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The Political Economy of (De)Regulation: Theory and Evidence from the US Electricity Industry.*

Carmine Guerriero
University of Bologna

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Abstract

The choice of whether to regulate firms or to allow them to compete is key. If the demand is sufficiently inelastic, competition entails narrower allocative inefficiencies but, also, smaller expected profits and, thus, weaker incentives to invest in cost reduction. Hence, deregulation should be found where cost reduction is less socially relevant and consumers are more politically powerful, and it should produce lower expected costs only when investment is not sufficiently effective. These predictions hold true under several alternative assumptions and are consistent with data on the deregulation initiatives implemented in 43 US state electricity markets between 1981 and 1999 and on the operating costs of the plants that served these markets. To illustrate, deregulation prevailed where the marginal fossil fuel cost and the inefficiency of fuel usage had been the lowest and politicians were the most pro-consumer. Moreover, GMM estimates imply that deregulation lowered labor and fossil fuel expenses by pushing the most efficient firms to serve the market, but it did not reduce the inefficiency of fuel usage. These results help rationalize the slowdown of the deregulation wave and are robust to considering the other key drivers of deregulation, i.e., costly long-term wholesale contracts and excessive capacity accumulation.
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JEL classification: L11; L51; L94; H11.

"Competition is not only the basis of protection to the consumer but is the incentive to progress. However, [. . .] destructive competition [. . .] may impoverish the producer and the wage earner" (Herbert Hoover, *States of the Union Address*, December 2, 1930).

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1 Introduction

Although the idea that competitive pressures help reach allocative efficiency to the detriment of investment-inducement has been discussed at length,[1] we lack a formal framework encompassing the trade-off between static and dynamic efficiency faced by a society choosing whether to deregulate an industry with inelastic demand and its link with political biases. Here, I develop such a model, and I employ it to provide an empirical strategy to structurally estimate the drivers and impact of deregulation, taking as case study the US power industry.

To elaborate, I build on Laffont and Tirole (1993) and Armstrong and Sappington (2006), and I compare competition and regulation in a world in which both market institutions and the regulatory contract are selected by a planner who maximizes a weighted average of the consumer surplus and the firms' utilities, with the weight on the latter rising with society's investment concerns. Before privately learning its marginal and average cost, which can be either high or low with the same ex ante probability, a firm can commit to an unobservable investment increasing the ex post probability of having low cost. Under competition, production is guaranteed by two firms. Each of them serves the entire market at the price proposed by the opponent when able to undercut it and half of it when the announced prices are the same. Under regulation instead, production is assured by a monopoly. Hence, the demand on which a firm makes a profit is larger under competition because the prevailing price equals the high cost, which is lower than the price necessary to assure incentive compatibility under regulation. Under competition, however, a firm realizes a profit only when its cost is low and that of the opponent is high and, thus, in default of investment, with probability 1/4, which is lower than the odds 1/2 with which a firm makes a profit absent investment under regulation. With inelastic demand, the impact on the expected profit of the larger chance of a rent that regulation entails is bigger than that of the larger demand on which the rent is obtained assured by competition. Hence, the latter entails narrower allocative inefficiencies but, also, smaller expected profits and, thus, weaker incentives to invest. Society's preferences for competition are, thus, stronger the less socially relevant cost

[1] While Schumpeter (1942) suggests that innovation by entrants destroys monopoly rents undermining the sustainability of capitalism, Vives (2008) shows that entry tends to decrease cost-reducing expenditures per firm. Similarly, Acemoglu et al. (2006) conclude that "monopolists appropriate only part of [the investment return]. Anticompetitive policies [then] encourage the investment-based strategy and may [foster] growth."

reduction is. If, instead, investment returns accrue more to the firm's profits than to the consumer surplus, a tension between shareholders and ratepayers arises, and the likelihood that competition is selected rises with the political power of consumers. Finally, since regulation yields a better cost distribution but competition makes it more likely that the most efficient firms serve the market conditional on such a distribution, competition induces lower expected costs only when investment is not sufficiently effective. Crucially, these implications survive for a generic probability of low cost, number of firms, and correlation between the costs of competing firms, under Cournot competition, for an implicitly motivated regulator, and when society can commit to reimburse investment expenses.

To evaluate the model predictions, I exploit data on the deregulation initiatives implemented in 43 US state electricity markets between 1981 and 1999 and on the operation of the generating plants that served these markets. This choice allows me to focus on institutions similar to those analyzed in the basic model and common to other major regulated markets (Barros and Maurer, 2011). On the one hand, electricity generation lacks the natural monopoly's cost structure typical of the distribution and transmission segments, but it serves an inelastic demand (Joskow, 2005). On the other hand, deregulation of the US power industry turned regulated local monopolies into markets offering competitive services at auction-based prices (Joskow, 2009).[2] To capture society's investment concerns, I posit that a state confronted with costs and/or inefficiencies of input usage larger than those of bordering states should be more willing to stimulate cost reduction (Guerriero, 2011; 2013), since even the most pro-consumer community prefers fostering profits and investment to facing the ratepayers' dissatisfaction. Following Fabrizio et al. (2007), I focus on fossil fuels because they are the most relevant inputs variable in the medium term.

Consistent with the model, Logit estimates reveal that deregulation was implemented where the marginal fossil fuel cost and the inefficiency of fuel usage had been the lowest and politicians were the most pro-consumer. Crucially, these results are not spuriously driven by the consumers' willingness to deregulate to deduct from prices the expenses driven

[2] Even if the terms 'deregulation' and 'restructuring' are sometimes used interchangeably, the former is more appropriate to describe the passage of the electricity supply chain in the hands of competing power plants, whereas the latter is more suited to depict the shift of the transmission regulation from a local to a regional scale (Joskow, 2009). The present paper is primarily concerned with deregulation initiatives.

by long-term wholesale contracts and investment in nuclear generation (White, 1996). To elaborate, I control for incentive regulation, share of divested plants, installed capacity, share of generation from nuclear sources, and the residential rate. Moreover, the message of the analysis is the same if I employ an Ordered Logit distinguishing between the decision to hold a hearing and that of legislating or if I study the timing of deregulation.

