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The Political Economy of Incentive Regulation: Theory and Evidence from U.S. States.*

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Abstract

The determinants of incentive regulation are a key issue in economics. More powerful rules relax allocative distortions at the cost of lower rent extraction. Thus, they should be found where rent extraction is less salient because the information-gathering process is more efficient, and where the reformer wants to incentivize more investments through higher rents. This prediction is consistent with U.S. electricity market data. During the 1990s, performance based contracts were given to the firms whose generation costs were historically higher and operating in states where the regulators had stronger incentives to exert information-gathering effort because elected instead of being appointed. Considering the endogeneity of regulatory institutions to technological and political forces suggests that OLS overestimate the impact of incentive regulation on costs, which was negative and statistically significant.

Keywords: Incentive Regulation; Regulatory Capture; Electricity; Accountability.
JEL classification: L11; L51; L94; D73.

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1 Introduction

Economists have long maintained that, in regulating a natural monopoly with unknown costs, a benevolent government should select incentive rules optimally trading off informational rents extraction and cost-saving inducement. Yet, in reality, the details of incentive contracts are designed by politicians, who care more or less about the firm's profits depending on the interests of their constituency, and by regulators accountable to specific groups of consumers and not to the society at large. The U.S. electricity market is a case in point. Major regulatory reforms, included the recent introduction of incentive regulation, are politically initiated but finalized within public hearings presided by regulators who can be either elected or appointed. How, therefore, do regulators' and politicians' incentives shape the basic rent extraction versus efficiency trade off?

This paper lays out a theoretical framework for thinking about this issue, and explores its empirical implications using U.S. electricity market data. In the model, I keep the complete contracting approach typical of the new theory of regulation (Laffont and Tirole, 1993; Laffont, 1996), recognizing however the different incentives faced by elected and appointed officials and the opposite political concerns moving pro-consumer and pro-shareholder parties when designing regulatory institutions. The contract on the regulated firm's unobserved cost reducing effort is chosen by an eventually partisan planner—who is a fiction for the Coasian bargaining necessary to make reforms acceptable, and it is contingent on a signal on the firm marginal cost whose precision increases with the effort exerted by a regulator who can be either elected or appointed. As in Alesina and Tabellini (2007), while elected officials strive for reelection, appointed ones are career-concerned. The model predicts that: 1. provided that effort sways enough votes, elected regulators exert more effort than appointed ones do; 2. the possibility of either manipulating the signal or diverting effort from information gathering to a less socially relevant task in exchange for bribes does not affect the regulator's behaviors when office holding is sufficiently valuable.[1] As a result, the election of regulators and, in general, a more efficient information-gathering technology decrease the expected probability that the planner remains uninformed, making at the same time less urgent rent extraction. Accordingly, the power of the equilibrium incentive rule—i.e., the effort prescribed by the equilibrium contract for the high cost firm—becomes higher. Also, more powerful rules soar expected ex ante informational rents reinforcing, in turn, the firm's incentive to invest in cost reducing technologies. Thereby, the power of the equilibrium rule is going to be higher the stronger are society's cost reducing investment concerns. When, however, investment expenses boost mainly the firm's profits, a tension between consumers and shareholders arises and it can be shown that the power of the equilibrium rule will be higher the more pro-shareholders is the reformer and the stronger is her grip on power.

In order to test these predictions, I look at the recent introduction of incentive regulation in the U.S. electricity market. I do analyze a panel of 106 investor owned utilities—IOUs hereafter—operating in 40 states over the period 1981-1999. Traditionally state Public Utility Commissions—PUCs hereafter—have set prices in order to assure a specific return on investment after recouping all operating costs recognized as reimbursable during rate reviews. Under such a mechanism, called cost of service regulation, firms may have relatively little incentive to minimize costs since cost reductions reflect directly into decreases in prices

[1] This incentive effect has an impact similar to the selection effect discussed by Besley and Coate (2003). The latter is driven by the fact that regulation is bundled at elections with more salient policies, and so politicians have electoral incentives and no costs to appoint pro-shareholders officials. Yet, such a bundling effect, differently form the one discussed here, does not survive when regulators can be bribed after election.

and, in turn, profits. Starting from the late 1980s, different forms of performance-based regulation—PBR hereafter—have replaced cost of service regulation in many states. The goal of these schemes was to communicate higher powered incentives to the firm by weakening, with respect to cost of service regulation, the link between rates and unit costs of service. Consistent with the model, PBR contracts were given to those firms whose generation costs were historically higher and operating in states where regulators were elected. Furthermore, taking into full consideration the endogeneity of regulatory reforms to technological and political forces suggests that OLS tend to overestimate the effect of PBR on labor input use which is negative, large in magnitude, and highly statistically significant. This evidence supports the idea that incentive regulation has been introduced mainly to accommodate dynamic efficiency concerns after an era of rising input costs and excessively pro-consumer attitudes by regulators (see Joskow [1974], and Guerriero [2009]).

Even if several studies have used telecommunications (Ai and Sappington, 2002; Ai, Martinez, and Sappington, 2004; Eckenrod, 2006), electricity (Ter-Martirosyan, 2003; Ajodhia and Hakvoort, 2005; Jamasb and Pollitt, 2007; Shumilkina, 2009) and motorways (Benfratello, Iozzi, and Valbonesi, 2009) data to show that PBR delivers lower rates and higher profits at the cost of more or less severe quality degradation, no previous paper has evaluated the determinants of its introduction. Indeed, the main contribution of this work is to formalize and test a theory of complementarities among regulator's implicit incentives and firms' explicit incentives arising endogenously from the contractibility of the firm's allocation as opposed to the non-contractibility of the regulatory performance.[2] The observed

[2]Recent empirical tests (Ka and Teske, 2002; Duso and Röller, 2003; Steiner, 2004; Duso, 2005; Knittel, 2006; Ando and Polasub, 2009) provide evidence but no theoretical justification of the relevance in explaining regulatory reforms of the forces discussed in the present work. An exception is Guerriero (2009, 2010).

reforms respond mainly to efficiency concerns. Also, I propose a first test of the endogenous medium-term efficiency benefits from replacing cost of service regulation with incentive regulation in the U.S. electricity market. The rest of the paper is organized as follows. Section 2 describes the role of the public officials involved in the U.S. electricity market regulatory reform process as an example of the setting studied in the model. Section 3 evaluates from a theoretical point of view the effect of regulators' and politicians' incentives on the power of the implemented incentive rules. Section 4 states the predictions which are tested in section 5; section 6 concludes. Proofs, tables and a data description are gathered in the appendix.

2 Institutions

Regulatory reforms in the U.S. electricity market: firms', regulators' and politicians' incentives.—The details of incentive schemes and, in particular, the sensitiveness of the firm's revenues to the costs of service, the duration of the contract and the possibility of being revisited before its planned conclusion are decided during rate reviews (NARUC, 1981-1999). The latter can be triggered by utilities in response to cost shocks, initiated periodically by the PUC or, often, required by the state government in order to assure that a particular rule is implemented. For instance, as Lee and Hill (1995) report, the 1995 Maine Alternative Rate Plan was introduced under the thrust of several laws—e.g., 1988 Least-Cost planning—approved by the Republican legislature. Rate reviews are quasi-judicial hearings open to all interested parties like the firms, consumer advocates, and the media. Within the hearings, commissioners cover an information gathering role: they examine witnesses and experts and receive the evidence (Gormley, 1983; Friedman, 1991). The final motion to be approved by the hearing assembly is proposed by the PUC's staff: this procedure should assure that all the decisions are reached in an open and fair manner (CDRA, 1992).[3] Media carefully track the evolution of the hearings as determined by the activity of commissioners and, accordingly, the latter constitutes the key task over which regulators are selected (Gormley, 1983).

From institutions to theory.—Building on such institutional design, I assume that the power of the incentive scheme is selected by an eventually partisan planner. The latter weights the firm's utility more or less than the net consumer surplus depending on society's investment concerns on one hand and on whether her constituency is mainly pro-shareholder or pro-consumer on the other hand. Such a setting captures the fact that, even if during the hearings the widest consensus among parties is needed, politicians can push toward the rule preferred by their constituency. The incentive rule is contingent on a signal produced out of the effort exerted by a regulator and of its random ability: this incorporates into the model the fact that the final decision is shaped by the information produced during the quasi-judicial hearings. The signal is truthful. This assumption reflects the role of the staff and can be relaxed at the cost of more cumbersome algebra as discussed in section 3.3. Finally, the regulator is rewarded on the basis of the observable signal's precision.[4]

3 Theory

The model builds on Laffont and Tirole (1993) and Laffont (1996). First, I will assess the impact of the regulator's implicit incentives on the pricing rule selected by a planner maximizing an utilitarian welfare function. Next, I will evaluate whether my conclusions

[3] If the filing is not approved or it is appealed, a High Court judge is asked to rule the case. In a previous version of the paper I have also tested the impact of judiciary institutions on the adoption of PBR: the estimated effects are in tune with the theory proposed below but they are not statistically significant.

[4] Should the precision be unobservable, the analysis would go through unchanged being signaling unavailable to the regulator who does not observe her ability when choosing effort. See also footnote 10.

change when the regulator can collude with the firm. Finally, I will establish the relation between the power of the incentive rule and the firm's investment decision: this exercise will clarify how the planner's choice is affected by investment concerns and partisan interests.

3.1 *Firm's Extrinsic Incentives and Regulator's Implicit Incentives*

Preliminaries.—The regulated firm produces a variable scale product q, charging a two-part tariff $A+pq$ with A, p and q strictly positive. Total cost is $(\beta - a)\,q = cq$ where $a > 0$ is the manager's effort and $\beta > 0$ is an inefficiency parameter which is equal to $\underline{\beta}$ with probability v and to $\overline{\beta}$ with probability $1-v$. Let $\Delta\beta \equiv \bar{\beta} - \underline{\beta} > 0$. Effort a implies a disutility in monetary units for the manager of $\psi(a)$ with $\psi(0) = 0$, $\lim_{a\to\beta} \psi(a) = \infty$, $\psi' > 0$, $\psi'' > 0$ and $\psi''' > 0$. This last assumption assures that the optimal rule is deterministic.

Consumers share the same preferences. Let $S(q)$, $p = P(q) = S'(q)$, $q(p)$ and $R(q) = P(q)\,q + A$ label the gross surplus, inverse and regular representative consumer's demand functions, and the firm's revenue; besides, $P' < 0$ and $q' < 0$. Consumers choose q to maximize the net surplus $S(q) - A - pq$ with A optimally fixed to make them indifferent between buying or not so that $A \equiv S(q) - P(q)\,q$.[5] The firm's utility is $U = t - \psi(a)$ where t labels the managerial rewards. In order to ensure that the firm participates it must be the case that $U \geq 0$ and that the firm's revenues cover managerial rewards or $A + (p-c)\,q(p) \geq t$.

