The Political Economy of Incentive Regulation: Theory and Evidence from US States

Carmine Guerriero

NOTA DI LAVORO 34.2008

APRIL 2008

PRCG – Privatisation, Regulation, Corporate Governance

Carmine Guerriero, *Faculty of Economics, University of Cambridge*

The Political Economy of Incentive Regulation: Theory and Evidence from US States

Summary

The determinants of incentive regulation are a key issue in industrial policy. I study an asymmetric information model of incentive rules selection by a political principal endowed with an information-gathering technology whose efficiency increases with the effort exerted by two accountable supervisors (a regulator and a judge). This set up captures the institutions of several international markets. The model predicts that reforms toward higher powered rules are more likely the more inefficient (efficient) is the production (information-gathering) technology, the less tight is political competition and the greater are pro-consumer supervisors' incentives. This prediction is consistent with evidence based on US electric power market data.

Keywords: Incentive Schemes, Accountability Rules, Regulatory Capture

JEL Classification: D73, H11, L51, K2

I don't know how to thank Toke Aidt, Yannis S. Katsoulacos, David Newbery, Michele Polo, Andrea Prat, Mark Schankerman, Guido Tabellini, David Ulph, and Melvyn Weeks for precious discussions on earlier drafts. I am deeply grateful to Tim Besley, Andy Hanssen and Junseok Kim for the data provided and for encouragement and to seminar participants at LBS, Cambridge University, at the 2006 EEA meeting in Vienna, at the 2007 Public Choice Society meeting in Amsterdam, and at 2007 EARIE meeting in Valencia for comments. I would like to acknowledge financial assistance from the Ente Luigi Einaudi, the Felice Gianani Foundation and the Marco Fanno Foundation.

Address for correspondence:

Carmine Guerriero
Faculty of Economics
University of Cambridge
Sidgwick Avenue
CB3 9DD Cambridge
UK
E-mail: cg372@econ.cam.ac.uk

1. Introduction

In regulating a natural monopoly with unknown costs, governments should select incentive rules optimally trading off informational rents extraction and cost-saving inducement (Laffont and Tirole, 1993). Yet, politicians put a greater or lesser weight on the firm's profit depending on whether their constituency is dominated by pro-shareholder or pro-consumer sentiments. Besides, the details of incentive contracts are designed by public officials who are accountable either to professional peers or to specific groups of voters and not to the society at large.

The US electric power market (along with other US markets) is a case in point. Major regulatory reforms, included the recent introduction of incentive regulation, are politically initiated but subject to lengthy quasi-judicial hearings aimed at gathering both the necessary technical information and the consensus of all interested parties. While regulators and judges, who can either be appointed or elected, preside over the hearings, the final policy position is proposed *de facto* by an independent staff. This institutional design is not unique to the US and, in the aftermath of the recent South-American and European privatization wave, a rising need for higher transparency of the regulatory process has exported beyond American boundaries a similar combination of independent staffs and accountable top-level regulators and judges (see Newbery, 2000).[1] How, therefore, do public officials' incentives and task-specific motivations shape regulatory reforms and

[1]Remarkably, the Competition Act of 1998 and the Utilities Act of 2000 reformed the UK gas and electricity market institutions introducing a top-level board of three officials (GEMA) appointed by the Secretary of State and supported by an independent staff (Ofgem). The latter proposes the policy position and is subject to a strict transparency requirement which, in turn, "provides the hook for judicial review" (OECD, 2002).

how does this mix of incentives and motivations interact with the rent extraction-efficiency trade off and the political environment?

To answer these questions, I provide a theoretical framework bridging the canonical principal-agent model of incentive regulation (Laffont, 1996) with two recent strands of political economics literature. While the first one compares accountable and non-accountable public agents (Alesina and Tabellini, 2007 and 2008), the second contrasts career and legacy concerns in politics (Maskin and Tirole, 2004). Bringing together these bodies of economic theory, I study the incentive rules selection problem performed by a principal faced with a monopoly with unknown costs. The principal is endowed with an information-gathering technology whose efficiency rises with the effort exerted by a regulator and a judge, whom hereafter I will call supervisors. Supervisors respond to implicit or accountability incentives and intrinsic or legacy motivations. Implicit incentives force supervisors to select effort looking at the ballot box (at the preferences of their professional peers) if elected (appointed) but not at the power—in terms of cost reducing effort—of the rule selected by the principal.

The model predicts that, under a mild condition on the distribution of supervisors' random abilities, elected supervisors exert more effort than appointed ones. These pro-consumers selection incentives are fuelled (curbed) by judges' fairness motivations (regulators' desires of pursuing a career in the industry). The principal foresees the effect of implicit incentives and intrinsic motivations on the expected probability of remaining uninformed, and, accordingly, the power of equilibrium incentive rules increases (decreases) with fairness (revolving door) motivations, and is greater when supervisors are elected. Also, if the principal is concerned by the long run efficiency of the market, the power of the optimal rules

increases (falls) with the efficiency of the production (information) technology. Finally, if the principal is one of two competing parties, incentive rules are also sensitive to tightness of political competition and to voters' preferences.

To test this set of predictions, I analyze US electric power market data at the state level. Consistently with the model, performance based regulation (PBR hereafter) is found where regulators and judges are elected, political competition is less harsh, generation more costly and regulatory resources more abundant.

There are three main contributions by this paper. First, I formalize and test a theory of complementarities among supervisors' implicit and firms' explicit incentives arising endogenously from the contractibility of the firm's allocation as opposed to the non-contractibility of supervisors' performance. I also offer one of the first accounts of the relation between public officials' intrinsic motivations and regulatory policies (see also Ka and Teske, 2002; Guerriero, 2008).

Second, I provide evidence that the observed regulatory institutions reflect both efficiency and strategic political concerns. This is particularly noteworthy because, even if several studies have used cross-state telecommunications (see Ai and Sappington, 2002; Eckenrod, 2006) and cross-country electricity data (see Jamasb and Pollitt, 2001) to show that PBR can deliver lower rates and higher profits, no previous paper has tried to evaluate the determinants of reforms toward incentive regulation.[2] Finally, I also propose a first test of the endogenous effect of incentive rules on US electricity rates using a GMM estimator. This last

[2] Recent empirical tests look at the determinants of electricity market restructuring experiences in the US (Ka and Teske, 2002) and around the world (Steiner, 2004) but without providing a formal theory of regulatory actors' incentives as derived by market institutions. Hanssen (2004) provides a first empirical result bridging strategic dynamics and institutional reforms.

exercise shows that rates are unaffected by PBR and suggests an investment-based explanation of the incentives revolution, stressing also the relevance of an endogenous regulatory institutions research program for policy evaluation.

The remainder of the paper is organized as follows. Section 2 describes the institutions governing the pricing process in the US electric power market. The first part of section 3 clarifies the effect of supervisors' incentives and motivations on incentive rules. Next, the benevolence assumption is relaxed and the strategic determinants of regulatory reforms are evaluated. Section 4 tests the model's implications, looking at the wave of reforms toward PBR that has interested the market in recent decades. Section 5 concludes. All proofs, tables and a detailed description of the data are gathered in the Appendix.

2. Institutions

Natural local monopolies and incentive rules.—Investor-owned electric power utilities (IOUs hereafter) account for over three-fourths of the electricity sales of the US electricity market. While jurisdiction over both interstate transmission and wholesale transactions lies with a federal body—the FERC, retail services are regulated by state public utility commissions (PUCs hereafter). The latter deal with several markets (natural gas, telecommunications, insurance, water, etc.) and perform several tasks (for example, they suggest lines of conduct on service provision, design environmental regulations and so on), among which price-setting is the most relevant. IOUs are not allowed to receive government subsidies and, therefore, regulated two-part tariffs should cover average costs to assure the firms' viability. Accordingly, rates have traditionally been linked to realized

average costs (cost-of-service regulation). Yet, from 1982 on, incentive rules have been applied to forty-one among the 144 major US IOUs, partially severing the price-average costs link (Basheda et al., 2001).

Two-tier hearings and supervisors' roles.—Reimbursable costs and target returns are selected during rate reviews which can be triggered by utilities in response to cost shocks, initiated periodically by the PUC (see Friedman, 1991) or, often, required by the state government in order to assure that a particular rule is implemented.[3] Rate reviews follow a precise routine composed of two levels of formal quasi-judicial hearings open to all interested parties (firms, ratepayers along with state-funded advocates, interest groups, etc).[4] First, commissioners—the head of the PUC—sit on the bench; next, if the filing is not approved or some party finds herself mistreated, a High Court judge (usually sitting in a state supreme court) is asked to rule the case. The appeal is on law and fact and "with so much at stake, [judicial review] is a very real possibility" (Gormley, 1983).[5]

During the hearings, the role of commissioners and judges is one of supervision. They examine witnesses and experts, receive the evidence and interpret prevailing precedents and regulations. The final motion to be approved, however, is proposed *de facto* by the PUC's staff, who acts as the jury in the

[3] 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.

[4] I follow Friedman (1991, pp. 92 – 98), CDRA (1992, pp. 52 – 68) and Gormley (1983, pp. 92 – 98) whose overviews are highly consistent with those available on the PUCs' websites.

[5] A huge body of press testimonies and empirical evidence highlights the critical role of judicial review. The appellate rate of PUC decisions reached between 1974 and 1979 the mean level of 37.4 percent with a peak of 52.3 percent and a share of partially reversed cases of 43.5 percent (Gormley, 1983). Teske et al. (2004, ch. 15) report similar figures for the 1995-1996 period.

typical Anglo-American adversarial trial.[6] The reason is that decisions should always be reached in "an open and fair manner" (CDRA, 1992).[7] This feature, along with the fact that the complete record of the hearings is widely publicized and all interested parties participate, assures that only if "hard" evidence—such that "every interested party can convince himself that [the judgment] corresponds to the true state of the world" (Laffont, 2000)—is obtained does the review end.

Accordingly, I set up a model in which incentive rules are selected by a planner obtaining orthogonal and truthful signals on the firm's technology. The precision of these signals increases with the effort exerted by a regulator and a judge. If benevolent, the planner represents a fiction for the Coasian bargaining among interested parties necessary to implement a reform. If partisan, a major emphasis is placed on political competition.

Supervisors' incentives.—Media carefully track the evolution of electricity files, which, in turn, represent some of the most advertised tasks over which regulators and judges are selected. High court judges and PUC commissioners are either elected or appointed. Coherently, I assume that supervisors are rewarded on the basis of the extent of hard information (reported in the docket official papers) they obtain during the hearings. Besides, I explicitly model the role of selection rules and of regulatory and judiciary specific motivations in the pricing process.

[6] "The judge just listens attentively. If it speaks, it will be to rule, at the request of the party or on his own motion, on the admissibility of a question put to a witness or a party or to ensure adherence to the rules of the game"(Zweigert and Kötz, 1998, pp. 272 – 273).

[7] Commissioners consider the staff as the most influential hearing actor (Gormley, 1983; Ka and Teske, 2002). While a part (trial staff) suggests a pre-hearing position, another (advisory staff) proposes the final motion (CDRA, 1992). Furthermore, courts usually examine the staff before issuing the judgement (Gormley, 1983).

3. Theory

The model takes its approach from Laffont and Tirole (1993), and includes a planner and two implicitly and intrinsically motivated supervisors.

3.1 Preliminaries

Preferences and information.—The regulated firm produces a variable scale product q, charging a two-part tariff $A+pq$ with q, A and p strictly positive. The total cost is $C=(\beta-a)q=cq$ 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 $1-v$. Define $\Delta\beta\equiv\overline{\beta}-\underline{\beta}>0$. Effort a lowers the marginal cost c of a and 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 incentive rule is deterministic).