Building on these results on the drivers of deregulation and the autoregressive structure of the outcome equations, I use the marginal fossil fuel cost lagged three years and the share of bordering states that deregulated as excluded instruments for deregulation to identify its impact on input uses, the inefficiency of fuel usage, and the mark-up of the residential price over marginal costs. Consistent with the limited effectiveness of investment in the industry and conditional on plant and year fixed effects, GMM estimates suggest that deregulation lowered labor and fossil fuel expenses by pushing the most efficient firms to serve the market but it did not reduce the inefficiency of fuel usage. Crucially, the excluded instruments have no direct impact on outcomes and the analysis remains robust to the consideration of the other aforementioned drivers of deregulation. Ultimately, my results help rationalize the slowdown of the deregulation wave and, in particular, the passage of legislation freezing or repealing reforms in nine out of the 24 states that had deregulated by 2000 (Joskow, 2009).

Two are the strands of literature most closely related to the present paper. First, a recent literature on "endogenous market design" has also employed the mix of the allocative efficiency versus investment-inducement trade-off and political biases to explain the distribution of other key competitive pressures.[3] Building on similar foundations, I provide, instead, the first normative and positive analyses of the choice of whether to regulate firms or to allow them to compete in the presence of investment inefficiencies and inelastic demand. Second, a long stream of empirical research has tried to address the endogeneity of deregulation by either controlling for plant and time fixed effects (Fabrizio et al., 2007; Parker et al., 2008; Craig and Savage, 2013; Cicala, 2015) or using as excluded instruments political preferences (Zhang, 2007; Gugler et al., 2013). These identification strategies display two major problems. First, the fixed effects OLS estimator might grossly underestimate the cost

[3] While Duso and Röller (2003), Teske (2004), Knittel (2006), Potrafke (2010), and Lim and Yurukoglu (2018) report correlations consistent with this approach, Guerriero (2011, 2013) employs a model similar to mine to identify the drivers of the method of selecting regulators and of incentive rules in the US power industry.

reduction brought by deregulation because this reform is more likely in states that are less investment-concerned and, thus, exert a systematically small effort to optimize input uses and reduce the inefficiency of fuel usage. By relying on time-varying excluded instruments, I can tackle this issue. Second, political preferences might directly shape input uses (Besley and Coate, 2003) and employing them as excluded instruments would fail to expunge the endogenous component of deregulation. By relying on the lagged marginal fossil fuel cost and the deregulation of bordering states, I do not incur this simultaneity problem.

The paper proceeds as follows. First, I describe in section 2 the key facts about the deregulation of the US electricity industry to inform my general model of market design, which I illustrate in section 3. Next, I state the key model predictions in section 4, and I discuss my test in section 5. Finally, I conclude in section 6, and I report the tables (proofs, sample construction, data sources and supplementary results) in the (Internet) appendix.

2 Deregulating the US Electricity Industry

Starting from the 1907 shift from municipal to state regulation, the US electricity industry was dominated by vertically integrated investor-owned utilities—IOUs hereafter—operated as regulated monopolists over generation, transmission, and distribution of electricity within their localized geographic market (Knittel, 2006). Prices were determined by Public Utility Commissions—PUCs hereafter—at the firm level in order to assure a specific rate of return on investment after recouping accounting costs of service, i.e., cost-of-service regulation (Joskow, 1974). After decades of productivity growth and falling electricity prices, serious problems emerged during the 1970s, as fossil fuel prices, inflation, and interest rates rose (Joskow, 1974). On the one hand, PURPA pushed the less efficient IOUs to sign with the most cost-effective ones long-term wholesale contracts for energy (Joskow, 1989), which became in the 1980s a burden because of the continuously rising fossil fuel prices.[4] On the other hand, the interest rate payments related to the investments in alternative—particularly nuclear—generation technologies skyrocketed (Joskow, 2005). These two instances brought about both high electricity prices and a growing gap between the regulated rates and the

[4]The 1978 Public Utility Regulatory Policies Act was part of the National Energy Act and meant to promote greater use and conservation of domestic and renewable energy (Joskow, 1989).

value of generation in the regional wholesale markets, pushing the powerful industrial users to lobby for gradually stronger competitive pressures (White, 1996).[5]

In the attempt to enhance efficiency, many PUCs replaced, over the 1980s and the early 1990s, cost-of-service regulation with higher-powered regulatory incentive schemes obtaining, however, limited effects (Guerriero, 2013). Accordingly, the 1992 Energy Policy Act required consideration of opening up the wholesale markets to competition. Deregulation initiatives were launched by the state legislatures but discussed and ratified during quasi-judicial hearings (Joskow, 2005). Open to both IOUs and consumers, these proceedings were directed by the PUC commissioners, who first examined experts and received evidence and, then, specified "findings of fact" upon which the regulatory order was based (Joskow, 1974). To capture these features, I assume that the market institutions and the regulatory contract are selected by a planner who maximizes a weighted average of the firms' utilities and the consumer surplus. There is, moreover, a broad agreement that the goal of the deregulation hearings was to obtain a market design assuring "adequate, safe, reliable, and efficient energy services at fair and reasonable prices" [EIA 2003, p. 24]. Hence, I maintain that the weight on the firms' utilities rises with society's investment concerns and, when investment returns accrue more to the firm's profit than to the consumer surplus, with the political power of shareholders. This assumption captures the idea that, although the widest consensus is needed to approve reforms, politicians pander to their constituency (Joskow, 2005).

By 1998, every jurisdiction had launched deregulation hearings, and by 2000, almost half had approved legislation introducing some form of competitive retail access [Fabrizio et al., 2007]. In deregulated states, IOUs own a limited fraction of generation capacity and plants sell electricity through either auction-based spot markets or long-term contracts calibrated on the expected bids [Barros and Maurer 2011, p. 65-73]. "The promise was that [of] lower costs and lower average retail price levels [...] compared to regulated monopoly alternative, while maintaining or enhancing system reliability" [Joskow 2005, p. 37]. The reality, instead, has been one of "insufficient net revenues to support the capital costs of an efficient portfolio of generating facilities" [Joskow 2006, p. 2], and the majority of the

[5] Bradley (2018) suggests that politically connected IOUs, such as Enron, pushed in similar directions to feather their own nests. Albeit Craig (2016) provides correlations consistent with the interest group theory of deregulation, detailed lobbying data are needed to confirm such a conjecture.

generating capacity recently entered service was built by "municipal utilities that have not been subject to [deregulation]" [Joskow 2006, p. 28]. Hence, it is not surprising that almost half of the states that had deregulated by 2000 reacted to projections of shortages by local system operators and power supply emergencies by repealing legislation (Joskow, 2009).

