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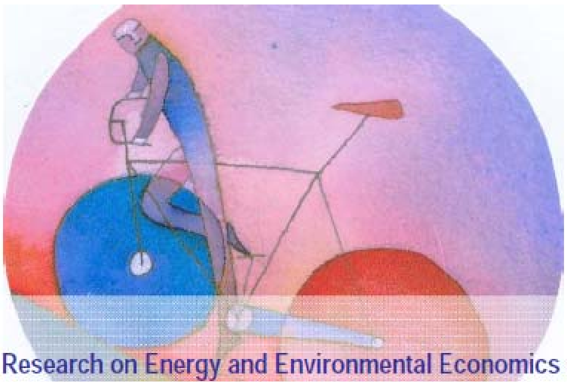

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The Political Economy of (De)Regulation: Theory and Evidence from the U.S. Electricity Market.*

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Abstract

The decision to introduce competition into regulated industries is a key issue in economics. Provided that demand is sufficiently inelastic, competition assures lower allocative distortions at the cost of weaker cost-reducing investment incentives via lower profits. Hence, deregulation is more likely where the extent of asymmetric information under regulation is more limited, cost reduction less socially salient and the political power of consumers stronger. This prediction is consistent with U.S. electricity market data. During the 1990s, restructuring was enacted where generation costs were historically lower and politicians had weaker pro-shareholder attitudes. Also, instrumental variables estimates show that restructuring has delivered a medium-term cost-reduction greater than that documented by previous analyses.
Keywords: Regulation; Competition; Electricity; Accountability.
JEL classification: L11; L51; L94; P16.

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1 Introduction

Economists have long maintained that if competition assures allocative efficiency, regulation could be better suited to incentivate the firm's cost-reducing investment. Hence, a benevolent government should choose between competition and regulation optimally trading off allocative distortions and investment inducement. Yet, market institutions are designed by more or less pro-shareholders politicians and the extent of asymmetric information is a function of the activity of regulators accountable to special interest groups and not to the society at large. How, therefore, do politicians' and regulators' incentives shape the allocative distortions-investment inducement trade off when market conducts are chosen?

This paper lays out a theoretical framework for thinking about this issue, and explores its empirical implications using U.S. electricity data. In the model, I build on a wide literature on incentives and competition (see Armstrong and Sappington, [2006]), and I compare two market institutions in a world in which the demand is inelastic and the firms can commit a cost-reducing investment before privately learning their cost. Under the first institution, two firms compete a' la Bertrand serving all the market at the price offered by the opponent when able to undercut it and splitting it when proposing the same price. Under the second, only one firm is regulated by exploiting the revelation principle (Laffont and Tirole, 1993). The model shows that regulation delivers a higher ex ante expected rent and, in turn, stronger incentives to invest. Hence, competition is more likely to be chosen when society is less concerned about cost-reducing investments and the extent of asymmetric information is more limited. If, instead, investment boosts mainly the firm's profits, a tension between consumers and shareholders arises and competition is more likely to be adopted when the political power of consumers is stronger. Also, being competition better suited to serve static efficiency—i.e., deliver milder allocative distortions—at the cost of a lower dynamic one—i.e., incentivate cost-reducing investment, the relation between the expected cost and market conducts is undecided. The model brings similar results under Cournot competition.

In order to test these predictions, I look at the restructuring of the U.S. electricity market. I analyze a panel of 503 plants owned by investor owned utilities—IOUs hereafter—operating in 43 states over the period 1981 to 1999. Until the beginning of the 1980s, Public Utility Commissions—PUCs hereafter—have set prices in order to assure a specific return on investment after recouping all operating costs recognized as reimbursable during rate reviews. After a phase of experimentation with incentive rules headed to severe the price-cost link and communicate stronger incentives to minimize costs, more radical reforms were enhanced in the mid-1990s. As a result, in many states IOUs own now only a small fraction of the total generation capacity and retail rates follow the prices clearing auction-based wholesale markets (Fabrizio, Rose and Wolfram, 2007). Consistent with the model, deregulation was enhanced in states where generation costs were historically lower and politicians had weaker pro-shareholder attitudes. Also, taking into full consideration that regulatory reforms depends on technological and political forces suggests that OLS overestimate the strong negative effect of deregulation on labor and fuel inputs. Given that the new generating capacity entered service in the last two decades was built mainly by firms not subject to restructuring (Joskow, 2008), the paper's evidence suggests that competition assures that the firm with the most efficient technology serves the market for a given cost distribution but that the latter will be more favorable under regulation. Hence, it should not strike as strange that several of the states that restructured prior to 2001 are now "re-regulating" their markets.

Even if several studies (Aghion et al., 2005; Alesina et al, 2005; Bushnell and Wolfram, 2005; Zhang, 2007; Fabrizio, Rose and Wolfram, 2007; Parker, Kirkpatrick and Zhang, 2008; Craig and Savage, 2010) have used electricity data to show that deregulation can deliver lower input uses and costs, no previous paper has evaluated the determinants of its introduction. To this extent, the main contribution of this work is to formalize and test a property rights—on sunk investments—theory of "endogenous market institutions".[1] In this perspective, the paper is complementary to a recent lively literature that see the rise of the regulatory state as a response to the risk that the majority of market participants is coerced by a subgroup of more powerful special interests (Glaeser and Shleifer, 2003) or of similarly powerful untrustworthy agents (Aghion et al., 2009; Pinotti, 2010).[2] The rest of the paper is organized as follows. Section 2 describes the role of the public officials involved in the U.S. electricity market institutional reform process as an example of the setting studied in the model. Section 3 illustrates the basic static versus dynamic efficiency trade off solved by society when designing market institutions. Section 4 evaluates the role of regulators' and politicians' incentives. Section 5 states the predictions which are tested in section 6; section 7 concludes. The appendix gathers proofs, tables and a detailed data description.

2 Institutions

Regulatory reforms in the U.S. electricity market: firms', regulators' and politicians'

[1] Recent works (Teske, 2004; Duso and Röller, 2003; Knittel, 2006; Zhang, 2007; Craig and Savage, 2010) provide empirical evidence but no formal theoretical explanation of the relevance for regulatory reforms of the forces discussed here. Two exceptions are Guerriero (2010a) and Benmelech and Moskowitz (2010). This last work shows that the extent of financial regulation falls with its costs and the political power of wealthy incumbents, who are faced with the chance of restricting political entry by applying restrictions on lending.

[2] The present paper also sheds light on the beginning of the 20th century reforms from a municipal regulation with its typical hold-up problems to a state regulation assuring a fair rate of return on investment. Indeed, as documented by Knittel (2006), these regulatory moves were more likely in states characterized by more severe capacity shortages and lower residential penetration rates.

incentives.—As anticipated above, restructuring initiatives have fundamentally changed the way plant owners earn revenues. At the wholesale level, plants sell through either newly created spot markets or long-term contracts based on expected spot prices. In the spot markets, plant owners submit bids indicating the prices at which they are willing to supply power. The dispatch order is set by the bids, and the bid of the marginal plant is paid to all plants that are dispatched. High-cost plants will be forced down in the dispatch order, reducing expected revenues. The details of this initiatives and, in particular, whether to disintegrate the firm, whether to participate in a pool of wholesale markets, and the duration of each deregulation phase were decided during rate reviews (Shumilkina, 2009). The latter can be triggered by the IOUs in response to cost shocks, initiated periodically by the PUC or, often, required by the state government in order to assure that a particular reform is implemented (EIA, 2003). All the interested parties—i.e., the firms, consumer advocates, and the media—participate to these quasi-judicial hearings which are presided by the commissioners, who also examine experts and collect the evidence. Given the media interest in the evolution of the rate reviews, this information gathering activity is the key task over which commissioners are selected (Gormley, 1983; Friedman, 1991).

From institutions to theory.—Inspired by such institutional design, I assume that the choice between competition and regulation is taken by a planner who weighs the firm's utility more the more salient cost-reducing investments are for society. Also, when investment are not in the interest of consumers, the weight on the firm's utility is higher when the political power of shareholders is stronger. This setting captures the fact that, even if during the hearings the widest consensus among parties is needed, politicians can bias the institutional choice in order to favor their constituency. The pricing rule under regulation can be contingent on a signal whose observable precision increases with the effort exerted by a regulator. Should the latter be the case, the regulator is rewarded on the basis of such precision.

3 Static Versus Dynamic Efficiency

The model builds on Laffont and Tirole (1993), and Armstrong and Sappington (2006). First, I compare competition and regulation in a world in which the firm can sink cost-reducing investments before observing its production efficiency and the regulator acts as perfect agent of society. This exercise stresses the relation between dynamic inconsistency in investment and deregulation. Next, I will evaluate the role played by the regulator's career concerns and the preferences of the politicians who design market institutions.

Preliminaries.—The representative demand for the homogeneous good is $q(p) > 0$ for $p \in [0, \bar{p})$ and 0 for $p \geq \bar{p}$ with $q'(p) < 0$ for $p \in [0, \bar{p}]$. Both $q(p)$ and p are common knowledge. Production is assured by either one regulated firm or two competitive ones. The marginal and average cost c_i equals either c_L or $c_H < \bar{p}$ with the same probability and $\Delta \equiv c_H - c_L > 0$. While the cost distribution is common knowledge, the realization of c_i is private information of the firm. Should the correlation between types be positive or the probability of having low cost be generic, none of the model's results would be affected (see footnote 8 and 10).