Consumers share the same preferences, and the demand is that of a representative consumer. Let $S(q)$, $p=P(q)=S'(q)$, $q=D(p)$ and $R(q)=P(q)q+A$ label the gross surplus, inverse and regular demand functions, and the firm's revenue. Consumers choose q in order to maximize the net surplus $S(q)-A-pq$, and A is fixed optimally to make them indifferent between buying or not the good: that is, $A\equiv S(q)-P(q)q$. The firm's utility is $U=t-\psi(a)$, and a reservation level of 0 is required. Finally, total revenues must cover costs and managerial rewards t; therefore, the budget constraint $A+(p-c)q(p)\geq t$ needs to be satisfied.

The planner's problem.—Ex post social welfare W is the sum of the net consumer surplus and of the firm's utility. The firm's budget constraint is

evaluated at the shadow price of the managerial rewards $1+\lambda$ and, consequently,[8]

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

Let $V\left(q\right)$ denote the social surplus brought about by the production of q. Given that the good is private, V is the sum of the consumers' net surplus plus the firm's revenue, computed at the shadow price $1+\lambda$ (because it helps to fulfil the firm's budget constraint). So, $V\left(q\right) = \left(S\left(q\right) - R\left(q\right)\right) + \left(1+\lambda\right)R\left(q\right) = \left(1+\lambda\right)S\left(q\right)$ with $V\left(0\right) = 0$, $V' > 0$, $V'' < 0$, $-V''\psi'' > 1+\lambda$. The strictly concave objective in (1) rewrites as:

$$W = V\left(q\right) - \left(1+\lambda\right)\left[\left(\beta - a\right)q + \psi\left(a\right)\right] - \lambda U. \qquad (2)$$

Under complete information, the planner achieves the first best allocation $\psi'\left(a^*\right) = q^*$ through a fixed price contract on t (see the Appendix). No rent is left to the firm. Instead, under asymmetric information, the planner observes total costs and output but not the inefficiency parameter. The planner offers the firm a menu of incentive compatible pairs $\left(t,c\right)$ trading off informational rent extraction and allocative distortion.[9] Let $\left\{\left(\underline{t},\underline{q},\underline{C},\underline{c},\underline{U},\underline{a}\right),\left(\overline{t},\overline{q},\overline{C},\overline{c},\overline{U},\overline{a}\right)\right\}$ denote the managers' rewards, output, total and marginal costs, utility and effort of the high and low cost (low and high type) firms respectively. Individual rationality and incentive

[8] Joskow and Schmalensee (1986) suggest that A here covers a role similar to the governmental transfers in Laffont and Tirole (1993). Thus, my analysis is formally similar to the latter when reimbursement is intended to be operated through regulated prices. In the present case, the shadow cost of public funds is replaced by the marginal deadweight loss from a rise in the fixed fee.

[9] Incentive compatibility prescribes that the contract designed for type $\underline{\beta}$ $(\overline{\beta})$ is the one preferred by type $\underline{\beta}$ $(\overline{\beta})$ in the menu of managerial rewards-marginal cost pairs. This amounts to saying that:

$$\underline{t} - \psi\left(\underline{\beta} - \underline{c}\right) \geq \overline{t} - \psi\left(\underline{\beta} - \overline{c}\right) \quad (IC\_H) \quad \text{and} \quad \overline{t} - \psi\left(\overline{\beta} - \overline{c}\right) \geq \underline{t} - \psi\left(\overline{\beta} - \underline{c}\right). \quad (IC\_L)$$

compatibility imply a binding high cost firm's individual rationality constraint

$$\overline{U} = \overline{t} - \psi\left(\overline{\beta} - \overline{c}\right) = 0, \qquad (IR\_L)$$

and a binding low cost firm's incentive compatibility constraint

$$\underline{U} = \underline{t} - \psi\left(\underline{\beta} - \underline{c}\right) = \overline{U} + \psi\left(\overline{\beta} - \overline{c}\right) - \psi\left(\underline{\beta} - \overline{c}\right) = \Phi\left(\overline{a}\right), \qquad (IC\_H)$$

where $\Phi(a) \equiv \psi(a) - \psi(a - \Delta\beta)$ with $\Phi' > 0$, $\Phi'' > 0$ (because $\psi''' > 0$).

Thus, under asymmetric information, expected social welfare is $\tilde{W} =$

$$v\left[V\left(\underline{q}\right) - (1+\lambda)\left[\left(\underline{\beta} - \underline{a}\right)\underline{q} + \psi\left(\underline{a}\right)\right] - \lambda\Phi\left(\overline{a}\right)\right] + (1-v)\left[V\left(\overline{q}\right) - (1+\lambda)\left[\left(\overline{\beta} - \overline{a}\right)\overline{q} + \psi\left(\overline{a}\right)\right]\right]. \qquad (3)$$

Except for the expected rent $v\lambda\Phi\left(\overline{a}\right)$, the optimization is the same as in (2). Prices are not distorted for rent extraction, and incentive concerns are entirely taken care of by the incentive scheme. Define $\Gamma(x) \equiv x/(1-x)$ with $\Gamma' > 0$. In order to limit the high type's rent, the low type receives a low powered rule ($\hat{\overline{a}} < a^*$):

$$\psi'\left(\hat{\overline{a}}\right) = \hat{\overline{q}} - \frac{\lambda}{1+\lambda}\Gamma(v)\Phi'\left(\hat{\overline{a}}\right). \qquad (4)$$

The supervision technology.—Let me now introduce two supervisors (a regulator and a judge) who, exerting costly effort, produce two independent signals that are observed by the planner.[10] The signals' precision is ξ_l with $l = \{R, J\}$. If $\beta = \underline{\beta}$, with probability ξ_l the planner sees $\underline{\beta}$ and implements the full information contract and with probability $1 - \xi_l$ she observes ϕ (*i.e.*, she remains uninformed). If, instead, $\beta = \overline{\beta}$ the planner observes ϕ always. The planner always assures a reservation utility r to the two supervisors, who always participate in the game

[10] The set up is justified, in the case of the US electricity market, by the nature of the evidence processing (which is *de facto* devolved upon the staff) and the extent of judicial review (*de novo* hearings). The contractability of the precision will lead to the first best but "does not even come close to any observed institutional arrangement" (Alesina and Tabellini, 2007).

and are not allowed to side contract with each other. The regulator moves first. If the planner remains uninformed, the judge generates an orthogonal signal with the same structure. Supervisors are evaluated on the observable but not contractible ξ_l, whose technology is multiplicative in the random (common) ability $\alpha \in [0,1]$ and in the unobservable effort $e_l \in [0,1]$: that is, $\xi_l = \alpha e_l$.[11]

The parameter α is drawn from a distribution with mean $\bar{\alpha}$, variance σ_α^2 and density f independent of e_l. In order to narrow down the possible cases, I shall focus on the class of canonical, non degenerate, continuous distributions supported on a bounded interval and with hump-shaped density: that is, Beta, generalized Kumaraswamy, raised cosine, inverted U-quadratic, and truncated normal (see Johnson et al., 1994). Moreover, I shall assume that:

A1: When f is truncated normal $\sigma_\alpha \left[\Phi\left((1-\bar{\alpha})/\sigma_\alpha \right) - \Phi\left(-\bar{\alpha}/\sigma_\alpha \right) \right] < 1/\sqrt{2\pi}$, where Φ is the standard normal cumulative function.

The assumption assures that, for all the distribution in the class, the density f is not too flat at the mean, and, in particular, that $f(\bar{\alpha}) > 1$. As a result, the marginal probability of drawing a supervisor with less than average talent is not too low. In the most sensible case, in which there are not extreme types and $f(0) = f(1) = 0$—Beta, generalized Kumaraswamy, raised cosine, and inverted U-quadratic—the requirement is always met (proofs available from the author). When, instead, this is not the case (truncated normal) the regularity on the

[11] The effort has to be considered correctly as net of all the activities intended to hide valuable information. A multiplicative technology avoids the tiresome qualifications that an additive one needs: the choice, however, is immaterial. If the performance is any continuous and increasing function of the precision (*e.g.*, expected social welfare), all the results remain unaffected.

measure of completely skilled and unskilled types, contained in A1, is required.[12] Nevertheless, this last assumption has to be considered as an essentially mild one given the high complexity and the fast changing nature of the regulation task. *Supervisors' objective functions.*—As suggested by Maskin and Tirole (2004), I suppose that supervisors respond to both implicit incentives and intrinsic motivations: they not only value being in office for its own sake but they also wish to leave a legacy. In other words, not only being reappointed or re-elected brings valuable perquisites or satisfies tastes for influence (implicit incentives), but supervisors want to be remembered for great things they have accomplished in favor of the society at large, or of a part of it (intrinsic motivations).

Thus, I posit that a supervisor's utility depends on both her identity (being a regulator or a judge) and the degree of accountability to which she is subjected (being elected or appointed). Therefore, a generic supervisor's interim (relative to the moment in which she exerts effort) utility function writes as

$$R_{i,l}\left(e_{i,l},S\right)=\left\{1+\left[\left(1-SR\right)G^{i}\left(e_{i,l}\right)-\left(1-\left(1-S\right)J\right)\left(1-K\right)\tilde{C}\left(e_{i,l}\right)\right]\right\}r, \tag{5}$$

where $i=\{A,E\}$ indexes the appointment rule to which she is subjected. $K\in(0,1)$ is an efficiency of the information gathering technology parameter and the effort cost function has $\tilde{C}(0)=0$, $\tilde{C}'>0$, $\tilde{C}'(0)<\infty$, $\tilde{C}''>0$, $\lim_{e_{i,l}\to 1}\tilde{C}'\left(e_{i,l}\right)=\infty$. The term in square brackets represents the non-monetary bonus obtained over and above r. Besides, the shape of the implicit rewards function $G^{i}(\cdot)$ differentiates appointed from elected officials and S distinguishes regulators from judges. In particular, S is equal to 1 for a regulator and to 0 for a judge. In order to grasp a deeper

[12] Some non-continuous distributions in the same class (for example, triangular) have the same property. To be hump-shaped, the Beta and Kumaraswamy need to have parameters greater than 1.

understanding of nonmonetary incentives, I shall leave aside signalling and money-burning incentives and assume that supervisors select effort before knowing their random ability. Then, nature chooses α. Next, the outcomes are observed. Finally, supervisors obtain the nonmonetary rewards inclusive utility.

For what concerns implicit incentives, I embrace the distinction between politicians and bureaucrats proposed in Alesina and Tabellini (2007): while elected officials are held accountable by voters, at election time, appointed ones are accountable to their professional peers or to the society for the way that they fulfil the goals of their organization. In particular, the latter want to maximize the conditional perception of their ability. Therefore, if $\mathrm{E}[\cdot]$ denotes the supervisor's unconditional expectation over $\xi_{A,l}$, E the evaluator's expectation over α conditional on $\xi_{A,l}$ and the (correct in equilibrium) evaluator's expectation over effort $e_{A,l}^{\exp}$, then $G^{A}\left(e_{A,l}\right)=\mathrm{E}\left[E\left(\alpha\middle|\xi_{A,l},e_{A,l}^{\exp}\right)\right]$. Turning to voters, they realize that the alternative to the incumbent is an average talented official exerting effort $e_{E,l}^{\exp}$. So the incumbent is re-elected if the realized performance is greater than $\tilde{\xi}_{E,l}=\bar{\alpha}e_{E,l}^{\exp}$ or $G^{E}\left(e_{E,l}\right)=\Pr\left\{\xi_{E,l}\geq\tilde{\xi}_{E,l}\right\}=\Pr\left\{\alpha\geq\left[\bar{\alpha}e_{E,l}^{\exp}/e_{E,l}\right]\right\}$. In order to simplify the analysis, let me normalize the market value of talent and the value of office holding to 1.

