)$ be the probability of financial distress, given $p^*(D,k,I)$. With probability ρ, the regulator is committed and sets a price of $p^*(D,k,1)$. The resulting probability of financial distress is then $\phi^*(D,k,1)$. With probability 1-ρ, the regulator is opportunistic, so the regulated price and probability of financial distress are $p^*(D,k,0)$ and $\phi^*(D,k,0)$. Since the expected cost of the regulated firm is $C = \frac{\bar{c}}{2} + \phi^*(D,k,I)T$ and since the firm ignores a fraction δ of its cost by the MPE approach, the firm's objective function is,

$$\begin{aligned} Y(D,k) = \rho\left[p^*(D,k,1) - (1-\delta)\left(\tfrac{\bar{c}}{2} + \phi^*(D,k,1)T\right) - k\right] \\ + (1-\rho)\left[p^*(D,k,1) - (1-\delta)\left(\tfrac{\bar{c}}{2} + \phi^*(D,k,0)T\right) - k\right]. \end{aligned} \tag{6}$$

The firm chooses its debt level, D, and investment, k, to maximize $Y(D,k)$. In CS we prove the following result:

Proposition 1: *In equilibrium, the regulated firm will issue debt with face value $D_2(k,0)$ if $\rho < \rho^*$, and will issue a higher debt with face value $D_2(k,1)$ if $\rho > \rho^*$, where*

$$\rho^* \equiv \frac{(1-\gamma)(1-\delta)\frac{T}{\bar{c}}}{1+(1-\gamma)(1-\delta)\frac{T}{\bar{c}}}.$$

Moreover, holding k fixed, the debt level of the regulated firm is higher the lower is δ.

In what follows, we will say that the regulator is "independent" if $\rho > \rho^*$ (the regulator is committed to take k into account with a relatively high probability) and "non independent" if $\rho < \rho^*$. Proposition 1 implies that the firm issues more debt when it faces an independent regulator. Intuitively, an independent regulator is more likely to be committed, and therefore sets a higher regulated price. This enables the firm to issue more debt.

Proposition 1 also shows that more privatized firms (δ is lower) should issue more debt. The reason is that the firm ignores a smaller part of its cost when δ is lower. Consequently, the regulator, who sets p by taking into account the firm's objective function, will set a higher p. This induces the firm to issue more debt.

In sum, Proposition 1 implies that in a sample of regulated firms that differ only with respect to the values of ρ (how independent their regulator is) and δ (the state's stake in the firm), firms that are regulated by an IRA and are more privatized should be more leveraged.

3.5. The equilibrium level of investment

Proposition 1 shows that under a non-independent regulator ($\rho < \rho^*$), the firm issues debt with face value $D_2(k,0)$ and the regulator sets a price $D_2(k,0)+\bar{c}$, which ensures that the firm never becomes financially distressed. Substituting these expressions in (6), the resulting expected payoff of the firm is

$$Y^{NI}(k) \equiv Y(D_2(k,0),k) = D_2(k,0) + (1+\delta)\tfrac{\bar{c}}{2} - k. \quad (7)$$

When the regulator is independent ($\rho > \rho^*$), the firm issues debt with face value $D_2(k,1)$. With probability ρ, the regulator is committed and sets a regulated price $D_2(k,1)+\bar{c}$, which again ensures that the firm never becomes financially distressed. With probability 1-ρ, the regulator is opportunistic and sets a price $D_1(k,0)+\bar{c}+M(D_2(k,1),0)$, which leaves the firm susceptible to financial distress with probability

$$\phi^I(k) = 1 - \frac{p^*\left(D_2(k,1),k,0\right) - D_2(k,1)}{\bar{c}} = \frac{\gamma k}{\bar{c}\left(1+(1-\delta)\frac{T}{\bar{c}}\right)}. \quad (8)$$

The overall probability of financial distress is therefore $(1-\rho)\phi^I(k)$. The expected regulated price under an independent regulator is

$$Ep^*(k) = \rho D_2(k,1) + (1-\rho)\left[D_1(k,0) + M\left(D_2(k,1),0\right)\right] + \bar{c}. \quad (9)$$

Substituting from (8) and (9) into equation (6), CS show that the firm's expected payoff under an independent regulator is,

$$Y^I(k) \equiv Y(D_2(k,1),k) = Ep^*(k) - (1-\rho)(1-\delta)\phi^I(k)T - (1-\delta)\tfrac{\bar{c}}{2} - k, \quad (10)$$

Using $Y^{NI}(k)$ and $Y^I(k)$, CS prove the following result:

Proposition 2: *The equilibrium level of investment, k*, is independent of the degree of regulatory independence, ρ, when ρ < ρ*, but is increasing with ρ when ρ > ρ*. Consequently, the firm invests more when the regulator is independent (i.e., ρ > ρ*) than when the regulator is non independent (i.e., ρ < ρ*). Moreover, equilibrium level of investment, k*, is decreasing with δ.*

Proposition 2 implies that the firm should invest more when it faces an independent regulator and when it is more privatized. This result arises since $Ep^*(k)$ is higher when the regulator is independent and when δ is low; consequently, the marginal benefit of investment is higher, so the firm invests more. The first part of Proposition 2 is consistent with a number of empirical papers that found that the regulatory independence is associated with higher investments (e.g., Wallsten, 2001, Henisz and Zelner, 2001, and Gutièrrez, 2003).