The planner maximizes the sum of the net consumer surplus, the firm's utility and the firm's budget constraint evaluated at the shadow price of managerial rewards $1+\lambda$:

[5]The analysis is similar when the planner offers a menu of price and marginal costs pairs as in Armstrong and Sappington (2007) or when the price is linear. Should the latter be the case, then the pricing rule would be of the Ramsey type and the algebra would be more cumbersome.

$$W = S(q(p)) - A - pq(p) + U + (1+\lambda)[A + (p-c)q(p) - t]. \quad (1)$$

Let $V(q)$ denotes the social surplus which is the sum of the consumers' net surplus and the firm's revenue evaluated at the shadow price $1+\lambda$ because helps to fulfill the budget constraint.[6] The equation in (1) rewrites as $W = V(q) - (1+\lambda)[(\beta - a)q + \psi(a)] - \lambda U$ with $V(q) = (S(q) - R(q)) + (1+\lambda)R(q) = (1+\lambda)S(q)$. Clearly $V(0) = 0$, $V' > 0$, $V'' < 0$. Assume also that $-V''\psi'' > 1+\lambda$; this last inequality assures that W is strictly concave. The planner always observes q and C. Under full information on the inefficiency parameter, she implements the first best allocation pinned down by the type dependent effort rule $\psi'(a^*) = q^*$ which implies $U = 0$—see the appendix. When instead the planner cannot disentangle the inefficiency parameter from the effort, the following timing arises:

1. The planner and the firm learn the nature of the regulatory environment—i.e., $q(\cdot)$ and $\beta \in \left\{\underline{\beta}, \bar{\beta}\right\}$. Next, the firm only discovers the realization of β.

2. Exploiting the revelation principle (Myerson, 1979) the planner offers the firm a menu of (t, c) pairs conditional on its report of β. If the firm refuses, the game ends.

3. The selected contract is executed.

Let $\left\{\left(\underline{a}, \underline{c}, \underline{q}, \underline{t}, \underline{U}\right), \left(\bar{a}, \bar{c}, \bar{q}, \bar{t}, \bar{U}\right)\right\}$ denote the cost-reducing effort, marginal cost, quantity, managerial rewards, utility of the low and high cost firms. In equilibrium it must be the case that $\underline{U} = \underline{t} - \psi\left(\underline{\beta} - \underline{c}\right) \geq \bar{t} - \psi\left(\underline{\beta} - \bar{c}\right)$ in order to have that the firm truthfully

[6] Joskow and Schmalensee (1986) suggest that the fixed fee covers a role similar to the governmental transfers. To this extent, my analysis will be formally similar to the one proposed by Laffont and Tirole (1993) when reimbursement is intended to be operated through prices and the shadow cost of public funds is replaced by the marginal deadweight loss due to a rise in the fixed fee.

reports its low marginal cost and that $\bar{U} = \bar{t} - \psi\left(\bar{\beta} - \bar{c}\right) \geq 0$ in order to assure that the firm produces when its marginal cost is high. Because the planner's utility falls as the rent increases, $\bar{U} = 0$ and $\underline{U} = \underline{t} - \psi\left(\underline{\beta} - \underline{c}\right) = \bar{U} + \psi\left(\bar{\beta} - \bar{c}\right) - \psi\left(\underline{\beta} - \underline{c}\right) = \Phi\left(\bar{a}\right)$ where $\Phi\left(a\right) \equiv \psi\left(a\right) - \psi\left(a - \Delta\beta\right)$ with $\Phi' > 0$ and $\Phi'' > 0$ because $\psi''' > 0$.[7] Thus, under asymmetric information, the planner maximizes the function

$$\tilde{W} = v\left\{V\left(\underline{q}\right) - (1+\lambda)\left[\left(\underline{\beta} - \underline{a}\right)\underline{q} + \psi\left(\underline{a}\right)\right] - \lambda\Phi\left(\bar{a}\right)\right\} +$$

$$+ (1-v)\left\{V\left(\bar{q}\right) - (1+\lambda)\left[\left(\bar{\beta} - \bar{a}\right)\bar{q} + \psi\left(\bar{a}\right)\right]\right\}.$$

The maximization is the same as for full information, except for the expected cost of the rent $v\lambda\Phi\left(\bar{a}\right)$, which depends only on $\bar{a}$. Thus, $\underline{q}$ and $\underline{a}$ are equal to the first best level, and incentive concerns are entirely taken care of by the power of the high cost equilibrium effort:

$$\psi'\left(\hat{\bar{a}}\right) = \hat{\bar{q}} - \frac{\lambda}{1+\lambda}\Gamma\left(v\right)\Phi'\left(\hat{\bar{a}}\right), \tag{2}$$

where $\Gamma\left(x\right) \equiv x\left(1-x\right)^{-1}$. In particular, in order to limit the high type's rent, the planner distorts the high cost firm's allocation giving it a low powered rule—i.e., such that $\hat{\bar{a}} < \bar{a}^*$.

The supervision technology.—Consider next the following information gathering technology. In $t = 2$ the planner offers the firm a menu of transfer-marginal cost pairs conditional not only on the firm's report but also on an a truthful signal produced by the activity of a regulator. The signal's observable but not contractible precision is ξ. If $\beta = \underline{\beta}$, with probability ξ the planner sees $\underline{\beta}$—and implements the first best contract—and with probability $1 - \xi$

[7] I also assume that $v < \bar{v}$ where $\bar{v}$ is the threshold such that for v larger than $\bar{v}$ the planner finds optimal to give up production by the $\overline{\beta}$ type and offers a contract with no rent to the $\underline{\beta}$ type. $\bar{v}$ is implicitly defined by: $(1-\bar{v})\,V\left(\bar{q}\left(\bar{v}\right)\right) - (1-\bar{v})\,(1+\lambda)\left(\bar{\beta} - \bar{a}\left(\bar{v}\right)\right)\bar{q}\left(\bar{v}\right) - (1-\bar{v})\,(1+\lambda)\,\psi\left(\bar{a}\left(\bar{v}\right)\right) = \bar{v}\lambda\Phi\left(\bar{a}\left(\bar{v}\right)\right)$.

she remains uninformed. If $\beta = \bar{\beta}$, the signal is always uninformative.[8] The precision has technology $\xi = \alpha e$ where $e \in [0, 1]$ labels the regulator's unobservable effort and $\alpha \in [0, 1]$ her talent. The latter is distributed independently of e with mean $\bar{\alpha}$, variance σ_α^2, and density f whose properties are discussed below.[9] The regulator always receives a reservation wage $w > 0$ and, as in Alesina and Tabellini (2007), she chooses the effort before exerting effort: this leaves aside signaling incentives emphasizing the residual rights nature of the regulatory task. All in all, the following two steps are added to to the timing studied above:

3'. The regulator chooses the effort; next, she observes α. Then, the planner sees the signal which leads to the first best if informative. If the latter is not the case, the planner asks the firm to report β.

4. The contract is executed, the precisions revealed and the regulator rewarded.

The regulator is either elected or appointed and maximizes the following objective function:

$$P_i(e_i) = \left\{1 + \left[G^i(e_i) - (1 - K)\,C(e_i)\right]\right\} w, \tag{3}$$

where $i = \{E, A\}$ labels the appointment rule through which the regulator is rewarded, $K \in (0, 1)$ is an efficiency of the information gathering technology parameter, and the terms in square brackets constitute the net perquisites in monetary terms obtained over and above the wage w from implicit incentives.[10] The effort cost function is such that $C(0) = 0$, $C' > 0$,

[8]Under different information technologies, the power of the contract can fall with the precision (see Boyer and Laffont, [2003]). Yet, only the technology used here matches the institutions of the market studied below: here, the hearings are aimed at proving that the firm has low costs and a price adjustment is unnecessary.

[9]Having an additive technology would not change the model's message (see Alesina and Tabellini, [2007]).

[10]Clearly enough, having as performance any continuous and increasing function of the precision—e.g., social welfare—or having C or G^i not multiplied by w, would not affect the results.

$C'(0) < \infty$, $C'' > 0$, $\lim_{e_i \to 1} C'(e_i) = \infty$. As proposed by Alesina and Tabellini (2007), while elected officials are held accountable by voters at elections and want to maximize the probability of being re-elected, appointed ones wish to maximize the conditional perception of their talent as a matter of self-image—i.e., pride or legacy, or "revolving door" interests.[11] Starting from the latter, this means that $G^A(e_A) = \mathrm{E}\left[E\left(\alpha \left|\xi_A, e_A^{\exp}\right.\right)\right]$ where $\mathrm{E}[\cdot]$ denotes the regulator's unconditional expectation over ξ_A, E the expectation of society over α and $e_A^{\exp}$ society's expectation over effort. For what instead concerns elected regulators, voters realize that the alternative to the incumbent is an average talented official exerting effort $e_E^{\exp}$. The incumbent regulator is re-elected whenever the performance is higher than $\tilde{\xi}_E = \bar{\alpha} e_E^{\exp}$ and thus $G^E(e_E) = \Pr\left\{\xi_E \geq \tilde{\xi}_E\right\}$. For sake of simplicity, I maintain that the market value of talent and the value of office holding are both equal to w.

A glance to the timing and to equation (3) suggests a key feature of the model: regulators are concerned about their evaluators' decisions and not about the power of the rule selected by the planner. Two are the key consequences. First, implicit incentives reduce the scope for side-contracts between the firm and the regulator, because colluding means for the latter the loss of valuable non-monetary rewards. Second, the regulator's and the planner's goals can collide whenever the former does not consider the informational rent as a pure loss. Before discussing these two points, let me illustrate the features of the equilibrium rule.

Equilibrium.—The solution concept is perfect Bayesian equilibrium. In order to analyze the two key cases in which the measures of extreme types—$f(0)$ and $f(1)$—are equal or different from zero, I maintain that talent is distributed according to one of the following non degenerate and continuous hump-shaped distributions supported on a bounded interval:

[11] In this last case, they care about those who may offer them alternative job opportunities.

Beta and generalized Kumaraswamy with parameters greater than 1, raised cosine, inverted U-quadratic, and truncated normal (see Johnson, Kotz, and Balakrishnan, [1994]). Labeling with $\Phi(\cdot)$ the standard normal cumulative function, I also assume that:

A.1: *When α is truncated normally distributed,* $\sqrt{2\pi}\left[\Phi\left(\left(1-\bar{\alpha}\right)\sigma_{\alpha}^{-1}\right)-\Phi\left(-\bar{\alpha}\sigma_{\alpha}^{-1}\right)\right]<1$.

The assumption assures that in the case of the truncated normal, which is the only distribution with a positive measure of extreme types, $f(\bar{\alpha})>1$; for all the other distributions I consider this is always the case—proofs available from the author.[12] As further discussed in the appendix, the solution to problem (3) is such that:

Lemma 1: *The regulator's problem has a unique and interior solution which is increasing in the quality of the information-gathering technology K. Besides, when A.1 holds, an elected regulator will exert a strictly higher effort than an appointed one will do.*

In equilibrium the marginal cost of effort and its marginal value are equalized: the latter equals $\bar{\alpha}/\hat{e}_A$ if the regulator is appointed and $f(\bar{\alpha})(\bar{\alpha}/\hat{e}_E)$ if she is elected. Because both these values fall with effort, the equilibrium is unique (Dewatripont, Jewitt, and Tirole, 1999). For a given $\hat{e}_i$, the evaluators estimate α as $\xi_i/\hat{e}_i$ which implies that a rise in $\hat{e}_i$ delivers marginal benefits $\bar{\alpha}/\hat{e}_i$. Yet, under election, this return is also weighted by the effect of a rise of the expected precision on the probability that the regulator is re-elected: this marginal effect is $f(\bar{\alpha})$. The higher is the latter the more effective is effort in swaying votes and assuring a higher probability of re-election. When $f(\bar{\alpha})$ is sufficiently high—i.e., bigger than 1—elected regulators exert an effort higher than appointed ones do. In the most realistic case in which there are no extreme types $f(\bar{\alpha})$ is always bigger than 1; when the latter is not

[12] A.1 holds whenever the talent distribution is not too disperse. This is a mild requirement in the environment discussed later. Here, the regulators' biographies are highly consistent (Gormley, 1983).

the case, the mild condition in A.1 is needed. Finally, a more efficient information gathering technology raises equilibrium effort.