Turning to intrinsic motivations, $J\in(0,1)$ and $R\in(0,1)$ measure the "fairness" and the "revolving door" motivations. Political and legal scholars have assumed that judges try to make the (ex post) right decision in order to signal their fairness and commitment. Miceli and Coşgel (1994) envision that judges suffer a utility loss when overturned and gain utility when cited and Gennaioli and Shleifer (2008) suppose that judges want to minimize type one and two errors.

The disclosure of the firm's information, instead, is less appealing for officials attracted by future job opportunities in the industry (see also Gormley, 1983). As Quirk (1981) shows, more pro-industry US federal regulators anticipate enhanced chances of working for regulated firms. Therefore, I assume that the judges' cost of exerting effort (the regulators' implicit rewards) decreases with J (R).

The timing.—The timing of the game is as follows:

1. Society (that is, the planner, the supervisors and the firm) learns the nature of the regulatory environment ($P, \beta \in \{\underline{\beta}, \overline{\beta}\}$). Next, the firm discovers the value of β.

2. The planner offers the firm a menu of (t, c) pairs. If it declines, the game ends.

3. The regulator chooses her level of effort; then, she discovers the value of α. Next, the planner receives the first signal. If this is informative the first best is implemented. If the planner remains uninformed, the judge moves.

4. Step 3 is repeated for the judge. If the signal is uninformative, the planner asks the firm to report its information.

5. The firm exerts equilibrium effort and the rewards-cost pair is implemented. Next, the signals precisions are revealed and each supervisor is rewarded.

Implicit incentives build into the model a division of power structure: officials care about their evaluators' moves and not about the incentive scheme selected by the planner. This model's feature has three consequences. First, implicit incentives reduce the scope for side-contracts between the firm and the supervisors because the former has to reimburse nonmonetary rewards to the latter. Second, if the firm's informational rent is not only a loss as it is in equation (3), supervisors' and planner's goals can collide. Third, the basic equilibrium can be easily obtained solving separately the supervisors' effort choice and the

planner's pricing scheme selection. Before looking at the details of the first two points, I shall illustrate the last one.

3.2 Firm's Extrinsic Incentives vs. Supervisors' Implicit Incentives

The solution concept is perfect Bayesian equilibrium. The latter can be characterized by a tuple of equilibrium efforts (one for each possible supervisor's type) and a menu of (t,c) pairs contingent on the signals realizations. Proceeding by backward induction, the solution to the supervisors' problem implies that:

LEMMA: *Label the regulators' (judges') selection rule with i (j). Each supervisor's problem has a unique and interior solution. In addition, equilibrium efforts $\hat{e}_{i,j}$ are such that, for all f in the class considered: (1) $\partial\hat{e}_{i,R}/\partial R<0\forall i$, $\partial\hat{e}_{j,J}/\partial J>0,\forall j$, $\partial\hat{e}_{i,I}/\partial K>0\forall i,I$ and $\partial\hat{e}_{j,I}/\partial K>0\forall j,I$; (2) under A1, $\hat{e}_{E,I}>\hat{e}_{A,I},\forall I$.*

Point 1 underscores not only the role of a more efficient information-gathering technology but also the effects of opposite legacy goals: the effort exerted by supervisors striving to please the industry (to be ex-post correct) tends to decrease (increase) as the congruency with original tasks fades away. Even more crucially, point 2 states that, whenever it is not too easy to substitute an incumbent supervisor for a mean-ability one (that is, when A1 holds), an elected supervisor panders to voters exerting more effort than would an appointed one.[13]

Despite the different set up, the result is driven by an incentive similar to the pandering ones identified by Maskin and Tirole (2004). Moreover, the lemma confirms, under the more realistic asymmetric information hypothesis, the results

[13] When the shape parameters equal 1, the Beta and Kumaraswamy become uniform and the inequality holds as equality (that is, elected and appointed supervisors exert the same effort).

obtained by Besley and Coate (2003).[14] At stage 2, the planner offers the firm a menu of transfers-marginal cost pairs that are function of the expected efforts. If $\gamma(i,j) \equiv \bar{\alpha}\hat{e}_{i,R} + (1-\bar{\alpha}\hat{e}_{i,R})\bar{\alpha}\hat{e}_{j,J}$, the planner's posterior belief on $\underline{\beta}$ conditional on two uninformative signals is $\Pr\{\beta = \underline{\beta}|\phi,\phi\} = v(1-\gamma(i,j))/[1-v\gamma(i,j)]$, and her optimum problem (indexed by S –that is supervision) writes as $\tilde{W}^s =$

$$v\gamma(i,j)\underline{W}^* + [1-v\gamma(i,j)]\left\{\frac{v[1-\gamma(i,j)]}{1-v\gamma(i,j)}\left[V(\underline{q}^s) - (1+\lambda)\left[(\underline{\beta}-\underline{a}^s)\underline{q}^S + \psi(\underline{a}^s)\right] - \lambda\Phi(\bar{a}^s)\right] + \right.$$

$$\left. + \frac{1-v}{1-v\gamma(i,j)}\left[V(\bar{q}^s) - (1+\lambda)\left[(\bar{\beta}-\bar{a}^s)\bar{q}^s + \psi(\bar{a}^s)\right]\right]\right\} - 2(1+\mu)r\,,$$

where $\underline{W}^*$ is the first best welfare obtained when at least one signal is informative. The planner evaluates supervisors' monetary perks at the shadow cost of public funds $1+\mu$ and, without loss of generality, does not value implicit incentives. All the novelties in the optimum problem, which has a unique and positive solution, are contained in the expected ex post probability of at least an informative signal $\gamma(i,j)$. Again, the rule giving price as a function of marginal cost is the same as the full information case (that is, $V'(\hat{\bar{q}}^s) = \hat{\bar{c}}^s = \bar{\beta} - \hat{\bar{a}}^s$) and the planner offers the high cost firm a scheme less powered than the first best and in particular:

$$\psi'(\hat{\bar{a}}^s) = \hat{\bar{q}}^s - \frac{\lambda}{1+\lambda}\Gamma(v)[1-\gamma(i,j)]\Phi'(\hat{\bar{a}}^s)\,. \qquad (6)$$

Clearly, the hierarchical hearings structure is useful, and the allocative distortion

[14] Focusing on normally distributed talent observable with noise, Alesina and Tabellini (2007) show that a sufficiently high uncertainty over talent implies patterns opposite to those in point 2. Yet, a similar scenario is not realistic in the present instance: regulatory policies are widely publicized (talent observed without noise) and supervisors' curricula vitae are consistent one with the other (small dispersion of possible ability levels).

is partially curbed with respect the solution in (4) (*i.e.*, $\hat{\bar{a}} < \hat{\bar{a}}^s < a^*$). In particular, given that $\gamma(i,j)$ increases with $\hat{e}_{i,R}$, $\hat{e}_{j,J}$, the following is true:

PROPOSITION 1: *(A) The power of the optimal incentive rule rises with the efficiency of the information-gathering technology, is increasing (decreasing) with the strength of judges' (regulators') intrinsic motivations and –under A1– is greater whenever supervisors are elected. (B) Regulated rates decrease with* $\hat{\bar{a}}^s$.

The main innovation of Proposition 1 rests in underlining that supervisors' implicit incentives and firm's explicit incentives are complement.[15] The pattern resembles the relation between career concerns and monetary rewards in labour contracts proposed by Gibbons and Murphy (1992). However, in contrast to the latter, the present result refers to players who belong to different tiers of the hierarchical structure but, yet, are linked by the revelation principle and the division of power. When pandering incentives become more powerful–because election is used instead of appointment–the expected probability of informative signals increases, and the planner relaxes the allocative distortion offering the low type a more powerful contract. Fairness motivations reinforce complementarities; revolving door concerns limit them.

The appeal of these results lies not only in the sensibility of the model's premises which bridge task-specific organizational imperatives to the asymmetry in technological information but also in the realism of the consequences. Studying a similar environment, the new regulatory economics (Laffont and Martimort,

[15] The assumption according to which the planner does not choose supervisors implicit incentives should not strike one as unreasonable given that, over the sample considered in the empirical section, there were only four regulatory and three judicial appointment rules reforms. Guerriero (2008) extends the model to a world in which the planner selects the power of implicit incentives.

1999; Laffont, 2000) obtains collusion-proof equilibria in which monetary perks equal to the firm's expected stake are given to explicitly interested supervisors to avoid corruption. This pattern matches consistent evidence on regulatory reforms (Gormley, 1983; Ka and Teske, 2002) which has clarified the narrow role of capture but is completely at odds with any observed regulatory contract.[16] The equilibrium discussed in Proposition 1, instead, has similar collusion-proofness properties but builds on the observed residual rights nature of supervisors' activities. The next section explains this point in detail.

3.3 Robustness: Lobbying and Bribery

Supervisors exert also effort in other tasks. I assume that a firms' lobby tries to divert supervisors' effort from information gathering to the fulfilment of a second task. For example, they try to avoid by-passing by non-regulated firms. The technology of the second task is $h_{i,l} = \alpha e_{i,l}^{h}$ and its benefits are negligible for consumers and $\kappa h_{i,l}$ (with $\kappa > 0$) for the firm. Following Alesina and Tabellini (2008), the planner does not foresee equilibrium capture and cannot condition her choice–that is, incentive schemes–on the supervisors' collusive activities; α is truncated normally distributed, and the supervisors' effort cost function is additive. Besides, the lobby, whose vote is irrelevant, has all the bargaining power and, in stage 2 commit to bribes $b_{i,l}$ and/or campaign contributions $n_{E,l}$ (to elected supervisors only) to be paid after stage 5.

[16] Collusion proof contracts are simply unrealistic if supervisors' monetary rewards are evaluated against the firm's stake: over the period 1980-1997, for instance, IOUs average revenues from retail sales were 1.94 billion dollars while the commissioners' average salary was 59,774 dollars.