Finally, in CS we prove the following result:

Proposition 3: *Taking into account the endogenous choice of investment, the firm's debt and the regulated price are higher when the regulator is independent (i.e.,* $\rho > \rho^*$*) than when the regulator is non independent (i.e.,* $\rho < \rho^*$*). Moreover, the firm's debt and the regulated price are both decreasing with the state's ownership stake* δ*.*

Proposition 3 implies that in a sample of regulated firms that differ only in terms of ρ and δ, the firm's debt and regulated price should be positively correlated. Moreover, in our model, debt affects the choice of regulated prices rather than vice versa.

4. Empirical results

Our empirical analysis is based on an unbalanced panel of 88 publicly traded utilities and transportation infrastructure operators from the EU 15 countries, over the period 1994 to 2005.[6] The interested reader is referred to BCRS for details on the construction of the data set. Descriptive statistics for our main variables are summarized in Table 3.

4.1 Leverage

Our measure of leverage is market leverage, which is defined as $D/(D+ME)$, where D is total financial debt (both long- and short-term) in book value and ME is the market value of equity (the number of outstanding shares at the end of the relevant year times the share price at that date expressed in U.S. dollars).[7]

We define firms as "privately-controlled" if the state's ultimate control rights (UCR), which take into account the state's direct stake in the firm, as well as its indirect stake via its holdings in other firms that have stakes in the regulated firm, are below 50%.[8] Otherwise the firm is defined as "state-controlled." Among the 88 firms in our sample, 42 firms are privately-controlled throughout our sample, 25 are state-controlled throughout our sample period, and 21 were privatized during our sample period and we therefore observe them before and after their privatization.

Figure 1 shows the evolution of market leverage from 5 years before privatization (year -5) to 5 years after privatization (year +5) for the 21 firms that were privatized during our sample period (solid line). Of these firms, 8 are energy utilities and 7 are telecoms. Figure 1 shows the evolution of market leverage for these subsamples (the dotted line for energy and dashed line for telecoms).

[6] The sample here has only 88 firms while in BCRS there are 92 firms. Since we estimate dynamic models that require us to use lagged variables as instruments, 4 firms with less than 5 consecutive observations drop from our sample.
[7] See Rajan and Zingales (1995) for a discussion of alternative leverage measures.
[8] The UCR variables were constructed by Bortolotti and Faccio (2009); the sources used to compute the state's UCR are listed in BCRS.

Figure 1 – Trend of the average market leverage for privatized utilities

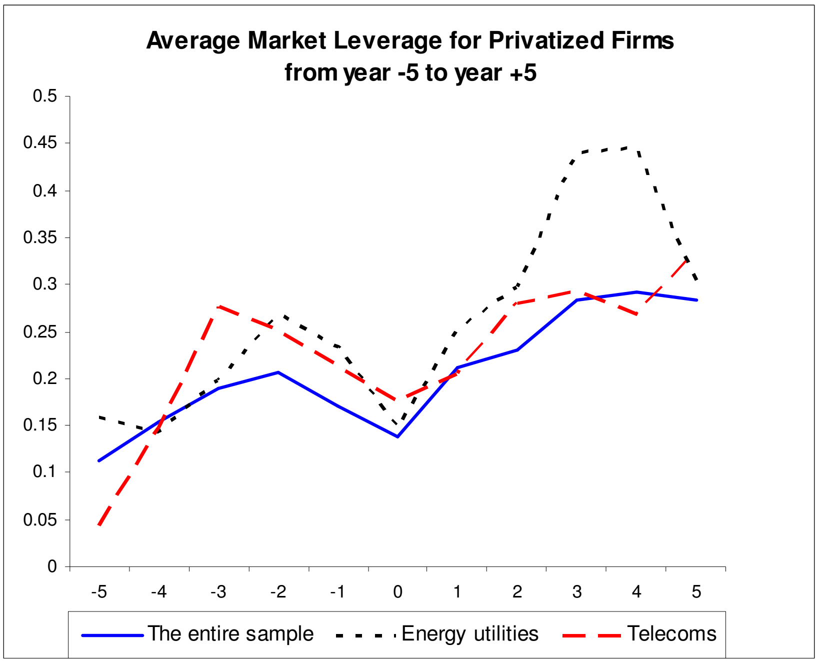

Figure 1 shows that privatized firms increase their market leverage around privatization from 11.3% in the year -5 to 28.4% in the year +5. The bulk of the increase though occurs following privatization, as market leverage increases from 13.8% in year 0 to 28.4% in year +5. The temporary decrease in market leverage from the year -2 to year 0 may be due to the increase in equity during the IPO in the year of privatization (year 0).

