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

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1. Introduction
In the last 30 years, many countries around the world have fundamentally reformed their public utilities sector. These reforms included, among other things, 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 here 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 and its growth (see e.g., Guthrie 2006 and Kessides 2004). Moreover, these investments 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). Indeed, in our theoretical and empirical results we will study the joint determination of investments and capital structure and we will examine how it is affected by state ownership and regulatory independence.

The paper is organized as follows: In Section 2 we briefly describe the relevant structural reforms in the public utilities sector in the EU. This will provide the institutional background for our analysis. 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 the data and the variables that we use in the econometric analysis that follows in Section 5. Concluding remarks are Section 6.
2. Institutional background

While the structural reforms of public utilities took place in many countries around the world since the 1990’s, we will focus here on the reforms that took place in the EU. Indeed, our empirical analysis is based on EU data. Until the early 1990’s (or the early 1980’s in the case of the UK), public utilities in Europe were largely characterized by vertical integration, state monopoly and public ownership. Ministries, governmental bodies or committee or local governments were in charge of regulating the market and set tariffs and quality standards. However, in that period, regulated prices were mainly set to counterbalance the rise of inflation and utilities were often asked to absorb labor whenever unemployment increased. The result of this “un-incentive regulation” 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 within EU member states is far from complete, and central and local governments still hold majority (and minority) ownership stakes in many regulated utilities.¹

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 retail and wholesale level (whenever granting access to essential facility is needed to promote competition), the definition of entry conditions, and 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. In Table 1 we report data of establishment of an IRA and the ownership status of the main relevant incumbent fixed telecom operators and the largest energy (electricity and gas) companies for all the EU 27 countries. The structural reforms are most advanced in the telecommunication and energy sectors where sector-specific IRAs were established in all member states 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

¹ See Bortolotti and Faccio (2009) for a recent analysis.
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 subject to regulation by ministries or other branches of the government rather than by independent regulatory agencies. Only recently, the IRAs for energy in some new member states (Latvia and Lithuania) started regulating also the water sector within a multi-sector regulatory model. Finally, from 2006, the German IRA (named Bundesnetzagentum) started regulating the railways sector.

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 in the institutional settings is also present in many countries outside Europe. In Table 2 we report data on the establishment of an IRA and the ownership status of the main relevant incumbent fixed telecom operators and the largest energy (electricity and gas) companies for a selected sub-sample of South American and Eastern 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 5 we will examine these predictions empirically. The interested reader is referred to CS for more details, as well as for formal proofs which are omitted here.

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 depends on the firm's investment, $k$, and is given by a twice differentiable, increasing, and concave function $V(k)$. Using $p$ to denote the regulated price; consumers’ surplus is given by $V(k) - p$.

The regulated firm is partially owned by the state (at the national or the local level). The state’s stake in the firm’s equity is $\delta$. To capture the effect of $\delta$ on the firm’s behavior, we adopt the managerially-oriented public enterprise (MPE) approach, due to Sappington and Sidak (2003, 2004). 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, $\pi$, and revenue, $R$, and given by $\delta R + (1-\delta)\pi$. Noting that $\pi = R-C$, where $C$ is cost, we can also write the firm’s objective function as $R-(1-\delta)C$. That is, the firm behaves as if it ignores a fraction $\delta$ of its cost. This reflects the idea that the managers of state-owned enterprises (and state officials who monitor them) often have considerable
interest in expanding the scale or scope of their activities and expand the firm's budget and its labor
force either for political reasons (e.g., cater to the needs of special interest groups), or because they
wish to realize the power and prestige that often accompany expanded operations. Alternatively, the
objective function can simply reflect managerial slack.

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. The firm’s cost of production,
however, is subject to random cost shocks (e.g., fluctuating energy prices) and is given by a random
variable, c, 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
\(C = \bar{c} + \phi(p, D)T\), where,

\[
\phi(p, D) = \begin{cases} 
0 & D + \bar{c} \leq p, \\
1 - \frac{p - D}{\bar{c}} & D \leq p < D + \bar{c}, \\
1 & p < D.
\end{cases}
\]  

(1)

Intuitively, as long as \(D + \bar{c} \leq p\), 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 \(p\): the firm is more likely to be financially distressed when its
debt is high and the regulated price is low.

As for the regulatory process, 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. Economic literature on institutions and regulation (see e.g., Levy and Spiller,
degree of regulatory independence improves the regulators’ ability to make long-term commitments
to regulatory policies.\(^2\) In line with this argument, we capture the regulator’s degree of
independence by assuming that although the regulator sets \(p\) after the firm's investment, \(k\), is sunk,
the regulator has some ability to commit to take \(k\) into account when setting \(p\).

\(^2\) An empirical support for this argument is provided by Guasch, Laffont, and Straub (2008). They show that the
presence of an IRA lowered the probability of renegotiation of contracts for the provision of utilities services by 5%-7.3%.
This effect is significant given that the average probability of renegotiation of any individual contract at any point
in time is around 1%. The better ability of IRAs to make long-term commitments suggests that IRAs are less
opportunistic than non-independent regulators.
Specifically, we assume that before the firm invests, the regulator commits with probability \( \rho \) to take into account the ex ante objective function of the firm, \( p-(1-\delta)C-k \), and hence sets \( p \) by maximizing the ex ante social welfare function

\[
(V(k) - p)^\gamma (p - (1-\delta)C - k)^{1-\gamma}.
\] (2)

However, with probability \( 1-\rho \), the regulator behaves opportunistically and once \( k \) is sunk, takes into account the ex post objective function of the firm, \( p-(1-\delta)C \), which does not include \( k \). In this case, the regulator chooses \( p \) to maximize the ex post social welfare function

\[
(V(k) - p)^\gamma (p - (1-\delta)C)^{1-\gamma}.
\] (3)

The parameter \( \gamma \in (0,1) \) captures the regulatory climate: the higher \( \gamma \), the more pro-consumer the regulator is. The parameter \( \rho \) captures the ability of the regulator to make long-term commitments and hence serves as our measure of regulatory independence, with larger values of \( \rho \) indicating a greater degree of independence.

The regulated price that maximizes (2) and (3) allocates the expected social surplus between consumers and the firm according to the asymmetric Nash bargaining solution for the regulatory process (\( \gamma \) and \( 1-\gamma \) then reflect the bargaining powers of the two parties). Our approach is therefore consistent with models that view the regulatory process as a bargaining problem between consumers and investors (e.g., Spulber, 1989 and Besanko and Spulber, 1992).

### 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 \( \delta \). 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.

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3 This approach is in line with recent models of regulatory risk by Lyon and Li (2004) and Strausz (2011a) and (2011b).
4 Our approach differs from De Fraja and Stones (2004) and Stones (2007) where the regulator, rather than the firm, chooses the capital structure of the firm. Our approach also differs from Lewis and Sappington (1995) who examine the optimal design of capital structure in the context of an agency model that involves a risk-averse regulator (a principal) and a risk-neutral regulated firm (an agent) under alternative assumptions regarding the principal’s ability to control the agent’s capital structure.
3.3. The regulated price

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

\[
(V(k) - p)^\gamma (p - (1 - \delta)C - Ik)^{1-\gamma}.
\]

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

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

where \( D_1(k,I) \equiv (1-\gamma)V(k) + \gamma(1-\delta)\frac{\bar{c}}{2} + \gamma k - \bar{c} \), \( M(D,I) \equiv \frac{\gamma(1-\delta)\frac{T}{\epsilon}(D + (1+\delta)\frac{\bar{c}}{2} - Ik)}{1+(1-\delta)\frac{T}{\epsilon}} \), \( D_2(k,I) \equiv \frac{D_1(k,I)(1+(1-\delta)\frac{T}{\epsilon}) + \gamma(1-\delta)\frac{T}{\epsilon}(1+\delta)\frac{\bar{c}}{2} - Ik}{1+(1-\gamma)(1-\delta)\frac{T}{\epsilon}} \), and \( D_3(k,I) \) is smaller than the value of \( D \) for which \( D_1(k,I) + \bar{c} + M(D,I) = D \).