Both of these influence instruments are contracts contingent on the efforts exerted in the two tasks, but bribes are illegal and, if a supervisor accepts them, with probability $\upsilon > 0$ she is caught and pays a fine $M > 0$. Thus, when $\tau > 0$ measures the value of implicit rewards relative to illegal bribes, supervisors' utility (indexed by C; that is, capture) rewrites as

$$R_{i,I}^{C}(e_{i,I}^{C}, e_{i,I}^{h}, S) = \left\{1 + \tau\left[(1 - SR)G^{i}\left(e_{i,I}^{C}, e_{i,I}^{h}\right) - \left(1 - (1 - S)J\right)(1 - K)\tilde{C}\left(e_{i,I}^{C} + e_{i,I}^{h}\right)\right]\right\} r + b_{i,I} - \upsilon M \,.$$

Implicit rewards are the same as in (5) when appointment is used but they differ if election is employed. Indeed, campaign funds lower voters' reservation utility to $\tilde{\xi}_{E,I}^{C} = \overline{\alpha} e_{E,I}^{\exp} - H\left(n_{E,I}\right)$ with $H(0) = 0$, $H' > 0$, $H'' < 0$. The lobby's indirect utility is

$$\tilde{U} = v\left[1 - \gamma^{C}(i,j)\right]\Phi\left(\hat{\tilde{a}}^{s,C}\right) + \kappa E\left[\alpha\left(\hat{e}_{i,R}^{h} + \hat{e}_{j,J}^{h}\right)\right] - \left(\hat{b}_{i,R} + \hat{b}_{j,J}\right) - \left(\hat{n}_{E,R} + \hat{n}_{E,J}\right),$$

where hats indicate equilibrium values. The subgame perfect equilibrium of the menu auction bribing game and of the lobbying game are jointly optimal for the organized group and the supervisor, given the evaluators' expectations. Tedious algebra (proofs available from the author) shows that for τ sufficiently large appointed supervisors never accept bribes, and that the lobby prefers to be ex-ante passive rather than pay bribes if the firm's stake is too narrow or legal systems work efficiently, that is υM is large. Strong (weak) fairness (revolving door) motivations favor capture-free equilibria. Full-capture equilibria with positive campaign funds are never optimal because supervisors always lose election. Also, the lobby is not willing to offer campaign aids if money is not very effective in swaying votes, that is H' is small. Thus, sufficiently strong implicit incentives and/or an inefficient corruption technology make the equilibrium in Proposition 1 endogenously collusion-proof.

3.4 Investment Concerns and Strategic Regulatory Reforms

Yet, the picture painted so far is, at least, partially incomplete: it takes into account static dimensions of regulatory performance but it does not deal 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. As shown by Laffont and Tirole (1993), whether or not the planner can commit to reimburse investment costs, the equilibrium can envision ex post expropriation of sunk investments. On the one hand, this dynamic inconsistency optimally pushes toward more powerful schemes, on the other, it creates the risk that inefficiently high or low powered incentives are imposed on the firm if reforms are directed by political parties committed to decide in favour of their own constituency and subject to uncertain elections.

In the next section, I first clarify the efficiency effect maintaining the planner's benevolence, and then I consider the positive determinants of incentive rules allowing for planner's special interests. In order to illustrate the point most clearly, I shall suppose that the planner cannot commit to reimburse investment expenses but correctly anticipates the firm's moves.[17] The assumption reflects the lack of formal guarantee of productivity offsets typical of incentive contracts (see Basheda et al., 2001) and is not at all restrictive. Indeed, under commitment, whether or not contractibility is assumed, not only the results continue to hold but also a bargaining inefficiency arises (see Laffont and Tirole, 1993, ch. 1).

[17] Even if the used and useful US doctrine constitutes a partial assurance against non-commitment, the assumption is the more appropriate in technologically mature and mass markets such as electricity, where a firm retaliation strategy could not be very damaging (Newbery, 2000, ch. 2).

Benevolent Planners

Before learning β, the firm commits a monetary investment of cost $I \geq 0$ which increases the ex ante probability of being a high type to $\tilde{v}(I) = v\left[1+\zeta(I)\right]$.[18] A higher I makes it more likely that the firm is efficient. I also assume that the cost-reducing technology is efficient enough, exhibits decreasing returns and does not exclude a $\overline{\beta}$ realization. This means that $\zeta' \geq 1/(v\Delta\beta)$, $\zeta'' < 0$, $\lim_{I\to\overline{I}} \zeta'(I) = \infty$, $\overline{I} = \zeta^{-1}(\overline{v}) = \infty$, $\overline{v} = \Gamma(v)^{-1}$. In the investment regime (notice the index I), the firm chooses $\hat{I}$ to maximize expected ex post rents minus investment costs:

$$\hat{I} \in \arg\max_{I\geq 0} \left\{ \tilde{v}(I)\left[1-\gamma(i,j)\right]\Phi\left(\hat{\overline{a}}^{S,I}\left(\hat{I}\right)\right) - I \right\}. \qquad (7)$$

The firm under-invests with respect to the social optimum (see the Appendix) and a decrease in the power of the incentive rule depresses expected ex post rents. Thus, a benevolent planner should select higher-powered schemes if investment decisions are sufficiently relevant. Formally, I shall assume that the firm's utility enters the planners' objective function with an extra weight χ with $\lambda > \chi > 0$ so that expected welfare rewrites as $\tilde{W}^{S,I}\left(\tilde{v}\left(\hat{I}\right)\right) = \chi\tilde{v}\left(\hat{I}\right)\left[1-\gamma(i,j)\right]\Phi\left(\overline{a}^{S,I}\right) + \tilde{W}^{S}\left(\tilde{v}\left(\hat{I}\right)\right)$, where the dependence on the expected probability of a high type is made explicit. The low type's contract is now pinned down by

$$\psi'\left(\hat{\overline{a}}^{S,I}\right) = \hat{\overline{q}}^{S,I} - \frac{\lambda-\chi}{1+\lambda}\Gamma\left(\tilde{v}\left(\hat{I}\right)\right)\left[1-\gamma(i,j)\right]\Phi'\left(\hat{\overline{a}}^{S,I}\right),$$

and by the first order condition to (7). Fixed-price contracts reach efficiency but leave a disproportionate rent to the firm. Therefore, optimal rules trade off

[18] Investment shortages also have a negative effect on service reliability and quality. Basheda et al. (2001) suggest that the restructuring-related investment uncertainties and the reduced availability of hydroelectric generation were two of the main causes of California's liberalization failures.

between static (rent extraction) and long-run (investment inducement) concerns.

PROPOSITION 2: *The power of the optimal incentive scheme increases with the planners' investment concerns* χ.

The result is similar to the one obtained by Sappington (1986), who claims that institutions preventing the regulator from observing the firm's costs are optimal if the expropriation of investments is a real issue. Even if cost-reduction is undoubtedly in interest of society, quality and reliability-enhancing investments can affect consumers asymmetrically if only some of them are also shareholders. Next, I prove that incentive rules reflect this conflict if the planner is a political party accountable to her constituency, and re-election is uncertain.

Partisan Planners

Suppose that the incentive rule is selected in stage 2 by the incumbent between the pro-shareholder party R and the pro-consumer D. Next and before the firm eventually commits to the investment (just after stage 5), an election with exogenous winning probability $x_m \left(m = D, R\right)$ is held. The winner can, exerting effort ρ_m, ease the firm's private-funds-seeking activity.[19] The investment fixed monetary cost is $\overline{I} \geq 0$ and its stochastic return has expected value $\pi \equiv \overline{\pi}\delta + \underline{\pi}\left(1-\delta\right) > 0$ with $\overline{\pi} > 0 > \underline{\pi}$ and $\delta > 0$. The firm is infinitively risk averse in the range of the ex-post negative utilities. Only the high type invest if

$$\Phi\left(\hat{\tilde{a}}_{\tilde{m}}^{S,I}\right) + \underline{\pi}\overline{I} \geq 0, \qquad (8)$$

[19] The set up 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).

where $\tilde{m} = D, R$ indexes the incumbent party.[20] Each party attaches to the ex-post participation to the investment game–constraint (8) both the common shadow price $1+o>1$ and a specific investment concern $\chi_{\tilde{m}}$ capturing the party's willingness to leave higher ex post rents to shareholders. Let me label $\rho_D x_D + \rho_R x_R \equiv \tilde{x}$. I assume the following restrictions on the exogenous parameters:

A2: $\rho_R > \rho_D > 1$; $\chi_R \equiv 1 + o - \theta < 1 + o + \theta \equiv \chi_D$; $\theta > 0$; $\tilde{x} < \lambda / \theta$.

Therefore, the incumbent maximizes:

$$\tilde{W}_{\tilde{m}}^{S,I} = \tilde{W}^S + (1+o-\chi_{\tilde{m}})\tilde{x}v\left[1-\gamma(i,j)\right]\Phi\left(\bar{a}_{\tilde{m}}^{S,I}\right).$$

In interpreting the foregoing, several observations should be borne in mind. First, the non-monetary nature of ρ_m simplifies the analysis assuring that the ex post participation constraint enters the expected welfare without the shadow price of public funds. Second, the restriction according to which the winning party cannot reform incentive rules squares with the typical commitment period common to almost all PBR contracts (Basheda et al., 2001). Third, the fact that the pro-shareholder party exerts a higher investment-enhancing effort and dislikes less leaving an extra ex post rent to the firm is in the spirit of those models of electoral competition in which candidates commit to well-defined policies ahead of elections and then stick to them (for a review see Persson and Tabellini, 2000, ch. 3). Fourth, the last two restrictions in A2 assure that the other propositions continue to hold. All in all, the equilibrium low type's allocation is

[20] The latter is the case even if perfect financial markets are available, provided that $-\underline{\pi}\bar{I} > \Phi\left(\hat{\bar{a}}_{\tilde{m}}^{S,I}\right)(\rho_{\tilde{m}}-1)$. If the aid is monetary, the analysis continue to hold under the assumption that party R dislikes more resorting to distortionary taxes in order to finance the aid (see Guerriero, 2008).

$$\psi'\left(\hat{\tilde{a}}_{\tilde{m}}^{S,I}\right) = \hat{\tilde{q}}_{\tilde{m}}^{S,I} - \Gamma(v)\left[1-\gamma(i,j)\right]\left[\frac{\lambda}{1+\lambda} - \frac{1+o-\chi_{\tilde{m}}}{1+\lambda}\tilde{x}\right]\Phi'\left(\hat{\tilde{a}}_{\tilde{m}}^{S,I}\right), \quad (9)$$

which, in turn, implies (see the Appendix) that:

PROPOSITION 3: *Under A2, the power of the optimal scheme rises with the incumbent grip on power* x_m *and is greater if the reformer is pro-shareholder.*

While the second part 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 holding on power of the incumbent is negative when the reformer is pro-shareholder party and null otherwise. The actual pattern originates from both the asymmetry in the parties' preferences and the uncertainty of elections and is similar to the strategic dynamic incentive pointed out by a long tradition of political economy (Persson and Svensson, 1989; Alesina and Tabellini, 1990; Hanssen, 2004).

This body of research claims that a lack of permanence in office can inspire policymakers to implement reforms either to influence political outcomes or to limit the actions of future incumbents.[21] In a similar way in the present environment, even if both parties value profit-enhancing investments, only the pro-shareholder one prefers investment inducement to shareholder exploitation.[22] An increase in the probability of being re-elected and exerting more (less) effort, without the danger of facing a new institutional reform, pushes party R (D) to

[21] For instance, the reform was promoted in Maine by Republicans who had defeated Democrats a few years earlier. The latter won back the state after the adoption of PBR (Lee and Hill, 1995).

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

select more powerful rules and so assure an even higher profit to her constituency (curb allocative distortion). Provided that A1 and A2 hold, and with P and β held constant, the above propositions can be restated as testable predictions on regulated prices and the likelihood of reforms toward PBR as:

TESTABLE PREDICTIONS: *The likelihood of a reform toward higher powered incentive rules will (1) rise if supervisors are elected, increase (decrease) with the strength of fairness (revolving door) motivations, (2) rise with the efficiency of the information-gathering technology and society's investment concerns, (3) increase with the incumbent's grip on power and if the reformer is Republican. (4) More powerful incentive rules will lower regulated prices.*

In what follows, I test these testable predictions, tackling first predictions 1 to 3, and then turning to the fourth one

4. Evidence

Between 1982 and 2002, twenty-five US states have experimented some form of broadly defined PBR (a firm-by-firm breakdown is available from the author). This variation constitutes a perfect source for a panel analysis. I consider forty-six states for which data on incentive rules, rates, average costs and proxies for the determinants of incentive rules are available (see the Appendix). From 1996, a wide deregulation and competition-enhancing process which came into force with either one or two years lag, has interested the market. Clearly, such a restructuring wave has dramatically altered the strategic environment (see, for a theoretical explanation, Laffont and Tirole, 1993, ch. 17). An inference unable to disentangle the fine details of the reforms can be highly misleading. So, I consider

the 1982-1997 period only.[23] During these years, three alternatives to cost of service have been used: price cap, earnings sharing and rate case moratoria. While the latter constitute agreements to freeze the firm's rates during a commitment period, earnings sharing requires the firm to share incremental earnings above and below an intermediate range with its users. When earnings are in between these bounds, the firm secures for herself greater profit only if a higher cost-reducement effort is exerted. Finally, under price cap the firm acts as residual claimant of its performance and can adjust its rates as long as, on average, prices rise no faster than inflation less a productivity offset. Thus, price cap is the most powerful rule, cost of service the least powerful and the others lie in between the two extremes.