Figure 1 is consistent with Proposition 1, which implies that firms should increase their leverage when the government's stake in the firm falls, but it stands in contrast to the findings in Dewenter and Malatesta (2001), Megginson et al (1994), and D'Souza and Megginson (1999). These papers show that firms typically lower their leverage following privatization and this decrease can often be substantial. However, unlike us, these papers do not focus on regulated firms, and moreover, many of the regulated utilities in their samples were not regulated by IRAs.

We now turn to regression analysis. In BCRS, we estimated a static leverage equation, and found strong support for Proposition 1. Specifically, we found that privately-controlled firms tend to have a higher leverage than state-controlled firms, provided that they are regulated by IRA. We also showed that this result continues to hold when firms are defined as "privately controlled" if the state holds less than 30% of the UCR instead of 50%, when we use book leverage instead of market leverage, when we take into account the "golden shares" that some privately-controlled regulated firms have which give the state special control rights, and when we restrict attention to a sub-sample of energy utilities.

In this paper we take a different approach and estimate a dynamic leverage equation that accounts for the possible adjustment process of leverage in response to changes in the exogenous determinants of leverage. This approach allows us to estimate the log-run effects of regulatory independence and privatization. The specification is the following:

$$L_{it} = \alpha_0 + \beta L_{it-1} + \alpha_1 IRA_{it} + \alpha_2 Private\,Control_{it} + \alpha_3 Private\,Control_{it} * IRA_{it} \\ + \alpha_4 \mathbf{X}_{it} + \alpha_5\, GDP\,Growth_{it} + \alpha_6 Investor\,\mathrm{Pr}\,otection_{it} + \eta_i + d_t + \varepsilon_{it}, \tag{11}$$

where L_{it} and L_{it-1} are the *Market Leverage* of firm i in the years *t* and *t*-1, IRA_{it} is a dummy equal to 1 if firm *i* was subject to regulation by an IRA in year *t* and equal to 0 otherwise, $PrivateControl_{it}$ is a dummy equal to 1 if firm *i* was privately-controlled in year *t* and equal to 0 otherwise, $\mathbf{X}_{it}$ is a vector of firm-specific controls that may affect the choice of leverage, *GDP Growth* and the *Investor Protection* index reflect time-varying country-specific institutional factors,[9] η_i and d_t are firm and time fixed effects, and ε_{it} is an error term.

The vector $\mathbf{X}_{it}$ includes the log of real total assets to control for firm size, the ratio of fixed to total assets to control for asset tangibility (more tangible assets may serve as a collateral and lower the cost of debt), the ratio of EBIT (earning before interests and taxes) to total assets to control for "efficiency" (more efficient firms are likely to have higher earnings with the same assets), and the ratio of depreciation and amortization to total assets to control for tax shields. These variables are commonly used in empirical studies of capital structure.[10] We wish to find out if private control and the existence of an IRA affect the choice of leverage even after controlling for these variables.

The effects of ownership and regulatory independence on leverage are captured by the coefficients α_1, α_2, and α_3. The sum $\alpha_1+\alpha_3$ captures the effect of regulatory independence (IRA vs. no IRA) on the leverage of privately-controlled firms, while α_1 captures the effect of regulatory independence on the leverage of state-controlled firms. Likewise, $\alpha_2+\alpha_3$ captures the effect of ownership (private- vs. state-control) on the leverage of firms which regulated by an IRA, while α_2 captures the effect of ownership on the leverage of firms which are not regulated by an IRA. In the regression below, we will report the values of α_1, α_2, $\alpha_1+\alpha_3$, and $\alpha_2+\alpha_3$, and the p-values associated with tests on their significance.

To estimate equation (11), we use the dynamic System-GMM model developed by Arellano and Bond (1991) and Blundell and Bond (1998), which is especially designed for dynamic models where the lagged dependent variable is persistent and the lagged levels of the dependent variables are therefore weak instruments. For the validity of the GMM estimates it is crucial, however, that the instruments are exogenous. We therefore report the two-step Sargan-Hansen test statistic under the null of joint validity of the instruments, as well as autocorrelation test to control for first- and second-order correlations in the residuals.