3 Endogenous Market Design

To clarify the mix of the static versus dynamic efficiency trade-off and political biases, I first study the former by envisioning a benevolent planner and, then, I drop this assumption.

3.1 A Benevolent Planner

Preferences.—The representative consumer demand is $q(p) > 0$ for $p \in [0, \bar{p})$ and 0 for $p \geq \bar{p}$, and $q'(p) < 0$. Production is assured by either one monopoly under regulation or two firms under competition. While $q(p)$, p, and the cost distribution are common knowledge, the marginal and average cost c_i is observed only by the firm and equals either c_L or c_H with odds 1/2. Let $\Delta \equiv c_H - c_L > 0$. Under institution $j \in \{R, C\}$, a type $i \in \{L, H\}$ firm maximizes the rent U_i^j, which equals the profits $\pi(p_i, c_i) \equiv q(p_i)(p_i - c_i)$ plus a type-dependent governmental transfer $t_i \geq 0$ under regulation. The social welfare W^j equals the sum of the consumer surplus $S(p) = \int_p^{\bar{p}} q(x)\,dx$ and each firm's rent evaluated at $\alpha \in [0, 1)$ minus the transfer evaluated at the shadow cost of public funds $1 + \lambda > 1$, i.e., $W^R = S(p) + \alpha U_i^R - (1 + \lambda) t_i$ and $W^C = S(p) + \alpha \left(U_{i,1}^C + U_{i,2}^C\right)$, where I have emphasized the existence of two firms under competition. While λ originates, for instance, from distortionary taxation, α is strictly lower than one because of the focus of regulation on consumer welfare (Joskow, 1974).[6] I also assume that the expected social welfare is strictly concave and the demand is, as in the relevant empirical cases, inelastic:[7]

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

The timing.—Market design and production proceed according to the following timeline:

$t = 1$.—The planner selects institution j on the basis of the sum of the expected social

[6] $\alpha < 1$ can be turned into the milder condition $\alpha < 1 + \lambda$ (Armstrong and Sappington, 2006). Only the interpretation changes when the regulated firm is private, e.g., IOU. Then, t_i is the managerial reward and λ is the shadow cost of the managerial moral hazard constraint (Joskow and Schmalensee, 1986).

[7] For instance, Lijesen (2007) reports that the mean of previous estimates, based on peak and base load power, of the long (short) run elasticity of the residential demand is 0.39 (0.29).

welfare and a mean zero pro-regulation shock δ distributed on $[-\infty, \infty]$ with density f and CDF F. Under regulation, a regulator acting as a perfect agent of the planner offers the monopoly a menu of (t_i, p_i) pairs conditional on the firm's report on c_i but not on investment.

$t = 2$.—Under market design j, each firm commits to an unobservable investment I^j costing $\psi(I^j) > 0$ with $\psi' > 0$, $\psi'' > 0$, $\psi(0) = 0$ and $\lim_{I \to 1} 2\psi'(I^j) \geq S(c_L) - S(c_H)$. I^j raises the odds of c_L to $(1 + I^j)/2$. The firms' choices under competition are contemporaneous.

$t = 3$.—Each firm discovers its piece of private information, which is c_i.

$t = 4$.—Under regulation, the firm makes its report and the corresponding contract is executed. Under competition, the two firms bid a price, and the one offering the lowest price serves the entire market at the opponent's bid. In case of a tie, the market is evenly split.

Discussion.—To evaluate the generality of the setup, several remarks should be borne in mind. First, considering the ex ante case in which the market is designed before each firm discovers its type is justified by the sizable uncertainty over the cost structure typical of regulated markets (Auriol and Laffont, 1992; Laffont and Tirole, 1993). Second, focusing on a monopoly instead of a duopoly and assuming that the monopolist pre-exists to the market design is consistent with the empirically relevant case of deregulation.[8] Third, since cost reduction is financed through the expected rent, α is a measure of society's dynamic efficiency concerns (Guerriero, 2011; 2013). Fourth, δ captures determinants of market design unrelated to technology and political biases, like generalized trust (Aghion et al., 2010). Fifth, I treat investment as non-monetary—e.g., effort in managing more efficiently a plant, but the model extends to monetary investments (see the Internet appendix). Finally, the gist of the model will be unaffected should the ex ante correlation between types be positive (see footnote 9), the probability of low cost be generic (see footnote 10), the regulator be career-concerned, society be able to commit to reimburse investment costs, the number of competing firms be generic, and under Cournot competition (see the Internet appendix).

[8] Because of the sampling and yardstick competition effects driven by the ex post type correlation, a duopoly delivers a static (dynamic) efficiency higher (lower) than that assured by a monopoly [Auriol and Laffont 1992, p. 510-521]. Auctioning the exclusive right to serve the market, instead, leaves unchanged (decreases) the extent of static (dynamic) efficiency of regulation [Laffont and Tirole 1993, p. 307-322]. Finally, the dynamic advantage of regulation over competition rises with fixed costs since they are duplicated under competition, whereas it falls with stranded costs, which discourage investment (Laffont and Tirole, 1993).

3.1.1 Regulation Versus Competition: Static Efficiency

Regulation.—As Laffont and Tirole (1993) and Vives (2008), I focus on symmetric pure strategy equilibria. Starting with regulation, the planner dislikes leaving a rent to the firm and prefers to let both types produce. Hence, the regulator offers type-dependent price-transfers pairs such that the firm truthfully reports a $c_i = c_L$—i.e., $q(p_L)(p_L - c_L) + t_L = q(p_H)(p_H - c_L) + t_H$—and operates if $c_i = c_H$, i.e., $U_H^R = 0$. Hence, a c_L-type enjoys an informational rent $U_L^R = \Delta q(p_H)$ (Myerson, 1979), and the expected social welfare equals

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

where $w_i(p_i, c_i) = S(p_i) + (1 + \lambda)\pi_i(p_i, c_i)$ and I made explicit that the regulator anticipates $\hat{I}^R$. To limit the c_L-type's rent, the regulator reduces the c_H-type's allocation compared to the full information optimum obtaining the expected social welfare he would get was the firm's cost observable but its higher realization equal $\hat{c}_H \equiv c_H + \frac{1+\hat{I}^R}{1-\hat{I}^R}\left(1 - \frac{\alpha}{1+\lambda}\right)\Delta$. No distortion is needed if the report is c_L, since there is no incentive to under-report. Thus, the price maximizes $w_L(\cdot)$ for cost c_L and $w_H(\cdot)$ for cost $\hat{c}_H$. Hence, $p_L = c_L$ and p_H equals $\hat{c}_H$, which tends to the monopoly price if λ is large and, thus, transfers entail large social costs. The expected social welfare under regulation can, then, be rewritten as

$$W^R = (1/2)\left(1 + \hat{I}^R\right) S(c_L) + (1/2)\left(1 - \hat{I}^R\right) S(\hat{c}_H).$$

In the following, I assume that $\bar{p} > \hat{c}_H$ for concreteness and $\lambda = 0$ for simplicity. This last restriction can be easily eliminated as illustrated in the Internet appendix.