The regulated price is illustrated in the following Figure 1.⁵

⁵ To limit the number of cases that can arise CS imposed some parameter restrictions that ensure that as illustrated in Figure 1, \( D_1(k,0) < D_1(k,1) < D_2(k,0) < D_2(k,1) \).
As Figure 1 shows, when $D \leq D_1(k,I)$, the regulated price is set equal to $D_1(k,I) + \bar{c}$ and it covers the firm’s cost plus its debt obligation even in the worst state of nature. The firm then is completely immune to financial distress. But once $D > D_1(k,I)$, a price of $D_1(k,I) + \bar{c}$ leaves the firm susceptible to financial distress. So long as $D$ does not exceed $D_1(k,I)$ by too much, the regulator finds it optimal to set $p = D + \bar{c}$ and thereby continue to ensure that the firm is completely immune to financial distress. However, when $D > D_1(k,I)$, this strategy is no longer optimal for the regulator because the resulting marginal loss in consumers’ surplus becomes too large relative to the benefit of preventing financial distress. Therefore, although the regulator continues to increase $p$ with $D$, the slope is now below 1 and the resulting $p$ is smaller than $D + \bar{c}$; hence now the firm becomes susceptible to financial distress. When $D > D_3(k,I)$, it is no longer optimal for the regulator to offset the effect of debt and the likelihood of financial distress and hence now financial distress is a sure thing; as a result, now $p = D_1(k,I) + \bar{c} + (1-\delta)T$.

It is easy to see from Figure 1 that $p^*(D,k,1) \geq p^*(D,k,0)$: holding the firm’s investment level and debt level fixed, the regulated price is (weakly) higher when the firm is facing a committed regulator who takes $k$ into account than when it faces an opportunistic regulator who ignores $k$.

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 the regulated price set by the regulator. With probability $\rho$, 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 $1-\rho$, the regulator is opportunistic, so the regulated price and probability of financial distress are $p^*(D,k,0)$ and $\phi^*(D,k,0)$. Recalling that the expected cost of the regulated firm is $C = \xi + \phi^*(D,k,1)T$ and the fact that by the MPE approach the partially state-owned firm ignore a fraction $\delta$ of its cost, the objective function of the firm is given by,

$$Y(D,k) = \rho[p^*(D,k,1) - (1-\delta)(\xi + \phi^*(D,k,1)T) - k] + (1-\rho)[p^*(D,k,1) - (1-\delta)(\xi + \phi^*(D,k,0)T) - k].$$  \hspace{1cm} (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

$$\rho^* = \frac{(1-\gamma)(1-\delta)\xi}{1+(1-\gamma)(1-\delta)\xi}.$$  

Moreover, holding $k$ fixed, the debt level of the regulated firm is higher the lower is $\delta$.

The first part of Proposition 1 shows that the firm issues more debt when $\rho$, which reflects the degree of regulatory independence, is relatively high. 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 $\rho < \rho^*$. Using this definition, the first part of Proposition 1 implies that the firm issues more debt when it faces an independent regulator. Intuitively, we saw earlier that a committed regulator sets a higher regulated price; since an independent regulator is more likely to be committed, the firm can afford to issue more debt when it faces an independent regulator.

The second part of Proposition 1 shows that firms that are more privatized (have lower values of $\delta$) should issue more debt. The reason for this is that when the firm ignores a smaller part of its cost when the state holds a smaller stake in the firm. Consequently, the regulator, who sets $p$ by taking into account the firm’s objective function, will set a higher price which in turn allows that 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 $\rho$ (how independent their regulator is) and $\delta$ (the state’s stake in the firm), firms that are regulated by an IRA and are more privatized should be more highly leveraged.
3.5. The equilibrium level of investment

Next, we turn to the choice of investment. Proposition 1 shows that when the regulator is non independent ($\rho < \rho^*$), the firm issues debt with face value $D_2(k,0)$. The regulator in turn sets a price $D_2(k,0)+\bar{c}$, which ensures that the firm is completely immune to financial distress. Substituting these expressions in equation (6), the expected payoff of the firm when it faces a non independent regulator is

$$Y^{NI}(k) = Y(D_2(k,0),k) = D_2(k,0) + (1 + \delta)\frac{\gamma k}{\bar{c}} - k.$$  

(7)

When the regulator is independent ($\rho > \rho^*$), the firm issues debt with face value $D_2(k,1)$. The resulting regulated price is $D_2(k,1)+\bar{c}$ with probability $\rho$, and $D_1(k,0)+\bar{c}+M(D_2(k,1),0)$ with probability $1-\rho$; the expected regulated when the regulator is independent is given by

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

(8)

As mentioned above, the firm is completely immune to financial distress when the regulator is non independent ($\rho < \rho^*$), and it is also immune to financial distress when the regulator is independent ($\rho > \rho^*$) but happens to be committed. In other words, the firm becomes financially distressed only when the regulator is independent ($\rho > \rho^*$) and is turns out to be opportunistic. Given that the regulator is opportunistic with probability $1-\rho$, the overall probability of distress in this case is $(1-\rho)\phi(k)$, where,

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

(9)

Substituting from (8) and (9) into equation (6), the firm’s expected payoff when the regulator is independent is given by,

$$Y^{I}(k) = Y(D_2(k,1),k) = Ep^*(k) - (1-\rho)(1 - \delta)\phi(k)T - (1 - \delta)\frac{\gamma k}{\bar{c}} - k.$$  

(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, $\rho$, when $\rho < \rho^*$, but is increasing with $\rho$ when $\rho > \rho^*$. Consequently, the firm invests...
more when the regulator is independent (i.e., \( \rho > \rho^* \)) than when the regulator is non independent (i.e., \( \rho < \rho^* \)). Moreover, equilibrium level of investment, \( k^* \), is decreasing with \( \delta \).

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, as we mentioned above, \( Ep^*(k) \) is higher when the regulator is independent and when \( \delta \) is low; consequently, the marginal benefit of investment is higher and the firm invests more.

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 \( \delta \).

Proposition 3 implies that in a sample of regulated firms that differ from each other only in terms of \( \rho \) and \( \delta \), 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. From theory to data: the sample and the definition of variables

To test the empirical predictions that we established in Section 3, we use 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 data covers firms that are either regulated by an IRA or by ministries, government committees, or local governments, and with varying degrees of state ownership. Accounting and financial data were collected from *Worldscope*. Table 3 summarizes the descriptive statistics for our main variables in Panel A, shows a break down of market leverage by sector in Panel B, and provides the precise definitions of our variables in Panel C.

4.1. Leverage, firm-specific controls, regulated prices, and fixed investments

Since the key driving force in the model that we presented in Section 3 is the possibility that a leveraged firm may default on its debt payments, it important for us to use measure of leverage that reflects this possibility. Therefore, in most of our empirical analysis, we will use market leverage as

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\(^6\) The interested reader is referred to BCRS for more details on the construction of the data set. The sample here is smaller than the sample of 92 firms used in BCRS, because here we estimate dynamic models that require us to use lagged variables and instruments. As a result, 4 firms on which we have less than 5 consecutive observations drop from the sample.
our measure of leverage. Market leverage 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 latter is computed by multiplying the number of outstanding shares at the end of the relevant year by the share price at that date expressed in U.S. dollars. It should be emphasized that market leverage can increase (decrease) either because the face value of debt increases (decreases) or because the market value of equity decreases (increases). In both cases, though, the firm becomes more vulnerable to financial distress and hence regulators may be forced to raise regulated prices.