In $t = 2$ the planner's posterior belief on $\beta = \underline{\beta}$ conditional on an uninformative signal is $v\left[1 - \bar{\alpha}\hat{e}_i\right]\left[1 - v\bar{\alpha}\hat{e}_i\right]^{-1}$. Let $\underline{W}^*$ label the first-best value of W obtained with an informative signal and let S index the supervision regime quantities. The planner maximizes the function

$$\tilde{W}^s = v\bar{\alpha}\hat{e}_i\underline{W}^* + v\left(1 - \bar{\alpha}\hat{e}_i\right)\left\{V\left(\underline{q}^s\right) - (1+\lambda)\left[\left(\underline{\beta} - \underline{a}^s\right)\underline{q}^S + \psi\left(\underline{a}^s\right)\right] - \lambda\Phi\left(\bar{a}^s\right)\right\} + \\ (1-v)\left\{V\left(\bar{q}^s\right) - (1+\lambda)\left[\left(\bar{\beta} - \bar{a}^s\right)\bar{q}^s + \psi\left(\bar{a}^s\right)\right]\right\} - 2\left(1+\mu\right)w.$$

and evaluates the regulator's wage at the shadow cost of public funds $1 + \mu$ where $\mu > 0$ accounts for the distortions created by the non lump-sum taxes used to raise the fund. Again, the rule giving prices as a function of marginal costs is the same as the full information case—$V'\left(\hat{\bar{q}}^s\right) = \hat{\bar{c}}^s = \bar{\beta} - \hat{\bar{a}}^s$—and the planner offers the high cost firm the scheme:

$$\psi'\left(\hat{\bar{a}}^s\right) = \hat{\bar{q}}^s - \frac{\lambda}{1+\lambda}\Gamma\left(v\right)\left(1 - \bar{\alpha}\hat{e}_i\right)\Phi'\left(\hat{\bar{a}}^s\right). \tag{4}$$

The supervision technology partially curbs the allocative distortion—i.e., $\hat{\bar{a}} < \hat{\bar{a}}^s < \bar{a}^*$—the more the lower is the expected probability that the planner remains uninformed; accordingly:

Proposition 1: *The power of the equilibrium incentive rule falls with the efficiency of the information-gathering technology K and, under A.1, is higher when regulators are elected.*

The main innovation of proposition 1 rests in underlining that regulators' implicit incentives and the firm's explicit incentives are complement. The pattern resembles the relation between career concerns and monetary rewards in labor contracts proposed by Gibbons and Murphy (1992). Yet, in contrast to the latter the present relation involves players who belong to different tiers of the hierarchical structure and are linked by the revelation principle.

Institutions fostering the regulators' pro-consumer incentives increase the expected probability of informative signals and, accordingly, the planner relaxes the allocative distortion offering the low type a more powerful contract.[13] The appeal of these results lies not only in the sensibility of the model's premises which bridge implicit incentives to the asymmetry in information but also in the realism of the consequences. Building on a similar structure, the new regulatory economics (Laffont and Tirole, 1993; Laffont, 2000) obtains collusion-proof equilibria in which monetary perks equal to the firm's expected stake are given to explicitly interested supervisors in order to avoid corruption. The latter are completely at odds with any observed regulatory contract; yet, consistent empirical evidence has clarified the narrow role of capture in the U.S. electricity market (see the study on electricity pricing by Leaver [2009] and the introduction of state regulation by Knittel [2006]). The above-discussed equilibrium, instead, has similar collusion-proofness properties originated exactly from the observed residual rights nature of supervision. Next section, whose proofs are available from the author, explains this point in details.

3.2 *Endogenous Collusion Proofness*

Regulators exert effort in other tasks like suggesting lines of conduct on service provision, ruling on environmental policies and so on. Following Alesina and Tabellini (2008), I assume that the regulator's performance in the second task is described by the technology $h_i = \alpha e_i^h$ where e_i^h is the task specific effort. The benefit linked to this second activity is κh_i—with $\kappa > 0$—for the firm and negligible for the consumers and the regulator so that she would not

[13] The assumption according to which the planner does not choose the regulator's implicit incentives is relaxed in Guerriero (2009), who employs the same model to assess the efficiency-enhancing and rent-seeking determinants of the election versus appointment comparison.

exert effort in this task except when side contracts with a lobby representing the regulated firm have been signed.[14] The planner cannot condition the pricing rule upon side contracts because—as it is likely—they are unobservable. As in Alesina and Tabellini (2008), I also maintain that: 1. α is truncated normally distributed; 2. the effort cost function is additive; 3. the lobby, whose vote is irrelevant, has all the bargaining power and, before the regulator's effort choice, commits to bribes b_i or campaign contributions n_E to be paid in $t = 4$ once the precisions become observable.[15] Both b_i and n_E are contingent on the exerted efforts; yet, while bribes are illegal and with probability $\upsilon > 0$ a bribed regulator is caught and pays a fine $M > 0$, campaign contributions are legal and turn the voters' outside option into $\tilde{\xi}_E^C = \bar{\alpha} e_E^{\exp} - H(n_E)$ with $H(0) = 0$, $H' > 0$, $H'' < 0$. When $\tau > 0$ measures the value of implicit rewards relative to illegal bribes, regulator i's utility rewrites as

$$P_i^C(e_i^C, e_i^h) = \left\{1 + \tau\left[G^i\left(e_i^C\right) - (1-K)\, C\left(e_i^C + e_i^h\right)\right]\right\} w + b_i - \upsilon M,$$

with C indexing the collusion regime. The lobby's indirect utility is given by

$$\tilde{U} = v\left[1 - \bar{\alpha}\hat{e}_i\right] \Delta\theta \hat{\bar{q}}^C + \kappa E\left[\alpha \hat{e}_i^h\right] - \hat{b}_i - \hat{n}_E.$$

As usual, a subgame perfect equilibrium of either the bribing or the lobbying game has to be jointly optimal for the lobby and the regulator, given the evaluators' expectations. The proofs of what is discussed as follows are available from the author upon request.

Discussion.—Proposition 1 always stands under collusion because a regulator, in order to preserve her implicit incentives, will never exert effort only in the second task. Also, under appointment: 1. for τ sufficiently high it does not exist an equilibrium with a positive second

[14] Allowing the second task to affect the regulator's implicit incentives, would bring essentially similar results provided that information gathering is sufficiently more relevant.

[15] Alternatively the firm could bribe the planner; this has the same effect of a higher weight on the firm's utility. Provided that this increase is weakly lower than λ—because of for instance a well-functioning legal system, all the results of the paper will continue to stand.

task effort because the loss of implicit incentives more than overcomes the extra firm's rent; 2. the lobby will not offer any bribe when her stake is too narrow or the expected punishment is sufficiently large. Under election, instead, the lobby will not try to side contract when money is not effective in swaying votes—i.e., H' is small. Collusion proofness extends also to the scenario in which the regulator can observe directly the signal and is re-appointed when she report an informative draw. Should the latter be the case, again the report will be truthful whenever implicit incentives are sufficiently relevant.

3.3 *Endogenous Regulatory Institutions*

The analysis so far has taken into account static dimensions of regulatory performance only but it has not dealt with the impact of incentive regulation on the firm's investment decisions. Indeed, a sharp tension between rent extraction and investment inducement arises in industrial policies and, whether or not the planner can commit to reimburse investment costs, the equilibrium pricing rule can envision ex post expropriation of sunk investments (see Laffont and Tirole [1993], ch. 1). On the one hand, this dynamic inconsistency optimally pushes toward more powerful rules; on the other, it creates the risk that inefficient incentives are imposed to the firm if investments affect asymmetrically consumers and shareholders and these constituencies can shape the decision of the Coasian bargaining—i.e., the planner.

Next, I will first clarify the efficiency bit and then I will look at the political determinants of incentive rules. For sake of simplicity, I will assume that the planner cannot commit to reimburse investment costs. Even if the used and useful U.S. doctrine partially insures against non-commitment, the hypothesis is the most appropriate in a technologically mature markets like the electricity ones where the firm's retaliation could not be very damaging (Newbery, 2000). In any case, it can be proved that the results discussed below hold even if the planner can write long run contracts on the firm's investment decision.[16]

A benevolent planner.—Consider the following investment game proposed by Laffont and Tirole (1993). Just before learning β, the firm commits an investment of cost $\zeta(I) \geq 0$ raising the ex ante probability of having low cost to $\tilde{v}(I) = v(1+I)$. The cost function is increasing and convex. In a pure strategy Nash equilibrium the planner anticipates the equilibrium investment $\hat{I}$ implementing the rule defined in (4) for a probability of $\underline{\beta}$ type of $\tilde{v}\left(\hat{I}\right)$. The firm chooses $\hat{I}$ so as to maximize expected ex ante rents minus investment costs

$$\hat{I} \in \arg\max_{I \geq 0} \left\{ \tilde{v}(I)(1-\bar{\alpha}\hat{e}_i)\Phi\left(\hat{\bar{a}}^{S,I}\left(\hat{I}\right)\right) - \zeta(I) \right\}, \tag{5}$$

where the apex I indexes the investment regime.[17] A glance to (5) it is enough to see that a fall in the power of the incentive rule depresses expected ex ante rents and, in turn, cost-reducing investments. Furthermore, as the appendix shows, in the empirically relevant case for a necessary good—when the the inverse demand is elastic—and under a mild assumption,[18] the firm invests less than is socially optimal. As a result, a planner concerned about the level of cost-reducing investments—because faced with systematically high costs—would

[16] Provided that the planner ensures the firm a positive ex post utility, the level of investment will be suboptimal also under commitment. If contractible the investment will be inefficient because the firm will foresee an higher rent extraction by a planner faced with a more favorable types' distribution. When, instead, the investment is non-contractible, the optimal rule will also have a positive term reflecting the shadow cost of the moral hazard in investment constraint and the analysis will go on unchanged (Laffont and Tirole, 1993).

[17] In the background I am also assuming that the cost function is increasing at a rate high enough to avoid that $\tilde{v}(I)$ reaches $\bar{v}$ or $\lim_{I\to\bar{I}} \zeta'(I) > v(1-\bar{\alpha}\hat{e}_i)\Phi\left(\hat{\bar{a}}^{S,I}\left(\bar{I}\right)\right)$ with $\bar{I} = (\bar{v}-v)v^{-1}$ and $\bar{v}$ implicitly defined this time by $(1-\bar{v})V(\bar{q}(\bar{v})) - (1-\bar{v})(1+\lambda)\left(\bar{\beta}-\bar{a}(\bar{v})\right)\bar{q}(\bar{v}) - (1-\bar{v})(1+\lambda)\psi(\bar{a}(\bar{v})) = \bar{v}(1-\bar{\alpha}\hat{e}_i)\lambda\Phi(\bar{a}(\bar{v}))$.