Competition.—Because of the Vickrey auction-type structure of competition, truth-telling is the only symmetric pure strategy equilibrium since a c_H-type strictly prefers to bid c_H, whereas playing c_L is a c_L-type's best response to an opponent with high cost and exhausts its incentives to undercut an opponent with low cost. To see why this is the case, notice that the expected profit of a c_L-type playing $p_L < c_H$ equals $\frac{1+\hat{I}^C}{4} q(p_L)(p_L - c_L) + \frac{1-\hat{I}^C}{2} q(c_H)\Delta$. Overall, the equilibrium price equals c_H except when both firms have low cost, and a firm enjoys a profit only when its type is c_L and the opponent's one is c_H. This happens with probability $(1/4)\left[1 - \left(\hat{I}^C\right)^2\right]$. The expected social welfare under competition is then

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

3.1.2 Regulation Versus Competition: Dynamic Efficiency

$\hat{I}^R$ maximizes the expected firm's rent $E\left(U_i^R\right)$ minus investment costs $\psi\left(I^R\right)$, i.e.,

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

where the dependence of $\hat{c}_H \equiv c_H + \frac{1+\hat{I}^R}{1-\hat{I}^R}(1-\alpha)\Delta$ on $\hat{I}^R$ and not I^R incorporates the lack of regulatory commitment (see Laffont and Tirole [1993], p. 101). Similarly,

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

Two are the key observations. First, $0 < \hat{I}^j < \hat{I}^{j,*} < 1$, where each socially optimal $\hat{I}^{j,*}$ maximizes the expected social welfare less investment costs under full information and regime j. Second, the extent of underinvestment is wider under competition. To elaborate, a competitive firm obtains a positive mark-up on a larger demand—i.e., $q\left(c_H\right) > q\left(\hat{c}_H\left(\hat{I}^R\right)\right)$—but less often—in half of the cases for $\hat{I}^C = \hat{I}^R = 0$—compared to a regulated one.[9] Yet, the larger probability of getting a rent, which is akin to a change in price, more than compensates the fall in demand because of assumption A1. As a consequence, $\hat{I}^R > \hat{I}^C$. This gap is widened by the mix of the ex post correlation between costs and the strategic complementarity of pricing decisions under competition (see also Vives, [2008]).

3.1.3 The Static Versus Dynamic Efficiency Trade-Off

In $t = 1$, competition is chosen when $W^C > W^R + \delta$ that, for $\delta = 0$, can be rewritten as

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

Under regulation, a rise in α has a triple impact on W^R. First, it increases the ex post probability of c_L by raising $\hat{I}^R$. This positive impact on W^R is the "investment-enhancing" effect of a rise in α on market design. Second, as α rises, allocative inefficiencies fall—

[9] Should the ex ante correlation between types be $\sigma > 0$, my results will survive since the rent falls with σ and, thus, it will be even smaller than that prevailing in the basic setup in which $\sigma = 0$.

i.e., $\hat{c}_H$ goes down—because of the larger social value of the firm's rent. This positive impact on W^R is the "distortion-curbing" effect of a rise in α on market design. Third, allocative inefficiencies become more necessary due to the more favorable cost distribution. This negative impact on W^R is the "distortion-enhancing" effect of a rise in α on market design. Under competition instead, a rise in α entails a greater social value of the firm's profit but does not affect investment, which differently from regulation is picked to maximize a function of its private—and not social—returns. This positive impact on W^C is the "profit-value" effect of a rise in α on market design. While the investment-enhancing effect is larger than the distortion-enhancing one because of the inelastic demand, the distortion-curbing effect is larger than the profit-value one if investment is sufficiently effective. Overall, a rise in α makes regulation more socially valuable under the following sufficient condition, which can be relaxed at the cost of more cumbersome algebra:[10]

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

Market design becomes, then, an indirect instrument to solve dynamic inefficiencies and:[11]

Proposition 1: *Under assumptions A1 and A2, the probability that competition is chosen—i.e., $F\left(W^C - W^R\right)$—falls with society's investment concerns α.*

This belongs to those findings suggesting that institutions curbing rent-extraction can be optimal when investment-inducement is socially relevant (Sappington, 1986; Guerriero, 2011, 2013). This implication also applies to communities less culturally inclined to accept that some citizens gain from investment, provided that the local technology is sufficiently less efficient than those of adjacent jurisdictions. Indeed, even the most pro-consumer community prefers fostering profits and investment to facing the ratepayers' dissatisfaction.

3.1.4 Relationship With the Evolution of the US Electricity Industry

Proposition 1 is consistent not only with the estimates illustrated in section 5 but, also, with the evidence on other competitive pressures experimented in the US electricity industry.

[10] All the model results remain unaffected when the probability of $c = c_L$ is the generic value $(1+v)/2$ since, then, $\hat{c}_H$ equals $c_H + \left(1+\hat{I}^R\right)\left(1-\hat{I}^R\right)^{-1}(1+v)(1-v)^{-1}(1-\alpha)\,\Delta$.

[11] Examples of direct mechanisms fostering investment in both capacity and reliability are "energy-only" markets, long-term on-bill investment financing, and performance metrics monitoring (Kelly and Rouse, 2011). Although these policies might reduce the extent of under-investment under competition, they are very costly, if not impossible, to implement in excessively pro-consumer societies as the USA (Joskow, 2005).