Panel A in Table 3 shows that the mean market leverage in our sample is 18.2%, while mean book leverage is 27.1%. The variability in the debt ratios across our sample is large: market leverage ranges from 0 to 88%, while book leverage may be as large as 100%. Panel A also shows that privately-controlled firms in our sample are more leveraged than state-controlled firms both in terms of market leverage and in terms of book leverage. Panel B of Table 3 shows that the most highly leveraged firms in our sample are electric utilities (a mean market leverage of 23.5%), followed by telecoms (20.4%). The least leveraged group of firms are airports with a mean market leverage of 5.7%, followed by ports and docks with a mean market leverage of 8.4%.

In the empirical analysis in the next section we wish to test, among other things, the hypothesis that regulated firms are more leveraged when they are privately controlled and subject to regulation by an IRA. The firm’s choice of leverage however may be also driven by other considerations. We wish to find out if private control and the existence of IRA have an effect on the choice of leverage, even after we control for other firm characteristics that are commonly used in empirical studies of capital structure and were shown to be reliable determinants of capital structure. The firm-specific controls that we will use include 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. Table 3 includes the definitions and summary statistics of these variables.

To test the impact of regulatory independence and state ownership on the firm’s investment, we measure investment as the ratio of gross fixed investment to capital stock at the replacement

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7 See Rajan and Zingales (1995) for a discussion of alternative leverage measures. Ideally, market leverage should also include the market value of debt. However, since debt is not always publicly traded, we were unable to find reliable data on the market value of debt. For this reason, we also cannot include bond ratings as a control variable in our regression analysis.

8 Only two firms in our data have zero leverage and both are state-controlled.

9 Note that a firm that was privatized during our sample period is counted as state-controlled up to the year of privatization and as privately-controlled from that year onward. Still, as Figure 2 below shows, regulated firms tend to raise their leverage after they are privatized.

10 See for example, Titman and Wessels (1988), Rajan and Zingales (1995), and Frank and Goyal (2009).
value. Gross fixed investment includes new plants, property, and equipment, as well as additions or deletions to capital goods due to mergers, acquisitions, or divestitures. To construct a measure of capital stock at the replacement value, we follow the common procedure (e.g., Blundell, Bond and Meghir, 1992) and use the perpetual inventory formula: 

$$p_{t+1}K_{t+1} = p_tK_t(1-\delta)(p_{t+1}/p_t) + p_{t+1}I_{t+1},$$

where

- $p_t$ is the country-specific implicit price deflator for gross capital formation in year $t$ sourced by the OECD,
- $K_t$ is the fixed capital stock in year $t$,
- $I_t$ is the investment flow in year $t$, and
- $\delta$ is the depreciation rate. To compute $\delta$, we use the “BEA Rates of Depreciation, Service Lives, Declining-Balance Rates, and Hulten-Wykoff Categories,” reported by the U.S. Department of Commerce, Bureau of Economic Analysis, and obtain the following depreciation rates: 4.4% for energy, gas and water supply, 3% for freight roads concessionaires, 8% for telecommunications, and 4.5% for ports and airports. To obtain the starting values of capital stock, we assume that replacement cost valuations are equal to their historic valuations for the first year of available data (usually 1994).

To test the hypothesis that increases in leverage leads to higher tariff rates, we need data on regulated prices. Unfortunately, we were unable to find reliable data on regulated retail prices at the individual firm level. Instead, we collected country- and sector-specific retail price indices. All price indices are in constant 2005 prices. We believe that given that there is still limited competition in the utilities sector and given that there is little price dispersion, these price indices appropriately reflect the relevant prices for the firms in our sample.

4.2. Regulation and country-specific variables

All firms operate in regulated sectors, i.e., where entry and prices are subject to regulatory oversight either by the state – through a ministry or an executive-branch commission - or by an Independent Regulatory Agency (IRA). In order to study the effect of regulatory independence on the interaction between capital structure and regulated prices, we constructed an IRA dummy, which is equal to 1 in all years in which the firm was subject to regulation by an IRA, and equals 0 otherwise. Hence, for each sector/country in our dataset, the IRA dummy switches from 0 to 1 in the year when an IRA was established. The IRA dummy was constructed using the inception dates collected by Gilardi (2002) for the energy and telecommunications sectors in which IRAs already exist in all countries.

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11 See [http://www.bea.gov/scb/account_articles/national/wth2594/tableC.htm](http://www.bea.gov/scb/account_articles/national/wth2594/tableC.htm)

12 Major acquisitions or divestitures may cause a major discontinuity (or outliers) in the investment rate series. In such a case, we split the firm’s time-series to a “before” and “after” sub periods, and keep the sub period in the sample provided that it has at least three consecutive observations.

13 We were unable to find price indices for airports, ports, and docks, whose services are considered to be intermediate rather than final services.

14 Although the telecommunication sector in the EU was gradually deregulated over time, complete deregulation was present during our sample period only in Finland; as of the end of 2005, price regulation in the form of price caps or other forms of tariff approval was widely applied in the EU, especially for basic voice services (OECD 2006, Table 10).
in our sample. We complemented this data by drawing from additional sources for freight roads, airports, port and docks, and water. As described in Section 2, except for the water and railway industries in the UK, in all other EU 15 countries, IRAs were not in place in the water and transportation sectors.

To account for cross-country differences, we include the GDP growth and an “investor protection” index, developed initially by La Porta et al. (1998) and updated by Pagano and Volpin (2005). This index increases from 0 to 7 as shareholders’ rights become more protected and it is conceivable that higher values of this index are associated with a lower cost of equity.

4.3. Ownership

Due to a complex web of cross-ownership patterns among firms (one firm holds the shares of another firm, which in turn holds the shares of a third firm), the state may hold both direct as well as indirect control rights in firms. To capture the public vs. private control status of the firm, we employ a dichotomous dummy variable, based on a continuous variable of the state’s ultimate control rights (UCR), constructed by Bortolotti and Faccio (2009). According to this approach, the UCR of a given investor (the state in our case) is simply equal to the minimum ownership stake along a chain (i.e., the weakest link). In the case of multiple chains, the UCR’s are summed up across all chains. The sources used to compute the state’s UCR are listed in BCRS (2011).

We define firms as “privately-controlled” if the state holds less than 50% of firm’s UCRs (otherwise the firm is “state-controlled”). Accordingly, we define the year of privatization as the year in which the state’s UCR’s dropped below 50% for the first time. 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. As reported in BCRS, the state’s mean UCR (including both central and local governments, ministries, and various branches of public administration) is 34.8% for the entire sample, 10% for privately-controlled firms, and 75.1% for state-controlled firms.

5. Empirical results

In this section we provide empirical evidence in the three theoretical predictions that we establish in Section 3. In Section 5.1 we provide results on leverage, in Section 5.2 we provide results regarding

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15 In some cases, firms in our data have shares with multiple voting rights, although as of May 1998, such shares were outlawed in Italy, Spain, the UK, and Germany. Unfortunately, our data sources do not report the identity of the owners of these shares and hence we must treat them as ordinary shares. As a result, our data on state’s UCR may be biased downward.
the firms’ investment levels, and in Section 5.3 we provide results on the relationship between leverage and prices.

5.1 Leverage
Before moving to our regression analysis, we first examine how the leverage of the 21 firms in our sample that were privatized during the sample period was affected by privatization. In Figure 2 we show the evolution of market leverage from 5 years before privatization (year -5) to 5 years after privatization (year +5). Of the 21 privatized firms in our sample, 8 are in the energy sector and 7 are telecoms. The figure also shows the evolution of market leverage for these two subsamples (the dotted line refers to energy utilities and the dashed line refers to telecoms).