[18] This is that the extent of asymmetric information is wide enough: $\Delta\beta \geq \psi'^{-1}(\bar{q}^*)$. Espey and Espey (2004) conclude that the median of previous estimates of the long run residential price elasticity of demand is 0.81.

select higher-powered rules.[19] Formally, let me assume that the planners add an extra weight χ with $\lambda > \chi > 0$ to the firm's utility increasing in her investment concerns so that: 1. her objective function writes now as $\tilde{W}^S\left(\tilde{v}\left(\hat{I}\right)\right) + \chi\tilde{v}\left(\hat{I}\right)(1-\bar{\alpha}\hat{e}_i)\,\Phi\left(\bar{a}^{S,I}\right)$; 2. the new high cost firm's equilibrium level of effort is pinned down by:

$$\psi'\left(\hat{\bar{a}}^{S,I}\right) = \hat{\bar{q}}^{S,I} - \frac{\lambda-\chi}{1+\lambda}\Gamma\left(\tilde{v}\left(\hat{I}\left(\hat{\bar{a}}^{S,I}\right)\right)\right)(1-\bar{\alpha}\hat{e}_i)\,\Phi'\left(\hat{\bar{a}}^{S,I}\right) \qquad (6)$$

and by the first order condition to (5). Fixed-price contracts reach efficiency but leave a disproportionate rent to the firm; thus, optimal rules should take into consideration, at the same time, allocative distortion, rent extraction and investment inducement or:[20]

Proposition 2: *The power of the equilibrium incentive rule increases with the planners' investment concerns* χ.

This last result belongs to a series of other findings showing that institutions directly or indirectly curbing rent-extraction could be optimal if expropriation of sunk investments is a real issue.[21] Yet, investment concerns could also distort institutional design away from efficiency when the firm's expenses favor shareholders over consumers and both groups can influence the planner's decision. A striking example of these expenses are those not strictly related to service provision *per se*—e.g., marketing, diffusion of smart-metering technologies reducing the fixed cost of transmission. Yet, the idea extends at the cost of more cumbersome

[19] Such investments always increase the planner's objective function when the demand is sufficiently inelastic.

[20] The result matches the stylized fact that incentive regulation "can also be designed to encourage other goals, such as maintaining or improving service quality and encouraging certain investments (e.g., network modernization or energy efficiency investments)" (Basheda et al., 2001).

[21] While Sappington (1986) looks at rules that hinder information gathering, Guerriero (2009) focuses on regulatory appointment rules. Knittel (2006) shows that the probability of a reform from a municipal regulation with its typical hold-up problems to a state regulation assuring a fair rate of return on investment were higher where capacity shortages were more severe and residential penetration rates were lower.

algebra to those investment opportunities that benefit both groups but asymmetrically.

In order to clarify the point in the sharpest way, I will focus on ex post expenses whose returns are negligible for consumers but accrue to the firm's rents. I will also suppose that the firm is infinitively risk averse in the range of negative ex post utilities.

A partisan planner.—This time the planner chooses incentive rules as a perfect agent of the incumbent $\tilde{m}$ between two parties—the pro-shareholder R and the pro-consumer D; besides, the following two periods are added to the timing studied in section 3.1:

5. The incumbent faces an election with exogenous winning probabilities $x_{\tilde{m}}$; next, the winner m implements a fixed aid $\rho_m > 0$ proportional to the firm's rent and paid out to the firm if the investment is committed. Ex post rents become $(1 + \rho_m) U$.

6. The firm eventually commits an investment of fixed cost $\bar{\bar{I}} > 0$. The net expected value of the investment is $\pi \bar{\bar{I}}$, with $\pi \equiv \bar{\pi}\delta + \underline{\pi}(1 - \delta) > 0$ and $\bar{\pi} > 0 > \underline{\pi}$. In words, the investment is stochastic and leads to a loss with probability $1 - \delta > 0$.

Clearly enough, only the low cost firm invests whenever $(1 + \rho_m) \Phi \left(\hat{\bar{a}}_{\tilde{m}}^{S,I}\right) + \underline{\pi}\bar{\bar{I}} \geq 0$, and a planner agent of a of type $\tilde{m}$ incumbent evaluates this ex-post participation—to the investment game—constraint at the shadow price $1 + \chi_{\tilde{m}} > 1$ and the investment aid $\rho_m \Phi \left(\hat{\bar{a}}_{\tilde{m}}^{S,I}\right)$ at the shadow cost of public fund $1 + \mu$. The parameter $\chi_{\tilde{m}}$ captures the incumbent's willingness to incentivate ex post investments. Define $\tilde{x} \equiv \rho_D x_D + \rho_R x_R$ and assume that the following restrictions on the exogenous parameters hold

A.1: $\rho_R > \rho_D; \chi_R > \mu > \chi_D$.

All in all, when the incumbent is of type $\tilde{m}$, the planner maximizes the function:

$\tilde{W}_{\tilde{m}}^{S,I} = \tilde{W}^S + v\left(1 - \bar{\alpha}\hat{e}_{i,R}\right)\left[(1 + \chi_{\tilde{m}})(1 + \tilde{x}) - (1 + \mu)\tilde{x}\right]\Phi\left(\bar{a}_{\tilde{m}}^{S,I}\right).$

In interpreting the foregoing, several observations should be borne in mind. First, the set up formalizes the existence of huge transfers from the federal and state governments to IOUs financed out of distortionary taxes and aimed to solve energy externalities—e.g., air pollution, roadway congestion. As discussed by Metcalf (2008), the total energy-related tax expenditures for major fuel categories investments and the production tax credits for renewable and advanced coal-based power sources reached in fiscal year 2008 the 3.46 billion dollars. Second, the fact that the winning party cannot reform incentive rules matches the existence of a commitment period typical of PBR (see Basheda et al., [2001]). Third, the exogeneity of $x_{\tilde{m}}$ captures the basic idea, proposed by Besley and Coate (2003), that regulation is bundled at election of politicians with more salient policies. Fourth, the fact that the pro-shareholder party is more willing to incentivate investment expenses incorporates into the model politicians' strategic incentives to propose and implement extremist platforms in order to empower their own supporters (Glaeser, Ponzetto, and Shapiro, 2004) or to buy more votes through the money of campaign contributors (Alesina and Holden, 2008). To the latter extent, the set up could also be interpreted as a game in which a pro-consumer and a pro-shareholder lobby are randomly selected to influence first the institutional design phase and then, with an exogenous probability, the new state government fixing the aid.

All in all, the new equilibrium high cost firm's effort is:

$$\psi'\left(\hat{\bar{a}}_{\tilde{m}}^{S,I}\right) = \hat{\bar{q}}_{\tilde{m}}^{S,I} - \Gamma(v)\left(1-\bar{\alpha}\hat{e}_{i,R}\right)\left[\frac{\lambda}{1+\lambda} - \frac{\left(1+\chi_{\tilde{m}}\right)\left(1+\tilde{x}\right)-\left(1+\mu\right)\tilde{x}}{1+\lambda}\right]\Phi'\left(\hat{\bar{a}}_{\tilde{m}}^{S,I}\right). \quad (7)$$

which, as the appendix shows, implies that:

Proposition 3: *Under A2, the power of the equilibrium incentive rule increases with the* *incumbent reformer hold on power $x_{\tilde{m}}$ and is greater if the reformer is pro-shareholder.*

While the second bit of proposition 3 is in tune with Laffont (1996), the first one differs from the conclusion of this seminal paper. There the relation between the likelihood of a reform toward more powerful rules and the hold on power of the incumbent is negative when the reformer is pro-shareholder and null otherwise. The actual pattern originates from the mix between the asymmetry in the parties' preferences and the uncertainty of elections and it is similar to the strategic dynamic proposed by a lively political economy tradition (Persson and Svensson, 1989; Alesina and Tabellini, 1990; Hanssen, 2004a), claiming that a lack of permanence in office can inspire policymakers to implement reforms in order to influence political outcomes or limit the actions of future incumbents.[22]

In the present environment, an higher probability of being re-elected and fixing a larger (smaller) aid, without the danger of facing a new institutional reform, pushes a pro-shareholder (pro-consumer) incumbent to have more powerful rules selected assuring in this way an even higher profit to her constituency (curb allocative distortion). Hence, the tension between consumers and shareholders could lead to inefficient rules being chosen (see also Faure-Grimaud and Martimort, 2003).[23] Next, I test the theory developed above.

4 Empirical Implications

The basic idea of the theory is that more powerful schemes relax allocative distortions

[22]The prediction is similar to those obtained by the Alesina and Tabellini (1990) and Hanssen (2004). Yet, PBR not only limits the options of successors—as fiscal deficits and appointed courts do—but it also ties the incumbent's hands later on, when electoral promises need to be met.

[23]The argument still holds when the government: 1. acts as a sponsor and increases the ex post firm's rent without monetary aids if $\chi_R > -1 > \chi_D$; 2. can decrease investment costs directed toward cost reduction, provided that the dynamic efficiency concerns more than outweighs the higher rent extraction needs.

at the cost of lower rent extraction; thus, they should be found where allocative distortions are less relevant because the information gathering process is more efficient, and where the reformer is more concerned with incentivizing investments through higher informational rents. This was embodied in Propositions 1, 2 and 3 above. Thus, the first prediction refers to the probability that a reform toward higher powered rules is enhanced and reads as:

Prediction 1: *The likelihood of a reform toward more powerful incentive rules will be higher when regulators are elected, increase with the efficiency of information-gathering technology, with society's concerns for cost-reducing investments, and with the reformer hold on power. Besides, it will be higher when the reformer is pro-shareholder.*

My second test is motivated by the theoretical observation that costs should decrease as more powerful rules are implemented. A glance to the firm's investment problem in (5) makes the point clear: not only more powerful incentive rules do lower the marginal cost of the firm when its type is $\bar{\beta}$ but they also increase the ex ante incentive to invest in a more favorable types' distribution—i.e., the probability that the firm is of type $\underline{\beta}$. On top of this, the second prediction deals with regulatory outcomes and reads as:

Prediction 2: *Incentive regulation will decrease production costs.*

Next, I look at the evidence on these predictions using data on U.S. electricity market firms.