Firms maximize the rent, U_i, which is the sum of the profits $\pi(p, c_i) \equiv q(p)(p - c_i)$ and a transfer $t \geq 0$ which can be positive only under regulation. The social welfare is given by the consumer gross surplus $S(p) = \int_p^{\bar{p}} q(x)\,dx$ plus $\alpha \in [0, 1)$ times the firm's rent minus the transfer evaluated at the shadow cost of public funds $1 + \lambda > 1$: $[S(p) + \alpha U - (1 + \lambda)t]$. Two are the key features of this welfare function. First, the assumption that society values consumer welfare at least as much as that of shareholders can be justified by the fact that consumers are less wealthy ad can be relaxed provided that $\lambda \geq \alpha \geq 1$ (see Armstrong and Sappington, [2007]). Second, a transfer t reduces the social welfare by $(1+\lambda)\,t$ because it is financed through distortionary taxes. Should the regulated firm be private, as in the market studied below, only the model's interpretation would change: i.e., t would represent the firm manager's reward and λ the shadow cost of the managerial moral hazard constraint (see Joskow and Schmalensee, [1986]). The expected social welfare function is strictly concave and the demand is inelastic as in the empirically relevant case; this amounts to require that:

A1: *The demand satisfies* $q''(p)(\bar{p} - c_L) + q'(p) < 0$ *and* $\varepsilon_{p,q} = -q'(p)\,p/q(p) < 1$.

The timing.—The design of institutions and production proceed according to this time line:

$t = 1$.—The planner chooses between regulation and competition on the basis of the sum of the expected welfare and a mean zero shock δ to her preferences for regulation; δ is distributed according to the density f on the support $[-\infty, \infty]$. If regulation is chosen, a regulator, who acts as a perfect agent of the planner, offers the monopoly a menu of (t_i, p_i) pairs conditional on the firm's report of its type but not on eventual investments.

$t = 2$.—Each firm eventually commits an unobservable investment I which, at the cost $\psi(I)$, increases the probability of c_L to $(1+I)/2$. The firms' investment choice is contemporaneous under competition. The function $\psi(\cdot)$ is increasing, strictly convex and such that $\psi(0) = 0$, $\psi(I) > 0$ for all $I > 0$ and $\lim_{I \to 1} 2\psi'(I) \geq S(c_L) - S(c_H)$.[3]

$t = 3$.—Each firm only discovers the realizations of c_i.

$t = 4$.—Under regulation the planner asks the firm to report c_i and the corresponding contract is executed. Under competition each firm bids a price and the firm with the lowest

[3]Such investment technology has been extensively studied within both regulated (Laffont and Tirole, 1993) and competitive (Raith, 2003; Baggs and de Bettignies, 2007; Vives 2008) environments.

bid serves the whole market at the price played by the opponent. If the two bids are equal, the market is evenly split. Clearly, the equilibrium is the same as under symmetric information.[4]

In interpreting the generality of the foregoing, several observations should be borne in mind. First, the shock δ captures the existence of determinants of regulation unrelated to technological and political forces (Glaeser and Shleifer, 2003; Aghion et al., 2009; Pinotti, 2010). Second, because the firm's cost-reducing investments are financed by the expected rent, α is a measure of society's dynamic efficiency concerns. Third, the assumption that the regulator is benevolent and that the planner cannot commit to reimburse investment expenses can be relaxed as explained in subsection 4.3. Finally, I focus on Bertrand competition because, as discussed above, this conduct bears the closest resemblance to the U.S. electricity market institutions. Cournot competition is discussed in subsection 4.3.

Regulating a monopoly with unknown costs.—Under regulation, the planner grants a reservation wage of 0 to the regulator and a legal monopoly to one firm.[5] The regulator exploits the revelation principle (Myerson, 1979) and announces that she will set price p_i and deliver a transfer t_i whenever the report is c_i. Because the planner dislikes leaving a positive rent to the firm and prefers to let both firms produce,[6] the equilibrium envisions a binding low cost firm's incentive compatibility constraint—i.e., $q(p_L)(p_L - c_L) + t_L = q(p_H)(p_H - c_L) + t_H$—and a binding high cost firm's individual rationality constraint—i.e., $U_H = 0$. While the former

[4]The interaction is strategically similar to a second price auction. Thus, exploiting the revelation principle, both types find optimal truthtelling. Moreover, reporting the truth not only exhausts the low cost firm's incentive to undercut an opponent with the same type but also maximizes its profit when facing a different type because the marginal revenues fall with the prevailing price under assumption A1.

[5]The planner could auction this right. As discussed in footnote 19 such eventuality changes some of the model's results; yet, this mechanism has never been used in the market studied in the empirical section.

[6]This is always the case whenever the planner, if indifferent between giving up production by the c_H type and offering a contract to both types, inclines for the second option. Indeed, the planner will never strictly prefer the first option for every probability $(1+v)/2$ of $c = c_L$ and every $\bar{p}$ because $(1-v)\,S(\hat{c}_H(v)) \geq 0$.

assures that a low cost firm truthfully reports its type, the second implies that a high cost firm operates. The low cost firm enjoys a rent $U_L = \Delta q(p_H) > 0$ and, for a given equilibrium investment $\hat{I}^R$ and with $w_i(p_i, c_i) = S(p_i) + (1+\lambda)\pi_i(p_i, c_i)$, the planner maximizes

$$W^R = (1/2)\left(1+\hat{I}^R\right)[w_L(p_L, c_L) - (1+\lambda-\alpha)\Delta q(p_H)] + (1/2)\left(1-\hat{I}^R\right)w_H(p_H, c_H).$$

Differentiating this expression with respect to $p_L \geq 0$ and $p_H \geq 0$ reveals that the high cost firm's allocation is distorted in such a way that the regulator is able to achieve the exact level of expected welfare were the firm's costs observable but the high marginal cost equal to $\hat{c}_H \equiv c_H + \left(1+\hat{I}^R\right)\left(1-\hat{I}^R\right)^{-1}\left[1-\alpha(1+\lambda)^{-1}\right]\Delta > c_H$.[7] While the regulator increases p_H over c_H and reduces t_H in order to limit the informational rent, she does not distort the firm's activities when the report is c_L because there is no incentive to misreport. The equilibrium is achieved through the Ramsey price obtained maximizing $w_L(\cdot)$ for cost c_L and $w_H(\cdot)$ for cost $\hat{c}_H$. Thus, the regulator fixes $p_L = c_L$ and $p_H = \hat{c}_H$ (the monopolist price) when λ is zero (large) because transfers entail no social costs (large distortions).

Competition.—Given an equilibrium investment profile $\hat{I}^C$, the price will be c_H except when both firms have low cost. The firm's rent is positive and, in particular, equal to $\Delta q(c_H)$ only when it has the low marginal cost while its rival has the high one. The latter happens with probability $(1/4)\left[1-\left(\hat{I}^C\right)^2\right]$. Hence, the expected social welfare under competition is:

$$W^C = \frac{\left(1+\hat{I}^C\right)^2}{4}S(c_L) + \frac{\left(1-\hat{I}^C\right)^2+2-2\left(\hat{I}^C\right)^2}{4}S(c_H) + \frac{1-\left(\hat{I}^C\right)^2}{2}\alpha\Delta q(c_H).$$

3.1 *Comparison*

For simplicity, I look at symmetric investment profiles under competition (see Vives, [2008]), and I maintain in the following that λ equals 0: this last assumption is relaxed in section

[7] For $c = c_L$, the necessary and sufficient first order condition is $(1+\lambda)[q'(p_L)(p_L - c_L) + q(p_L)] = q(p_L)$.

4. The firm chooses $\hat{I}^j$ with $j \in \{R, C\}$ to maximize expected rents minus investment costs. Under regulation, this means solving the strictly concave program

$$\hat{I}^R = \arg\max_{I \geq 0} (1/2)(1+I)\Delta q\left(\hat{c}_H\left(\hat{I}^R\right)\right) - \psi(I) \tag{1}$$

with $\hat{c}_H \equiv c_H + \left(1+\hat{I}^R\right)\left(1-\hat{I}^R\right)^{-1}(1-\alpha)\Delta$. Under competition, instead, the firm solves:

$$\hat{I}^C = \arg\max_{I \geq 0} (1/4)(1+I)\left(1-\hat{I}^C\right)\Delta q(c_H) - \psi(I). \tag{2}$$

The appendix shows that: 1. both I^R and I^C are positive and strictly lower than the socially optimal investment level $I^* < 1$; 2. the extent of underinvestment is wider under competition. In this last case, the firm obtains a positive rent on a larger demand but less often: in particular, half of the time when $I^C = I^R = 0$. Yet, whenever the demand is inelastic, the higher probability of rents, which is a price effect, more than compensates the fall in demand, which is a quantity one, and $I^R > I^C$. Also, underinvestment is worsened under Bertrand competition due to the mix of the positive correlation between types introduced by the investment technology, and the strategic complementarity between firms' pricing decisions.[8] In $t = 1$ competition is chosen when $W^C > W^R + \delta$ that, for $\delta = 0$, rewrites as:

$$\begin{aligned} 2\left(1-\hat{I}^R\right)\left[S(c_H) - S(\hat{c}_H)\right] + 2\left[1-\left(\hat{I}^C\right)^2\right]\alpha\Delta q(c_H) > \\ \left[1+2\left(\hat{I}^R-\hat{I}^C\right)-\left(\hat{I}^C\right)^2\right]\left[S(c_L)-S(c_H)\right]. \end{aligned} \tag{3}$$

[8]The firm's incentive to invest are maximized when there is no ex post correlation between types for $\hat{I}^C = 0$ and minimized when such correlation becomes maximal for $\hat{I}^C = 1$. Should the ex ante correlation between types be positive and equal to ρ, the model's results would survive because the rent will decrease with ρ.