**Figure 2 – Trend of the average market leverage for privatized utilities**

As Figure 2 shows, 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. Interestingly, it appears that market leverage increases from year -5 to year -2 by about 9 percentage points and then decreases from the year -2 to year 0 by almost 8 percentage points. This pattern may be due to the increase in equity during the IPO in the year of privatization (year 0).

Figure 2 is consistent with the second part of Proposition 1 which shows implies that firms should increase their leverage when the government stake in the firm falls. It should be noted that the pattern shown in Figure 2 stands in contrast to the findings in Dewenter and Malatesta (2001), Megginson, Nash, and Van Radenborgh (1994), and D’Souza and Megginson (1999). These papers
study privatizations in different countries, sectors, and time periods, and show that in most cases, firms 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.

Having found some support for Proposition 1, we next turn to regression analysis. In BCRS (2011), we used a static model of firm leverage, 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 firm’s control rights 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 in the firm and when we restrict attention to a sub-sample of energy utilities (electricity and gas).

In the current paper, we take a different approach: we now estimate a dynamic leverage equation that accounts for the possible adjustment process of leverage that takes place when firms respond to a change in the value of one (or more) of the exogenous determinants of leverage. An attractive feature of the dynamic model is that it enables us to estimate the log-run effects of regulatory independence and privatization. The specification is the following:

\[ L_{it} = \alpha_0 + \beta_1 L_{it-1} + \alpha_2 IRA_{it} + \alpha_3 Private Control_{it} + \alpha_4 Private Control_{it} \times IRA_{it} + \alpha_5 Private Control_{it} + \alpha_6 GDP Growth_{it} + \alpha_7 Investor Protection_{it} + \eta_i + d_t + \varepsilon_{it}, \]  

(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 which is equal to 1 if firm \( i \) was subject to regulation by an IRA in year \( t \) and is equal to 0 otherwise, \( Private Control_{it} \) is a dummy which is equal to 1 if firm \( i \) was privately-controlled (i.e., the government’s UCR was below 50%) in year \( t \) and is equal to 0 otherwise, \( X_{it} \) is the vector of firm-specific controls that may affect the choice of leverage (see Section 4.1 for details), \( GDP Growth \) and \( Investor Protection \) reflect time-varying country-specific institutional factors, \( \eta_i \) and \( d_t \) are firm and time fixed effects, and \( \varepsilon_{it} \) is an error term.

Our main interest in the leverage regressions is with the effects of ownership and regulatory independence on leverage; these effects are captured by the coefficients \( \alpha_1 \), \( \alpha_2 \), and \( \alpha_3 \), which capture the effect of the Private Control, IRA, and Private Control*IRA dummies. The following table conveniently summarizes the value of the intercept in equation (11), depending on the firm’s.
ownership and regulatory structures and the ownership effect controlling for the existence of IRA as well as the IRA effect controlling for ownership type.

<table>
<thead>
<tr>
<th></th>
<th>IRA</th>
<th>No IRA</th>
<th>IRA effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Privately-controlled</td>
<td>$\alpha_0+\alpha_1+\alpha_2+\alpha_3$</td>
<td>$\alpha_0+\alpha_2$</td>
<td>$\alpha_1+\alpha_3$</td>
</tr>
<tr>
<td>State-controlled</td>
<td>$\alpha_0+\alpha_1$</td>
<td>$\alpha_0$</td>
<td>$\alpha_1$</td>
</tr>
<tr>
<td>Ownership effect</td>
<td>$\alpha_2+\alpha_3$</td>
<td>$\alpha_2$</td>
<td></td>
</tr>
</tbody>
</table>

The table shows that the sum $\alpha_1+\alpha_3$ captures the effect of regulatory independence (IRA vs. no IRA) on the leverage of privately-controlled firms, while $\alpha_1$ captures the effect of regulatory independence on the leverage of state-controlled firms. Likewise, the sum $\alpha_2+\alpha_3$ captures the effect of ownership (private- vs. state-control) on the leverage of firms which regulated by an IRA, while the coefficient $\alpha_2$ 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 $\alpha_1$, $\alpha_2$, $\alpha_1+\alpha_3$, and $\alpha_2+\alpha_3$, and the p-values associated with tests on their significance.

To estimate equation (11), we use the Arellano and Bond (1991) and Arellano and Bover (1995) linear generalized method of moments (GMM) estimator, which is especially designed for dynamic models where the lagged dependent variable is included and some of the regressors are not strictly exogenous. More specifically, we use the dynamic System-GMM model developed by Arellano and Bond (1991) and Blundell and Bond (1998), which deals with situations where the lagged dependent variable is persistent and the lagged levels of the dependent variables are therefore weak instruments. This model estimates a system of level and first-differenced equations and uses lags of first-differenced variables as instruments for equations in levels and lags of variables in levels as instruments for equations in first-differences. For the validity of the GMM estimates it is crucial, however, that the instruments are exogenous. We therefore calculate the two-step Sargan-Hansen statistic under the null of joint validity of the instruments and report the resulting p-values with the regression results. Since the Sargan-Hansen test may be weakened if there are too many instruments (with respect to the number of observations), we follow a conservative strategy and use no more than three (but mostly two) lags of the instrumenting variables. We finally report the Arellano and Bond (1991) autocorrelation test to control for first...

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16 For estimation we used the xtabond2 Stata command created by Roodman (2006).
17 Lagged values of right-hand variables are used as instruments: lagged levels are used in first-differences equations and lags of first-differenced variables are used in levels equations. All regressions include year dummies both as regressors and as instruments.
order and second order correlation in the residuals. If AR(2) is detected, instruments dated t-2 are invalid and only instruments dated t-3 and earlier can be used.

In Table 4 we present 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. Empirical papers in capital structure typically find that this variable, which serves a proxy for asset tangibility, has a positive effect on leverage. The logic for this result is that tangible assets can serve as a collateral and hence lower the cost of debt financing. However, in our sample of regulated firms, 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) in Table 4 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. In Column (2) we investigate whether the impact of IRA on leverage differs across privately- and publicly-controlled firms by including the Private Control*IRA dummy in the regression. The results show that the coefficient of this dummy is positive and significant, which 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.

In Columns (3) and (4) we present the results for the sub-sample of firms that remained state- or privately-controlled throughout our sample period. The results show that 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 the IRA on the leverage. In particular, the lagged value of the Leverage term is significant in all columns, which implies that the adjustment process to a new equilibrium level, following a change in exogenous variables of leverage, is not instantaneous. If we denote the coefficient of the lagged value of Leverage by $\beta$, then a 1% increase in market leverage in the short run translates into a long-run increase of $1+\beta+\beta^2+\beta^3+\ldots = 1/(1-\beta)$ percents.

We report the long-run coefficients and their p-values at the bottom of Table 4. 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 subsample of 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: the long-run effect of PrivateControl 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 if a firm is privatization together with regulation by an IRA have a positive and significant effect on leverage.

5.2 Investment equation

Next, we estimate a following simple investment equation:

\[
\left(\frac{I}{K}\right)_{it} = \beta_1 \left(\frac{I}{K}\right)_{it-1} + \beta_2 \left(\frac{CF}{K}\right)_{it-1} + \beta_3 \left(\frac{S}{K}\right)_{it-1} + \alpha_1 IRA_{it-1} + \alpha_2 PrivateControl_{it-1} + \alpha_3 IRA_{it-1} * PrivateControl_{it-1} + d_t + \eta_i + \epsilon_{it},
\]

(12)

where \((I/K)_{it}\) and \((I/K)_{it-1}\) are the investment to capital stock ratio 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, \(\eta_i\) and \(d_t\) are firm and time fixed effects, and \(\epsilon_{it}\) is an error term.