4.1 Non Random Incentive Rules Selection

Once a comparable sample of institutions that vary in their effects on incentive power has been identified, to evaluate the model's predictions, proxies for both the determinants of incentive rules and a suitable strategy are needed. In order to fully exploit the three-dimensional variation (over time, across states and across power levels) in incentive schemes, I estimate two models. Both models aim at explaining the probability of reforms toward more powerful rules.

Empirical strategy.—The first model is the following ordered logit:

$y_{i,t} = k$ if $\tau_{k-1} \le y^*_{i,t} < \tau_k$ for $y^*_{i,t} = \beta' z_{it} + \varepsilon_{it}$ and $k = 1, 2$,

which can be expressed in terms of the conditional distribution of $y_{i,t}$ given z_{it} as

$$\Pr\left(y_{i,t} = k \middle| z_{i,t}\right) = \Lambda\left(\tau_k - \beta' z_{it}\right) - \Lambda\left(\tau_{k-1} - \beta' z_{it}\right),$$

[23] Adding restructuring dummies or considering a sample with one or two more (less) years does not affect the empirical results in any appreciable way.

where τ_k are the unknown threshold parameters, Λ is the logit function and $y_{i,t}$ (*PBR_O* hereafter) equals one if state i uses cost of service regulation in year t, three if it uses price cap and two if it uses one of the other two procedures.[24] The second model is the following exponential proportional hazard rate model:

$$\lambda(t, z_{it}) = \exp(\beta' z_{it})\tilde{\lambda}_t$$

where $\tilde{\lambda}_t$ is the baseline hazard and $\lambda(t, z_{it})$ is the instantaneous probability of reforming from cost of service to PBR in year t and state i (that is, the failure event is identified by *PBR*, which is equal to 1 if at least one firm in the state i adopts price cap, rate case moratoria or earnings sharing).[25] z_{it} collects the (eventually)[26] time-varying proxies for the efficiency of the information-gathering technology, society's investment concerns, the strength of supervisors' implicit incentives and intrinsic motivations, and the incumbent's grip on power.

Measuring the structural determinants of incentive rules.—Let me start from the first prediction. Supervisors' implicit incentives can be summarized by an elected regulators (*Reg_Elec*) dummy and an elected judges (*Jud_Elec*) binary. I also consider whether appointed commissioners cannot all be from the same party

[24] The nonlinearity of the right hand side of (9) does not exclude a role for interacted regressors. If I estimate a logit model with dependent *PBR* and interaction terms, these are usually not significant at a probability of the reform level of 0 and 0.5 (see Ai and Norton, 2003).

[25] If I use the single IOUs within a state as the cross sectional identifiers, none of the results is affected. Similarly, switching to an ordered probit, imposing a different duration distribution or running a logit (or probit) model with dependent variable *PBR* does not change the main message.

[26] The embraced empirical strategy is also driven by the lack of within variation in many controls; yet, the coefficients attached to the time-varying covariates are qualitatively similar when a fixed effects logit is run. Finally, clustering the standard errors does not affect the analysis significantly.

(*Bipartisan*). The latter proxies for a less relevant Besley and Coate's (2003) bundling effect, being linked to less pro-shareholder appointed regulators.[27] Thus, *Bipartisan* should display a sign similar to *Reg_Elec*. A more challenging task is to find meaningful proxies for intrinsic motivations. I follow Teske et al. (2004, ch.4) and use, as a proxy for revolving door motivations, a binary variable equal to one if the PUC imposes restrictions on how long, after service, a commissioner must wait before taking a job in the industry (*Rev_Door*). *Rev_Door* can proxy for weaker or stronger pro-industry motivations depending on whether the loss of attractiveness of future job opportunities dominates the incentive to implement more biased and everlasting decisions to signal a revolving door interest or the opposite is true.[28] Concerning fairness motivations, a wide literature on judicial independence (see Hanssen, 2004) claims that a longer length of the judicial term should assure more insulation diluting reputational concerns. Thus, the length of judicial term (*Jud_Term*) should proxy for less powerful fairness motivations.

Focusing on the second prediction, it is reasonable to assume that more abundant resources and more powerful consumer groups ease information gathering. So I add to the other controls the total budget (in thousands of dollars) available to the PUC's staff (*Budget*). I also add a proxy for the power of the industrial users' watchdog group. The latter is the share of revenues from sales to industrial customers (*Industrial*). However, the utilities themselves fight in the

[27] Besley and Coate (2003) prove that, because regulation is bundled with more salient policies, politicians have electoral incentives (and no costs) to appoint pro-shareholders regulators.

[28] Similar crowding effects have been widely documented in environments where implicit and intrinsic motivations interact: Bénabou and Tirole (2006) provide a first full-fledged theory. I thank David Ulph for drawing my attention to this particular point.

regulatory arena. Following Steiner (2004), a reasonable proxy for the industry influence is the share of generation from nuclear sources (*Gen_Nucl*). Indeed, nuclear plants require a large investment, which is typically undertaken by huge utilities: thus, the nuclear share is correlated with the influence of large producers. I also need proxies for society's investment concerns. Here, my strategy is to assume that higher residential rates increase society's interest in cost-reducing investments (for a similar approach see Steiner, 2004). Accordingly, I include the residential price—defined in terms of revenue (in cents per Kwh) from electricity sales—lagged two periods (*Price_R(-2)*). A proxy for the reformer's constituency ideology is required as well. A broad consensus (see Ka and Teske, 2002 and Teske et al., 2004) holds that the Republican Party has been supported historically by shareholders lobbies. This suggests that a time dummy for the years in which both houses were under the control of the Republicans (*Rep*) can be used to control for more pro-shareholders sentiments of the incumbent.

Turning to the third prediction, I follow Hanssen (2004), and I employ the share of seats held by the majority party averaged across upper and lower houses (*Majority*) as a proxy for how strong the incumbent's hold on power is.

Finally, scholars of policy innovation (see, for example, Ka and Teske, 2002) claim that the diffusion pattern of a new policy displays learning features: after one state has adopted a new policy, surrounding states are more likely to follow suit. So I use the share of surrounding states adopting PBR (*PBR_Nei*).[29]

[29] *Gen_Nucl* together with *Industrial* and *Budget* are conditionally independent because they are either set in advance or driven by the cost structure captured by *Price_R(-2)*. Using deflated prices or including income per capita, population, proportion of young and old, regional dummies and also the mean price prevailing in neighboring states does not affect appreciably the results.

Table 1 reports the descriptions and summary statistics of all variables. Column 1 (2) of Table 2 lists the estimated coefficients (marginal effects) of the ordered logit model. Column 3 reports the hazard ratios of the hazard rate model.

Empirical results.—Focusing, for ease of interpretation, on the marginal effects in column 2, the results are consistent with the model's predictions. Starting from the first, supervisors' implicit incentives and the firm's explicit incentives display strategic complementarities, and a reform from appointed to elected regulators implies a little more than a 4 percentage point increase in the likelihood of a reform toward price cap. The commissioners' appointment rule seems to be more relevant than the judicial one. The coefficient attached to *Bipartisan* displays the correct sign but it is not significant. For what concerns intrinsic motivations, the results are mixed. While *Rev_Door* is significantly correlated with *PBR_O* and the timing limits seem to enhance the revolving door boosts, the coefficient attached to *Jud_Term* has the right sign but it is not statistically significant.

Turning to the second prediction, higher values of *Budget* increase both the ordered log-odds of adopting more powerful schemes in column 1 and the likelihood of a reform toward price cap. The relative coefficient is significant at 1 percent. The behavior of *Industrial* is unexpected. This result could be driven by the fact that the watchdog groups' special interests can deteriorate in spite of ameliorating the quality of the information-gathering technology. Also, *Gen_Nucl* is not relevant in explaining *PBR_O*: this suggests that, when implicit incentives and intrinsic motivations are sufficiently strong, industry's special interests have no voice at the Constitutional table. Turning to the efficiency of the generation technology, a one-standard-deviation (2.082) increase in *Price_R(-2)* (whose coefficient is significant at 1 percent) raises the likelihood of a reform toward

price cap by a 1.4 percentage points. For what concerns *Rep*, even if the attached coefficient displays the correct sign the covariate is not statistically significant.

Turning to the strategic dynamics prediction, the estimated effects suggest that more powerful schemes are found where the political competition is less tight; however, *Majority* is significant only at 20 percent. Finally, as expected, *PBR_Nei* increases the ordered log-odds of adopting higher powered rules.

Column 2 of Table 2 considers as dependent variable the hazard of PBR adoption. Again the empirical results are consistent with the model's predictions. This time, the commissioners' selection rule, the PUC budget and the lagged residential price are the most powerful in explaining the instantaneous probability of a reform toward performance based regulation.[30]

All in all, observed institutions seem to reflect both efficiency and forward-looking concerns. This non random assignment of reforms to US states not only confirms the model's ideas but also implies that the effect of incentive rules on performance can be assessed correctly only when these institutions are treated as endogenous: I perform this empirical exercise in the next section.

4.2 Regulatory Performance and Endogenous Incentive Rules

States may well self select into PBR on the bases of unobserved political and technological shocks affecting at the same time the cost structure and the

[30] The reported figures are hazard ratios, and a coefficient greater than 1 implies higher odds that an individual in the treatment group implements the reform before an individual in the control group. Thus, for instance, a state selected at random from the group of states electing their PUC commissioners has an 80.9 percent (= 4.23/(4.23+1)) higher probability of implementing the reform before a state selected at random from the group of states appointing their commissioners.

political and social saliency of the reform. If the variation in incentive rules used to explain prices is related to these unexplained determinants of performance, the OLS estimator becomes biased.