5 Evidence

Between 1982 and 2002, forty-one IOUs in twenty-three U.S. states introduced some form of broadly defined PBR—see table 1 and 2 for an exhaustive account.[24] During these years,

[24]Other important restructuring changes were the divestiture of generation and transmission components of electric utilities and the activation of wholesale competitive markets. This process has changed the industry dramatically by confronting managers with the choice of cost reduction of their competitors, and by reducing agency costs (see Baggs and de Bettignies [2007]). Once considered, restructuring does neither

the most common alternatives to cost of service regulation were: rate case moratorium, rate freeze, price and revenue cap, and earnings sharing. Rate case moratorium is an agreement between the utility and the PUC to discontinue rate reviews for a certain period. Thus systematic price variations are not permitted, but some individual rate elements may be changed. Under a rate freeze, instead, no rate can be changed by the firm during the commitment period. For price cap regulation the initial rates are set based on the costs and then they can be adjusted by the IOU as long as on average they rise no faster than inflation less a productivity offset. Revenue cap is similar but focuses on allowed revenues rather than allowed prices. Finally, earnings sharing contracts require the firm to share earnings above and below an intermediate range with its users. When earnings are in the range, the firm secures for herself greater profits only when a higher cost-reducement effort is exerted. It is widely accepted that cost of service regulation is the least powerful scheme, that price cap effectively leaves the firm residual claimant of its performance, and that along the power dimension the other incentive rules lie in between these two extremes (Basheda et al., 2001).

Building on the above discussion, I consider two dependent variables. The first one is the dummy *PBR* which equals one for IOU regulated under a PBR contract and zero otherwise. The second is *PBR_Ord*, which equals three for IOUs regulated under a price or revenue cap; one for IOUs regulated under cost of service regulation and two otherwise.[25] I will use the latter to explain the choice of the power of the incentive rule and the former to compare cost of service regulation with more powerful rules. I consider data on 106 IOUs in 40 states for the years 1981-1999: for this sample, I have sufficient observations on IOUs productivity,

show complementarities with incentive regulation nor change the gist of the results discussed below.

[25] Depending on the width of the bands and the level of sharing, revenue sharing can provide minimal or large incentives (see Ter-Martirosyan, [2003]). Using different definitions for *PBR_Ord*—e.g. having the latter assuming value three also when earnings sharing was in place, does not affect the main empirical results.

regulatory institutions and political competition—see the appendix for details on the sample construction. I first identify the determinants of PBR adoption and then examine whether PBR decreases input requirements estimating labor and fuel use equations.

5.1 *Non Random Incentive Rules Selection*

The empirical strategy.—In order to exploit the three-dimensional variation—over time and across firms and power levels—of incentive rules, I use a an ordered logit with dependent *PBR_Ord* and a logit with dependent *PBR*. For what concerns the former, let $y^*_{f,t}$ be the unobserved preference of a reformer dealing with firm f at time t driving the choice of a rule $y_{f,t}$. Here, $y_{f,t} = k \Leftrightarrow \vartheta_{k-1} \leq y^*_{f,t} \leq \vartheta_k$ where $k = 1, 2, 3$ and the ϑ_k are unknown thresholds to be estimated. The related structural model is $y^*_{f,t} = \theta' \mathbf{z}_{f,t} + \nu_{f,t}$, where $\nu_{f,t}$ is the error term and $\mathbf{z}_{f,t}$ is the vector gathering the determinants of incentive rules.[26] Thus, the odds ratio of the reformer adopting for firm f a more powerful rule at time t—i.e., $y_{f,t} > k$ is:

$$\Delta_{f,t}\left(y_{f,t} > k\right) = P\left[y_{f,t} > k\right] / P\left[y_{f,t} \leq k\right] = \left[1 - \Lambda\left(\vartheta_k - y^*_{f,t}\right)\right]\left[\Lambda\left(\vartheta_k - y^*_{f,t}\right)\right]^{-1} \forall k, \quad (8)$$

where Λ is the c.d.f. of ν which I assume to be logistic. The linear log-odds obtained taking the logarithm of both sides of (8) characterize the ordered logit model, which is straightforwardly estimated by maximum likelihood. I will focus on the exponentiated coefficients because for a one unit change in the predictor variable the odds that the reformer adopts an incentive rule more powerful than k versus one at most as powerful as k are the exponentiated coefficient times larger. For the logit, I will report the marginal effects; the latter give

[26] Equation (7) does not exclude a role for interaction terms: when introduced in the logit, they are usually not significant for the groups whose probability of reforming is either 0 or 0.5 (Ai and Norton, 2003).

the percentage variation in the likelihood of the outcome considered when the control rises by one percentage point. Next, I will introduce the proxies gathered in $\mathbf{z}_{f,t}$.

Measuring information gathering technology efficiency and investment concerns.—Implicit incentives can be easily summarized by the dummy *Reg_Elec* which is equal to one where the public utility commissioners are elected and zero otherwise. Because this variable lack enough within variation, its introduction prohibits the use of firm effects; excluding *Reg_Elec* and switching to a fixed effects logit would leave the coefficients attached to the other variables qualitatively similar. I also obtain results not different from those discussed below when the errors, which are "robust" to generic heteroskedasticity or serial correlation, are clustered at the state level. Focusing on the efficiency of the supervision technology, it is reasonable to assume that more abundant resources ease information gathering. Thus, I add to the other controls the total budget in thousands of dollars available to the PUC's staff—*PUC_Budget*. This sum is set at the state level in order to be comparable with similar bureaucracies and, thus, fairly exogenous to the reform wave (see NARUC, [1981-1997]).

Creating meaningful proxies for society's investment concerns is a more challenging task. My strategy is to assume that the saliency of investment inducement for a state is higher when marginal costs and prices are higher than those prevailing in neighboring states. Following Fabrizio, Rose and Wolfram (2007), the two key inputs for electricity generation variable in the medium-term, which is the horizon of the present study, are labor and fuel inputs. As a consequence I use as proxy for more pressing society'investment concerns one of the three following variables in cents of dollar per Kwh sales lagged three years: 1. the ratio of the own state over the mean of the neighboring states mean marginal labor cost obtained dividing the product of the number of employees and the annual wage bill by the total generation—*Ratio_Mlc*; 2. the ratio of the own state over the mean of the neighboring states mean marginal fuel cost obtained dividing the product of the total BTU and its composite price by the total generation—*Ratio_Mfc*; 3. the ratio of the own state over the mean of the neighboring states revenues from sales to residential users—*Ratio_Res*. This choice is also guided by the fact that the residuals of the input demand equations estimated in the next section show first-order serial correlation and, as further discussed below, lagging of three years these proxies assures that an orthogonality condition is met. Making use of different proxies for dynamic efficiency concerns—e.g., lagged marginal costs or the ratio of the firm's marginal costs over neighboring firm's marginal costs—does not change the message of the results coming from the empirical exercise.[27] Turning to political competition, Hanssen (2004) proposes the share of seats held by the majority party averaged across upper and lower houses—*Majority*—as a proxy of the strength of the incumbent hold on power. Switching to other available measures—e.g. the Ranney index—the essence of the evidence does not change. For what concerns the identity of the reformer's constituency, a broad political science literature claims that Republicans have been historically nearer to the shareholders' interests (see Teske, [2004]). Therefore, I introduce a binary equal to one if both houses were under the Republicans' control—*Republican*. If, as Besley and Coate (2003) suggest, regulation is not salient for the majority of voters at politicians' elections, the two proxies will be orthogonal to unobserved policy-driven determinants of investment concerns.

Scholars of policy innovation (Teske, 2004) claim that the diffusion of a new institution displays peculiar learning features: the introduction of PBR in one state could shift support

[27] In order to maximize the sample size 46 data points have been inputed using the year foregoing the missing observation: this choice does not affect the qualitative idea of the evidence. The latter is also true when I consider: whether there is a state consumer advocate, the number of PUC employees, the salary of commissioners, the share of generation from hydroelectric sources, and the other controls used in section 5.2.

for the same reform in neighboring states without affecting their regulatory performances until the reform is implemented (Steiner, 2004). In order to capture this exogenous imitation process, I will introduce the share of surrounding states using PBR in the same year: *PBR_Nei*. Finally, I also control for the state population—*Population*, the proportion aged over 65—*Old*, the one aged 5-17—*Young* and the state income per capita—*GSP*. Variables descriptions and statics are listed in table 3; the data sources are listed in the appendix.

Empirical results.—While the estimates of the ordered logit are reported in the first three columns of table 4, those of the logit are listed in last three columns of the same table. For the most part, the results are consistent with prediction 1, and the implied effects are large. Starting from the proxy for the efficiency of the information gathering technology, the odds that in a state electing its regulators a more powerful incentive rule is selected is about fifteen times those in a state appointing its regulators; also, a reform from appointed to elected regulators increases the likelihood that PBR is adopted of roughly 21-percentage-points. These estimates are always statistically significant at one percent. *PUC_Budget* shows the expected sign but it is never statistically significant. In this perspective, it seems the case that the management of the witness and experts by the commissioners matters more than the PUC staff's ability to discover the firm's type. Turning to society's investment concerns, the likelihood of PBR adoption increases by almost 1-percentage-points as a result of a one-standard-deviation rise in lagged marginal labor costs, and by a little bit more that 1-percentage-point as lagged residential prices increase of one-standard-deviation. Both effects are significant at one percent; the coefficient attached to lagged marginal fuel costs, instead, always show the expected sign but it is never significant. More mixed is the evidence on the political competition, while the reformer hold on power has the expected sign but is not significant, *Republican* shows an unexpected pattern because reduces the likelihood of PBR. This result could be simply driven by the failure of the maintained assumption that a Republican government is more pro-shareholder, but nevertheless it deserves more attention in future research. Finally, the data confirm the idea that regulatory reforms could be produced by shocks to preferences due to the decisions of surrounding markets.[28]

All in all, it is fair to conclude that the distribution of incentive regulation across American states is not random but reflects efficiency-enhancing forces. This non random assignment of reforms not only confirms the model's idea but also implies that the effect of PBR on costs can be correctly evaluated only when these rules are treated as endogenous. If, indeed, the variation in *PBR* used to explain input choices is related to unobserved shocks affecting also the firm's cost minimization decisions, OLS will become biased. Even more crucially, this bias could go either way. It could be negative because incentive regulation could correlate with unobserved cost-reducing effort by an highly investment concerned state; yet, it could also be positive because incentive regulation could correlate with unobserved forces raising the efficiency of the information gathering technology and, in turn, weakening the firm's incentives to invest and so the probability of low costs (Guerriero, 2009). Which sign the bias takes is ultimately an empirical question: as follows I provide an answer.

5.2 *Costs and Endogenous Incentive Rules*

To test prediction 2, I follow Fabrizio, Rose and Wolfram (2007) and I examine whether PBR pushes the firm to use a better mix of inputs given prices. The inputs I consider are

[28] As shown in Guerriero (2009), implicit incentives are driven by the same battery of rent-seeking and efficiency forces shaping incentive regulation. When I instrument *Reg_Elec* with the share of neighboring states electing their regulators and with the year of foundation of the PUC, the results are consistent with prediction 1.

the natural log of the number of employees—*Ln_Emp*–and the natural log of the total Btus of fuel consumption—*Ln_Btu*—in the plants operated by firm f in year t. I estimate first by OLS and then by GMM the following input N use equations:[29]

$$\ln(N_{f,t}) = \beta_1^N \ln\left(Q_{f,t}^N\right) + \beta_2^N \ln\left(P_{f,t}^N\right) + \mathbf{j}'\mathbf{x}_{f,t}^N + \gamma_{f,t}^N + \alpha_f^N + \delta_t^N + \varepsilon_{f,t}^N$$

where $Q_{f,t}^N$ is the annual net MWh generation for the plants operated by firm f in year t; $P_{f,t}^N$ is the price of the input N—i.e., the BLS annual wage bill in dollars divided by total employment for *Ln_Emp* and none for *Ln_Btu*;[30] $\mathbf{x}_{f,t}^N$ gathers the determinants of incentive regulation which cannot be excluded by the input use equation—*Elec_Reg*, *PUC_Budget*, *Republican* and *Majority* (see also Guerriero, [2008]); $\gamma_{f,t}^N$ is the dummy *PBR*. Finally, while base differences in input use are embedded in the IOU fixed effects α_f^N, common annual changes in input use are measured by the time effects δ_t^N.