For $I^C = I^R = 0$ the comparison in (3) can be restated in the following form

$$\frac{1}{2}\left[\frac{S(c_L)+S(c_H)}{2} - \frac{S(c_L)+S(\hat{c}_H)}{2}\right] > \frac{1}{2}\left\{\frac{S(c_L)+S(\hat{c}_H)}{2} - \left[S\left(c_H\right) + \alpha\Delta q\left(c_H\right)\right]\right\}.$$

As this last inequality shows, in the absence of investment concerns competition always outperforms regulation if the firms have the same type (see the left hand side); when however the types are different, regulation could deliver a lower mean price when the demand is sufficiently elastic and α is small (see the right hand side). Also for $I^C = I^R = 0$, a rise in α undoubtedly enhances the likelihood that competition is adopted because it increases more the expected rent under competition than it curbs the distortions under regulation.[9]

This comparison changes dramatically when investments are considered. In this case, a rise in α not only increases the dynamic advantage of regulation but also have a double countervailing impact on allocative distortions: the latter are relaxed due to the higher social value of investment inducement but are also strengthen because of the more favorable distribution of types. As the appendix shows, the last indirect effect is smaller than the rise in the dynamic advantage and, provided that the investment is sufficiently effective, the fall in allocative distortion due to the higher investment concerns overcomes the increased value of the firm's rent under competition and the probability of adopting regulation rises with α. I will assume the following which can be relaxed at the cost of more cumbersome algebra:

A2: $\psi'\left(1/2\right) \leq \left(\Delta/8\right) q\left(c_H\right)$.

Taking the derivatives of both sides of the inequality in (3) implies the following:[10]

Proposition 1: *Under assumptions A1 and A2, the probability of competition is chosen*

[9] This is because $\Delta\left(q\left(c_H\right) - q\left(\hat{c}_H\right)\right) > 0$. Notice that, in this case, provided that $2\left[S\left(c_H\right) - S\left(\hat{c}_H\right)\right] > S\left(c_L\right) - S\left(c_H\right)$, competition will outperform regulation for every value of α.

[10] Clearly the pattern summarized in proposition 1 as well those discussed in the remaining part of the theoretical section hold true when the probability of $c = c_L$ is equal to the generic value $(1+v)/2$; should the latter be the case, $\hat{c}_H$ would equal $c_H + \left(1+\hat{I}^R\right)\left(1-\hat{I}^R\right)^{-1}\left(1+v\right)\left(1-v\right)^{-1}\left(1-\alpha\right)\Delta$.

falls with the society's investment concerns α.

This belongs to a series of findings showing that institutions curbing rent-extraction could be optimal if expropriation of sunk investments is an issue. While, for instance, Sappington (1986) focuses on institutions preventing the planner from observing the firm's true costs, Guerriero (2010b) shows that appointment rules limiting the regulator's incentive to provide information on the firm's true cost are found where investment shortages are more dramatic.

4 Information and Politics

Crucially, the model shows that the possibility of committing cost-reducing investments make regulation more useful transforming the planner's choice into a trade-off between static and dynamic efficiency. The more investment concerned she is—because, for instance, past costs have been persistently high or higher than those in neighboring regions—the lower is the probability of adopting competition. Yet, this statement needs to be qualified. Indeed, regulation is appealing as long as the asymmetry in information is sufficient to justify the wider allocative distortions. Moreover, the dynamic advantage of regulation will not be in the interest of society at large when investment increases mainly the ex post rent of the firm without affecting the net consumer welfare. In the following I discuss the two points and to what extent the basic model is robust to alternative assumptions.

4.1 *Capture and Regulators' Implicit Incentives*

As seen above, top-level regulators respond to implicit incentives and not to performance-based contracts and, in the case of the market studied in the empirical section below, they are simply either elected or appointed on the base of their information-gathering effort. Building on these observations, I consider the following information gathering technology. In $t = 1$ the planner directly offers the firm a menu of (t_i, p_i) pairs conditional on the firm's report and the realization of a signal on c_i that she observes between $t = 3$ and $t = 4$. The signal is such that, if $c = c_L$, with probability $\gamma \in [0, 1]$ the planner sees c_L and implements the full information contract and with probability $1 - \gamma$ she remains uninformed. If $c = c_H$, she remains uninformed throughout. Whenever uninformed she asks the firm to report its type. The observable precision has technology $\gamma_s = \theta e_s$ where $\theta \in [0, 1]$ is the regulator's random ability, $e_s \in [0, 1]$ the information gathering effort, and $s = \{E, A\}$ the type of implicit incentives to which the regulator is subject to.[11] The ability θ has mean $\bar{\theta}$ and is drawn from a truncated normal density g with $g\left(\bar{\theta}\right) > 1$. This last hypothesis assures that the probability of drawing a regulator with ability lower than the mean is not too low which is always the case when the talent distribution is not too disperse.[12]

The regulator selects effort after $t = 3$, next Nature chooses θ, then the signal is observed by the planner, finally the precision γ_s is revealed and the regulator rewarded on its base. The regulator's objective function is $B + \tau [T(e_s) - C(e_s)]$ where τ measures the value of the net implicit rewards relative to the bribes B offered by the firm. The effort cost function is such that $C(0) = 0$, $C' > 0$, $C'(0) < \infty$, $C'' > 0$, $\lim_{e_s \to 1} C'(e_s) = \infty$. As suggested by Alesina and Tabellini (2007), while elected officials are held accountable by voters, appointed ones are career concerned. In particular, elected regulators want to maximize the probability that

[11] Even if under different information structures allocative distortions can rise with the precision of the signal (see Boyer and Laffont, [2003]), only the actual one matches the institutions of the market studied below: there, the hearings are aimed at proving that the firm has low costs and prices should not be adjusted.

[12] This is a mild requirement in the market studied below being the regulators' biographies very similar (Gormley, 1983). Guerriero (2010a, b) shows that this section's message would be unaffected should: 1. the precision be unobservable; 2. the precision technology be linear; 3. the regulator care also about social welfare.

the realized precision is higher than the one obtained by an incumbent with mean ability $\bar{\theta}$ so that $T^E(e_E) = \Pr\left\{e_E \geq \bar{\theta} e^{\exp}\right\}$ where $e^{\exp}$ is the voters' expectation over effort. Appointed regulators, on the other hand, want to maximize society's perception of their ability given the precision's realization or $T^A(e_A) = \mathrm{E}_\theta\left[E_\theta\left(\theta \left|\gamma_A, e_A{}^{\exp}\right.\right)\right]$ where $\mathrm{E}_\theta[\cdot]$ denotes the regulator's unconditional expectation over γ_A and E_θ society's expectation over θ conditional on γ_A.

For a given equilibrium effort $\hat{e}_s$, the evaluators estimate θ as $\xi_s/\hat{e}_s$ which implies that a rise in effort delivers marginal benefits $\bar{\theta}/\hat{e}_A$ under appointment and $g\left(\bar{\theta}\right)\left(\bar{\theta}/\hat{e}_E\right)$ under election.[13] Differently from the case of appointment, under election the effect of a rise in effort on the estimated talent is multiplied also by the impact of a change of the estimated talent on the probability of re-election: this last marginal effect is $g\left(\bar{\theta}\right)$. The higher the latter is the more effective is effort in swaying votes and assuring a higher probability of victory. When $g\left(\bar{\theta}\right)$ is greater than one, election leads to a higher equilibrium effort. This pandering incentive effect of election is complementary to the selection one proposed by Besley and Coate (2003) but, differently from the latter, it survives when the regulator can divert effort from information gathering to a less socially relevant task in exchange for bribes. Indeed, as shown in Guerriero (2010b), to preserve implicit incentives she will never exert effort only in the socially irrelevant task.[14] Thus, $\gamma_E > \gamma_A$ and the impact of a reform from appointment to election on the planner's institutional choice is isomorphic to the one of a rise in the precision γ. In the supervision regime—notice the apex S, expected social welfare is now

$W^{R,S} = \frac{1+\hat{I}^{R,S}}{2}\left\{\gamma S\left(c_L\right) + (1-\gamma)\left[S\left(c_L\right) - (1-\alpha)\,\Delta q\left(\hat{c}_H^S\right)\right]\right\} +$

[13]While the marginal benefit of effort always falls with $\hat{e}_s$, the marginal cost of effort is decreasing: this implies that here the solution to the regulator's problem is unique and interior (see Guerriero, [2010b]).