Empirical methodology.—In order to assess correctly the effect of PBR, I estimate the following dynamic panel model:

$$y_{i,t}^{s} = \eta_i + \vartheta_t + \theta y_{i,t-1}^{s} + \phi PBR_{i,t} + \varphi X_{i,t} + \varepsilon_{i,t}, \qquad (10)$$

using the Arellano-Bond difference GMM estimator. $y_{i,t}^{s}$ is a price in state i and year t for customer class s. The classes considered are: residential (*Price_R*), commercial (*Price_C*) and industrial (*Price_I*). $y_{i,t-1}^{s}$ is a lagged performance term and picks up the persistence in the pricing process.[31] $X_{i,t}$ is a vector of factors likely to influence regulation. They are the time-varying determinants of incentive regulation discussed above (*Reg_Elec*, *Jud_Elec*, *Majority*, *Budget*, *Industrial*, *Gen_Nucl*, *Rep*), a fossil fuels costs index (*c*) devised by Besley and Coate (2003), state population (*Pop*), share of population aged between five and seventeen (*Young*) and sixty-five and over (*Old*), and state income per capita in dollars (*GSP*). Even after controlling for all these factors, some relevant systematic variation inevitably remains. I introduce both state (η_i) and time (ϑ_t) dummies. While the former captures time-invariant features of the regulated environment such as state laws and long-run differences in production systems, the latter pick up macro-shocks such as interest rates shocks, changes in federal

[31] Friedman (1991) claims that past prices constitute crucial benchmarks for the PUC staff (see Ai and Sappington, 2002). The temporal structure implicit in the estimated model is not general. The effects of incentive rules may not materialize until several years after implementation. Replacing PBR with its counterparts lagged one year produces results similar to the findings reported below.

policies and industry wide technological advances. *PBR* captures incentive rules. Estimating the model in difference avoid the well-know "dynamic panel bias" driven by the correlation between $y^s_{i,t-1}$ and the past errors and, therefore, the de-meaned errors $\varepsilon_{i,t} - \overline{\varepsilon}_i$ (see, for details, Baltagi 1995, ch. 8). I treat $y^s_{i,t-1}$ as predetermined and *c* as endogenous: treating both as endogenous does not affect the main message of the estimates discussed below. Finally given that state by state partial autocorrelation functions suggest that these two covariates are both autoregressive of order one, I introduce only one lag of $y^s_{i,t-1}$ and *c* in the (collapsed) instruments matrix: this also helps avoiding an over-instrumentation failure.[32] I also add *PBR_Nei* as exogenous instrument. Steiner (2004) proposes the following justification to this exclusion restriction: while the presence of low prices in reforming neighbouring states could shift support for reform in state i, electricity rates do not adjust until the reform is implemented in state i.[33] Similar results are obtained when I use, instead, an indicator for the contemporaneous use of incentive regulation in the state telecommunications sector. Finally, I always apply the Windmeijer finite-sample correction to the robust standard errors in order to avoid downward bias (see Roodman, 2006).

[32] The instruments count tends to explode with the number of years T, and too many moment conditions can overfit endogenous variables, failing to expunge their endogenous component, and weakening the power of the Hansen test for overidentification restrictions. This strategy reduces the instrument count well below the number of cross sections which is a rule of thumb precaution against this "too many instruments" failure (see Roodman, 2006).

[33] The first stage equations (not reported) confirm that the instruments are correlated to the endogenous covariates. Besides, the F-test on the excluded instruments are generally greater than 10: this reassures about a possible weak instrumentation (see Stock et al., 2002).

Empirical results.—The basic results are given in Table 3. The Arellano and Bond (1991) autocovariance test does not reject a zero second-order correlation in the differenced residuals at a level lower than 0.33, and the Hansen test does not reject the over-identifying restrictions at a level lower than 0.42. This reassures about the consistency of the estimates. Focusing on *PBR*, columns 1 to 3 clearly shows that incentive regulation had a negative (positive) but insignificant effect on commercial (residential and industrial) ratepayers. The result could be driven by the lack of a sufficiently long sample period or could just suggest that the main impact of incentive regulation has been on marginal costs. However, another and more appealing explanation suggested by the model is that many of the reforms were mainly implemented—as the results discussed in subsection 4.1 seems to suggest—to accomodate dynamic investment concerns after an era of rising input costs and fierce consumers opposition to price adjustements.

5. Concluding Remarks

The relevance of regulatory institutions to economic development is key, especially in a period of deregulation and competition enhancing reforms. Yet, the determinants of efficiency-enhancing contracts are essentially poorly understood: in this paper, I developed and tested a model of endogenous pricing rules. Given the technology environment and both the implicit incentives and the intrinsic motivations of public officials, political reformers not only consider the comparative advantages of different incentive schemes but they also use high powered rules to tie the hands of rival parties when uncertain about re-election. Consistent with the model's main intuitions, the likelihood of reforms toward

higher powered rules has been linked to elected supervisors, institutional settings enhancing the fairness of judges, a stronger incumbent's holding on power, more abundant regulatory resources and a more expensive electricity generation. As a result, my analysis delivers three pieces of advice for constitutional designers:

1. It is crucial to assess carefully the dynamic effects of more powerful rules when expropriation of sunk investment is a real concern;

2. Before calibrating the power of the firm's explicit incentives, the efficiency of the information-gathering technology and the broad set of concerns to which supervisors respond need to be considered attentively; and

3. The success of regulatory regime reforms is linked to a Constitutional table insulated from short-term electoral boosts.

Even if several states have recently tried to enhance competition, US electricity firms, along with other major utilities, are still regulated through settings similar to those studied above. Moreover, very similar institutions have recently been exported beyond American boundaries as an answer to the rising demand for a more effective judicial review and for a greater transparency of the regulatory process (see Newbery, 2000, ch. 2). This institutional trend makes the US lesson an increasingly relevant case study, especially useful for the future harmonization of European regulated markets.[34]

[34] As stressed by Breyer (2003) and Motta (2004), several recent antitrust cases (*e.g.*, Ahlstrom versus European Commission, 1993 and Enel versus Wind-Infostrada, 2002) have focused the interest of several European countries on the "gate-keeper" role of administrative judges.

References

Ai, C., and Sappington, D. "The Impact of State Incentive Regulation on the U.S. Telecommunications Industry." *J. of Regul. Econ.*, Vol. 22 (2002), pp. 133–160.

Ai, Chunrong, and Norton, Edward C. "Interaction Terms in Logit and Probit Models." *Economics Letters*, Vol. 80 (2003), pp. 123–129.

Alesina, Alberto, and Tabellini, Guido. "A Positive Theory of Fiscal Deficits and Government Debt." *Review of Economic Studies*, Vol. 57 (1990), pp. 403–414.

_____ . "Bureaucrats or Politicians? Part I: A Single Policy Task." *American Economic Review*, Vol. 97 (2007), pp. 169–179.

_____ . "Bureaucrats or Politicians? Part II: Multiple Policy Tasks." *Journal of Public Economics*, Vol. 92 (2008), pp. 426–447.

Arellano, M., and Bond, S.. "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations." *Review of Economic Studies*, Vol. 58 (1991), pp. 277–297.

Baltagi, B. *Econometric Analysis of Panel Data*. Chichester: Wiley, 1995.

Basheda G., Hanser, P. , Pfeifenberger J. and Sappington, D. "The State of Performance–Based Regulation in the U.S. Electric Utility Industry." *The Electricity Journal*, Vol. 14 (2001), pp. 71–79.

Bénabou, R. and J. Tirole, "Incentives and Prosocial Behavior," *American Economic Review*, 96 (2006): 1652-1678.

Besley, Timothy, and Coate, Stephen. "Elected versus Appointed Regulators: Theory and Evidence." *J. of the Eur. Econ. Assoc.*, Vol. 1 (2003), pp. 1176–1206.

Breyer, S. "Economic Reasoning and Judicial Review." Distinguished Lecture, Washington, AEI-Brookings Joint Center for Reg. Studies, 2003.

CDRA (Colorado Department of Regulatory Agencies). "1992 Sunset Review of the Colorado Public Utilities Commission." Mimeo, CDRA, 1992.

Dewatripont, Mathias, Jewitt, Ian and Tirole, Jean. "The Economics of Career Concerns, Part I: Comparing Information Structures." *Review of Economic Studies*, Vol. 66 (1999), pp. 183–199.

Eckenrod, S. "Incentive Regulation in Local Telecommunications: The Effects on Price Markups." *Journal of Regulatory Economics*, Vol. 30 (2006), pp. 217–231.

Friedman, L. S. "Energy Utility Pricing and Customer Response." In R. J. Gilbert et al. eds., *Regulatory Choices: A Perspective on Developments in Energy Policy*. Ch. 2. Berkeley: University of California Press, 1991.

Gennaioli, Nicola, and Andrei Shleifer, "Judicial Fact Discretion." *Journal of Legal Studies*, forthcoming (2008).

Gibbons, R., and Murphy, K. "Optimal Incentive Contracts in the Presence of Career Concerns: Theory and Evidence." *Journal of Political Economy*, Vol. 100 (1992), pp. 468–505.

Gormley, W. T. *The Politics of Public Utility Regulation*. Pittsburgh, PA: University of Pittsburgh Press, 1983.

Guerriero, C.. "Accountability in Government and Regulatory Policies: Theory and Evidence." Mimeo, Cambridge University, 2008.

Hanssen, F. Andrew. "Is There a Politically Optimal Level of Judicial Independence?" *American Economic Review*, Vol. 94 (2004), pp. 712–729.

Jamasb, T. and Pollitt, M. "Benchmarking and Regulation: International Electricity Experience." *Utilities Policy*, Vol. 9 (2001), pp. 107–130.

Johnson, N. L., Kotz, S. and Balakrishnan, N. *Continuous Univariate Distributions, Vols. 1 and 2*, 2nd edn. New York: John Wiley, 1994.

Joskow, P., and Schmalansee, R. "Incentive Regulation for Electric Utilities." *Yale Journal of Regulation*, Vol. 4 (1986), pp. 1–49.

Ka, S. and Teske, G. "Ideology and Professionalism: Electricity Regulation and Deregulation Over Time in the American States." *American Politics Research*, Vol. 30 (2002), pp. 323–343.

Laffont, Jean-Jacques. "Industrial Policy and Politics." *International Journal of Industrial Organization*, Vol. 14 (1996), pp. 1–27.

Laffont, J.-J. *Incentives and Political Economy*. Oxford: Oxford University Press, 2000.

Laffont, Jean-Jacques, and Tirole, Jean. *A Theory of Incentives in Procurement and Regulation*. Cambridge MA: MIT Press, 1993.

Laffont, J.-J., and Martimort, D. "Separation of Regulators Against Collusive Behavior." *Rand Journal of Economics*, Vol. 30 (1999), pp. 232–262.

Lee, C. R., and Hill, R. C. "Evolution of Maine's Electric Utility Industry, 1975-1995." *Maine Policy Review*, Vol. 4 (1995), pp. 17–27.

Maskin, E., and Tirole, J. "The Politician and the Judge: Accountability in Government." *American Economic Review*, Vol. 94 (2004), pp. 1034–1054.

Miceli, T. J., and Coşgel, M. M. "Reputation and Judicial Decision-making." *Journal of Economic Behavior and Organization*, Vol. 23 (1994), pp. 31–51.

Motta, Massimo. "L'economica e il Giudice." Mimeo: IUE, 2004.

Newbery, D. M. *Privatization, Restructuring and Regulation of Network Utilities*. Walras-Pareto Lectures, 1995. Cambridge MA: MIT Press, 2000.

OECD. "Regulatory Reform in Gas and Electricity and the Professions." OECD, 2002.

Persson, Torsten, and Svensson, Lars E. O. "Why a Stubborn Conservative Would Run a Deficit: Policy with Time-Inconsistent Preferences." *Quarterly Journal of Economics*, Vol. 104 (1989), pp. 325–345.

Persson, Torsten, and Tabellini, Guido. *Political Economics: Explaining Economic Policy*. Cambridge MA: MIT Press, 2000.

Quirk, Paul J. *Industry Influence in Federal Regulatory Agencies.* Princeton, NJ: Princeton University Press, 1981.

Roodman, D., 2006. “How to Do xtabond2: An Introduction to “Difference” and “System” GMM in Stata.” Mimeo. CGD.

Sappington, D. E. M. “Commitment to Regulatory Bureaucracy.” *Information Economics and Policy*, Vol. 2 (1986), pp. 243–258.