Table 5 lists the OLS estimates; column (1) refers to the equation with dependent *Ln_Emp* and column (3) to the one with dependent *Ln_Btu*. The key observation is that albeit the estimated $\gamma_{f,t}^N$ is negative, it is never statistically significant. Quite different is the picture coming from the estimates produced by the difference GMM estimator and listed in column (2) and (4). I treat as endogenous *PBR*, and I use a two-step procedure. Here, the challenge is to avoid too many instruments because the instruments count tends to explode with the number of years and too many moment conditions can fail to expunge the endogenous component of the endogenous variables, weakening also the power of the overidentification restrictions test (see Roodman, [2009]). To accomplish the task, I use as instruments all the regressors except the endogenous and those determinants of incentive

[29] The equations are obtained taking the logs of both sides of the binding first order conditions coming from a canonical and well behaved cost minimization problem (see for details Fabrizio, Rose and Wolfram, 2007).

[30] The choice reflect the fact that while labor decisions are made in advance of production, fuel input decisions are made in real time; in any case it turns out to be immaterial (Fabrizio, Rose and Wolfram, 2007).

regulation that can be excluded by the input use equation. The latter are *PBR_Nei* and *Ratio_Res* lagged three periods which is the investment concern proxy assuring the strongest first step. Employing either *Ratio_Mlc* or *Ratio_Mfc* each lagged three years would deliver qualitative similar results. While the exogeneity of *PBR_Nei* has been motivated above, a few other words are useful to explain the one of *Ratio_Res* lagged three periods. Because the residuals of the input use equations show first-order serial correlation, variables correlated to the dependent variable and lagged two periods or less would be not orthogonal to the error term which is lagged in the difference specification. Each moment condition is collapsed into a single column. In this way, the instrument count is well below the number of cross sections: this should assure that "too many instruments" are not considered (see Roodman, [2009]).[31]

The key observation is that OLS overestimate the cost reduction incentives brought by PBR. Indeed, the implied percentage reduction in input usage rise from approximately 2 to 11.8 percentage points in the case of labor inputs and from 0.06 to almost 2 percentage points in the case of fuel inputs.[32] While the former is statistically significant at ten percent, the latter continues to be not statistically significant. This last result could be driven by the inability of the proxy used to control for changes in the IOU's operational characteristics.[33]

Thus, the bias introduced by not taking into account the endogeneity of PBR to the efficiency of the information gathering technology seems to outweigh the one of not considering the endogeneity of incentive regulation to the strength of society's investment concerns: this

[31] Differently from Fabrizio, Rose and Wolfram (2007), I use a GMM and not a GLS-IV approach because it has the nice features of: 1. maintaining the length of the sample; 2. allowing the use of kernel-based estimator for the standard errors handling arbitrary patterns of covariance within individuals; 3. sustaining a feasible two step estimator which can be easily corrected in a small sample (Windmeijer, 2005).

[32] I use $100\left[\exp\left(\gamma_{f,t}^{N}\right)-1\right]$ to approximate the implied percentage effect of *PBR* on input use.

[33] Fuel efficiency at a plant is heavily influenced by factors such as the allocation of output across units, the number of times the units are stopped and started, and the length of activity below capacity.

interpretation is consistent with the observation that the impact of the first force was greater than the one of the second in the estimates of table 4.[34] Finally, it is worth to notice that the Hansen test, which is the consistent one with robust standard errors, does not reject the over-identifying restrictions at a level nowhere lower than fifteen percent.

Guerriero (2009) provide evidence according to which during the Oil-crisis pre-reform period—in particular during the years 1970-1983—having an elected instead of an appointed public commissioners reduced of roughly 40-percentage-points the pass-through of cost shocks into prices. This along with the fact that *PBR* had a negative but no statistically significant endogenous impact on residential and industrial rates during the 1981-1999 period—evidence available from the author—leads to the following interpretation of my results: the wave of reforms toward incentive regulation was directed to accommodate dynamic efficiency concerns after an era of rising input costs and excessively pro-consumer attitudes by regulators.

6 Concluding Comments

The relevance of regulatory institutions to economic development is key especially in a period of deregulation and liberalization. Yet, the determinants of these settings are still poorly understood: here, I developed and tested a theory of "endogenous regulatory institutions" (see also Guerriero [2009, 2010]), focusing on the incentive rules put in place to foster the cost reducing effort by the regulated firm.

Rather than reviewing my results, I close by highlighting several avenues for further re-

[34] A very similar picture arises when I consider the time-varying controls enumerated in footnote 27. Switching to the one-step estimator, estimating the model in levels, or including among the instruments one more lag of the endogenous variables or the state sales for correcting the possible endogeneity of *Ln_Mwhs* (see Fabrizio, Rose and Wolfram, [2007]) would not affect in any appreciable way the empirical results.

search. The first one is to collect data on service quality and quality benchmarks. A lively theoretical (Ajodhia and Hakvoort, 2005) and empirical (Ter-Martirosyan, 2003; Ai, Martinez, and Sappington, 2004; Shumilkina, 2009) literature has provided evidence according to which incentive regulation might induce firms to reduce quality of service in order to achieve additional cost savings. Yet, once again, no one of these studies has taken into full consideration the endogeneity of the details of the regulatory contract to the technological and political environment. Such an exercise is of first order relevance in order to evaluate the overall welfare properties of differently powered rules. A second avenue for further research is to obtain cleaner measures of fuel efficiency and richer information on independent factors that affect fuel use. As the results discussed above suggest, utility plants data are inadequate for the fine-level analysis required to estimate within and across-firms changes in fuel efficiency. Finally, an important question related to the choice of the power of the incentive scheme is the decision of liberalizing a regulated market. Clearly enough, a framework similar to the one developed in this work could be fruitfully applied to the understanding of the political economy of deregulation (see Guerriero, [2010]).

Appendix

Equilibrium under Perfect Information

Under perfect information, the planner knows β and infers a from c. She obtains the first best maximizing her strictly concave objective function with respect to a, U and q in such a way that:

1. The disutility of effort is equalized to the cost reduction at the margin: $\psi'(a^*) = q^*$;

2. Given the positive shadow cost of rewards, no rent is left to the firm so that:

   $U = 0$ or $t^* \equiv \psi(a^*)$;

3. The social marginal value of output and its marginal cost are equalized:

   $V'(q^*) = (1+\lambda)(\beta - a^*)$ or $S'(q^*) = p^* = c$.

This equilibrium can be implemented through a simple fixed price contract on the managerial rewards: $t^*(c^*q^*) = T - (cq - c^*q^*)$. The fixed charge is tailored in order to fully extract the firm's rent—i.e., $T \equiv \psi(a^*)$ and $c^* \equiv (\beta - a^*)$, and the firm as residual claimant of its cost saving maximizes $T - ((\beta - a)q - c^*q^*) - \psi(a)$ with respect a and q, choosing as a result a^* and q^*. □

Proof of Lemma 1

The effort exerted in equilibrium by elected regulators is obtained maximizing $P_E(e_E)$ with respect to e_E with $e_E^{\exp}$ taken as given and, then, imposing the equilibrium condition $\hat{e}_E = e_E^{\exp}$. Being the regulator's objective function strictly concave, such effort is implicitly defined by the inequality

$$LHS(\hat{e}_E) \equiv \bar{\alpha} f(\bar{\alpha})(\hat{e}_E)^{-1} - (1-K)C'(\hat{e}_E) \leq 0, \tag{A1}$$

and by the slackness conditions $(\hat{e}_E - 1) LHS(\hat{e}_E) = 0$ and $\hat{e}_E LHS(\hat{e}_E) = 0$. While the first term in $LHS(\hat{e}_E)$ is a rectangular hyperbola centered in $(0,0)$, the second one is a function increasing with $\hat{e}_E$. This, along with the fact that $C'(0) < \infty$ and $\lim_{e_i \to 1} C'(e_i) = \infty$ for all i, assures that

$\hat{e}_E$ exists and is both interior and unique. Turning to appointed officials and following Dewatripont, Jewitt and Tirole (1999), the equilibrium effort is implicitly defined by the first order condition

$$\mathrm{E}\left[\alpha f_{e_A}\left(\xi_A|\,\hat{e}_A\right) f^{-1}\left(\xi_A|\,\hat{e}_A\right)\right] \leq (1-K)\, C'\left(\hat{e}_A\right), \tag{A2}$$

which holds as an equality. The slackness conditions are met. The marginal density of the observable conditional on effort is proportional to $\exp\left[-(1/2)\left(\xi_A - \bar{\alpha} e_A\right)^2 \left(e_A^{\exp}\sigma_\alpha\right)^{-2}\right]$ when f is the truncated normal and equal to $\hat{e}_A f(\alpha)$ when f is one of the other distributions considered. In equilibrium $\hat{e}_A = e_A^{\exp}$ and thus $\mathrm{E}\left[\alpha f_{e_A}\left(\xi_A|\,\hat{e}_A\right) f^{-1}\left(\xi_A|\,\hat{e}_A\right)\right] = \bar{\alpha}\left(\hat{e}_A\right)^{-1}$ so that (A2) rewrites as

$$\bar{\alpha}\left(\hat{e}_A\right)^{-1} = (1-K)\, C'\left(\hat{e}_A\right). \tag{A3}$$

From (A1) and (A3), it follows that $\partial\hat{e}_i/\partial K > 0$ for all i, and elected regulators exert more effort than appointed regulators do whenever $f(\bar{\alpha}) > 1$, which is always true under A.1. □

Proof of Proposition 2

Totally differentiating the first order condition in (6), I have that

$$\left\{-\tfrac{\lambda-\chi}{1+\lambda}\left(1-\bar{\alpha}\hat{e}_i\right)\left\{\Gamma\left(v\left(\hat{I}\right)\right)\Phi''\left(\hat{\bar{a}}^{S,I}\right) + v\left[1-v\left(\hat{I}\right)\right]^{-2}\Phi'\left(\hat{\bar{a}}^{S,I}\right)\tfrac{\partial\hat{I}}{\partial\hat{\bar{a}}^{S,I}}\right\} - \psi''\left(\hat{\bar{a}}^{S,I}\right)\right\} d\hat{\bar{a}}^{S,I} +$$
$$+\left\{\tfrac{1}{1+\lambda}\Gamma\left(v\left(\hat{I}\right)\right)\left(1-\bar{\alpha}\hat{e}_i\right)\Phi'\left(\hat{\bar{a}}^{S,I}\right)\right\} d\chi = 0 \rightarrow d\hat{\bar{a}}^{S,I}/d\chi > 0. \quad \square$$