[14]Guerriero (2010b) shows also that, when the regulator directly observes the signal, she will truthfully reports her information whenever implicit incentives are sufficiently important—i.e., τ is sufficiently high. This collusion-proofness property squares with broad evidence on the limited role of capture in the U.S. electricity market (see the study on pricing by Leaver [2009] and that on the rise of state regulation by Knittel [2006]).

$$\frac{1-\hat{I}^{R,S}}{2}\left\{S\left(\hat{c}_H^S\right)+\left(\hat{c}_H^S-c_H\right)q\left(\hat{c}_H^S\right)\right\}=\frac{1+\hat{I}^{R,S}}{2}S\left(c_L\right)+\frac{1-\hat{I}^{R,S}}{2}S\left(\hat{c}_H^S\right),$$

where $\hat{c}_H^S \equiv c_H + \frac{1+\hat{I}^{R,S}}{1-\hat{I}^{R,S}}\left(1-\gamma\right)\left(1-\alpha\right)\Delta$. The planner's choice is described by inequality (3) with $\hat{c}_H^S$ in the place of $\hat{c}_H$ and the equilibrium investment under regulation is given by:

$$\hat{I}^{R,S} = \arg\max_{I\geq 0}\left(1/2\right)\left(1+I\right)\left(1-\gamma\right)\Delta q\left(\hat{c}_H^S\left(\hat{I}^{R,S}\right)\right)-\psi\left(I\right). \tag{4}$$

As shown in the appendix, under assumption A1, a more precise signal crowds out ex ante investment incentives; as a result, on one hand, regulation becomes less efficient in insulating the firm from ex post expropriation of sunk investments; on the other, however, a more limited extent of allocative distortion is needed to support incentive compatibility. While the latter is a quantity effect, the former is a price one. Again, provided that the demand is sufficiently inelastic, the price effect will prevail and the following will hold:

Proposition 2: *Whenever assumption A1 holds and* $\varepsilon_{p,q} < \min\left\{\bar{\varepsilon}_{p,q}, 1\right\}$*, the probability that competition is chosen rises with the signal precision* γ *and it is higher when the regulator is elected if also her effort is sufficiently effective in swaying votes or* $g\left(\bar{\theta}\right) > 1$.[15]

The result resembles that proposed by Guerriero (2010a) who documents the existence of a positive relation between the power in term of cost-reducing effort of incentive rules and the information gathering effort. Yet, while this last pattern is driven directly by the lower need of allocative distortion, the relation documented in proposition 2 is more subtle a goes through the effect of the fall in the extent of asymmetric information on both allocative distortions and the firm's cost-reducing investment incentives.

[15] $\bar{\varepsilon}_{p,q}$ could be either greater or lower than one depending on the degree of convexity of the ψ function and the size of Δ. Should it be much lower than one the assumption would remain mild: indeed, Espey and Espey (2004) conclude that the median of previous estimates of the long run residential price elasticity is 0.81.

4.2 *Strategic Deregulation*

Institutional design could be inefficient when the firm's investment expenses favor shareholders over consumers and both groups can influence the planner's decision. A striking example of these expenses are those not strictly related to service provision *per se*—e.g., marketing, diffusion of smart-metering technologies, reducing the fixed cost of transmission. In order to clarify the point in the sharpest way, I assume that: 1. the return from investment accrues only to the firm's rents without affecting the consumers welfare;[16] 2. the firm is infinitely risk averse in the range of negative ex post utilities; 3. the planner acts as an agent of the incumbent $\tilde{m}$ between the pro-shareholder party Re and the pro-consumer De; 4. the following two periods succeed the four steps studied in section 3.1:

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

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

Clearly, only the low cost firm invests whenever $(1+\rho_m)\,\hat{U}^j + \underline{\pi}\bar{I} \geq 0$. Suppose that a planner agent of a type $\tilde{m}$ incumbent evaluates this ex-post participation constraint at the shadow price $\chi_{\tilde{m}}$, and the investment aid $\rho_m\hat{U}^j$ at the shadow cost of public funds λ. Clearly, $\chi_{\tilde{m}}$ captures the incumbent's willingness to encourage ex post investments. Define $\tilde{x} \equiv \rho_{De}x_{De} + \rho_{Re}x_{Re}$ and assume the following restrictions:

[16] At the cost of cumbersome algebra, the idea extends to investments benefiting asymmetrically both groups.

A.3: $\rho_{Re} > \rho_{De}$; $\chi_{Re} > \lambda > \chi_{De}$.

All in all, for $\delta = 0$ the planner will incline for competition if:

$$\left(1-\hat{I}^{R}\right)\left[S\left(c_{H}\right)-S\left(\hat{c}_{H}\right)\right]+\left[1-\left(\hat{I}^{C}\right)^{2}\right]\alpha\Delta q\left(c_{H}\right)>\frac{1+2\left(\hat{I}^{R}-\hat{I}^{C}\right)-\left(\hat{I}^{C}\right)^{2}}{2}\left[S\left(c_{L}\right)-S\left(c_{H}\right)\right]+$$

$$\Delta\left[\chi_{\tilde{m}}\left(1+\tilde{x}\right)-\lambda\tilde{x}\right]\left\{\left(1+\hat{I}^{R,S}\right)q\left(\hat{c}_{H}\right)-\left[1-\left(\hat{I}^{C}\right)^{2}\right]q\left(c_{H}\right)\right\}. \quad (5)$$

In interpreting the foregoing, several observations should be pointed out. First, the set up formalizes the existence of huge transfers from the federal and state governments to IOUs, financed out of distortionary taxes and aimed to solve energy externalities—e.g., air pollution, roadway congestion. As discussed by Metcalf (2008), the total energy-related tax expenditures for major fuel categories investments, and the production tax credits for renewable and advanced coal-based power sources reached 3.46 billion dollars in fiscal year 2008. Second, the fact that the winning party cannot reform the market conduct is consistent with the existence of a commitment period typical of regulation (see Guerriero, [2010a]). Third, the exogeneity of $x_{\tilde{m}}$ captures the basic idea, proposed by Besley and Coate (2003), that regulation is bundled at politicians election with more salient policies. Fourth, the fact that the pro-shareholder party is more willing to subsidize investment expenses incorporates into the model politicians' strategic incentives to propose and implement extremist platforms in order to empower their own supporters (Glaeser, Ponzetto, and Shapiro, 2005) or to buy votes through campaign contributions (Alesina and Holden, 2008). Again, under assumptions A1, the expected firm's rent would be lower under competition and:

Proposition 3: *Under assumptions A1, A2 and A3, the probability that competition is selected falls with the reformer hold on power* $x_{\tilde{m}}$ *and is greater if she is pro-consumer.*

The actual pattern originates from the mix between the asymmetry in the parties' preferences and the uncertainty of elections, and it is similar to the strategic dynamic proposed by a lively political economy tradition (Persson and Svensson, 1989; Alesina and Tabellini, 1990; Hanssen, 2004), claiming that a lack of permanence in office can inspire policymakers to implement reforms with the hope of limiting the actions of future incumbents. Here, a higher probability of being re-elected and fixing a larger (smaller) aid, without facing the danger of facing a new reform, pushes a pro-shareholder (pro-consumer) incumbent to have regulation selected assuring in this way an even higher profit to her constituency (curbing underinvestment). Hence, the tension between consumers and shareholders could lead to inefficient rules being chosen (see also Faure-Grimaud and Martimort, [2003]).[17]

Next, I explore whether the patterns laid down in proposition 1, 2 and 3 are robust to alternative assumptions. The message coming from this exercise, whose proofs are available from the Author, is that the model's message continues to stand.

4.3 *Robustness to Alternative Assumptions*

A generic number of Bertrand competitors.—In this case, the welfare under regulation remains unchanged and so the direct and the indirect—via both $\hat{I}^R$ and $q\left(\hat{c}_H\left(\hat{I}^R\right)\right)$—impact on it of both α and γ. Thus, in order to conclude that the model's patterns remain unaffected, it is enough to check that regulation preserves its dynamic advantage. Exploiting an argument similar to those reported in footnote 4, it can be shown that the expected firm's rent under competition strictly falls with the number of firms N for every $N > 2$.

[17] The argument still holds when the government: 1. acts as a sponsor and increases the ex post firm's rents without monetary aids if $\chi_{Re} > 0 > \chi_{De}$; 2. can decrease investment costs directed toward cost reduction, provided that the dynamic efficiency concerns more than outweighs the higher rent extraction needs.

Cournot competition.—Let me assume that the firms have symmetric information about c and let me consider the case of downward sloping best replies or $P' + P''q(c, l, N-1) < 0$, where $P(\cdot)$ indicates the strictly decreasing inverse demand and $q(c, l, N-i)$ is the output choice of a firm of type c when, among the N entrants, l have type c_L and $N-l$ a type c_H. Entry happens at the cost $\kappa \geq 0$ between stage 1 and 2. With inelastic direct demand, the firm's marginal revenues fall with the quantity sold. Yet, when such elasticity is not too low, an equilibrium price respecting the usual Cournot conditions and strictly greater than the mean marginal cost exists. Also, for a sufficiently low entry cost and sufficiently efficient investment technology, it can be shown that the firm's incentives to invest under competition are weaker than under regulation: thus, all the model's results are preserved.

A positive shadow cost of public funds.—For $\lambda > 0$ the rule giving the type dependent price as a function of the marginal cost will be of the Ramsey type and will be implicitly defined by $p = \Psi(c)$ with $\Psi \equiv \varphi^{-1}$ and $\varphi(\lambda, p) \equiv p + \lambda(1+\lambda)^{-1} q(p)[q'(p)]^{-1} = c$ so that $\partial p/\partial c > 0$. A reasoning similar to that applied in the proof of proposition 1 shows that the level of investment continues to be higher under regulation. The effect of a change in α and γ on the level of welfare under regulation will be multiplied by $\partial p/\partial c$; yet, provided that conditions slightly stricter than assumptions A1 and A2 hold, the model's message will be unaffected.