Steiner, F. “The Market Response to Restructuring: A Behavioural Model.” *Journal of Regulatory Economics*, Vol. 25 (2004), pp. 59–80.

Stock, J., Wright, J. and Yogo, M. “A Survey of Weak Instruments and Weak Identification in Generalized Method of Moments.” *Journal of Business and Economic Statistics*, Vol. 20 (2002), pp. 518–529.

Teske P. et al. *Regulation in the States*. Brookings Institution: Washington, DC, 2004.

Zweigert, Konrad, and Kötz, Hein. *Introduction to Comparative Law*. 3rd edn. Oxford – New York: Oxford University Press, 1998.

6. Appendix

Equilibrium under Perfect Information

Under perfect information, the planner knows β and infers a from the observation of c. Maximizing (2) with respect to a, U and q, the first best prescribes that:

1. The disutility of effort is equalized to the cost reduction at the margin:

$$\psi'(a^*) = q^*; \qquad (A1)$$

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

$$U = 0 \qquad \text{or} \qquad t^* \equiv \psi(a^*);$$

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

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

A fixed price contract on the managerial reward t gives the firm the right incentives for cost reduction. Label $T \equiv \psi(a^*)$ and $C^* \equiv (\beta - a^*)q^*$, equilibrium managerial rewards are $t^*(C^*) = T - (C(q) - C^*)$. The planner tailors the fixed charge T to fully extract the firm's rent, and the firm, which is left as the residual claimant of its cost savings, maximizes $T - ((\beta - a)q - C^*) - \psi(a)$ and, consequently, chooses the optimal a. ■

Proof of Lemma

I shall start from the equilibrium efforts prevailing when supervisors are elected. To this extent, maximizing $R_{E,I}(e_{E,I}, S)$ with respect to $e_{E,I}$ with $e_{E,I}^{\exp}$ taken as given and, then, imposing the equilibrium condition $\hat{e}_{E,I} = e_{E,I}^{\exp}$, the equilibrium is implicitly defined by

$$LHS(\hat{e}_{E,I}) \equiv (1-SR) f(\bar{\alpha}) \bar{\alpha} / \hat{e}_{E,I} - (1-(1-S)J)(1-K)\tilde{C}'(\hat{e}_{E,I}) \leq 0 \qquad (A2)$$

and by the slackness $(\hat{e}_{E,I} - 1) LHS(\hat{e}_{E,I}) = 0$ and $\hat{e}_{E,I} LHS(\hat{e}_{E,I}) = 0$. In the $\{\hat{e}_{E,I}, R_{E,I}(e_{E,I}, S)\}$ space, the first term in $LHS(\hat{e}_{E,I})$ is a rectangular hyperbola centred on $(0,0)$ while the second term is an increasing function. This, along with the fact that $\tilde{C}'(0) < \infty$ and

$\lim_{e_{i,l}\to 1}\tilde{C}'\left(e_{i,l}\right)=\infty$, assures that $\hat{e}_{E,l}$ exists and is both interior and unique. Turning to appointed supervisors and following the treatment in Dewatripont et al. (1999), equilibrium efforts are implicitly defined by the following first order condition

$$(1-SR)\mathrm{E}\left[\alpha f_{e_{A,l}}\left(\xi_{A,l}\middle|\hat{e}_{A,l}\right)\middle/ f\left(\xi_{A,l}\middle|\hat{e}_{A,l}\right)\right]\leq\left(1-(1-S)J\right)(1-K)\tilde{C}'\left(\hat{e}_{A,l}\right). \qquad (A3)$$

Again $(A3)$ holds as an equality (and thus the slackness conditions are always met). The marginal density of the observable conditional on effort $f\left(\xi_{A,l}\middle|\hat{e}_{A,l}\right)$ is proportional to $\exp\left[-\left(\xi_{A,l}-\bar{\alpha}e_{A,l}\right)^2\middle/2\left(e_{A,l}^{\exp}\sigma_\alpha\right)^2\right]$ if f is the truncated normal and equal to $\hat{e}_{A,l}f(\alpha)$ if f is one of the other distributions in the relevant class. Therefore, from the equilibrium condition $\hat{e}_{A,l}=e_{A,l}^{\exp}$, it follows that $\mathrm{E}\left[\alpha f_{e_{A,l}}\left(\xi_{A,l}\middle|\hat{e}_{A,l}\right)\middle/ f\left(\xi_{A,l}\middle|\hat{e}_{A,l}\right)\right]=\bar{\alpha}/\hat{e}_{A,l}$ and $(A3)$ rewrites as

$$(1-SR)\bar{\alpha}/\hat{e}_{A,l}=\left(1-(1-S)J\right)(1-K)\tilde{C}'\left(\hat{e}_{A,l}\right). \qquad (A4)$$

$(A2)$ and $(A4)$ clarify that: 1. Elected supervisors exert strictly greater effort than appointed ones if $f(\bar{\alpha})>1$ (which is always true under A1); 2. Supervisors' objective functions are strictly concave and the following three global comparative statics apply: $\partial\hat{e}_{i,R}/\partial R<0$, $\partial\hat{e}_{j,J}/\partial J>0,\forall j$, $\partial\hat{e}_{i,l}/\partial K>0,\partial\hat{e}_{j,l}/\partial K>0\forall i,j,l$. ■

Underinvestment When the Planner Cannot Commit

The socially optimal I minimizes the sum of investment costs and ex post costs

$$I^*\in\arg\min_{I\geq 0}\left\{I+v\left(1+\zeta(I)\right)\underline{\beta}+\left[1-v\left(1+\zeta(I)\right)\right]\bar{\beta}\right\}. \qquad (A5)$$

This amounts to saying that the objective in $(A5)$ assumes a value greater at $\hat{I}$ than at I^*; the same can be said for the objective function in (7). As a result, it follows that

$$\hat{I}+\bar{\beta}-v\left(1+\zeta\left(\hat{I}\right)\right)\Delta\beta+v\left(1+\zeta\left(\hat{I}\right)\right)\left[1-\gamma(i,j)\right]\Phi\left(\hat{\bar{a}}^{S,I}\left(\hat{I}\right)\right)-\hat{I}\geq$$

$$I^*+\bar{\beta}-v\left(1+\zeta\left(I^*\right)\right)\Delta\beta+v\left(1+\zeta\left(I^*\right)\right)\left[1-\gamma(i,j)\right]\Phi\left(\hat{\bar{a}}^{S,I}\left(\hat{I}\right)\right)-I^*\Rightarrow$$

$$v\left(\zeta\left(I^*\right)-\zeta\left(\hat{I}\right)\right)\left\{\Delta\beta-\left[1-\gamma(i,j)\right]\Phi\left(\hat{\bar{a}}^{S,I}\left(\hat{I}\right)\right)\right\}\geq 0. \qquad (A6)$$

Given that $\zeta' \geq 1/(v\Delta\beta)$, $\zeta'' < 0$ and $\lim_{I \to \bar{I}} \zeta'(I) = \infty$, the solutions to $(A5)$ and (7) are interior (so that the slackness conditions are always met) and such that

$$\left[1-\gamma(i,j)\right]\Phi\left(\hat{\tilde{a}}^{S,I}\left(\hat{I}\right)\right) = 1/v\zeta'\left(\hat{I}\right) \leq \Delta\beta = 1/v\zeta'\left(I^*\right); \qquad (A7)$$

where I have imposed the first order conditions and used, once again, the fact that $\zeta' \geq 1/(v\Delta\beta)$. Clearly $(A7)$ implies that $\zeta'\left(I^*\right) \leq \zeta'\left(\hat{I}\right) \Leftrightarrow I^* \geq \hat{I}$ (by the concavity of the ζ function). Withal, also $(A6)$ is met. ■

Proof of Proposition 3

Applying the implicit function theorem to (9) it follows that $\partial \hat{\tilde{a}}^{S,I}_{\tilde{m}} / \partial \chi_{\tilde{m}} < 0$ (which proves the second part of Proposition 3 being $\chi_R = 1 + o - \theta < \chi_D = 1 + o + \theta$) and that

$$sign\left\{\partial \hat{\tilde{a}}^{S,I}_{\tilde{m}} / \partial x_{\tilde{m}}\right\} = sign\left\{\partial \tilde{x}\left(1 + o - \chi_{\tilde{m}}\right)/\partial x_{\tilde{m}}\right\}.$$

As a result, the following two derivatives conclude the proof:

$$\partial \tilde{x}\left(1 + o - \chi_R\right)/\partial x_R = \theta\left(\rho_R - \rho_D\right) = -\theta\left(\rho_D - \rho_R\right) = \partial \tilde{x}\left(1 + o - \chi_D\right)/\partial x_D > 0\,.$$ ■

Data

The data set gathers observations for 46 states over the period 1980-1997. Only a few data points are available for the District of Columbia and no data on PBR are available for Alaska, Utah and Wyoming. No major IOUs serves Nebraska. Variables sources are:

1. Data on incentive schemes are collected directly from: A. Basheda et al. (2001); B. EEI. *Performance Based Regulation: EEI Member Survey*, mimeo, EEI, 2000.

2. Data on sales, revenue, generation shares and the price of fossil fuels (composite) per net Kwh are collected or calculated from the EEI (Edison Electric Institute) yearbook:

A. EEI. *1960 – 1992: Historical Statistics of the Electric Utility Industry*. Washington, DC: EEI, 1995.

B. EEI, (1993-1997). *Statistical Yearbook of the Electric Utility Industry*. Washington, DC: EEI.

EEI refers to the source of data for its yearbooks to various places including DOE, EIA, Federal Power Commission and FERC. EEI reports annual revenues (in dollar terms) and sales (in Kwh) by state and class of service. Residential, commercial and industrial users account for the 95 percent of revenues. EEI reports electric generation and sources of energy for generation in two types of breakdown, *i.e.*, by type of prime mover driving the generator and by energy source. The totals from the two of them are consistent. I used the second one, except for generation by hydro (see also Besley and Coate, 2003). Prices are calculated from the revenues and sales in terms of cents per Kwh.

3. Political preferences are from the CSG (Council of State Governments) yearbooks:

CSG, (1982-1997). *The Book of the States*. CSG, Lexington, KY.

4. Data on regulatory selection rules, revolving door restrictions on commissioners, bipartisanship requirements, and total budget are collected from: A. PUCs' web pages;

B. NARUC, (1982-1997). *Yearbook of Regulatory Agencies*. NARUC, Washington DC.

5. Data on judicial selection rules and length terms are collected from:

A. Hanssen, F. A. "Learning About Judicial Independence: Institutional Change in the State Courts." *Journal of Legal Studies*, 33 (2004): 431-474, table 1.

B. Besley, T., and Payne, A. "Implementation of Anti-Discrimination Policy: Does Judicial Selection Matter?" Working Papers, LSE, 2005, table 1.

6. In order to construct the fossil fuel cost index, let s_{ijt} and q_{ijt} be, respectively, the share and price of input j (coal, gas and oil) used in state i and year t. So, if $p_{it} \equiv \sum_j q_{ijt} p_{ijt} / q_{it}$ is the average price of fossil fuels (composite) per net Kwh for state i in year t, then the cost index is defined as $c_{it} = s_{it} p_{it}$.

7. State income per capita, population, proportion aged over 65 and proportion aged 5–17 are calculated from a US Census Bureau (UCB) publication:

UCB, (1980-1997). *Population Estimates Program*. Washington, DC: UCB.