Table 4 reports the one-step System-GMM estimates. The table shows that the various firm-specific controls are significant and their signs are generally consistent with earlier empirical studies on the determinants of the capital structure. The only exception is the negative and significant coefficient on *fixed-to-total assets* (our proxy for tangibility) which is typically found to be positive, reflecting the fact that

[9] The "investor protection" index, developed initially by La Porta *et al.* (1998) and updated by Pagano and Volpin (2005), increases from 0 to 7 as shareholders' rights become more protected. It is conceivable that higher values of this index are associated with a lower cost of equity.

[10] See for example, Rajan and Zingales (1995), and Frank and Goyal (2009).

tangible assets can serve as collateral and hence lower the cost of debt. However, in our sample, fixed assets are highly firm-specific and non-redeployable (e.g., roads, airports, physical electricity or telecommunications networks) and may therefore serve as poor collaterals.

More importantly for us, Column (1) shows that the coefficient on *IRA* is positive and significant: the point estimate shows that on average, IRA is associated with a 4.2% increase in leverage. The coefficient on the *PrivateControl* dummy is positive but insignificant. Column (2) shows that the coefficient of the *Private Control*IRA* dummy is positive and significant; this indicates that the positive effect of IRA on leverage is significantly larger for firms that are both privately-controlled and subject to regulation by an IRA.

Columns (3) and (4) show results for the sub-sample of firms that remained state- or privately-controlled throughout our sample period. The positive direct effect of IRA on leverage is even stronger now and equals to 4.8% on average. Column (4) shows that the coefficient of the *IRA*PrivateControl* dummy is also larger than it is for the entire sample.

Our dynamic specification allows us to estimate the long-run effect of the introduction of an IRA on leverage. In particular, a 1% increase in market leverage in the year t translates into a long-run increase of $1+\beta+\beta^2+\beta^3+\ldots = 1/(1-\beta)$ percents. Columns (1) and (3) show that the introduction of an IRA leads to a long-run increase in leverage by 7.2% for the full sample and by 8.3% for the firms that remained privately- or state-controlled throughout our sample period. Columns (2) and (4) show that if we restrict attention to privately-controlled firms, then the introduction of an IRA is associated with an even larger long-run increase in leverage: 9.2% for all privately-controlled firms and 11.9% for firms that were privately controlled throughout (these long-run effects are captured by the values of $(\alpha_1+\alpha_3)/(1-\beta)$ in Columns (2) and (4)). By contrast, the introduction of an IRA does not have a significant effect on the leverage of state-controlled firms, as the coefficients of $\alpha_1/(1-\beta)$ in Columns (2) and (4) are not significant.

Columns (1) and (3) also show that in and of itself, private control does not have a significant effect on leverage. Columns (2) and (4), however, show that if we restrict attention to firms that were regulated by an IRA, then *PrivateControl* does have a positive and significant effect on leverage, and its long-run effect for firms that were regulated by an IRA (captured by the values of $(\alpha_2+\alpha_3)/(1-\beta)$ in Columns (2) and (4)) are 7.7% for all privately-controlled firms and 8.3% for firms that were privately controlled throughout our sample period.

In sum, our estimates indicate that privatization together with regulation by an IRA has a positive and significant effect on leverage

4.2 Investment equation

Next, we estimate a following simple investment equation:

$$(I/K)_{it} = \beta_1(I/K)_{it-1} + \beta_2(CF/K)_{it-1} + \beta_3(S/K)_{it-1} + \alpha_1 \mathrm{IRA}_{it-1} + \alpha_2 PrivateControl_{it-1} + \\ + \alpha_3 IRA_{it-1}*PrivateControl_{it-1} + d_t + \eta_i + \varepsilon_{it}, \quad (12)$$

where $(I/K)_{it}$ and $(I/K)_{it-1}$ are the gross fixed investment (including new plants, property, and equipment, and accounting for mergers, acquisitions, or divestitures) to capital stock at the replacement value of firm i in the years t and t-1, $(CF/K)_{it-1}$ is the cash-flow to capital stock ratio of firm i in year t-1, $(S/K)_{it-1}$ is the sales to capital stock ratio of firm i in year t-1, η_i and d_t are firm and time fixed effects, and ε_{it} is an error term.[11]

Table 5 presents the Arellano-Blundell-Bond GMM-System estimates of equation (12). Table 5 shows that the coefficient β_1 of lagged investment is positive and significant; this indicates that the adjustment of capital is gradual. The table also shows that the coefficient β_2 of the cash flow term, which is included to reflect capital market imperfections (e.g., Hubbard, 1998), is also positive and significant.

More importantly for us, the results show that α_1, which captures the effect of IRA on the investment of state-controlled firms, is positive and significant in all columns. The sum $\alpha_1+\alpha_3$, which captures the effect of IRA on the investment of privately-controlled firms, is not significant however. These results provide support for Proposition 2, but only when firms are state-controlled.