To estimate this dynamic model, we once again use the Arellano-Bond GMM-System estimator. The results are presented in Table 5. Columns (1)-(3) provide results for the entire sample and Columns (4)-(5) show that our results continue to hold when we restrict attention to the sub-sample of firms that remained either privately- or state-controlled over the entire period. As Table 5 shows, the coefficient \(\beta_1\) of the lagged investment term, which accounts for the gradual adjustment process of investment, is positive and significant. This indicates that the adjustment of capital is indeed gradual as might be expected. The table also shows that the coefficient \(\beta_2\) 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 the coefficient \(\alpha_1\) of the IRA dummy is positive and significant in all columns. This provides empirical support for Proposition 3 which
implies that firms that are subject to regulation by an IRA have a stronger incentive to invest. The sign and significance of $\alpha_1$ is consistent with the findings in Cambini and Rondi (2011b) who study a panel of 80 regulated firms from the EU 15 states over the period 1994-2004. The result is also consistent with a number of papers that find the regulatory independence and better ability of regulators to make long-term commitments are associated with higher investment levels (e.g., Wallsten 2001, Henisz and Zelner 2001, Gutiérrez 2003, and Egert 2009).

Columns (2) and (3), however, show that the PrivateControl dummy is insignificant, irrespective of whether an IRA exists or not. One possible reason why state-owned firms do not invest less than privately-controlled firms as Proposition 3 predicts might be that state-controlled firms may not be able to choose investments to maximize their objective functions. Rather it might be that the government may lean on state-owned firms to induce them to invest in order to advance the government’s own political agenda. This type of political intervention is not captured by our theoretical model.

The signs and significance of $\alpha_1$, $\alpha_2$, and $\alpha_3$ are 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. Interestingly, Wallsten (2001) who studies the investments of Telecoms in 30 African and Latin American countries from 1984 to 1997 finds that privatization which is not accompanied by regulatory independence is negatively correlated with interconnection capacity. By contrast, Alesina et al. (2005) who study the aggregate levels of investment in the transport, telecommunications, and energy sectors in 21 OECD countries over the period 1975-1998 find that a larger ownership stake of the state is associated with lower levels of investment.

Similarly to the leverage equation, the dynamic investment model allows us to quantify the magnitude of the long-run effect of the IRA on regulated firms’ investments. At the bottom of Table 5, we report the long-run coefficients and their significance levels. We find that the presence of an IRA is associated with a long-run 2.5% increase in the investment rate for the full sample (Column (1)) and 2.6% for firms that remained either privately- or state-controlled throughout the entire period (Column (4)). These effects are substantial given that as Table 1 shows, the mean rate of investment (investment to capital stock) in our sample is 11.1%.

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18 Cambini and Rondi (2010) find that private ownership is positively associated with higher investment rates, but this effect disappears after controlling for the potential endogeneity of ownership.
5.3 Leverage and regulated prices

Finally, we examine the prediction of Proposition 3 which implies that higher leverage induces regulators to raise regulated prices, especially when the firm is privately-controlled. When the firm is state-controlled, the state plays a dual role of an owner and a regulator and hence the firm does not need to use its leverage to induce higher regulated prices.

To test this hypothesis, we use the Granger (1969) and Sims (1972) causality tests to examine whether an increase in leverage is followed by an increase in regulated prices, but not vice versa. In principle, there are three alternative possibilities. 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), and the firm in turn would adjust its capital structure to match its expected revenue stream. In that case, regulated prices would Granger-cause leverage. Second, it could be that leverage and regulated prices are correlated but neither one Granger causes the other; rather the two variables are correlated with a third variable that causes both of them. A third possibility is that leverage and regulated prices are simply not correlated with one another.

We perform the Granger tests by estimating the following bivariate VAR(2) model for sector- and country-specific retail price indices and leverage:

\[
P_{it} = \alpha_{L,t-1}P_{i,t-1} + \alpha_{L,t-2}P_{i,t-2} + \beta_{L,t-1}L_{i,t-1} + \beta_{L,t-2}L_{i,t-2} + \sum_{j} \mu_{j}^{P}Firm_{i} + \sum_{j} \lambda_{j}^{P}Year_{t} + \varepsilon_{P_{it}},
\]

\[
L_{it} = \alpha_{P,t-1}P_{i,t-1} + \alpha_{P,t-2}P_{i,t-2} + \beta_{P,t-1}L_{i,t-1} + \beta_{P,t-2}L_{i,t-2} + \sum_{j} \mu_{j}^{L}Firm_{i} + \sum_{j} \lambda_{j}^{L}Year_{t} + \varepsilon_{L_{it}},
\]

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 \(\alpha_{P,t-1}\) and \(\alpha_{P,t-2}\) 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).

Table 6 presents a subset of the results reported in Tables VIII and IX of BCRS. The estimated coefficients from equations (13) and (14) are presented in Panels A and B, respectively. We examine the full sample in Column (1), and four subsamples in Columns (2)-(5). The results of the Granger tests in Panel A show that with the exception of firms which are not regulated by an

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19 See Arellano (2003, Ch. 6) for details regarding the use Granger causality tests in the context of a panel setting and an application to panel data. 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).

20 A main concern when estimating a dynamic model as in equations (2) and (3) is that the lagged dependent variables are endogenous to the fixed effects in the error term, thus giving rise to a dynamic panel bias. To deal with this bias and with the potential endogeneity of other regressors in the leverage equation, we use the Arellano and Bond (1991) and Arellano and Bover (1995) linear generalized method of moments (GMM) estimators.
IRA (Column (3)), or are state-controlled (Column (5)), the second lag of market leverage has a significant positive effect on regulated prices. Moreover, the Wald statistics tests indicate that the first and second lags of market leverage are jointly significantly. By contrast, the tests for the reverse equation (14), reported in Panel B, show that 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. These results are consistent with the hypothesis that regulated firms which are privately-controlled or regulated by an IRA (or both), choose their leverage strategically in order to induce regulators to set higher prices, 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. The results are also inconsistent with the hypothesis that regulated prices increase when firms issue more equity, say because regulators base prices on the firm’s Weighted Average Cost of Capital (WACC) which is decreasing with the firm’s leverage.

A similar Granger-test analysis is applied by Cambini and Rondi (2011a) to study the relationship between regulation, financial structure, and investment decisions of 15 EU Public Telecommunication Operators (PTO), taking into account the vertically integrated structure of the telecom industry. They show that an increase in leverage positively affects not only the retail charges, but also the wholesale (access) rates, and that an increase in leverage has a negative effect on competition, but a positive effect on the PTOs’ investment rates.

6. 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 that we establish in Section 3 are that (i) regulated firms should become more leveraged and should invest more when they are subject to regulation by IRAs, (ii) regulated firms should become more leveraged and should invest more when they are more privatized (the state holds a smaller stake in the firm), and (iii) higher financial leverage should lead to higher regulated prices.

The empirical results in Section 5, which are based on evidence from the EU 15 countries, provide strong support for hypotheses (i) and (iii) and much weaker support for hypothesis (ii). Specifically, we find that EU regulated firms tend to have higher leverage and tend to invest more when they are subject to regulation by an IRA. In particular, 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 of regulated firms 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 2.5% in the investment rate for the full sample and 2.6% for firms that remained privately- or 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 on 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, in the presence of an IRA, private control is associated with an increase in leverage by 7.7% for all privately-controlled firms and 8.3% for firms that were privately controlled throughout our sample period.