8. State income per capita is collected directly from a UCB publication:

UCB, (1980-1997). *Statistical Abstract of the United States*. Washington, DC: UCB.

Tables

Table 1: Variable Names and Descriptions

	Variables	Description	Mean [Standard Deviation]
Incentive schemes:	*PBR*:	Dummy taking value 1 if in the state a PBR contract is in use; 0 otherwise.	0.080 [0.272]
	PBR_O:	Dummy taking value 3 if in the state a price cap contract is in use; 1 if cost of service is employed and 2 otherwise.	1.115 [0.416]
Supervisors' implicit incentives:	*Reg_Elec*:	Dummy taking value 1 if commissioners are elected; 0 otherwise.	0.217 [0.413]
	Bipartisan:	Dummy taking value 1 if appointed commissioners cannot all be from the same party; 0 otherwise.	0.217 [0.413]
	Jud_Elec:	Dummy taking value 1 if High Court judges are elected; 0 otherwise.	0.482 [0.500]
Supervisors' intrinsic motivations:	*Rev_Door*:	Dummy equal 1 if there is a time restriction on commissioners working for the regulated industry once they have left the PUC; 0 otherwise.	0.652 [0.477]
	Jud_Term:	Length of High Court judges' term in years.	8.761 [3.082]
Political competition:	*Majority*:	Percentage of seats (averaged across upper and lower houses) held by the majority party.	0.651 [0.118]
Supervision technology:	*Budget*:	PUC's total receipts in thousands of dollars.	18382.94 [34828.78]
	Industrial:	Percentage of revenue from sales to customers that are industrial.	0.292 [0.087]
Interest groups:	*Gen_Nucl*:	Percentage of total generation from nuclear sources.	0.194 [0.211]
Prices:	*Price_R*:	Revenue (cents per Kwh) from sales to residential users.	7.595 [2.109]
	Price_R(-2):	*Price_R* lagged two years.	7.241 [2.082]
	Price_C:	Revenue (cents per Kwh) from sales to commercial users.	6.897 [1.803]
	Price_I:	Revenue (cents per Kwh) from sales to industrial users.	4.918 [1.526]
Average costs:	*c*:	Cost of fossil fuels (in cents per Kwh).	1.233 [0.940]
Investment concerns:	*Rep*:	Dummy taking value 1 if both houses are controlled (with the absolute majority of seats) by the Republican party; 0 otherwise.	0.365 [0.482]
Other controls:	*PBR_Nei*:	Share of neighbouring states using PBR.	0.075 [0.150]
	Pop:	State population.	5,318,228 [5,476,011]
	Old:	Percentage of population aged 65 and over.	0.126 [0.017]
	Young:	Percentage of population aged 5–17.	0.188 [0.015]
	GSP:	Gross state product per capita in dollars.	15975.28 [5369.74]

Table 2: Non Random Incentive Schemes Selection

	(1)	(2)	(3)
	Dependent Variable		
	PBR_O	*PBR_O = 3*	*PBR*
Reg_Elec	2.033 [0.402]***	0.043 [0.012]***	4.230 [2.852]**
Bipartisan	– 0.482 [0.514]	– 0.004 [0.004]	0.994 [0.682]
Jud_Elec	0.566 [0.357]†	0.006 [0.004]†	1.102 [0.822]
Rev_Door	– 0.851 [0.334]**	– 0.010 [0.005]**	0.908 [0.557]
Jud_Term	– 0.060 [0.057]	– 0.0006 [0.0006]	1.049 [0.088]
Majority	1.904 [1.481]†	0.020 [0.015]†	14.022 [46.512]
Budget	0.00002 [4.69e^{-06}]***	2.38e^{-07} [0.00000]***	1.00002 [4.03e^{-06}]***
Industrial	– 3.305 [2.539]†	– 0.034 [0.030]†	0.001 [0.004]*
Gen_Nucl	– 0.219 [1.004]	– 0.002 [0.010]	0.312 [0.562]
Price_R(-2)	0.703 [0.128]***	0.007 [0.002]***	1.370 [0.217]**
Rep	0.035 [0.354]	0.0004 [0.004]	0.573 [0.353]
PBR_Nei	1.360 [1.038]†	0.014 [0.012]	18.811 [27.334]**
Estimation	Ordered logit.		Exponential survival.
Log Likelihood			– 24.169
Log Pseudolikelihood	– 187.493		
Pseudo R^2	0.24		
Number of Observations	736		692

Notes: 1. Robust standard errors (z distribution) in columns (1) and (2) parentheses; standard errors in column (3) parentheses;
2. *** denotes significant at the 1% confidence level; **, 5%; *, 10%; †, 20%;
3. The entries in column (2) are hazard ratio estimates.

Table 3: Effects of PBR on Regulated Rates

	(1)	(2)	(3)
	Dependent Variable		
	Price_R	*Price_C*	*Price_I*
PBR	0.163 [0.234]	– 0.074 [0.159]	0.115 [0.140]
Other Controls	*Reg_Elec*, *Jud_Elec*, *Majority*, *Budget*, *Industrial*, *Gen_Nucl*, *Rep*, *Pop*, *Young*, *Old*, *GSP*.		
Predetermined	*Lagged dependent variable*		
Endogenous	*c*, *PBR*		
Instruments (collapsed)	*One lag of predetermined and of c*, *PBR_N*		
Estimation	Fixed state and time effects difference GMM estimator.		
Instruments count	30	30	30
Autocov. of order 2	0.84	0.33	0.61
Hansen test for overid. restrictions	0.89	0.42	0.66
Number of observations	644	644	644

Notes: 1. Standard errors in parentheses;
2. *** denotes significant at the 1% confidence level; **, 5%; *, 10%; †, 20%.

NOTE DI LAVORO DELLA FONDAZIONE ENI ENRICO MATTEI

Fondazione Eni Enrico Mattei Working Paper Series

Our Note di Lavoro are available on the Internet at the following addresses:

http://www.feem.it/Feem/Pub/Publications/WPapers/default.htm
http://www.ssrn.com/link/feem.html
http://www.repec.org
http://agecon.lib.umn.edu
http://www.bepress.com/feem/

NOTE DI LAVORO PUBLISHED IN 2008

CCMP	1.2008	*Valentina Bosetti, Carlo Carraro and Emanuele Massetti*: Banking Permits: Economic Efficiency and Distributional Effects
CCMP	2.2008	*Ruslana Palatnik and Mordechai Shechter*: Can Climate Change Mitigation Policy Benefit the Israeli Economy? A Computable General Equilibrium Analysis
KTHC	3.2008	*Lorenzo Casaburi, Valeria Gattai and G. Alfredo Minerva*: Firms' International Status and Heterogeneity in Performance: Evidence From Italy
KTHC	4.2008	*Fabio Sabatini*: Does Social Capital Mitigate Precariousness?
SIEV	5.2008	*Wisdom Akpalu*: On the Economics of Rational Self-Medication
CCMP	6.2008	*Carlo Carraro and Alessandra Sgobbi*: Climate Change Impacts and Adaptation Strategies In Italy. An Economic Assessment
ETA	7.2008	*Elodie Rouvière and Raphaël Soubeyran*: Collective Reputation, Entry and Minimum Quality Standard
IEM	8.2008	*Cristina Cattaneo, Matteo Manera and Elisa Scarpa*: Industrial Coal Demand in China: A Provincial Analysis
IEM	9.2008	*Massimiliano Serati, Matteo Manera and Michele Plotegher*: Econometric Models for Electricity Prices: A Critical Survey
CCMP	10.2008	*Bob van der Zwaan and Reyer Gerlagh*: The Economics of Geological CO_2 Storage and Leakage
KTHC	11.2008	*Maria Francesca Cracolici and Teodora Erika Uberti*: Geographical Distribution of Crime in Italian Provinces: A Spatial Econometric Analysis
KTHC	12.2008	*Victor Ginsburgh, Shlomo Weber and Sheila Weyers*: Economics of Literary Translation. A Simple Theory and Evidence
NRM	13.2008	*Carlo Giupponi, Jaroslav Mysiak and Alessandra Sgobbi*: Participatory Modelling and Decision Support for Natural Resources Management in Climate Change Research
NRM	14.2008	*Yaella Depietri and Carlo Giupponi*: Science-Policy Communication for Improved Water Resources Management: Contributions of the Nostrum-DSS Project
CCMP	15.2008	*Valentina Bosetti, Alexander Golub, Anil Markandya, Emanuele Massetti and Massimo Tavoni*: Abatement Cost Uncertainty and Policy Instrument Selection under a Stringent Climate Policy. A Dynamic Analysis
KTHC	16.2008	*Francesco D'Amuri, Gianmarco I.P. Ottaviano and Giovanni Peri*: The Labor Market Impact of Immigration in Western Germany in the 1990's
KTHC	17.2008	*Jean Gabszewicz, Victor Ginsburgh and Shlomo Weber*: Bilingualism and Communicative Benefits
CCMP	18.2008	*Benno Torgler, María A.GarcíaValiñas and Alison Macintyre*: Differences in Preferences Towards the Environment: The Impact of a Gender, Age and Parental Effect
PRCG	19.2008	*Gian Luigi Albano and Berardino Cesi*: Past Performance Evaluation in Repeated Procurement: A Simple Model of Handicapping
CTN	20.2008	*Pedro Pintassilgo, Michael Finus, Marko Lindroos and Gordon Munro* (lxxxiv): Stability and Success of Regional Fisheries Management Organizations
CTN	21.2008	*Hubert Kempf and Leopold von Thadden* (lxxxiv): On Policy Interactions Among Nations: When Do Cooperation and Commitment Matter?
CTN	22.2008	*Markus Kinateder* (lxxxiv): Repeated Games Played in a Network
CTN	23.2008	*Taiji Furusawa and Hideo Konishi* (lxxxiv): Contributing or Free-Riding? A Theory of Endogenous Lobby Formation
CTN	24.2008	*Paolo Pin, Silvio Franz and Matteo Marsili* (lxxxiv): Opportunity and Choice in Social Networks
CTN	25.2008	*Vasileios Zikos* (lxxxiv): R&D Collaboration Networks in Mixed Oligopoly
CTN	26.2008	*Hans-Peter Weikard and Rob Dellink* (lxxxiv): Sticks and Carrots for the Design of International Climate Agreements with Renegotiations
CTN	27.2008	*Jingang Zhao* (lxxxiv): The Maximal Payoff and Coalition Formation in Coalitional Games
CTN	28.2008	*Giacomo Pasini, Paolo Pin and Simon Weidenholzer* (lxxxiv): A Network Model of Price Dispersion
CTN	29.2008	*Ana Mauleon, Vincent Vannetelbosch and Wouter Vergote* (lxxxiv): Von Neumann-Morgenstern Farsightedly Stable Sets in Two-Sided Matching
CTN	30.2008	*Rahmi İlkiliç* (lxxxiv): Network of Commons
CTN	31.2008	*Marco J. van der Leij and I. Sebastian Buhai* (lxxxiv): A Social Network Analysis of Occupational Segregation
CTN	32.2008	*Billand Pascal, Frachisse David and Massard Nadine* (lxxxiv): The Sixth Framework Program as an Affiliation Network: Representation and Analysis
CTN	33.2008	*Michèle Breton, Lucia Sbragia and Georges Zaccour* (lxxxiv): Dynamic Models for International Environmental Agreements

(lxxxiv) This paper was presented at the 13th Coalition Theory Network Workshop organised by the Fondazione Eni Enrico Mattei (FEEM), held in Venice, Italy on 24-25 January 2008.