Moreover, Columns (2) and (3) show that α_2 and $\alpha_2+\alpha_3$, which capture the effect of *PrivateControl* for state-controlled and for privately-controlled firms, are both insignificant. One possible reason why state-owned firms do not invest less than privately-controlled firms, as Proposition 2 predicts, might be that governments lean on state-owned firms to induce them to invest in order to advance their own political agenda. This type of political intervention is not captured by our theoretical model.

The signs and significance of α_1, α_2, and α_3 are broadly consistent with the findings in Cambini and Rondi (2010), who study a panel of energy utilities from 5 EU states over the period 2000 to 2007, and Cambini and Rondi (2011b) who study a panel of 80 regulated firms from the EU 15 states over the period 1994-2004.

The value of $\alpha_1/(1-\beta_1)$ in Table 5 shows that the presence of an IRA is associated with a long-run 3.4% increase in the investment rate of all state-controlled firms (Column (3)) and 2.5% for firms that remained state-controlled throughout the entire period (Column (5)). These effects are substantial given that Table 1 shows that the mean rate of investment (investment to capital stock) in our sample is 11.1%.

4.3 Leverage and regulated prices

Finally, we use the Granger causality tests to examine whether an increase in leverage is followed by an increase in regulated prices, but not vice versa, as Proposition 3 predicts.[12] In principle, Proposition 3 has three possible alternatives. First, if regulators can make a long-term commitment to regulated prices, then regulated prices will determine the firm's revenues (up to some exogenous demand shocks), so the firm would adjust its capital structure to match its expected revenue stream. Consequently, regulated prices would Granger-cause leverage. Second, leverage and regulated prices may be correlated due to a third variable that causes both of them. A third possibility is that leverage and regulated prices are simply not correlated.

[11] See Cambini and Rondi (2011b) for details on the construction of the gross investment and capital stock variables.

[12] Granger causality tests were also used in a similar context by a number of recent papers, including Alesina et al (2005) and Edwards and Waverman (2006).

We estimate the following bivariate VAR(2) dynamic model for sector- and country- specific retail price indices and leverage:

$$P_{it} = \alpha^{P}{}_{t-1}P_{i,t-1} + \alpha^{P}{}_{t-2}P_{i,t-2} + \beta^{P}{}_{t-1}L_{i,t-1} + \beta^{P}{}_{t-2}L_{i,t-2} + \sum_{i}\mu^{P}{}_{i}Firm_{i} + \sum_{t}\lambda^{P}{}_{t}Year_{t} + \varepsilon^{P}{}_{it}, \tag{13}$$

$$L_{it} = \alpha^{L}{}_{t-1}P_{i,t-1} + \alpha^{L}{}_{t-2}P_{i,t-2} + \beta^{L}{}_{t-1}L_{i,t-1} + \beta^{L}{}_{t-2}L_{i,t-2} + \sum_{i}\mu_{i}{}^{L}Firm_{i} + \sum_{t}\lambda_{t}{}^{L}Year_{t} + \varepsilon^{L}{}_{it}, \tag{14}$$

where P_{it} and L_{it} are the regulated price and market leverage of firm i in period t, $Firm_i$ and $Year_t$ are firm and year dummies, and $\varepsilon^{P}{}_{it}$ and $\varepsilon^{L}{}_{it}$ are error terms. Our hypothesis that, conditional on individual and time effects, leverage Granger-causes regulated prices, but not vice versa, requires that $\beta^{P}{}_{t-1}$ and $\beta^{P}{}_{t-2}$ are positive and significant, while $\alpha^{L}{}_{t-1}$ and $\alpha^{L}{}_{t-2}$ are not significant. Moreover, it requires that $L_{i,t-1}$ and $L_{i,t-2}$ contribute significantly to the explanatory power of regression (13), while $P_{i,t-1}$ and $P_{i,t-2}$ do not contribute significantly to the explanatory power of equation (14). Since we were unable to find reliable data at the individual firm level, the regulated prices we use are country- and sector-specific retail price indices.[13] All price indices are in constant 2005 prices.

The results of one-step GMM-system estimates of equations (13) and (14) are reported in Tables VIII and IX of BCRS. The results show that with the exception of firms which are not regulated by an IRA, or are state-controlled, the second lag of market leverage has a significant positive effect on regulated prices. Moreover, Wald statistics tests indicate that the first and second lags of market leverage are jointly significantly. By contrast, the lagged regulated prices do not have significant effect on leverage either individually or jointly.

These results imply that, so long as firms are privately-controlled and/or regulated by an IRA, leverage Granger-causes regulated prices, but not vice versa. This is consistent with Proposition 3 and inconsistent with the alternative hypotheses that long-term regulatory commitments to prices induce firms to adjust their capital structure to match their resulting expected revenue stream, or that leverage and regulated prices are driven by a third variable that causes them both.