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

* Since 1998 regulation is carried on by a branch of the Estonian Competition Authority.
** The IRA (Bundesnetzagentur) 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.
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

<table>
<thead>
<tr>
<th>Country</th>
<th>Date of establishing an IRA</th>
<th>Ownership (end 2010)</th>
<th>Ownership (end 2010)</th>
<th>Date of establishing an IRA</th>
<th>Ownership (end 2010)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>1993</td>
<td>Partially Private and State (100%)*</td>
<td>State (65%)</td>
<td>1990</td>
<td>Private</td>
</tr>
<tr>
<td>Brazil</td>
<td>1996</td>
<td>State (52%)**</td>
<td>Private</td>
<td>1997</td>
<td>Private</td>
</tr>
<tr>
<td>Chile</td>
<td>1978</td>
<td>Private</td>
<td>Private</td>
<td>1977</td>
<td>Private</td>
</tr>
<tr>
<td>Colombia</td>
<td>1994</td>
<td>State</td>
<td>--</td>
<td>1994</td>
<td>State (49%)</td>
</tr>
<tr>
<td>Ecuador</td>
<td>1996</td>
<td>--</td>
<td>--</td>
<td>1995</td>
<td>State (100%)</td>
</tr>
<tr>
<td>Perù</td>
<td>1996</td>
<td>Private</td>
<td>--</td>
<td>1994</td>
<td>Private</td>
</tr>
<tr>
<td>Mexico</td>
<td>1995</td>
<td>State</td>
<td>State</td>
<td>1996</td>
<td>Private</td>
</tr>
<tr>
<td>Uruguay</td>
<td>2002***</td>
<td>State</td>
<td>State</td>
<td>2001</td>
<td>State (100%)</td>
</tr>
<tr>
<td>Venezuela</td>
<td>-</td>
<td>State (100%)</td>
<td>State (100%)</td>
<td>1991</td>
<td>State owned (renationalized in 2007 after being privatized in 1991)</td>
</tr>
<tr>
<td>China</td>
<td>-</td>
<td>State (100%)</td>
<td>State (100%)</td>
<td>-</td>
<td>State (100%)</td>
</tr>
<tr>
<td>India</td>
<td>1998</td>
<td>State</td>
<td>State (74%)</td>
<td>1997</td>
<td>State</td>
</tr>
<tr>
<td>Malaysia</td>
<td>2001</td>
<td>State (100%)</td>
<td>State (100%)</td>
<td>1998</td>
<td>Private</td>
</tr>
<tr>
<td>Phillipines</td>
<td>2001</td>
<td>Partially private (State 30%)</td>
<td>--</td>
<td>-</td>
<td>Private</td>
</tr>
<tr>
<td>Singapore</td>
<td>2001</td>
<td>State (100%)</td>
<td>State (100%)</td>
<td>1982</td>
<td>State (&gt;50%)</td>
</tr>
<tr>
<td>Taiwan</td>
<td>-</td>
<td>State (100%)</td>
<td>--</td>
<td>2006</td>
<td>Partially privatized State (&lt; 50%)</td>
</tr>
<tr>
<td>Thailand</td>
<td>2007</td>
<td>State</td>
<td>State</td>
<td>-</td>
<td>State</td>
</tr>
</tbody>
</table>

* 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.ier.net) for energy markets. Guitierrez 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.

Note: Private: fully private company. State: majority of shares controlled by state; when data 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 3 - Summary statistics
88 publicly listed European regulated firms, 1994 – 2005

Panel A – The entire sample

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
<th>No. Obs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Leverage</td>
<td>0.182</td>
<td>0.169</td>
<td>0</td>
<td>0.881</td>
<td>757</td>
</tr>
<tr>
<td>Private Control</td>
<td>0.192</td>
<td>0.735</td>
<td>0</td>
<td>0.881</td>
<td>532</td>
</tr>
<tr>
<td>State control</td>
<td>0.158</td>
<td>0.151</td>
<td>0</td>
<td>0.757</td>
<td>225</td>
</tr>
<tr>
<td>Book Leverage</td>
<td>0.271</td>
<td>0.216</td>
<td>0</td>
<td>1</td>
<td>874</td>
</tr>
<tr>
<td>Private Control</td>
<td>0.288</td>
<td>0.223</td>
<td>0</td>
<td>1</td>
<td>547</td>
</tr>
<tr>
<td>State control</td>
<td>0.244</td>
<td>0.202</td>
<td>0</td>
<td>1</td>
<td>327</td>
</tr>
<tr>
<td>Log of Real Total Asset</td>
<td>11.031</td>
<td>1.812</td>
<td>5.694</td>
<td>14.534</td>
<td>876</td>
</tr>
<tr>
<td>Tangibility</td>
<td>0.621</td>
<td>0.211</td>
<td>0.034</td>
<td>0.967</td>
<td>876</td>
</tr>
<tr>
<td>EBIT-to-Total Asset</td>
<td>0.073</td>
<td>0.099</td>
<td>-1.948</td>
<td>0.299</td>
<td>857</td>
</tr>
<tr>
<td>Non-debt Tax Shield</td>
<td>0.052</td>
<td>0.03</td>
<td>0</td>
<td>0.183</td>
<td>876</td>
</tr>
<tr>
<td>Investment to Capital Stock</td>
<td>0.111</td>
<td>0.072</td>
<td>0</td>
<td>0.673</td>
<td>703</td>
</tr>
<tr>
<td>Cash Flow to Capital Stock</td>
<td>0.135</td>
<td>0.102</td>
<td>-0.936</td>
<td>0.871</td>
<td>719</td>
</tr>
<tr>
<td>Sales to Capital Stock</td>
<td>0.742</td>
<td>0.803</td>
<td>0.020</td>
<td>6.191</td>
<td>684</td>
</tr>
<tr>
<td>Private Control dummy</td>
<td>0.624</td>
<td>0.484</td>
<td>0</td>
<td>1</td>
<td>876</td>
</tr>
<tr>
<td>Regulatory Independence dummy</td>
<td>0.594</td>
<td>0.491</td>
<td>0</td>
<td>1</td>
<td>876</td>
</tr>
<tr>
<td>Investor Protection</td>
<td>3.815</td>
<td>1.222</td>
<td>1</td>
<td>5</td>
<td>876</td>
</tr>
<tr>
<td>GDP Growth</td>
<td>2.461</td>
<td>1.347</td>
<td>-1.120</td>
<td>10.720</td>
<td>876</td>
</tr>
</tbody>
</table>

Panel B – Market leverage by sector

<table>
<thead>
<tr>
<th>Sector</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
<th>No. Obs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>0.235</td>
<td>0.182</td>
<td>0</td>
<td>0.881</td>
<td>273</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>0.204</td>
<td>0.187</td>
<td>0</td>
<td>0.826</td>
<td>130</td>
</tr>
<tr>
<td>Freight Roads</td>
<td>0.175</td>
<td>0.171</td>
<td>0.012</td>
<td>0.775</td>
<td>55</td>
</tr>
<tr>
<td>Water</td>
<td>0.165</td>
<td>0.156</td>
<td>0</td>
<td>0.742</td>
<td>119</td>
</tr>
<tr>
<td>Gas</td>
<td>0.130</td>
<td>0.099</td>
<td>0.003</td>
<td>0.437</td>
<td>85</td>
</tr>
<tr>
<td>Ports and Docks</td>
<td>0.084</td>
<td>0.085</td>
<td>0</td>
<td>0.493</td>
<td>49</td>
</tr>
<tr>
<td>Airports</td>
<td>0.057</td>
<td>0.069</td>
<td>0</td>
<td>0.303</td>
<td>46</td>
</tr>
</tbody>
</table>