Underinvestment When the Planner Cannot Commit

The socially optimal level of investment I^* is the solution of the following strictly concave program:

$$I^* = \arg\max_{I\geq 0} v\,(1+I)\left[V\left(\underline{q}^*\right) - (1+\lambda)\left[\left(\underline{\beta} - \underline{a}^*\right)\underline{q}^* + \psi\left(\underline{a}^*\right)\right]\right] +$$
$$+\left[1 - v\,(1+I)\right]\left[V\left(\bar{q}^*\right) - (1+\lambda)\left[\left(\bar{\beta} - \bar{a}^*\right)\bar{q}^* + \psi\left(\bar{a}^*\right)\right]\right] - \zeta\,(I),$$

where $\left\{\underline{q}^*, \underline{a}^*\right\}$ and $\{\bar{q}^*, \bar{a}^*\}$ are the full information quantity and effort for the low cost and high cost firm respectively. It is straightforward to see that the first best I^* is implicitly defined by

$$v\left[V\left(\underline{q}^*\right)-V\left(\bar{q}^*\right)-(1+\lambda)\left[\left(\underline{\beta}-\underline{a}^*\right)\underline{q}^*-\left(\bar{\beta}-\bar{a}^*\right)\bar{q}^*+\psi\left(\underline{a}^*\right)-\psi\left(\bar{a}^*\right)\right]\right]=\zeta'\left(I^*\right) \quad \text{(A4)}$$

The first order condition to the strictly concave problem in (5) is binding and consequently:

$$v\left(1-\bar{\alpha}\hat{e}_i\right)\Phi\left(\hat{\bar{a}}^{S,I}\right)=\zeta'\left(\hat{I}\right). \quad \text{(A5)}$$

Notice also that when the demand is inelastic, a fall in price from $\bar{\beta}-\bar{a}^*$ to $\underline{\beta}-\underline{a}^*$ involves that $-q'(p)\left(p/q(p)\right)<1 \leftrightarrow \frac{\underline{q}^*-\bar{q}^*}{\left(\Delta\beta-\bar{a}^*+\underline{a}^*\right)}\frac{\bar{\beta}-\bar{a}^*}{\bar{q}^*}<1 \leftrightarrow \left[2\left(\bar{\beta}-\bar{a}^*\right)-\left(\underline{\beta}-\underline{a}^*\right)\right]\bar{q}^*>\left(\bar{\beta}-\bar{a}^*\right)\underline{q}^*$.

The following series of inequalities concludes the proof showing that whenever $\left(\Delta\beta-\bar{a}^*\right)\underline{q}^*\geq 0$ and thus $\Delta\beta\geq\bar{a}^*=\psi'^{-1}\left(\bar{q}^*\right)$ (see footnote 19), $I^*>\hat{I}$ for every $\lambda\geq 0$ and $\hat{e}_i>0$ because the left hand side of (A4) is greater than the one of (A5):

$$\begin{aligned} S\left(\underline{q}^*\right)-S\left(\bar{q}^*\right)-\left[\left(\underline{\beta}-\underline{a}^*\right)\underline{q}^*-\left(\bar{\beta}-\bar{a}^*\right)\bar{q}^*+\psi\left(\underline{a}^*\right)-\psi\left(\bar{a}^*\right)\right]&>\\ \left[\left(\bar{\beta}-\bar{a}^*\right)-\left(\underline{\beta}-\underline{a}^*\right)\right]\bar{q}^*-\left[\left(\underline{\beta}-\underline{a}^*\right)\underline{q}^*-\left(\bar{\beta}-\bar{a}^*\right)\bar{q}^*+\psi\left(\underline{a}^*\right)-\psi\left(\bar{a}^*\right)\right]&>\\ \left(\Delta\beta-\bar{a}^*+\underline{a}^*\right)\underline{q}^*-\psi\left(\underline{a}^*\right)+\psi\left(\bar{a}^*\right)&> \end{aligned}$$

$$\left(\Delta\beta-\bar{a}^*+\underline{a}^*-\underline{a}^*\right)\underline{q}^*-\psi\left(\underline{a}^*\right)+\psi\left(\bar{a}^*\right)=\left(\Delta\beta-\bar{a}^*\right)\underline{q}^*+\psi\left(\bar{a}^*\right)>\psi\left(\hat{\bar{a}}^{S,I}\right)-\psi\left(\hat{\bar{a}}^{S,I}-\Delta\beta\right),$$

where the penultimate inequality comes from the fact that $\underline{a}^*\underline{q}^*\geq\psi\left(\underline{a}^*\right)$. □

Proof of Proposition 3

Applying the implicit function theorem to (7), it follows that $\partial\hat{\bar{a}}^{S,I}_{\tilde{m}}\big/\partial\chi_{\tilde{m}}>0$ which proves the relation between the identity of the political planner and the power of the equilibrium low type cost-reducing effort. Also, it is easy to see that $sign\left\{\partial\hat{\bar{a}}^{S,I}_{\tilde{m}}\big/\partial x_{\tilde{m}}\right\}=sign\left\{\partial\tilde{x}\left(\chi_{\tilde{m}}-\mu\right)/\partial x_{\tilde{m}}\right\}$. As a consequence, the following derivatives conclude the proof:

$\partial\tilde{x}\left(\chi_R-\mu\right)/\partial x_R=\left(\chi_R-\mu\right)\left(\rho_R-\rho_D\right)>0$; $\partial\tilde{x}\left(\chi_D-\mu\right)/\partial x_D=\left(\chi_D-\mu\right)\left(\rho_D-\rho_R\right)>0$. □

Sample Construction

This study analyzes productivity for large fossil-fueled steam turbine or combined cycle plants owned by IOUs only. The core data source is the Utility Data Institute (UDI) O&M Production Cost Database, which is based on the FERC Form 1 filings. Following Fabrizio, Rose and Wolfram (2007), I have eliminated the plants with mean capacity in gross megawatts below 100 MW or with three years of operations at a scale not greater than 100 MW, the plants with missing or nonpositive output data and the outliers spotted using the Stata's dfbeta regression diagnostic. Moreover, I did not consider the plants for which data on regulatory institutions and political competition were not available: i.e., those in Alaska, the District of Columbia, Nebraska, Rhode Island, South Dakota, Tennessee, Utah, Vermont and Wyoming. Also, there are no IOUs serving Hawaii and Idaho in the UDI Database. As a result, after imputing 46 data points using the year foregoing the missing observation, I obtain a dataset with 9,367 observations on 493 plant-epochs—i.e. years over which the plant capacity did not change more than 40 MW or the 15 percent of the capacity. Aggregating the plant-epochs data at the IOU level produces the strongly balanced panel of 2014 observations (19 yearly data points for 106 IOUs in 40 states) used to obtain the tables reported below.

Data Sources

PBR.—Data on incentive rules are collected from Basheda et al. (2001) and EEI (2000).

Appointment rules, PUC total budget and PUC year of foundation.—NARUC (1981-1999).

Political competition.—CSG. 1981-1999. *The Book of the States.* CSG: Lexington, KY.

IOU operating data.—The number of employees, the total annual Btus of fuel consumption and net MWh generation are collected from the UDI O&M Production Cost Database as explained above.

Wages.—US Department of Labor, BLS. Electric Utility Wages: SIC Industries 4911.

Economic and demographic variables.—UCB. 1981-1999. *Population Estimates Program.* UCB: Washington, DC; UCB. 1981-1999. *Statistical Abstract of the United States.* UCB: Washington.

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Tables

Table 1: Broad-Based PBR in the U.S. Electric Power Market — 1980-2002

States	IOUs	PBR	Period
AL	Alabama Power Co.	Rate case moratorium	1982-2002
AR	Entergy Arkansas Inc.	None	
AZ	Arizona Public Service Co.	None	
	Tucson El. Power Co.	None	
	Pacific Gas and El. Co.	None	
CA	San Diego Gas and El. Co.	Price cap with earnings sharing	1994-2002
	Southern California Edison	Price cap with earnings sharing	1997-2001
CO	Public Service of Colorado	Rate case moratorium with earnings sharing	1996-2006
	Citizen Utilities Co.*	None	
CT	Connecticut Light and Power	Price cap	2000-2001
	United Illuminating Co.	None	
DC	Potomac El. Power Co.*	None	
DE	Delmarva Power and Light	None	
	Florida Power Co.	None	
FL	Florida Power and Light	None	
	Gulf Power Co.	None	
	Tampa El. Co.	Rate freeze with earnings sharing	1995-1999
GA	Georgia Power Co.	None	
	Savannah El. and Power	None	
HI	Hawaii El. Co.*	Price cap with earnings sharing	1997-1999
	Maui El. Co. Ltd.*	None	
ID	Idaho Power Co.*	None	
	Interstate Power Co.	None	
IA	IES Utilities Inc.	None	
	Midamerican Energy Co.	Rate case moratorium with earnings sharing	1998-2000
	Central Illinois Light Co.	Price cap with earnings sharing	1998-2002
	Central Illinois Public Service	Price cap with earnings sharing	1998-2002
IL	Commonwealth Edison Co.	Price cap with earnings sharing	1998-2002
	Illinois Power Co.	Price cap with earnings sharing	1998-2002
	Mt. Carmel Public Service Co.*	Price cap with earnings sharing	1998-2002
	Indiana Michigan Power Co.	None	
	Indianapolis Power and Light	None	
IN	Northern Indiana Public Service	None	
	PSI Energy Inc.	None	
	Southern Indiana Gas and El.	None	
KS	Kansas Gas and Electric Co.	None	
	Western Resources Inc.	None	
	Kentucky Power Co.	None	
KY	Kentucky Utilities Co.	None	
	Louisville Gas and El. Co.	Revenues sharing	1999-2000
	Union Light Heat and Power*	None	
	Central Louisiana Inc.	None	
LA	Entergy Louisiana Inc.	Rate case moratorium with earnings sharing	1996-2002
	Entergy New Orleans Inc.	None	
	Southwestern El. Power Co.	None	
	Boston Edison Co.	None	
	Canal El. Co.	None	
	Eastern Edison Co.*	Revenues sharing	1998-2000
MA	Holyoke Water Power Co.	None	
	Massachusetts El. Co.*	Rate freeze with earning sharing	1998-2009
	New England Power Co.	None	
	Western Massachusetts Electric	Revenues sharing	1998-2000
MD	Baltimore Gas and Electric Co.	Price cap	1998-2002
	Potomac El. Co.	Price cap and rate freeze	2000-2002
	Bangor Hydroelectric Co.*	Rate freeze	1995-2000
ME	Central Maine Power Co.	Price cap with earnings sharing	1991-2007
	Maine Public Service Co.*	Price cap with earnings sharing	1996-2000
	Consumers Energy Co.	None	
MI	Detroit Edison Co.	None	
	Edison Sault El. Co.*	None	
	Upper Peninsula Power Co.*	None	
	Minnesota Power and Light Co.	None	
MN	Northern State Power Co.	Price cap with earnings sharing	2001-2005
	Otter Tail Power Co.	Price cap with earnings sharing	2001-2005
	Empire District El. Co.	None	
	Kansas City Power and Light	None	
MO	St. Joseph Light and Power*	None	
	Union El. Co.	Rate freeze with earnings sharing	1995-2001
	UtilCorp United Co.	None	

Notes:
1. Firms followed by a star are not part of the sample used in the following tables;
2. Firms with no PBR scheme have been regulated for all the period with cost of service regulation;
3. The data on incentive schemes are collected directly from Basheda et al. (2001) and EEI (2000).