5. Conclusions

In this paper we study the effect of privatization and regulatory independence on the capital structure of regulated firms, their investments, and the effect of financial leverage on regulated prices. The theoretical predictions in Section 3 are that (i) regulated firms should be more leveraged and should invest more when they are subject to regulation by IRAs, (ii) regulated firms should be more leveraged and should invest more when they are more privatized (the state holds a smaller stake in the firm), and (iii) higher leverage should lead to higher regulated prices.

[13] Airports, ports, and docks, are not included in our regressions since their services are considered to be intermediate rather than final services. We believe that given that there is still limited competition in the utilities sector and given that there is little price dispersion, our price indices appropriately reflect the relevant prices for the firms in our sample.

The empirical evidence in Section 4 from the EU 15 countries, provides strong support for hypotheses (i) and (iii), but much weaker support for hypothesis (ii). Specifically, our estimates reveal that the introduction of an IRA is associated with a long-run increase in leverage by 7.2% for the full sample and 8.3% for the subsample of firms that remained privately- or state-controlled throughout the period. The long-run effect of an IRA on the leverage is even larger if we restrict attention to privately-controlled firms: the long-run effect then is 9.2% for all privately-controlled firms, and 11.9% for firms that were privately controlled throughout our sample period. Moreover, the introduction of an IRA is associated with a long-run increase of 3.4% in the investment rate of all state-controlled firms and 2.5% for firms that remained state-controlled throughout our sample period. These effects are substantial given that the mean rate of investment in our sample is 11.1%.

Our results on privatization are less conclusive: in and of its own, private control does not have a significant effect on leverage or investment. However, when attention is restricted to firms that are regulated by an IRA, we do find a positive and significant effect of private control on leverage, though not on investment. In particular, under an IRA, private control is associated with a long-run increase in leverage by 7.7% for all privately-controlled firms and 8.3% for firms that were privately controlled throughout our sample period.

We also find, in line with hypothesis (iii), that so long as firms are privately-controlled and/or are subject to regulation by an IRA, lagged market leverage has a significant positive effect on regulated prices, but not vice versa. These results are consistent with the main premise of our theoretical model that regulated firms choose their leverage strategically to induce regulators to set higher prices.

Our results indicate that the “dash for debt” phenomenon observed in many countries is a natural response of regulated firms to the privatization process and the establishment of independent regulatory agencies. Our results also indicate that while the increase in debt is associated with higher regulated prices, it is also associated with higher investments and hence may be welfare enhancing.

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Table 1 - The timing of regulation and privatization in the energy and telecommunications sectors in the EU 27 countries

	Energy			Telecommunications	
		Electricity	Gas		
Country	**Date of establishing an IRA**	**Ownership (end 2010)**	**Ownership (end 2010)**	**Date of establishing an IRA**	**Ownership (end 2010)**
Austria	2000	State (51%)	Partially private (State 31%)	1997	Partially private (State 25%)
Belgium	1999	Partially private (State 49%)	Partially private (State 31%)	1991	State (> 50%)
Bulgaria	1999	State (100%)	State (100%)	2006	Private
Czech Rep.	2001	State (67%)	Private	2005	Private
Cyprus	2003	State (100%)	State (100%)	2002	State (100%)
Denmark	1999	--	--	2002	Private
Estonia	2008*	Partially private	Partially private	2008*	Private
Finland	1995	State (54%)	--	1987	State (>50%)
France	2000	State (85%)	Partially private (State 37.5%)	1996	Partially private (State 32%)
Germany	2006**	Private (State 2.5%)	Private (State 2.5%)	1996**	Partially private (State 28%)
Greece	2000	State (51%)	--	1992	Partially private (State 10%)
Hungary	1994	Private	Private	2003	Private
Ireland	1999	--	--	1997	Private
Italy	1995	Partially private (State 33%)	Partially private (State 20%)	1997	Private
Latvia	2001***	State	Private	2001***	State (51%)
Lithuania	1997****	State (96.5%)	Partially private (State 30%)	2004	Private
Luxemburg	2000	State (100%)	State (100%)	1997	State (100%)
Malta	2001	State	State	2001	Private
Netherlands	1998	--	--	1997	Private
Poland	1997	State (100%)	Private	2006	Private
Portugal	1995	Partially private (State 26%)	--	2001	Private (State 6%)
Romania	2000	Private	Private	2006	Partially private (State 46%)
Slovenia	2001	State	Partially private (State 31%)	2001	Partially private (State 49%)
Slovakia Rep.	2001****	State (51%)	State (51%)	2004	Partially private (State 49%)
Spain	1998	Private	Private	1996	Private
Sweden	1998	Private	Private	1992	State (> 50%)
UK	1989	Private	Private	1984	Private