Panel C - Variable definitions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Leverage</td>
<td>Short and long term financial debt/(Market equity+(ST+LT financial debt))</td>
</tr>
<tr>
<td>Book Leverage</td>
<td>Short and long term financial debt/(Book equity+(ST+LT financial debt))</td>
</tr>
<tr>
<td>IRA</td>
<td>Dummy equal to 1 if an IRA is in place and equal to 0 otherwise</td>
</tr>
<tr>
<td>Private Control</td>
<td>Dummy equal to 1 if the government holds less than 50% of the ultimate control rights and equal to 0 otherwise</td>
</tr>
<tr>
<td>Total Assets</td>
<td>Log of real total assets</td>
</tr>
<tr>
<td>Tangibility</td>
<td>Net fixed assets/Total assets</td>
</tr>
<tr>
<td>EBIT-to-Total Asset</td>
<td>Earnings before interests and taxes/Total assets</td>
</tr>
<tr>
<td>Non-Debt Tax Shield</td>
<td>Depreciation and amortization/Total assets</td>
</tr>
<tr>
<td>Investor Protection</td>
<td>Time-varying “antidirector rights” index by Pagano and Volpin (2005)</td>
</tr>
<tr>
<td>Investment to Capital Stock (VK)</td>
<td>Capital Expenditure/Capital stock at replacement value</td>
</tr>
<tr>
<td>Cash Flow to Capital Stock (CF/K)</td>
<td>Cash Flow/Capital stock at replacement value</td>
</tr>
<tr>
<td>Sales to Capital Stock (S/K)</td>
<td>Sales/Capital stock at replacement value</td>
</tr>
</tbody>
</table>
Table 4 – GMM estimates of a dynamic leverage equation with independent regulation and mixed ownership

The dependent variable is Market Leverage. All variables are defined in Table 3. 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 heteroscedasticity 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%.

<table>
<thead>
<tr>
<th>Leverage, (_t)</th>
<th>(1) Full sample</th>
<th>(2) Full sample</th>
<th>(3) Privately- or State-controlled throughout the period</th>
<th>(4) Privately- or State-controlled throughout the period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leverage, (_t-1) ((\beta))</td>
<td>0.418*** (0.082)</td>
<td>0.361*** (0.082)</td>
<td>0.423*** (0.087)</td>
<td>0.430*** (0.088)</td>
</tr>
<tr>
<td>Log of real total assets</td>
<td>0.012*** (0.004)</td>
<td>0.016*** (0.005)</td>
<td>0.006 (0.006)</td>
<td>0.009 (0.007)</td>
</tr>
<tr>
<td>Fixed-to-Total Assets</td>
<td>-0.099** (0.048)</td>
<td>-0.108** (0.050)</td>
<td>-0.088* (0.052)</td>
<td>-0.099* (0.053)</td>
</tr>
<tr>
<td>Non-debt Tax Shield</td>
<td>-1.110*** (0.305)</td>
<td>-1.312*** (0.311)</td>
<td>-1.202*** (0.384)</td>
<td>-1.260*** (0.391)</td>
</tr>
<tr>
<td>EBIT-to-Total Assets</td>
<td>-0.249** (0.099)</td>
<td>-0.247** (0.097)</td>
<td>-0.249** (0.114)</td>
<td>-0.250** (0.113)</td>
</tr>
<tr>
<td>GDP Growth</td>
<td>-0.005 (0.006)</td>
<td>-0.008 (0.006)</td>
<td>-0.007 (0.008)</td>
<td>-0.010 (0.009)</td>
</tr>
<tr>
<td>Investor Protection</td>
<td>-0.013 (0.010)</td>
<td>-0.012* (0.011)</td>
<td>-0.014 (0.014)</td>
<td>-0.012 (0.015)</td>
</tr>
<tr>
<td>IRA ((\alpha_1))</td>
<td>0.042** (0.016)</td>
<td>-0.018 (0.042)</td>
<td>0.048** (0.022)</td>
<td>-0.020 (0.051)</td>
</tr>
<tr>
<td>Private Control ((\alpha_2))</td>
<td>0.025 (0.022)</td>
<td>-0.028** (0.040)</td>
<td>0.024 (0.025)</td>
<td>-0.041 (0.051)</td>
</tr>
<tr>
<td>Private Control*IRA ((\alpha_3))</td>
<td>- (0.043)</td>
<td>0.077* (0.044)</td>
<td>- (0.043)</td>
<td>0.088* (0.051)</td>
</tr>
</tbody>
</table>

\[
\frac{\alpha_1}{(1-\beta)} \quad 0.072*** (0.004) \quad -0.028 (0.067) \quad 0.083*** (0.021) \quad -0.035 (0.670) \\
(p-value) \quad (p-value) \quad (p-value) \quad (p-value) \quad (p-value)
\]

\[
\frac{(\alpha_1+\alpha_3)}{(1-\beta)} \quad - (0.002) \quad 0.092*** (0.002) \quad - (0.002) \quad 0.119*** (0.002) \\
(p-value) \quad (p-value) \quad (p-value) \quad (p-value) \quad (p-value)
\]

\[
\frac{\alpha_2}{(1-\beta)} \quad 0.043 (0.254) \quad -0.044 (0.482) \quad 0.042 (0.323) \quad -0.072 (0.428) \\
(p-value) \quad (p-value) \quad (p-value) \quad (p-value) \quad (p-value)
\]

\[
\frac{(\alpha_2+\alpha_3)}{(1-\beta)} \quad - (0.034) \quad 0.077*** (0.034) \quad - (0.034) \quad 0.083* (0.058) \\
(p-value) \quad (p-value) \quad (p-value) \quad (p-value) \quad (p-value)
\]

<table>
<thead>
<tr>
<th>Test</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arellano-Bond test for AR(1) ((p-value))</td>
<td>0.000</td>
<td>0.000</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>Arellano-Bond test for AR(2) ((p-value))</td>
<td>0.823</td>
<td>0.739</td>
<td>0.958</td>
<td>0.971</td>
</tr>
<tr>
<td>Sargan-Hansen test ((p-value))</td>
<td>0.465</td>
<td>0.607</td>
<td>0.683</td>
<td>0.789</td>
</tr>
</tbody>
</table>
Table 5 – GMM estimates of a dynamic investment equation with independent regulation and mixed ownership

Dynamic panel-data estimation, one-step system GMM estimates. All variables are defined in Table 3. All regressions include year dummies. Standard errors in parentheses are robust to heteroscedasticity 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%.