Regulatory commitment: contractible and noncontractible investments.—Provided that an ex post participation constraint is imposed, the level of investment under regulation, when contractible, would still be inefficient and higher than the one under competition. Besides, the rule giving price as a function of marginal cost would be unaffected (see Laffont and Tirole, [1993]).[18] As a consequence, proposition 1, 2 and 3 would still hold. When investment is

[18] Without ex post participation constraint the first best is achieved with a fixed contract.

not contractible, instead, the allocation of the high cost firm would be distorted even more in order to take into consideration the moral hazard in investment constraint. However, regulation would retain its dynamic advantage and, under a condition similar to assumption A2 and with sufficiently inelastic demand, the model's message would survive.[19]

5 Empirical Implications

The basic idea of the theory is that, under reasonable conditions, while competition delivers more limited allocative distortions, regulation brings stronger cost-reducing investment incentives via higher expected profits. Thus, deregulation is more likely to be implemented when regulation leaves lower rents and the reformer's dynamic efficiency concerns are weaker. This was embodied in proposition 1, 2 and 3 above. Hence, the first prediction refers to the probability that a reform toward more competitive settings is enhanced and reads as:

Prediction 1: *The likelihood of a reform toward more competitive settings will be higher when regulators are elected, and will fall with society's cost-reducing investment concerns and with the reformer hold on power. Also, it will be lower when the reformer is pro-shareholder.*

My second test is motivated by the observation that while regulation produces a better distribution of firms' type due to the higher expected cost-reducing investment, fixed such distribution competition induces more often the firm with the lowest cost to serve the market. In other words, competition will assure a lower expected ex ante cost whenever

[19] Should the planner auction an incentive contract as in Laffont and Tirole (1993), the low cost firm interim expected rent would be $(1/2)\left(1-\hat{I}^R\right)x^1\left(c_H,c_H\right)\Delta q\left(\hat{c}_H\right)$ where $x^j\left(c^1,c^2\right)$ for $j=1,2$ is the probability that firm j is chosen when firm 1 has type c^1 and 2 type c^2. Under symmetric auctions, this rent becomes $(1/4)\left(1-\hat{I}^R\right)\Delta q\left(\hat{c}_H\right)$ and regulation would lose its dynamic advantage; yet, proposition 2 would survive.

$$\left[2\frac{1-\left(\hat{I}^C\right)^2}{4}+\frac{\left(1+\hat{I}^C\right)^2}{4}\right]c_L+\frac{\left(1-\hat{I}^C\right)^2}{4}c_H<\frac{1+\hat{I}^R}{2}c_L+\frac{1-\hat{I}^R}{2}c_H\leftrightarrow\frac{1-2\left(\hat{I}^R-\hat{I}^C\right)-\left(\hat{I}^C\right)^2}{4}\left(c_L-c_H\right)<0,$$

which could fail under the restriction imposed by assumptions A1, A2 and A3.[20] On top of this, the second prediction deals with regulatory outcomes and reads as:

Prediction 2: *Production costs could be either greater or lower under competition.*

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

6 Evidence

While between 1993 and 1998 all states held hearings on possible restructuring, just under half the jurisdictions—23 states and the District of Columbia—enacted restructuring legislations between 1996 and 2000.[21] Yet, as widely documented by Fabrizio, Rose and Wolfram (2007), utilities often acted before final legislations altering in advance their behaviors. In order to capture at best the role of expectations and have a wide enough comparison period, I take into consideration productivity of all the large fossil-fuel steam and combined cycle gas turbine generating plants for which data were reported to the FERC between 1981 and 1999 period. I also restrict the sample to states for which data on the quality of the information gathering technology and political competition are available—see the appendix. Hence, the dataset gathers 8,059 observations on 503 plant-epochs—i.e. years over which the plant capacity did not change more than 40 MW or the 15 percent of the capacity—operating in 43 U.S. states. I consider two dependent variables: 1. *Deregulation* which equals one for IOU plants in states that restructured beginning in the year of the first formal hearing and

[20]It fails for $\hat{I}^R$ much bigger than $\hat{I}^C$, which happens when ψ' is not too small and α tends to one.

[21]Between 1982 and 2002, forty-one IOUs in twenty-three U.S. states introduced some form of broadly defined incentive regulation (see Guerriero, [2010a]). Once considered the latter do not show complementarities with restructuring and their presence do not change the gist of the results discussed below.

zero otherwise; 2. *Der_Ord* which equals three for states that restructured beginning in the year that legislation was enacted, two for states that restructured beginning in the year of the first formal hearing, one otherwise.[22] I will use the latter to explain the choice of the power of competitive pressure and the former to compare competition and regulation. I first identify the determinants of deregulation and then examine whether the latter decreases input requirements estimating labor and fuel use equations.

6.1 *Non Random Market Conduct Selection*

The empirical strategy.—In order to exploit the three-dimensional variation—over time and across states and power levels—of competitive pressures, I use a an ordered logit with dependent *Der_Ord* and a logit with dependent *Deregulation* both run on data aggregated at the state level. For what concerns the former, let $y^*_{s,t}$ be the unobserved preference of a reformer in state s at time t driving the choice of a competitive pressure $y_{s,t}$. Here, $y_{s,t} = k \Leftrightarrow \vartheta_{k-1} \leq y^*_{s,t} \leq \vartheta_k$ where $k = 1, 2, 3$ and the ϑ_k are unknown thresholds to be estimated. The related structural model is $y^*_{s,t} = \theta' \mathbf{z}_{s,t} + \nu_{s,t}$, where $\nu_{s,t}$ is the error term and $\mathbf{z}_{s,t}$ is the vector gathering the determinants of deregulation.[23] With Λ representing the c.d.f., which I assume to be Logistic, of ν, the odds ratio of the reformer adopting for state s a more powerful competitive pressure at time t is:

$$\Delta_{s,t}\left(y_{s,t} > k\right) = P\left[y_{s,t} > k\right] / P\left[y_{s,t} \leq k\right] = \left[1 - \Lambda\left(\vartheta_k - y^*_{s,t}\right)\right]\left[\Lambda\left(\vartheta_k - y^*_{s,t}\right)\right]^{-1} \forall k. \qquad (6)$$

[22] The coefficients attached to the dummies *Law*, which equals one for IOU plants in states that restructured beginning in the year that legislation was enacted, and *Retail*, which equals one for IOU plants in states that restructured beginning in the year that retail access was introduced, would show behaviors similar to that of the coefficient attached to *Deregulation*—results available from the author.

[23] Inequality (5) does not exclude a role for interaction terms: when introduced in the logit, they are usually not significant for the groups whose probability of reforming is either 0 or 0.5 (Ai and Norton, 2003).

The linear log-odds obtained taking the logarithm of both sides of (6) characterize the ordered logit model, which is easily estimated by maximum likelihood. I will focus on the exponentiated coefficients because for a one unit change in the control the odds that the reformer selects a competitive pressure more powerful than k versus one at most as powerful as k are the exponentiated coefficient times larger. For the logit, I will report the marginal effects which give the percentage variation in the likelihood of the *Deregulation* when the control rises by one percentage point. Next, I will introduce the proxies gathered in $\mathbf{z}_{s,t}$.

Measuring the regulator's implicit incentives and investment concerns.—Implicit incentives are summarized by *Reg_Elec* which is equal to one where the public utility commissioners are elected and zero otherwise. Because this variable lacks enough within variation, its introduction prohibits the use of firm effects; excluding *Reg_Elec* and switching to a fixed effects logit would leave the evidence on the other variables pretty similar.[24] I also obtain results not very different from those discussed below when the errors, which are "robust" to generic heteroskedasticity and serial correlation, are clustered at the state level.

Creating meaningful proxies for society's cost-reducing investment concerns is a more challenging task. My strategy is to assume that the saliency of investment inducement for a state is higher when marginal costs are structurally high or higher than those prevailing in neighboring states. Following Fabrizio, Rose and Wolfram (2007), the two key inputs for electricity generation variable in the medium-term, which is the horizon of the present study, are labor and fossil fuels. Hence, I use as proxy for more pressing society's cost-reducing investment concerns one of the following four variables lagged three years: 1. the average

[24] Guerriero (2010b) shows that regulatory appointment rules are driven by the same battery of forces that drives deregulation; should I instrument *Reg_Elec* with the share on neighboring states electing PUC commissioners, which is an exogenous instrument as explained below, I would obtain very similar estimates.

marginal labor cost in cents of dollar obtained, at the plant level, dividing the product of the number of employees and the annual wage bill by the total generation—*Mc_Labor*; 2. the average marginal fuel cost in cents of dollar obtained, at the plant level, dividing the product of total BTU and the price of fossil fuels composite by the total generation—*Mc_Fuel*; 3. the ratio of the own state over the mean of the neighboring states mean marginal labor cost—*Ratio_Mlc*; 4. the ratio of the own state over the mean of the neighboring states mean marginal fuel cost—*Ratio_Mfc*. As discussed below, the choice of lagging these proxies assures an orthogonality condition when testing prediction 2. Making use of different proxies for the dynamic efficiency concerns—e.g., marginal costs calculated as in the state there was a single monopoly—does not change the message of the present section.[25]

Turning to political competition, Hanssen (2004) proposes the share of seats held by the majority party averaged across upper and lower houses—*Majority*—as a proxy of the strength of the incumbent hold on power. Switching to other available measures—e.g. the Ranney index—the essence of the evidence does not change. For what concerns the identity of the reformer's constituency, a broad political science literature claims that Republicans have been historically nearer to the shareholders' interests (see Teske, [2004]). Therefore, I introduce a binary equal to one if both houses were under the Republicans' control—*Republican*. If, as Besley and Coate (2003) suggest, regulation is not salient for the majority of voters at politicians' elections, the two proxies will be orthogonal to unobserved policy-

[25]In order to maximize the sample size 46 data points have been inputed using the year foregoing the missing observation. This choice does not affect the qualitative idea of the evidence. The latter is also true when I consider: the state population, the proportion aged over 65, the one aged 5-17, the state income per capita, the number of employees and budget of the PUC, the commissioner term of office, whether there is a state consumer advocate, the other controls used in section 6.2, the share of generation from hydroelectric sources and the lagged residential price. The latter tend to increase the likelihood of deregulating which squares with the observation made above that competition curbs allocative distortions.

driven determinants of investment concerns. Finally, scholars of policy innovation (Teske, 2004) claim that the diffusion of a new institution displays peculiar learning features: the deregulation in one state could shift support for the same reform in neighboring states without affecting their regulatory performances until the reform is implemented (Steiner, 2004). In order to capture this exogenous imitation process, I will introduce the share of surrounding states for which *Deregulation* equals one. Using as neighboring states those in the same NERC or census region would not change the gist of the results. While the data sources are illustrated in the appendix, the variable descriptions are listed in Table 1.