* Since 1998 regulation is carried on by a branch of the Estonian Competition Authority.
** The IRA (Bundesnetzagentun) was originally in charge of regulating the telecommunications sector but since 2006 it also became in charge of started regulating the energy, railway and postal services.
*** The IRA was established with a multi-sector regulatory model (energy, telecoms, transport and water)
**** The regulatory agency is also in charge of regulating the water industry.
Source: International European Regulation Network (www.iern.net) for energy markets and European Regulators Group (http://www.erg.eu.int/) for telecommunications. For ownership see www.privatizationbarometer.net and www.enercee.net.
Note**:** *Private*: fully private company. *State*: majority of shares controlled by state; when data is available we also report the stakes controlled by the central or local governments, in combination with holdings by companies or entities fully owned by the government. *Partially private*: the government's share is below 50%; when available we report the exact residual state's stake. --: no available data.

Table 2 - The timing of regulation and privatization in the energy and telecommunications sectors in selected South American and Eastern Asian countries

	Energy			Telecommunications	
		Electricity	Gas		
Country	**Date of establishing an IRA**	**Ownership (end 2010)**	**Ownership (end 2010)**	**Date of establishing an IRA**	**Ownership (end 2010)**
Argentina	1993	Partially Private and State (100%)*	State (65%)	1990	Private
Brazil	1996	State (52%)**	Private	1997	Private
Chile	1978	Private	Private	1977	Private
Colombia	1994	State	--	1994	State (49%)
Ecuador	1996	--	--	1995	State (100%)
Perù	1996	Private	--	1994	Private
Mexico	1995	State	State	1996	Private
Uruguay	2002***	State	State	2001	State (100%)
Venuezuela	-	State (100%)	State (100%)	1991	State owned (renationalized in 2007 after being privatized in 1991)
China	-	State (100%)	State (100%)	-	State (100%)
India	1998	State	State (74%)	1997	State
Malaysia	2001	State (100%)	State (100%)	1998	Private
Phillippines	2001	Partially private (State 30%)	--	-	Private
Singapore	2001	State (100%)	State (100%)	1982	State (>50%)
Taiwan	-	State (100%)	--	2006	Partially privatized State (< 50%)
Thailand	2007	State	State	-	State

* Companies in generation and distribution are mostly privatized, while the transmission companies are still fully state-controlled.
** Most of the generating and transport companies are fully state controlled at national or federal level. Privatization occurs for in distributions (64% of the concessionaries are privately controlled). Here the reported percentage is related to Eletrobras, the largest power utility in Brazil.
*** Also operating in the water sector
Source: International European Regulation Network (www.iern.net) for energy markets. Gutierrez and Berg (1998) and Trillas and Montoya (2011) for telecommunications. See also the IRAs web sites. For ownership data on energy, we used the Companies' web sites.

Table 3 - Summary statistics
88 publicly listed European regulated firms, 1994 – 2005

Variable	Mean	Std. Dev.	Min	Max	No. Obs.
Market Leverage	0.182	0.169	0	0.881	757
Private Control	0.192	0.735	0	0.881	532
State control	0.158	0.151	0	0.757	225
Log of Real Total Asset	11.031	1.812	5.694	14.534	876
Tangibility	0.621	0.211	0.034	0.967	876
EBIT-to-Total Asset	0.073	0.099	-1.948	0.299	857
Non-debt Tax Shield	0.052	0.03	0	0.183	876
Investment to Capital Stock	0.111	0.072	0	0.673	703
Cash Flow to Capital Stock	0.135	0.102	-0.936	0.871	719
Sales to Capital Stock	0.742	0.803	0.020	6.191	684
Private Control dummy	0.624	0.484	0	1	876
Regulatory Independence dummy	0.594	0.491	0	1	876
Investor Protection	3.815	1.222	1	5	876
GDP Growth	2.461	1.347	-1.120	10.720	876

Table 4 – GMM estimates of a dynamic leverage equation

Dynamic panel-data estimation, one-step system GMM estimates. 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. 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%.