First, the beginning of the 1900s reforms from a municipal regulation with its hold-up problems to a fair rate of return state regulation were implemented first where capacity shortages were most severe (Knittel, 2006). Second, Guerriero (2011) documents that, between 1960 and 1997, appointment, which curbs the regulators' incentives to discover the firm's cost raising its rent, was embraced by the states characterized by the largest generation costs. Finally, Guerriero (2013) shows that, between 1981 and 1999, more powerful incentive contracts, limiting allocative inefficiency and rent extraction, were signed by IOUs operating in states where marginal costs and prices were higher than those of neighboring ones.

3.2 The Political Economy of Market Design

A tension between shareholders and ratepayers arises when investment returns accrue more to the firm's rent than to the consumer surplus, e.g., marketing. Then, market design can be distorted by political biases. To clarify the point in the sharpest way, I consider an investment possibly implemented after $t = 4$, costing $\bar{I} > 0$, raising the firm's ex post rent—but not the consumer surplus—of $\bar{\beta}\bar{I}$ with probability μ and zero otherwise, and affected by an aid fixed by a political party possibly different from the planner.

Setup.—To elaborate, the timing is augmented with two periods:

$t = 5$.—The planner $\tilde{m}$, who is either the pro-shareholder party s or the pro-consumer party r and has selected institution j in $t = 1$, faces an election with exogenous winning probability $x_{\tilde{m}}$. Next, the winner of the election $m \in \{s, r\}$ implements an aid equal to $\rho_m > 0$ times the firm's rent and paid out to the firm after the investment is undertaken.

$t = 6$.—The firm possibly commits to the investment.

The firm has no wealth to post as a bond in the case of unsuccessful investment except the ex post rent, which is now $(1 + \rho_m)\,\hat{U}_i^R$. The ex post rent, however, is initially illiquid and can only be pledged as collateral against borrowing $\bar{I}$. The debt contract is such that the lender receives a payment $\tau\bar{I}$ in the case of a successful project and a collateral $\underline{\beta}\bar{I} > 0$, with $\bar{\beta} > \tau > \underline{\beta}$, otherwise (Besley and Ghatak, 2010). Thus, only the c_L-type invests if the limited liability constraint $(1 + \rho_m)\,\hat{U}_i^R - \underline{\beta}\bar{I} \geq 0$ is satisfied and if the lender agrees—i.e., $\mu\left(\bar{\beta} - \tau\right)\bar{I} - (1 - \mu)\,\underline{\beta}\bar{I} \geq 0$ and $\mu\tau\bar{I} + (1 - \mu)\,\underline{\beta}\bar{I} \geq \bar{I}$, which are both true if $\bar{\beta} \geq \mu^{-1}$. As a result, in $t = 1$ the planner evaluates the investment aid $\rho_m\hat{U}_i^R$ at $1 + \lambda$ and the

limited liability constraint at $1 + \chi_{\tilde{m}}$, where $\chi_{\tilde{m}}$ captures his willingness to boost ex post investment. Finally, to ease the exposition, I assume that $\lambda > 0$, that the firm picks $\hat{I}^R$ without considering ex post investment,[12] and that the exogenous parameters are such that:
A.3: $\rho_s > \rho_r$; $\chi_s > \lambda > \chi_r$; $\bar{\beta}\mu \geq 1$.

Discussion.—A handful of observations help stress the solidity of this simple setup. First, the aid technology incorporates into the setup the huge transfers from the federal and state governments to IOUs, financed through distortionary taxes (Metcalf, 2008).[13] Second, at the cost of a more cumbersome algebra, my results will be similar should investment decisions be continuous. Third, the assumption that the winning party cannot reform the market institution captures the commitment period typical of regulation (Guerriero, 2013). Fourth, the exogeneity of $x_{\tilde{m}}$ matches the idea that regulation is bundled at election with more salient policies (Besley and Coate, 2003). Finally, the hypothesis that the pro-shareholder party is more willing to subsidize investment expenses is consistent with politicians' strategic incentives to adopt extremist platforms to empower their supporters (Guerriero, 2011).

Equilibrium.—For $\delta = 0$ and $\tilde{x} \equiv \rho_r x_r + \rho_s x_s$, a $\tilde{m}$ planner picks competition if

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

$$\Delta\left[\left(1+\chi_{\tilde{m}}\right)\left(1+\tilde{x}\right) - \left(1+\lambda\right)\tilde{x}\right]\left\{\left(1+\hat{I}^R\right)q\left(\hat{c}_H\right) - \left[1 - \left(\hat{I}^C\right)^2\right]q\left(c_H\right)\right\}. \qquad (4)$$

The expected firm's rent is again smaller under competition, and the following pattern arises:

Proposition 2: *Under assumptions A1, A2, and A3, the odds that competition is selected fall with the planner's hold on power $x_{\tilde{m}}$ and are smaller if he is pro-shareholder.*

This result originates from the mix of the asymmetry in the parties' preferences and the uncertainty of elections, and it is similar to the strategic dynamics proposed by a lively political economy tradition (Hanssen, 2004). To illustrate, a higher probability of being re-elected and, then, fixing a larger (smaller) aid, without facing a new market reform, pushes a pro-shareholder (consumer) planner to value regulation more because of the even larger rent accruing to his constituency (prospect of underinvestment). This incentive can drive

[12] Should this restriction be eliminated, $\hat{I}^R$ will be higher and the gist of the model will remain the same.

[13] The model results are unaffected when the government acts as a sponsor and augments the ex post firm's rent without monetary aids if $\chi_s > 0 > \chi_r$, or when it can lower cost-reducing investment expenses provided that the additional dynamic efficiency concerns more than outweigh the extra rent-extraction needs.

inefficient reforms and, for instance, a pro-consumer party to prefer competition despite the prospect of sizable dynamic inefficiencies. Crucially, the normative conclusions summarized in propositions 1 can be also derived from the positive analysis synthesized in inequality (4).

3.2.1 Relationship With the Evolution of the US Electricity Industry

Proposition 2 not only matches the evidence discussed in section 5 but, also, that on other competitive pressures experimented in the US electricity industry. First, state regulation was favored by stronger residential consumer interests, i.e., lower penetration rates among residential users (Knittel, 2006). Second, Guerriero (2011) shows that PUC commissioners are elected when consumers are more politically powerful. Finally, Guerriero (2013) documents that, under the very same circumstances, less powerful incentive rules are selected.