Table 2: Broad-Based PBR in the U.S. Electric Power Market — 1980-2002 (Continued)

States	IOUs	PBR	Period
MS	Entergy Mississippi Power Co.	Benchmarks	1994-1998
	Mississippi Power Co.	Rate case moratorium with earnings sharing	1995-2001
MT	Montana Power Co.	Price cap with earnings sharing	1997-1998
NC	Carolina Power and Light Co.	None	
	Duke Power Co.	None	
	Nanthala Power and Light Co.*	None	
ND	Montana-Dakota Utilities	None	
NH	Public Service Co. of New Hampshire	None	
NJ	Atlantic City El. Co.	None	
	Jersey Central Power and Light	None	
	Public Service El. and Gas Co.	None	
	Rockland El. Co.*	None	
NM	Public Service Co. of New Mexico	None	
NV	Nevada Power Co.	None	
	Sierra Pacific Power Co.	None	
NY	Central Hudson Gas and El. Co.	None	
	Consolidated Edison Co.	Revenue cap with earnings sharing	1995-2005
	Long Island Lighting Co.	None	
	New York State El. and Gas Co.	Price-cap with earnings sharing	1993-2002
	Niagara Mohawk Power Co.	Rate freeze-price cap	1991-2002
	Orange and Rockland Utils Inc.	None	
	Rochester Gas and El. Co.	Revenue cap with earnings sharing	1993-2002
OH	Cincinati Gas and El. Co.	None	
	Cleveland El. Illumination Co.*	None	
	Columbus Southern Power Co.	None	
	Dayton Power and Light Co.	None	
	Ohio Edison Co.	None	
	Ohio Power Co.	None	
	Toledo Edison Co.*	None	
OK	Oklahoma Gas and El. Co.	None	
	Public Service Co. of Oklahoma	None	
OR	PacifiCorp*	Price cap with earnings sharing	1994-2001
	Portland General El. Co.	None	
PA	Duquesne Light Co.	None	
	Metropolitan Edison Co.	None	
	Pennsylvania El. Co.	None	
	Pennsylvania Power and Light	None	
	Pennsylvania Power Co.	None	
	PECO Energy Co.*	None	
	West Penn Power Co.	None	
RI	Blackstone Valley El. Co.*	Price cap with earnings sharing	1997-1998
	Narragansett El. Co.*	Price cap with earnings sharing	1997-1998
	Newport El. Co.*	Price cap with earnings sharing	1997-2004
SC	South Carolina El. and Gas	None	
	South Carolina Generating Co.	None	
SD	Black Hills Co.*	Rate freeze	1995-2005
	Northwestern Public Service*	None	
TN	Kingsport Power Co.*	None	
TX	Central Power and Light Co.	None	
	El Paso El. Co.	None	
	Entergy Gulf States Inc.*	None	
	Houston Lighting and Power Co.	None	
	Southwestern El. Service Co.	None	
	Southwestern Public Service Co.	None	
	Texas Utilities El. Co.	Benchmarks	2000-2002
	Texas-New Mexico Power Co.*	Benchmarks	2000-2002
	West Texas Utility Co.	None	
VA	Appalachian Power Co.	None	
	Virginia El. and Power Co.	None	
VT	Central Vermont Public Service*	None	
	Green Mountain Power Co.*	None	
WA	Pacificorp	None	
	Puget Sound Energy*	Price cap	1997-2001
WI	Consolidated Water Power Co.	None	
	Madison Gas and El. Co.	None	
	Northern States Power Co.*	None	
	Northwestern Wisconsin El.*	None	
	Pioneer Power and Light Co.*	None	
	South Beloit Water Gas and El.*	None	
	Superior Water Light and Power*	None	
	Wisconsin El. Power Co.	None	
	Wisconsin Power and Light Co.	None	
	Wisconsin Public Service Co.	None	
WV	Monongahela Power Co.	None	
	Wheeling Power Co.*	None	

Notes:
1. Firms followed by a star are not part of the sample used in the following tables;
2. Firms with no PBR scheme have been regulated for all the period with cost of service regulation;
3. The data on incentive schemes are collected directly from Basheda et al. (2001) and EEI (2000).

Table 3: Variables Names and Descriptions — Full Sample (1981–1999)

	Variables Name	Variable Description	Mean (Standard deviation)
Incentive schemes:	*PBR*:	1 for IOU regulated under a PBR contract; 0 otherwise.	0.054 (0.226)
	PBR_O:	3 for IOU regulated under a price cap or a revenue cap contract; 1 for IOU regulated under cost of service regulation and 2 otherwise.	1.082 (0.362)
Supervision technology:	*Elec_Reg*:	1 for IOU in a state where the public utility commissioners are elected; 0 otherwise.	0.145 (0.352)
	PUC_Budget:	Total receipts (in thousands of dollars) of the PUC of the state in which the IOU operates.	24029.83 (37907.95)
Input uses and investment concerns:	*Ln_Emp*:	ln (Annual mean number of employees).	5.922 (0.939)
	Ln_Btu:	ln (Total Btus of fuel consumption). Total Btus are calculated as follows: (tons of coal*2000 lbs/ton*Btu/lb) + (barrels of oil*42 gal/barrel*Btu/gal) + (Mcf gas*1000 cf/mcf*Btu/cf)	31.952 (1.165)
	Ratio_Mlc:	Ratio of the own state over the mean of the neighboring states marginal labor cost in cents of dollar per Kwh. Such cost is obtained dividing the product of the number of employees and the annual wage bill by the total generation.	1.449 (3.922)
	Ratio_Mfc:	Ratio of the own state over the mean of the neighboring states marginal fuel cost in cents of dollar per Kwh. Such cost is obtained dividing the product of the total BTU and its composite price by the total generation.	1.020 (0.660)
	Ratio_Res:	Ratio of the own state over the mean of the neighboring states revenues from sales to residential users in cents of dollar per Kwh.	1.024 (0.164)
Political competition:	*Republican*:	1 for IOU in a state where both houses are controlled with the relative majority of seats by the Republican party; 0 otherwise.	0.177 (0.382)
	Majority:	Share of seats held by the majority party averaged across both houses. The variable equals 0 when there is no party holding the majority in both houses.	0.497 (0.303)
Other controls:	*Ln_Mwhs*:	ln (annual net MWh generation).	15.786 (1.202)
	Ln_Wage:	ln (BLS annual wage bill in dollars divided by total employment in the state in which the IOU operates).	10.437 (0.394)
	PBR_Nei:	Share of states bordering the one in which the IOU operates that uses PBR.	0.087 (0.161)
	Population:	Population of the state in which the IOU operates.	8,166,693 (6,294,092)
	Old:	Percentage of the population of the state in which the IOU operates aged 65 and over.	11.309 (4.223)
	Young:	Percentage of the population of the state in which the IOU operates aged 5-17.	16.760 (5.834)
	GSP:	Gross state product per capita in dollars in the state in which the IOU operates.	17,652.67 (7,288.73)

Table 4: Determinants of Incentive Rules — Ordered Logit and Logit

	(1)	(2)	(3)	(4)	(5)	(6)
			The dependent variable is:			
	PBR_O	*PBR_O*	*PBR_O*	*PBR*	*PBR*	*PBR*
Elec_Reg	17.904	16.607	14.657	0.241	0.233	0.210
	(6.691)***	(6.145)***	(5.419)***	(0.052)***	(0.050)***	(0.048)***
PUC_Budget	1.000	1.000	1.000	5.90e^{-08}	4.29e^{-08}	7.61e^{-08}
	(1.88e^{-06})	(1.90e^{-06})	(2.10e^{-06})	(0.000)	(0.000)	(0.000)
Ratio_Mlc(-3)	1.071			0.002		
	(0.027)***			(0.0008)***		
Ratio_Mfc(-3)		1.216			0.006	
		(0.251)			(0.006)	
Ratio_Res(-3)			20.703			0.074
			(13.952)***			(0.019)***
Republican	0.444	0.487	0.362	- 0.019	- 0.018	- 0.022
	(0.173)**	(0.185)*	(0.146)**	(0.007)***	(0.008)**	(0.007)***
Majority	1.053	1.015	1.204	0.006	0.005	0.009
	(0.400)	(0.378)	(0.441)	(0.011)	(0.012)	(0.011)
PBR_Nei	0.244	0.268	0.276	- 0.035	- 0.033	- 0.032
	(0.208)*	(0.227)	(0.237)	(0.027)	(0.027)	(0.026)
Other Controls			*Population*, *Old*, *Young*, *GSP*.			
Estimation Procedure	Ordered Logit.	Ordered Logit.	Ordered Logit.	Logit.	Logit.	Logit.
Pseudo R^2	0.19	0.18	0.20	0.21	0.21	0.22
Log-Pseudolikelihood	- 384.58	- 386.39	- 380.18	- 315.69	- 317.37	- 313.12
Number of Obs.	1696	1696	1696	1696	1696	1696

Notes: 1. Robust standard errors–z distribution–in parentheses;
2. The entries are marginal effects except columns (1), (2) and (3) where they are odds ratios;
3. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.

Table 5: Labor and Fuel Input Use Equations Estimates – OLS Versus Difference GMM

	(1)	(2)	(3)	(4)
		The dependent variable is:		
	Ln_Emp	*Ln_Emp*	*Ln_Btu*	*Ln_Btu*
PBR	- 0.019	- 0.125	- 0.0006	- 0.020
	(0.027)	(0.066)*	(0.008)	(0.028)
Elec_Reg	0.175	0.013	0.017	0.002
	(0.054)***	(0.012)	(0.031)	(0.004)
PUC_Budget	- 9.24e^{-07}	- 2.61e^{-07}	- 3.73e^{-07}	- 1.08e^{-07}
	(2.14e^{-07})***	(3.01e^{-07})	(1.40e^{-07})***	(2.48e^{-07})
Republican	- 0.031	- 0.013	- 0.013	- 0.009
	(0.023)	(0.009)	(0.007)*	(0.005)*
Majority	0.097	0.029	0.006	- 0.010
	(0.029)***	(0.018)	(0.008)	(0.015)
Estimation Procedure	OLS	Two-step difference GMM	OLS	Two-step difference GMM
Endogenous		*PBR*		*PBR*
Excluded Instruments		*Ratio_Res*(-3) and *PBR_Nei*.		*Ratio_Resl*(-3) and *PBR_Nei*.
Instruments Count		29		28
Hansen Test		0.31		0.15
AR(2) in First Differences Test		0.35		0.14
R^2	0.61		0.99	
Number of Obs.	2014	1908	2014	1908

Notes: 1. All specifications consider also *Population*, *Old*, *Young*, *GSP*, *Ln_Mwhs* and *fixed firm and time effects*. In columns (1) and (2) I also control for *Ln_Wage*.
2. Robust standard errors in parentheses; the Windmeijer correction is applied to those in columns (2) and (4);
3. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.