<table>
<thead>
<tr>
<th>I/K_t</th>
<th>(1) Full sample</th>
<th>(2) Full sample</th>
<th>(3) Full sample</th>
<th>(4) Privately- and State-controlled throughout the period</th>
<th>(5) Privately- and State-controlled throughout the period</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I/K)_{t-1} (β_1)</td>
<td>0.307*** (0.082)</td>
<td>0.305*** (0.087)</td>
<td>0.303*** (0.090)</td>
<td>0.384*** (0.046)</td>
<td>0.387*** (0.049)</td>
</tr>
<tr>
<td>(CF/K)_{t-1} (β_2)</td>
<td>0.162** (0.074)</td>
<td>0.161** (0.073)</td>
<td>0.162** (0.073)</td>
<td>0.113 (0.086)</td>
<td>0.116 (0.087)</td>
</tr>
<tr>
<td>(S/K)_{t-1} (β_3)</td>
<td>-0.001 (0.004)</td>
<td>-0.001 (0.004)</td>
<td>-0.001 (0.004)</td>
<td>-0.000 (0.003)</td>
<td>-0.000 (0.003)</td>
</tr>
<tr>
<td>IRA_{t-1} (α_1)</td>
<td>0.017** (0.007)</td>
<td>0.017** (0.007)</td>
<td>0.024* (0.014)</td>
<td>0.016** (0.007)</td>
<td>0.015** (0.007)</td>
</tr>
<tr>
<td>Private Control_{t-1} (α_2)</td>
<td>- (0.007)</td>
<td>0.004 (0.011)</td>
<td>- (0.005)</td>
<td>- (0.005)</td>
<td></td>
</tr>
<tr>
<td>Private Control_{t-1}*IRA_{t-1} (α_3)</td>
<td>- (0.019)</td>
<td>- (0.019)</td>
<td>- (0.019)</td>
<td>- (0.019)</td>
<td></td>
</tr>
<tr>
<td>α_1/(1-β_1)</td>
<td>0.025*** (0.006)</td>
<td>0.025*** (0.006)</td>
<td>0.034* (0.063)</td>
<td>0.026** (0.022)</td>
<td>0.025** (0.025)</td>
</tr>
<tr>
<td>(p-value)</td>
<td>(p-value)</td>
<td>(p-value)</td>
<td>(p-value)</td>
<td>(p-value)</td>
<td>(p-value)</td>
</tr>
<tr>
<td>α_2/(1-β_1)</td>
<td>- (0.835)</td>
<td>-0.022 (0.693)</td>
<td>0.006 (0.581)</td>
<td>0.004 (0.581)</td>
<td></td>
</tr>
<tr>
<td>(p-value)</td>
<td>(p-value)</td>
<td>(p-value)</td>
<td>(p-value)</td>
<td>(p-value)</td>
<td></td>
</tr>
<tr>
<td>(α_1+α_3)/(1-β_1)</td>
<td>- (0.124)</td>
<td>0.020 (0.646)</td>
<td>-0.009 (0.646)</td>
<td>-0.009 (0.646)</td>
<td></td>
</tr>
<tr>
<td>(p-value)</td>
<td>(p-value)</td>
<td>(p-value)</td>
<td>(p-value)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arellano-Bond test for AR(1) (p-value)</td>
<td>0.033</td>
<td>0.030</td>
<td>0.029</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>Arellano-Bond test for AR(2) (p-value)</td>
<td>0.517</td>
<td>0.507</td>
<td>0.512</td>
<td>0.689</td>
<td>0.668</td>
</tr>
<tr>
<td>Sargan-Hansen test (p-value)</td>
<td>0.375</td>
<td>0.381</td>
<td>0.410</td>
<td>0.521</td>
<td>0.501</td>
</tr>
</tbody>
</table>

Table 6 – Price-Leverage interaction– Granger tests

In panel A the dependent variable is the country-sector-specific utility price index. In panel B the dependent variable is Market Leverage. Dynamic panel-data estimation, one-step system GM estimates. Lagged values of Market Leverage and Utility Price used as instruments: lagged levels are used in first-differences equations and lags of first-differenced variables are used in levels equations (see last row). All regressions include year dummies. Standard errors in parentheses are robust to heteroschedasticity and to within group serial correlation (observations are clustered by firms). AR(1) tests the null hypothesis of no first-order correlation in the differenced residuals (Arellano-Bond test is still valid if differenced errors are AR(1)). AR(2) tests the null hypothesis of no second-order correlation in the differenced residuals (Arellano-Bond test is not valid if differenced errors are AR(2)). 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%.

### Panel A - Regulated Price Equations

<table>
<thead>
<tr>
<th>Utility Price, ( t )</th>
<th>(1) Full sample</th>
<th>(2) IRA exists</th>
<th>(3) IRA does not exist</th>
<th>(4) Privately-controlled</th>
<th>(5) State-controlled</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha^P_1 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utility Price, ( t-1 )</td>
<td>0.759***</td>
<td>0.694***</td>
<td>0.738***</td>
<td>0.787***</td>
<td>0.821***</td>
</tr>
<tr>
<td></td>
<td>(0.083)</td>
<td>(0.073)</td>
<td>(0.200)</td>
<td>(0.074)</td>
<td>(0.134)</td>
</tr>
<tr>
<td>( \alpha^P_2 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utility Price, ( t-2 )</td>
<td>0.183*</td>
<td>0.289**</td>
<td>0.078</td>
<td>0.161*</td>
<td>0.025</td>
</tr>
<tr>
<td></td>
<td>(0.103)</td>
<td>(0.109)</td>
<td>(0.180)</td>
<td>(0.092)</td>
<td>(0.118)</td>
</tr>
<tr>
<td>( \beta^L_1 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leverage, ( t-1 )</td>
<td>-0.052</td>
<td>0.021</td>
<td>-0.013</td>
<td>-0.019</td>
<td>0.040</td>
</tr>
<tr>
<td></td>
<td>(0.053)</td>
<td>(0.057)</td>
<td>(0.021)</td>
<td>(0.038)</td>
<td>(0.065)</td>
</tr>
<tr>
<td>( \beta^L_2 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leverage, ( t-2 )</td>
<td>0.154***</td>
<td>0.192***</td>
<td>-0.004</td>
<td>0.154***</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(0.057)</td>
<td>(0.064)</td>
<td>(0.017)</td>
<td>(0.055)</td>
<td>(0.045)</td>
</tr>
</tbody>
</table>

p-value test on \( H_0: \beta^P_1 = \beta^P_2 = 0 \)

0.025 0.012 0.679 0.024 0.604

p-value test on \( H_0: \beta^P_1 + \beta^P_2 = 0 \)

0.048 0.011 0.388 0.023 0.327

Arellano-Bond test for AR(1) (p-value)

0.000 0.000 0.109 0.000 0.031

Arellano-Bond test for AR(2) (p-value)

0.898 0.087 0.177 0.475 0.764

Sargan-Hansen test (p-value)

0.191 0.358 0.994 0.264 0.964


### Panel B – Leverage Equations

<table>
<thead>
<tr>
<th>Leverage, ( t )</th>
<th>(1) Full sample</th>
<th>(2) IRA exists</th>
<th>(3) IRA does not exist</th>
<th>(4) Privately-controlled</th>
<th>(5) State-controlled</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha^L_1 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utility Price, ( t-1 )</td>
<td>-0.205</td>
<td>-0.166</td>
<td>-0.008</td>
<td>-0.082</td>
<td>0.154</td>
</tr>
<tr>
<td></td>
<td>(0.192)</td>
<td>(0.198)</td>
<td>(0.012)</td>
<td>(0.197)</td>
<td>(0.263)</td>
</tr>
<tr>
<td>( \alpha^L_2 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utility Price, ( t-2 )</td>
<td>0.326</td>
<td>0.160</td>
<td>0.011</td>
<td>0.070</td>
<td>-0.183</td>
</tr>
<tr>
<td></td>
<td>(0.230)</td>
<td>(0.236)</td>
<td>(0.011)</td>
<td>(0.200)</td>
<td>(0.218)</td>
</tr>
<tr>
<td>( \beta^L_1 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leverage, ( t-1 )</td>
<td>0.390**</td>
<td>0.191</td>
<td>0.423***</td>
<td>0.367*</td>
<td>0.546***</td>
</tr>
<tr>
<td></td>
<td>(0.187)</td>
<td>(0.210)</td>
<td>(0.142)</td>
<td>(0.219)</td>
<td>(0.151)</td>
</tr>
<tr>
<td>( \beta^L_2 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leverage, ( t-2 )</td>
<td>0.135</td>
<td>0.168</td>
<td>0.102</td>
<td>0.265</td>
<td>0.065</td>
</tr>
<tr>
<td></td>
<td>(0.143)</td>
<td>(0.154)</td>
<td>(0.206)</td>
<td>(0.187)</td>
<td>(0.137)</td>
</tr>
</tbody>
</table>

p-value test on \( \alpha^L_1 = \alpha^L_2 = 0 \)

0.364 0.639 0.193 0.912 0.674

Arellano-Bond test for AR(1) (p-value)

0.022 0.083 0.103 0.090 0.078

Arellano-Bond test for AR(2) (p-value)

0.275 0.153 0.126 0.138 0.109

Sargan-Hansen test (p-value)

0.126 0.306 0.996 0.179 1.000


Instruments t-3; t-4; ∆t-2 t-3; t-4; ∆t-2 t-3; t-4; ∆t-2 t-3; t-4; ∆t-2 t-2; ∆t-1