4 Testable Predictions

The mix of the static versus dynamic efficiency trade-off and political biases implies, then, the following testable prediction on the determinants of market design:

Prediction 1: *The likelihood of deregulation decreases with society's dynamic efficiency concerns and with the incumbent's hold on power, and it is smaller when he is pro-shareholder.*

Since regulation yields a better cost distribution but, conditional on types, competition leads the most efficient firms to serve the market, deregulation lowers expected costs if

$$\left[2\frac{1-\left(\hat{I}^C\right)^2}{4}+\frac{\left(1+\hat{I}^C\right)^2}{4}\right]c_L+\frac{\left(1-\hat{I}^C\right)^2}{4}c_H<\frac{1+\hat{I}^R}{2}c_L+\frac{1-\hat{I}^R}{2}c_H, \tag{5}$$

which must be the case for $\frac{1-2\left(\hat{I}^R-\hat{I}^C\right)-\left(\hat{I}^C\right)^2}{4}(c_L-c_H)<0 \leftrightarrow \hat{I}^R<(1/2)\left[1+2\hat{I}^C-\left(\hat{I}^C\right)^2\right]$. This inequality holds true if ψ' is not too small and α not too large, i.e., investment is not sufficiently effective because of sizable marginal investment costs and society's limited investment concerns. Both features represent two key characteristics of the US electricity industry as suggested by its suboptimal technological speed (Margolis and Kammen, 1999) and a regulatory focus on keeping prices from increasing (Joskow, 1974). Building on this remark, the second testable prediction deals with the link between market design and outcomes:

Prediction 2: *Compared with regulation, competition limits allocative inefficiencies given the initial cost distribution, without, however, improving such distribution over time.*

Next, I test both predictions in turn, employing US electricity industry data.

5 Evidence

To control for the other post-1980 competitive pressures, I focus on the 1981-1999 period. In addition, I exclude the District of Columbia and seven states since, for these jurisdictions, I do not always observe political biases and/or outcomes. Hence, I study the drivers of deregulation by using a balanced panel of 43 states s spanning each year t between 1981 and 1999, whereas I assess the impact of the market design by analyzing an unbalanced panel of 503 plant-epochs p observed in the aforementioned 43 states between 1981 and 1999 for a total of 8,059 yearly data points. Plant-epochs are obtained by assigning a new identifier to each combined-cycle gas and steam turbine power plant surveyed by FERC in the 43 states when its capacity changed more than 40 MW or 15 percent (Fabrizio et al., 2007).

5.1 Endogenous Deregulation

Testing prediction 1 requires to both measure deregulation and its determinants and select an appropriate model of the probability of deregulation.

5.1.1 Measuring Deregulation

As suggested by Fabrizio et al. (2007), IOUs acted before legislation altering their behaviors soon after the deregulation hearings. Therefore, I capture the shift from a regulated to a competitive market design with the dummy *Deregulation*, which equals one for states or IOU plants in states that deregulated, beginning in the year of the first deregulation hearing. To evaluate the possibility that utilities did not respond until legislation, I perform the following two robustness checks. First, I substitute *Deregulation* with the dummy *Law*, which turns on in the year the state passed legislation. Second, I consider the indicator *Deregulation-O*, which equals 3 beginning in the year of legislation, 2 beginning in the year of the first deregulation hearing, and 1 otherwise. The results of both checks are consistent with the testable predictions (see the Internet appendix and section 5.1.5, respectively).

5.1.2 Measuring the Determinants of Deregulation

To capture society's investment concerns, I assume that a state confronted with marginal costs and/or inefficiencies of input usage that are larger than those of bordering states should be more willing to stimulate cost reduction to catch up (see Guerriero, [2011; 2013]), and I focus on fossil fuels because they are the key inputs variable in the short and medium run covered by my sample (Fabrizio et al., 2007). To alleviate the possible issues of the endogeneity of these proxies moreover, I consider them lagged three years. The rationale of this choice is as follows. First, market design at time t is a function of the ex ante cost distribution, which is extracted during deregulation hearings from the costs observed in $t-1$ (Joskow, 2009). Second, I document below that the outcome equations display an AR(1) structure (see section 5.2.1). Together these two remarks imply that instruments related to input uses and costs are exogenous only if lagged three years or more. I consider the: 1. arithmetic mean—i.e., average thereafter—of the marginal fossil fuel cost in cents per Kwh, i.e., *Mc-Fuel*; 2. average of the BTUs of fossil fuels necessary to produce one MWh—i.e., *Heat-Rate*,[14] which captures inefficiencies of fuel usage; 3. ratio of the average marginal fossil fuel cost to the average of the marginal fossil fuel costs in the bordering states, i.e., *Ratio-Mfc*; 4. ratio of the average heat rate to the average of the heat rates in the bordering states, i.e., *Ratio-Hr*. *Mc-Fuel* and *Heat-Rate* allow the comparison of a state with the rest of the Union, whereas the other two proxies take as reference group the bordering states (see table 1 for a summary of all variables). The gist of my analysis will survive, should I substitute the arithmetic mean of either the marginal fossil fuel cost or the heat rate in the bordering states with their average weighted by population size (see the Internet appendix).

Turning to political biases, a large body of literature claims that the Republicans have been more attentive to the shareholders' interests (Teske, 2004). Yet, it is also true that there are more shareholders of firms buying electricity than there are of firms selling it and, thus, Republican politicians might be more interested in safeguarding the industrial consumers' welfare than in maximizing the firm's profits. Hence, I consider a dummy that turns on if both state legislatures were under the Republicans' control, i.e., *Republican*. Regarding the incumbent's hold on power, I follow Hanssen (2004), and I consider a variable equal to the

[14] A key avenue for future research is to consider output-specific scale efficiency measures (Walheer, 2018).

share of seats held by the majority party averaged over state legislatures and to 0 when no party holds the relative majority in both state legislatures, i.e., *Majority*. If regulation is not salient at elections (Besley and Coate, 2003), both *Republican* and *Majority* are exogenous. Finally, the diffusion of a new institution displays distinctive imitation patterns whereby a reform in one jurisdiction should shift support in the neighboring jurisdictions, without affecting performance before implementation (Teske, 2004). To capture this exogenous process, which produces a second exclusion restriction in testing prediction 2, I consider the share of bordering states that deregulated, i.e., *Deregulation-B*. My results will be similar should I switch to *Deregulation* either averaged over bordering states and weighted by their population size or averaged over all other states (see the Internet appendix).