$Leverage_t$	**(1) Full sample**	**(2) Full sample**	**(3) Privately- or State-controlled throughout the period**	**(4) Privately- or State-controlled throughout the period**
$Leverage_{t-1}$ (β)	0.418***	0.361***	0.423***	0.430***
	(0.082)	*(0.082)*	*(0.087)*	*(0.088)*
Log of real total assets	0.012***	0.016***	0.006	0.009
	(0.004)	*(0.005)*	*(0.006)*	*(0.007)*
Fixed-to-Total Assets	-0.099**	-0.108**	-0.088*	-0.099*
	(0.048)	*(0.050)*	*(0.052)*	*(0.053)*
Non-debt Tax Shield	-1.110***	-1.312***	-1.202***	-1.260***
	(0.305)	*(0.311)*	*(0.384)*	*(0.391)*
EBIT-to-Total Assets	-0.249**	-0.247**	-0.249**	-0.250**
	(0.099)	*(0.097)*	*(0.114)*	*(0.113)*
GDP Growth	-0.005	-0.008	-0.007	-0.010
	(0.006)	*(0.006)*	*(0.008)*	*(0.009)*
Investor Protection	-0.013	-0.012*	-0.014	-0.012
	(0.010)	*(0.011)*	*(0.014)*	*(0.015)*
IRA (α_1)	0.042**	-0.018	0.048**	-0.020
	(0.016)	*(0.042)*	*(0.022)*	*(0.051)*
Private Control (α_2)	0.025	-0.028**	0.024	-0.041
	(0.022)	*(0.040)*	*(0.025)*	*(0.051)*
Private Control*IRA (α_3)	-	0.077*	-	0.088*
	-	*(0.043)*	-	*(0.051)*
$\alpha_1/(1-\beta)$	0.072***	-0.028	0.083**	-0.035
(p-value)	*(0.004)*	*(0.670)*	*(0.021)*	*(0.693)*
$(\alpha_1+\alpha_3)/(1-\beta)$	-	0.092***	-	0.119***
(p-value)		*(0.002)*		*(0.002)*
$\alpha_2/(1-\beta)$	0.043	-0.044	0.042	-0.072
(p-value)	*(0.254)*	*(0.482)*	*(0.323)*	*(0.428)*
$(\alpha_2+\alpha_3)/(1-\beta)$	-	0.077**	-	0.083*
(p-value)		*(0.034)*		*(0.058)*
Arellano-Bond test for AR(1) *(p-value)*	0.000	0.000	0.001	0.001
Arellano-Bond test for AR(2) *(p-value)*	0.823	0.739	0.958	0.971
Sargan-Hansen test *(p-value)*	0.465	0.607	0.683	0.789
N. Firms [N. Obs.]	88 [612]	88 [612]	63 [445]	63 [445]

Table 5 – GMM estimates of a dynamic investment equation

Dynamic panel-data estimation, one-step system GMM estimates. 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. ***, **, * denote statistical significance at 1%, 5% and 10%.

I/K_t	**(1) Full sample**	**(2) Full sample**	**(3) Full sample**	**(4) Privately- and State-controlled throughout the period**	**(5) Privately- and State-controlled throughout the period**
$(I/K)_{t-1}$ (β_1)	0.307***	0.305***	0.303***	0.384***	0.387***
	(0.082)	*(0.087)*	*(0.090)*	*(0.046)*	*(0.049)*
$(CF/K)_{t-1}$ (β_2)	0.162**	0.161**	0.162**	0.113	0.116
	(0.074)	*(0.073)*	*(0.073)*	*(0.086)*	*(0.087)*
$(S/K)_{t-1}$ (β_3)	-0.001	-0.001	-0.001	-0.000	-0.000
	(0.004)	*(0.004)*	*(0.004)*	*(0.003)*	*(0.003)*
IRA_{t-1} (α_1)	0.017**	0.017**	0.024*	0.016**	0.015**
	(0.007)	*(0.007)*	*(0.014)*	*(0.007)*	*(0.007)*
Private $Control_{t-1}$ (α_2)	-	0.001	0.004	-	0.003
	-	*(0.007)*	*(0.011)*	-	*(0.005)*
Private $Control_{t-1}$*IRA_{t-1} (α_3)	-	-	-0.010	-	-
	-	-	*(0.019)*	-	-
$\alpha_1/(1-\beta_1)$	0.025***	0.025***	0.034*	0.026**	0.025**
(*p-value*)	*(0.006)*	*(0.006)*	*(0.063)*	*(0.022)*	*(0.025)*
$\alpha_2/(1-\beta_1)$	-	-0.022	0.006		0.004
(*p-value*)		*(0.835)*	*(0.693)*		*(0.581)*
$(\alpha_1+\alpha_3)/(1-\beta_1)$	-		0.020		
(*p-value*)			*(0.124)*		
$(\alpha_2+\alpha_3)/(1-\beta_1)$			-0.009		
(*p-value*)			*(0.646)*		
Arellano-Bond test for AR(1) *(p-value)*	0.033	0.030	0.029	0.001	0.001
Arellano-Bond test for AR(2) *(p-value)*	0.517	0.507	0.512	0.689	0.668
Sargan-Hansen test *(p-value)*	0.375	0.381	0.410	0.521	0.501
N. Firms [N. Obs.]	83 [422]	83 [422]	83 [422]	61 [399]	60 [312]