Empirical results.—While the estimates of the ordered logit are reported in the first three columns of Table 2, those of the logit are listed in the last three columns of the same table. For the most part, the results are consistent with prediction 1, and the implied effects are large. Starting with society's investment concerns, the likelihood of deregulation falls by 11.4-percentage-points as a result of a one-standard-deviation rise in the lagged mean of marginal fuel costs and by 7.6-percentage-points as a consequence of a one-standard-deviation rise in the lagged ratio of the own marginal costs over those of neighboring states. All these coefficients are significant at the 1 percent. Much smaller and statistically insignificant is the reduction implied by an increase in both *Mc_Labor* and *Ratio_Mlc*. Very similar is the impact of past marginal costs on the odds of more powerful competitive pressures. More mixed, instead, is the evidence on the political competition, while the reformer hold on power has the expected sign and it is always significant at 10 percent implying a decrease of the likelihood of deregulation of about 7 percentage points for each one-percentage-point increase, *Republican* is insignificant and shows an unexpected pattern. This could be simply due to the fact that Republicans do not obtain higher perquisites in favoring shareholders, but nevertheless it deserves more attention in future research. The odds that in a state electing its regulators a more powerful competitive pressure is selected is about 1.2 times those in a state appointing its regulators; yet the coefficient is never statistically significant. The data also confirm the idea that regulatory reforms could be produced by shocks to preferences due to the decisions of surrounding markets.

All in all, it is fair to conclude that the distribution of deregulation across American states is not random but reflects efficiency-enhancing and strategic political forces. Also, this non random assignment implies that the variation in deregulation used to explain input choices could be related to shocks shaping also the firm's cost minimization decisions: this correlation would make OLS biased. Even more crucially, this bias could go either way. It could be positive because deregulation could correlate with low cost-reducing effort by a low investment concerned state; yet, it could also be negative because deregulation could correlate with forces increasing the efficiency of the information gathering technology and, in turn, lowering the firm's cost-reducing investments. Which sign the bias takes is ultimately an empirical question: the following subsection provides an answer.

6.2 *Input Use and Endogenous Market Conducts*

To test prediction 2, I follow Fabrizio, Rose and Wolfram (2007) and I examine whether deregulation pushes the firm to use a better mix of inputs given their prices. The inputs I consider are the natural log of the number of employees—*Ln_Emp*—and the natural log of the total Btus of fuel consumption—*Ln_Btu*—in the plants p in year t. I estimate first by OLS and then by GMM the following input N use equations:

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

where $Q_{p,t}^N$ is the annual net MWh generation for plant p in year t;[26] $P_{p,t}^N$ is the price of the input $N_{p,t}$—i.e., the BLS annual wage bill in dollars divided by total employment for *Ln_Emp* and none for *Ln_Btu*;[27] $\mathbf{x}_{p,t}^N$ gathers the determinants of deregulation which cannot be excluded by the input use equation—*Elec_Reg*, *Republican* and *Majority* (see also Guerriero, [2010a])—and a dummy for the presence of a FGD scrubber;[28] $\gamma_{p,t}^N$ is the dummy *Deregulation*.[29] Finally, while base differences in input uses are embedded in the plant fixed effects α_p^N, common annual changes are measured by the time effects δ_t^N.

Table 3 lists the OLS and GMM estimates. Columns (1) to (3) refers to the equation with dependent *Ln_Emp*, columns (4) to (6) to the one with dependent *Ln_Btu*. While columns (1) and (4) list OLS estimates, the others report the GMM estimates. In the GMM specification I treat as endogenous *Deregulation*, and I use a two-step procedure. Here, the challenge is to avoid too many instruments because the instruments count tends to explode with the number of years and too many moment conditions can fail to expunge the endogenous component of the endogenous variables, weakening also the power of the over-identification restrictions test (see Roodman, [2009]). To accomplish the task, I collapse into a single column of instruments all the regressors except the endogenous and those determinants of deregulation that can be excluded by the input use equation. The latter are *Der_Nei* and either *Mc_Fuel*

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

[27]The choice reflects the fact that while labor decisions are made in advance of production, fuel input decisions are made in real time; in any case it turns out to be immaterial (Fabrizio, Rose and Wolfram, [2007]). Also using the log of the non fossil fuels expenses instead of *Ln_Emp* leads to the same empirical conclusions.

[28]There may be variation within plant-epoch when "scrubbers"—fuel-gas desulfurization systems, or FGDs—are installed to reduce sulfur-dioxide emissions by some coal plants (Fabrizio, Rose and Wolfram, 2007).

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

or *Ratio_Mfc*, both lagged three periods. The last two are the investment concern proxies assuring the strongest first step. While the exogeneity of *Der_Nei* has been motivated above, a few other words are useful to explain the one of the other two instruments. Because the residuals of the input use equations show first-order serial correlation, variables correlated to the dependent variable and lagged two periods or less would be not orthogonal to the error term which is lagged in the difference specification.[30]

The key observation is that OLS tend to overestimate the cost reduction incentives brought by deregulation. Indeed, the implied percentage reduction in input usage rise from 6.6 to 12 (almost 8) percentage points in the case of labor inputs and from 2 to 14 (almost 9) percentage points in the case of fuel inputs when the lagged value of *Mc_Fuel* (*Ratio_Mfc*) is used an an instrument.[31] All these coefficients are significant at ten percent or better. Finally, the Hansen test, which is the consistent one with robust standard errors, does not reject the over-identifying restrictions at a level nowhere lower than fourteen percent which assure about the consistency of the estimates even when the residual of the differenced equation shows some second order autocorrelation in the residuals—i.e. column (5).[32]

Thus, the bias introduced by not taking into account the endogeneity of deregulation to the strength of society's investment concerns seems to outweigh the one of not considering the role played by the efficiency of the information gathering technology:[33] this conclusion

[30] In this way, the instrument count is well below the number of cross sections: this assures that "too many instruments" are not considered (Roodman, 2009).

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

[32] A very similar picture arises when I consider the time-varying controls enumerated in footnote 25. Switching to the one-step estimator, estimating the model in levels, or including among the instruments one more lag of the endogenous variables or the state sales for correcting the possible endogeneity of *Ln_Mwhs* (see Fabrizio, Rose and Wolfram, [2007]) would not change the gist of the empirical results.

[33] This evidence nicely squares the fact that, from a theoretical point of view, politics has only a second order effect on incentive regulation and information has only a second order effect on market design.

is consistent with the observation that the impact of the first force was greater than the one of the second in the estimates of Table 2. Guerriero (2010b) provides evidence according to which, during the Oil-crisis pre-reform period, the pass-through of cost shocks into prices was fiercely opposed by regulators specially those directly elected by consumers. This along with the fact that deregulation has a negative but statistically insignificant endogenous impact on residential and industrial rates during the 1981-1999 period—evidence available from the author—leads to the following interpretation of my results: reforms were not enhanced where there was a pressing need of accommodating dynamic efficiency concerns after an era of rising input costs and excessively pro-consumer attitudes by regulators.

7 Concluding Comments

The relevance of regulatory institutions to economic development is key especially in a period of deregulation and liberalization (Newbery, 2000). Yet, the determinants of these settings are still poorly understood: here, I developed and tested a theory of "endogenous market institutions" (see also Guerriero [2010a, 2010b]), focusing on the choice between competition and regulation when the demand is inelastic.

I close by highlighting several avenues for further research. The first one is to assess the effect of endogenous deregulation on service quality. This exercise is of first order relevance in order to evaluate the overall welfare properties of different market conducts. Also, even if a lively theoretical and empirical literature (see Ajodhia and Hakvoort, [2005]) has provided evidence according to which competitive pressures might induce firms to reduce quality in order to minimize costs, regulatory reforms have been always considered as exogenous. A second avenue for further research is to endogenize the probability of re-election after a reform. Indeed, even if it is hard to envision elections where regulation is salient for voters there are examples of political failures originated by rash regulatory reforms: the defeat of Democrat governor Gray Davis in the aftermath of the crisis following the California market deregulation is a case in point. Finally, an extremely topical issue is to understand the determinants and the endogenous impact of competitive pressures on other markets like the pharmaceutical or commercial banking ones (see also Benmelech and Moskowitz, [2010]).