5.1.3 Model Selection

By linearizing inequality (4) and decomposing the shock δ in an idiosyncratic component $\delta_{s,t}$ less a state-specific term c_s, endogenous market design is described by

$$Pr\left(Deregulation_{s,t} = 1 \mid c_s, \mathbf{X}_{s,t}, \mathbf{Z}_{s,t}\right) = F\left(c_s + \mathbf{X}'_{s,t}\mathbf{\Gamma} + \mathbf{Z}'_{s,t}\mathbf{\Lambda}\right), \tag{6}$$

where c_s captures unobserved time-invariant drivers of market design, $\mathbf{X}_{s,t}$ incorporates the proxies for the strength of society's investment concerns and the political biases, $\mathbf{Z}_{s,t}$ gathers *Deregulation-B* and possibly the extra controls discussed below, and F is assumed Logistic. I estimate equation (6) by either a Logit model, which forces the c_s to be equal across s, or a random effects—RE—Logit model,[15] which requires that $c_s \mid \mathbf{W}_s \sim N\left(0, \sigma_c^2\right)$, where $\mathbf{W}_s$ is the union of $\mathbf{X}_{s,t}$ and $\mathbf{Z}_{s,t}$. This strategy is supported by the following two pieces of evidence. First, I never reject the null hypothesis of the Hausman test of the RE versus the fixed effects—FE—Logit model—i.e., unobserved state effects are uncorrelated with the regressors—at a level nowhere lower than 0.99 (see table 2). Second, I never reject the null hypothesis of the Hausman test that the Logit—and not the FE Logit—model is appropriate at a level nowhere lower than 0.61 (see table 2). These patterns are driven by the loss of 336 observations in the computation of the conditional FE Logit model likelihood.

[15] While the FE Probit model delivers inconsistent estimates because of the large s and small t (Greene, 2018), my conclusions are similar if I switch to either a Probit or a RE Probit (see the Internet Appendix).

5.1.4 Main Results

While columns (1) to (4) of table 2 report the estimates of the Logit model, columns (5) to (8) list those of the RE Logit model. For ease of interpretation, I focus on the Logit model marginal effects, which give the percentage change in the likelihood of *Deregulation* when a control rises by one percentage point, and the RE Logit model coefficients. Both are consistent with prediction 1, and the implied effects are large. Starting with the impact of society's dynamic efficiency concerns, the likelihood of deregulation falls by: 1. 16.6-percentage-points as a result of a one-standard-deviation rise in *Mc-Fuel*(-3); 2. 3.6-percentage-points as a consequence of a one-standard-deviation increase in the lagged average heat rate; 3. 8.2-percentage-points as *Ratio-Mfc*(-3) increases by one-standard-deviation; and 4. 7-percentage-points as *Ratio-Hr*(-3) rises by one-standard-deviation. These coefficients are significant at 1 percent. The estimates of the RE Logit model deliver a similar message, although the coefficients are less significant. More mixed is the evidence on the role of political biases. The planner's hold on power tends to decrease the likelihood of deregulation as expected, whereas the sign of the coefficient on *Republican* is consistent with prediction 1 only if one is inclined to think that industrial consumers were politically stronger than IOUs (Joskow, 2005). Finally, deregulation was driven by the decisions of bordering states.

5.1.5 Robustness Checks

The Internet appendix gathers the following battery of robustness checks.

First, the gist of the analysis stands when I include in $\mathbf{Z}_{s,t}$ either stepwise or all together year dummies controlling for countrywide shocks and changes in federal policies and the five drivers of deregulation most discussed by the extant literature.[16] The first one is a dummy for whether a state adopted incentive regulation, i.e., *PBR*. These reforms have granted a larger rent to the firm inducing less stringent society's dynamic efficiency concerns (Guerriero, 2013). The other four controls capture the idea that deregulation was implemented where regulated prices were high and most exceeded the value of electricity in the wholesale markets (White, 1996). They are the: 1. share of plants divested because of deregulation; 2. capacity

[16] To illustrate, I consider them lagged three years to tackle their possible endogeneity, and I capture society's investment concerns with its most powerful proxy, i.e., *Mc-Fuel*. Similar patterns arise when I turn to the other proxies for society's dynamic efficiency concerns (results available upon request).

in MW; 3. share of generation from nuclear sources; 4. residential price in cents per Kwh.

Second, the message of the empirical exercise is consistent with prediction 1 if I analyze the ordered competitive pressure indicator *Deregulation-O* via the Ordered Logit estimator.

Third, I document that the results of my analysis are qualitatively similar when I study, instead, the timing of deregulation by running Exponential Survival models.

Finally, I show that the analysis is quite similar when the errors, instead of being robust to generic heteroskedasticity and serial correlation, allow for clustering by state.

5.1.6 Implications

Ultimately, table 2 suggests that regulation was retained where the need to accommodate investment concerns was sufficiently pressing and the consumers' political power weak enough. This interpretation aligns with both anecdotal and empirical evidence on the underinvestment in the industry between the oil crises of the 1970s and the deregulation phase (Joskow, 1974; Margolis and Kammen, 1999), and it implies that the distribution of the design of the electricity market across US states is not random. Therefore, estimates produced by OLS regressions of outcomes on deregulation will be inconsistent, and the key challenge of the following tests of prediction 2 is to properly address endogeneity issues.

5.2 Endogenous Market Design and Outcomes

Testing prediction 2 requires measuring the efficiency of a single-output plant and its drivers and selecting an appropriate model of the effect of deregulation on such an outcome.

5.2.1 Measurement and Model Selection

I embrace a two-step strategy. First, I follow Fabrizio et al. (2007), and I evaluate whether deregulation pushed the plants to use the best mix of inputs variable in the short and medium run given their prices. Second, I follow Craig and Savage (2013), and I test whether the usage of fossil fuels became more efficient and, more generally, whether investment incentives—as captured by the mark-up of price over marginal costs—raised after deregulation.