Appendix

Underinvestment: Regulation Versus Competition

The socially optimal investment level I^* solves the following strictly concave problem

$$\hat{I}^* = \arg\max_{I\geq 0} (1/2)\left[(1+I)\,S(c_L) + (1-I)\,S(c_H)\right] - \psi(I)\,. \tag{A1}$$

whose unique interior solution is implicitly defined by $\psi'(I^*) = (1/2)\left[S(c_L) - S(c_H)\right]$. Clearly enough $I^* < 1$ because $\lim_{I\to 1} 2\psi'(I) \geq S(c_L) - S(c_H)$. The unique and interior solutions to problem (1) and (2) are implicitly defined respectively by $\psi'\left(\hat{I}^R\right) = (\Delta/2)\,q(\hat{c}_H)$ and $\psi'\left(\hat{I}^C\right) = \left(1-\hat{I}^C\right)(\Delta/4)\,q(c_H)$. Being $(1/2)\left[S(c_L) - S(c_H)\right] > \max\left\{(\Delta/2)\,q(\hat{c}_H)\,, \left(1-\hat{I}^C\right)(\Delta/4)\,q(c_H)\right\}$, both institutions lead to underinvestment. Also, $I^R > I^C$ whenever $2q(\hat{c}_H) > q(c_H)$, which is true under assumption A1 because, with inelastic demand, a fall in price from $\hat{c}_H$ to c_H implies that:
$\left|\frac{q(\hat{c}_H)-q(c_H)}{\left(1+\hat{I}^R\right)\left(1-\hat{I}^R\right)^{-1}(1-\alpha)\Delta}\frac{c_H+\left(1+\hat{I}^R\right)\left(1-\hat{I}^R\right)^{-1}(1-\alpha)\Delta}{q(\hat{c}_H)}\right| < 1 \leftrightarrow q(\hat{c}_H)\frac{c_H+2\left(1+\hat{I}^R\right)\left(1-\hat{I}^R\right)^{-1}(1-\alpha)\Delta}{c_H+\left(1+\hat{I}^R\right)\left(1-\hat{I}^R\right)^{-1}(1-\alpha)\Delta} > q(c_H)$.
A fortiori it must be the case that $2q(\hat{c}_H) > q(c_H)$. Clearly the argument remains true for all $p > \hat{c}_H$ and consequently also when $\hat{c}_H$ becomes so high to be equal to $\bar{p}$. □

Inequality (3) in Details

In order to obtain the inequality in (3) notice that $W^C - W^R$ can be written as $\frac{\hat{I}^R-2\hat{I}^C-\left(\hat{I}^C\right)^2}{4}S(c_L)$ $+\frac{1+\hat{I}^R}{4}\left[S(c_L) - S(c_H)\right] < \frac{1-\hat{I}^R}{2}\left[S(c_H) - S(\hat{c}_H)\right] + \frac{\hat{I}^R-2\hat{I}^C-\left(\hat{I}^C\right)^2}{4}S(c_H) + \frac{1-\left(\hat{I}^C\right)^2}{2}\alpha\Delta q(c_H)$. □

Proof of Proposition 1

The impact of α on the probability of choosing competition has the sign of $\partial\left(W^C - W^R\right)/\partial\alpha =$ $-2\frac{\partial\hat{I}^R}{\partial\alpha}\left[S(c_L) - S(\hat{c}_H) - 2\frac{1-\alpha}{1-\hat{I}^R}\Delta q(\hat{c}_H)\right] + 2\left[1-\left(\hat{I}^C\right)^2\right]\Delta q(c_H) - 2\left(1-\hat{I}^R\right)\frac{1+\hat{I}^R}{1-\hat{I}^R}\Delta q(\hat{c}_H)$.

By totally differentiating the first order condition to problem (1) I obtain that:
$\left[\frac{2(1-\alpha)\Delta^2 q'(\hat{c}_H)}{2\left(1-\hat{I}^R\right)^2} - \psi''\left(\hat{I}^R\right)\right]d\hat{I}^R - \frac{\left(1+\hat{I}^R\right)\Delta^2 q'(\hat{c}_H)}{2\left(1-\hat{I}^R\right)}d\alpha = 0 \rightarrow \frac{\partial\hat{I}^R}{\partial\alpha} > 0$.

After noticing that $S(c_L) - S(\hat{c}_H) - 2\frac{1-\alpha}{1-\hat{I}^R}\Delta q(\hat{c}_H) > \alpha\Delta q(\hat{c}_H)$, a sufficient condition to have

$\partial\left(W^C - W^R\right)/\partial\alpha < 0$ is that $\left[1 - \left(\hat{I}^C\right)^2\right] q\left(c_H\right) < \left(1 + \hat{I}^R\right) q\left(\hat{c}_H\right)$ which is true if $2\left(\hat{I}^C\right)^2 + \hat{I}^R - 1 > 0$—where I used the fact shown above that $2q\left(\hat{c}_H\right) > q\left(c_H\right)$—and *a fortiori* when $2\left(\hat{I}^C\right)^2 + \hat{I}^C - 1 > 0$. Under assumption A2, $\hat{I}^C > 1/2$ and thus $2\left(\hat{I}^C\right)^2 + \hat{I}^C - 1 > 0$. □

Proof of Proposition 2

The unique solution to problem (4) is defined by $\psi'\left(\hat{I}^{R,S}\right) = (1-\gamma)\left(\Delta/2\right) q\left(\hat{c}_H^S\right)$ so that:

$$\left[\frac{(1-\gamma)^2(1-\alpha)\Delta^2 q'\left(\hat{c}_H^S\right)}{\left(1-\hat{I}^{R,S}\right)^2} - \psi''\left(\hat{I}^{R,S}\right)\right] d\hat{I}^{R,S} + \left[-\frac{\Delta q\left(\hat{c}_H^S\right)}{2} - \frac{\left(1+\hat{I}^{R,S}\right)(1-\gamma)(1-\alpha)\Delta^2 q'\left(\hat{c}_H^S\right)}{2\left(1-\hat{I}^{R,S}\right)}\right] d\gamma = 0,$$

which implies $\frac{\partial \hat{I}^i}{\partial\gamma} < 0$ because the expression in the second square bracket is negative being

$$-\frac{q'\left(\hat{c}_H^S\right)\left(1+\hat{I}^{R,S}\right)\left(1-\hat{I}^{R,S}\right)^{-1}(1-\gamma)(1-\alpha)\Delta}{q\left(\hat{c}_H^S\right)} < -\frac{q'\left(\hat{c}_H^S\right)\hat{c}_H^S}{q\left(\hat{c}_H^S\right)} < 1$$

under assumption A1. The probability of competition being chosen increases with γ whenever

$$\frac{\partial\left(W^C - W^{R,S}\right)}{\partial\gamma} = -2\frac{\partial\hat{I}^{R,S}}{\partial\gamma}\left[S\left(c_L\right) - S\left(\hat{c}_H^S\right) - 2\frac{1-\alpha}{1-\hat{I}^R}\left(1-\gamma\right)\Delta q\left(\hat{c}_H\right)\right] - 2\left(1+\hat{I}^{R,S}\right)\left(1-\alpha\right)\Delta q\left(\hat{c}_H^S\right)$$

is positive. The latter is indeed the case whenever $2\left(1+\hat{I}^{R,S}\right)\left(1-\alpha\right)\Delta q\left(\hat{c}_H^S\right) <$

$$\frac{\Delta q\left(\hat{c}_H^S\right)+\left(1+\hat{I}^{R,S}\right)\left(1-\hat{I}^{R,S}\right)^{-1}(1-\gamma)(1-\alpha)\Delta^2 q'\left(\hat{c}_H^S\right)}{\psi''\left(\hat{I}^{R,S}\right)-\left(1-\hat{I}^{R,S}\right)^{-2}(1-\gamma)^2(1-\alpha)\Delta^2 q'\left(\hat{c}_H^S\right)}\left(\alpha+\gamma-\alpha\gamma\right)\Delta q\left(\hat{c}_H^S\right) \leftrightarrow$$

$$-\frac{\left(1+\hat{I}^{R,S}\right)(1-\gamma)(1-\alpha)}{1-\hat{I}^{R,S}}\Delta^2\left[2\left(1-\gamma\right)\left(1-\alpha\right)+\left(1-\hat{I}^{R,S}\right)\left(\alpha+\gamma-\alpha\gamma\right)\right] q'\left(\hat{c}_H^S\right) <$$

$$\left(1-\hat{I}^{R,S}\right)\left(\alpha+\gamma-\alpha\gamma\right)\Delta q\left(\hat{c}_H^S\right) - 2\left[1-\left(\hat{I}^{R,S}\right)^2\right]\left(1-\alpha\right)\psi''\left(\hat{I}^{R,S}\right) \leftrightarrow$$

$$\varepsilon_{p,q} = -\frac{q'\left(\hat{c}_H^S\right)\hat{c}_H^S}{q\left(\hat{c}_H^S\right)} < \bar{\varepsilon}_{p,q} \equiv \frac{\hat{c}_H^S\left(1-\hat{I}^{R,S}\right)(\alpha+\gamma-\alpha\gamma)\Delta - 2\hat{c}_H^S\left[1-\left(\hat{I}^{R,S}\right)^2\right](1-\alpha)\psi''\left(\hat{I}^{R,S}\right)\left[q\left(\hat{c}_H^S\right)\right]^{-1}}{\frac{1+\hat{I}^{R,S}}{1-\hat{I}^{R,S}}(1-\gamma)(1-\alpha)\Delta^2\left[2(1-\gamma)(1-\alpha)+\left(1-\hat{I}^{R,S}\right)(\alpha+\gamma-\alpha\gamma)\right]}.$$ □

Proof of Proposition 3

The probability of adopting competition falls with $\left\{\left(1+\hat{I}^{R,S}\right) q\left(\hat{c}_H\right) - \left[1-\left(\hat{I}^C\right)^2\right] q\left(c_H\right)\right\}$ which is positive as seen above. Therefore, it will decrease with both $\chi_{\tilde{m}}$ and $\tilde{x}\left(\chi_{\tilde{m}} - \lambda\right)$ and party *Re* will choose competition less often. Finally, the following derivatives conclude the proof:

$\frac{\partial\tilde{x}(\chi_{Re}-\lambda)}{\partial x_{Re}} = \left(\chi_{Re} - \lambda\right)\left(\rho_{Re} - \rho_{De}\right) > 0$; $\frac{\partial\tilde{x}(\chi_{De}-\lambda)}{\partial x_{De}} = \left(\chi_{De} - \lambda\right)\left(\rho_{De} - \rho_{Re}\right) > 0$. □

Sample Construction

This study analyzes productivity for large fossil-fueled steam turbine or combined cycle plants owned by IOUs only. The core data source is the Utility Data Institute (UDI) O&M Production Cost Database, which is based on the FERC Form 1 filings. Following Fabrizio, Rose and Wolfram

(2007), I have eliminated the plants with mean capacity in gross megawatts below 100 MW or with three years of operations at a scale not greater than 100 MW, the plants with missing or nonpositive output data and the outliers spotted using the Stata's dfbeta regression diagnostic. Moreover, I did not consider the plants for which data on regulatory institutions and political competition were not available: thus, there are no observations for Alaska, the District of Columbia, Nebraska, Rhode Island, Tennessee and Vermont. Also, there are no IOUs serving Hawaii and Idaho in the UDI Database. As a result, after imputing 46 data points using the year foregoing the missing observation, I obtain a dataset with 8,059 observations on 503 plant-epochs—i.e., years over which the plant capacity did not change more than 40 MW or the 15 percent of the capacity—operating in 43 U.S. states. Aggregating the plant-epochs data at the state level produces the strongly balanced panel of 817 observations—i.e., 19 yearly data points for 43 states—used to obtain Table 3 below.

Data Sources

Deregulation.—Data on restructuring come from: 1. EIA (2003); 2. EIA. 2000. "The Changing Structure of the Electric Power Industry: 2000 An Update." EIA; 3. EIA. 2002. "Status of State Electric Industry Restructuring Activity." EIA; 4. Edison Electric Institute. 2001. "Electric Competition in the States." EEI; 5. National Association of Regulatory Utility Commissioners (NARUC). 1995 and 1996. "Utility Regulatory Policy in the United States and Canada, Compilation." NARUC; 6. Council of State Governments (CGS). 1999. "Restructuring the Electricity Industry." CSG; 7. State Public Utility Commission Web sites, relevant legislation, and reports.

Appointment rules.—NARUC (1981-1999).

Political competition.—CSG. 1981-1999. *The Book of the States.* CSG.

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

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

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Tables

Table 1: Variables Names and Descriptions

	Variables Name	Variable Description	Mean (Standard deviation)
Market institutions:	*Deregulation*:	1 for IOU plants in states or states that restructured; beginning in the year of the first formal hearing, 0 otherwise.	0.137 (0.344)
	Law:	1 for IOU plants in states or states that restructured; beginning in the year that legislation was enacted, 0 otherwise.	0.055 (0.228)
	Der_Ord:	Indicator equal to 3 when both *Deregulation* and *Law* are equal to 1, 2 when only *Deregulation* equals 1 and 1 otherwise.	1.192 (0.515)
Supervision technology:	*Elec_Reg*:	1 for IOU in a state or states where the public utility commissioners are elected; 0 otherwise.	0.215 (0.411)
Input uses and marginal costs:	*Ln_Emp*:	ln (annual mean number of employees).	4.097 (1.446)
	Ln_Btu:	ln (total Btus of fuel consumption). Total Btus are calculated as follows: (tons of coal*2000 lbs/ton*Btu/lb) + (barrels of oil*42 gal/barrel*Btu/gal) + (Mcf gas*1000 cf/mcf*Btu/cf).	25.872 (5.408)
	Mc_Labor:	Average marginal labor cost in cents of dollar per Kwh. At the plant level, such cost is obtained dividing the product of the number of employees and the annual wage bill by the total generation.	0.570 (1.688)
	Mc_Fuel:	Average marginal fuel cost in cents of dollar per Kwh. At the plant level, it is obtained dividing the product of total BTU and the price of fossil fuel composite by the total generation.	1.889 (1.407)
	Ratio_Mlc:	Ratio own state over the mean of the neighboring states marginal labor cost.	1.530 (4.640)
	Ratio_Mfc:	Ratio own state over the mean of the neighboring states marginal fuel cost.	1.051 (0.722)
Political competition:	*Republican*:	1 for IOU in a state pr states where both houses are controlled with the relative majority of seats by the Republican party; 0 otherwise.	0.258 (0.438)
	Majority:	Share of seats held by the majority party averaged across both houses. The variable equals 0 when there is no party holding the majority in both houses.	0.542 (0.283)
Other controls:	*Ln_Mwhs*:	ln (annual net MWh generation).	14.374 (1.369)
	Ln_Wage:	ln (BLS annual wage bill in dollars divided by total employment in the state in which the IOU operates).	10.576 (0.277)
	Scrubber:	1 if there is an FGD scrubber at the plant; 0 otherwise.	0.096 (0.295)
	Der_Nei:	Share of states bordering the one in which the plant operates for which *Deregulation* is equal to 1.	0.141 (0.278)

Note : 1. All the statistics are computed across states for the full sample except *Ln_Mwhs*, *Ln_Wage* and *Scrubber* which are computed across plants for the sample used in Table 3 below.

Table 2: Determinants of Deregulation — Ordered Logit and Logit

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				The dependent variable is:				
	Der_Ord	*Der_Ord*	*Der_Ord*	*Der_Ord*		*Deregulation*		
Elec_Reg	1.324	1.155	1.317	1.300	0.015	- 0.001	0.015	0.009
	(0.496)	(0.445)	(0.489)	(0.482)	(0.028)	(0.017)	(0.027)	(0.024)
Mc_Labor(-3)	0.881				- 0.007			
	(0.200)				(0.016)			
Mc_Fuel(-3)		0.256				- 0.082		
		(0.078)***				(0.013)***		
Ratio_Mlc(-3)			0.931				- 0.004	
			(0.083)				(0.007)	
Ratio_Mfc(-3)				0.338				- 0.105
				(0.174)**				(0.034)***
Republican	1.313	1.201	1.307	1.255	0.035	0.018	0.034	0.027
	(0.407)	(0.378)	(0.402)	(0.396)	(0.029)	(0.020)	(0.029)	(0.027)
Majority	0.461	0.538	0.476	0.450	- 0.077	- 0.038	- 0.075	- 0.069
	(0.212)*	(0.240)	(0.224)	(0.198)*	(0.037)**	(0.027)	(0.038)**	(0.035)**
Der_Nei	322.495	201.726	322.2	340.21	0.414	0.256	0.411	0.392
	(146.318)***	(91.439)***	(146.14)***	(155.60)***	(0.051)***	(0.047)***	(0.052)***	(0.051)***
Estimation Procedure	Ordered Logit.	Ordered Logit.	Ordered Logit.	Ordered Logit.	Logit.	Logit.	Logit.	Logit.
Pseudo R^2	0.37	0.39	0.38	0.38	0.45	0.48	0.45	0.46
Log-Pseudolik.	- 238.44	- 231.02	- 238.24	- 236.38	- 169.29	- 159.60	- 169.18	- 165.58
Number of Observations	688	688	688	688	688	688	688	688

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

Table 3: Input Use Equations Estimates – OLS Versus Two-Step Difference GMM

	(1)	(2)	(3)	(4)	(5)	(6)
			The dependent variable is:			
	Ln_Emp	*Ln_Emp*	*Ln_Emp*	*Ln_Btu*	*Ln_Btu*	*Ln_Btu*
Deregulation	- 0.069	- 0.127	- 0.082	- 0.021	- 0.153	- 0.095
	(0.010)***	(0.032)***	(0.026)***	(0.007)***	(0.081)*	(0.047)**
Elec_Reg	0.139	- 0.001	0.0002	0.012	- 0.005	- 0.003
	(0.030)***	(0.004)	(0.004)	(0.019)	(0.006)	(0.005)
Republican	- 0.046	- 0.0004	- 0.003	0.004	0.005	0.001
	(0.012)***	(0.004)	(0.004)	(0.008)	(0.007)	(0.004)
Majority	0.031	- 0.007	- 0.011	0.001	0.009	0.002
	(0.014)**	(0.008)	(0.007)	(0.014)	(0.014)	(0.011)
Wage	- 0.122	- 0.061	- 0.086			
	(0.106)	(0.048)	(0.045)*			
Ln_Mwhs	0.121	0.024	0.025	0.883	0.850	0.853
	(0.008)***	(0.007)***	(0.007)***	(0.009)***	(0.021)***	(0.020)***
Estimation Procedure	OLS	GMM	GMM	OLS	GMM	GMM
Endogenous		*Deregulation*	*Deregulation*		*Deregulation*	*Deregulation*
Excluded Instruments		*Mc_Fuel*(-3), and *Der_Nei*.	*Ratio_Mfc*(-3) and *Der_Nei*.		*Mc_Fuel*(-3) and *Der_Nei*.	*Ratio_Mfc*(-3) and *Der_Nei*.
Instruments count		25	25		24	24
Hansen test		0.51	0.14		0.34	0.98
AR(2) in first differences test		0.52	0.11		0.05	0.17
R^2	0.37			0.97		
Number of obs.	8059	7429	7429	8059	7429	7429

Notes: 1. All specifications consider also *Scrubber* and *fixed plant and time effects*;
2. Robust standard errors in parentheses; the Windmeijer correction is applied to those in columns (2), (3), (5) and (6);
3. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.