Starting from my first test, I assume, for concreteness and to compare my results with the extant empirical literature (Fabrizio et al., 2007), that the constant returns to scale production function considered in the model is, indeed, a Cobb-Douglas function of the technological parameter $A_{p,j,t}$, labor $L_{p,j,t}$ and fossil fuel $F_{p,j,t}$, i.e., $A_{p,j,t}L_{p,j,t}^{\gamma}F_{p,j,t}^{\eta}$ with $\gamma + \eta = 1$. This hypothesis also reflects the fact that while fuel inputs are varied in response to real-time dispatching and operational changes and staffing can be adjusted over the medium run, capital is chosen at the time of the plant's construction and should, then, be considered as fixed (Fabrizio et al., 2007). Therefore, p will minimize, in t and under regime j, the total costs $W_{p,j,t}L_{p,j,t} + S_{p,j,t}F_{p,j,t}$, given wages $W_{p,j,t}$ and fossil fuel prices $S_{p,j,t}$, and subject to the technological constraint $Q_{p,j,t} \leq A_{p,j,t}L^{\gamma}_{p,j,t}F^{\eta}_{p,j,t}$ evaluated at its shadow value $\xi_{p,j,t}$. Solving this program yields the factor demands $L_{p,j,t} = (\xi_{p,j,t}\gamma Q_{p,j,t})\, W^{-1}_{p,j,t}$ and $F_{p,j,t} = (\xi_{p,j,t}\eta Q_{p,j,t})\, S^{-1}_{p,j,t}$. By taking logs of both sides and adding an error term, divided in a plant-epoch α_p, a deregulation-specific ϕ_j, a time β_t and an idiosyncratic $\varepsilon_{p,j,t}$ component, I can rewrite the outcome regressions as $\ln(L_{p,j,t}) = \theta^L_1 \ln(Q_{p,j,t}) + \theta^L_2 \ln(W_{p,j,t}) + \alpha^L_p + \phi^L_j + \beta^L_t + \varepsilon^L_{p,j,t}$ and $\ln(F_{p,j,t}) = \theta^F_1 \ln(Q_{p,j,t}) + \alpha^F_p + \phi^F_j + \beta^F_t + \varepsilon^F_{p,j,t}$, where $\ln(S_{j,t})$ is encapsulated in β^F_t having no plant variation. ϕ^L_j and ϕ^F_j could, then, reflect systematic changes in the productivity of the inputs γ and η, in the cost-reduction parameter $A_{p,j,t}$, in the shadow value of the availability constraint $\xi_{p,j,t}$ due to allocative distortions, or in the optimization error $\varepsilon_{p,j,t}$.

Turning to my second test, by linearizing the expressions for $\hat{I}^j$ and $E\left(U^j_i\right)$ and adding an error term akin to the one just discussed, I can rewrite the equations for the inefficiency of fuel usage and the mark-up of price over marginal costs in regression format as $\ln(H_{p,j,t}) = \alpha^H_p + \phi^H_j + \beta^H_t + \varepsilon^H_{p,j,t}$ and $M_{p,j,t} = \alpha^M_p + \phi^M_j + \beta^M_t + \varepsilon^M_{p,j,t}$, respectively.[17] Here, two remarks are key. First, the distribution of the two dependent variables suggests that only $H_{p,j,t}$ should be logged. Second, both efficiency measures depend on expected costs and quantity, but they are selected—at time $t = 2$—before types—i.e., $W_{p,j,t}$ and $Q_{p,j,t}$—are realized and, thus, these features are encapsulated in the plant-epoch and time error components.

Overall, I test prediction 2 by running equations of the type

$$O_{p,j,t} = \theta^O_1 \ln(Q_{p,j,t}) + \theta^O_2 \ln\left(P^O_{p,j,t}\right) + \mathbf{Z}'_{p,j,t}\mathbf{\Psi^O} + \alpha^O_p + \phi^O_j + \beta^O_t + \varepsilon^O_{p,j,t}, \tag{7}$$

where $O_{p,j,t}$ can be either the log of the number of employees $\ln(L_{p,j,t})$—i.e., *Ln-Emp*, the log of the BTUs of fossil fuel consumption *Ln-Btu*—i.e., $\ln(F_{p,j,t})$, the log of the heat rate

[17] While $E\left(U^j_i\right)$ equals the first term of the objective functions in problems (1) and (2), $\hat{I}^R$ and $\hat{I}^C$ are implicitly defined by $\psi'\left(\hat{I}^R\right) = \frac{\Delta q(\hat{c}_H)}{2}$ and $\psi'\left(\hat{I}^C\right) = \left(1 - \hat{I}^C\right)\frac{\Delta q(c_H)}{4}$, respectively (see the Internet appendix).

Ln-Hr—i.e., $\ln(H_{p,j,t})$, or the mark-up of the residential price over the sum of the marginal fossil fuel and labor costs in cents per Kwh *Mark-Up*, i.e., $M_{p,j,t}$. While $Q_{p,j,t}$ labels the net generation in MWh, $\mathbf{Z}_{p,j,t}$ gathers a FGD scrubber dummy, as in Fabrizio et al. (2007), and the drivers of deregulation that cannot be excluded by equation (7). These are *Republican* and *Majority* since, although political preferences should not affect simultaneous market design (Besley and Coate, 2003), they might shape simultaneous input uses. Finally, base differences in input uses are embedded in the plant-epoch effects α_p^O, ϕ_j^O labels *Deregulation* and the year effects β_t^O pick up macro and input price shocks and changes in federal policies.

I estimate equation (7) by either OLS or by two-step difference GMM with ϕ_j^O treated as endogenous. Here, the challenge is to avoid too many instruments because their count tends to explode with the number of years and too many moment conditions can fail to expunge the endogenous component of *Deregulation* and can weaken the power of the overidentifying restrictions test (Roodman, 2009). Therefore, I use as excluded instruments *Mc-Fuel* lagged three years and the exogenous imitation process captured by *Deregulation-B*, and I collapse the moment conditions to have only one instrument column per year. Because $\varepsilon_{p,j,t}^O$ shows first-order serial correlation but not greater-order ones (see table 3) and it is lagged one year in the differenced specifications, *Mc-Fuel*(-3) is exogenous.

Ultimately, my empirical strategy displays three key advantages over those embraced by the extant literature. First, it more credibly addresses the endogeneity of *Deregulation.* On the one hand, the fixed effects OLS estimator might grossly underestimate the cost reduction brought by deregulation because this reform is more likely in states that are less investment-concerned and, thus, exert a systematically small effort to optimize input uses and reduce the inefficiency of fuel usage. By relying on time-varying excluded instruments, I am able to address this issue. On the other hand, political preferences might directly shape input uses (Besley and Coate, 2003) and employing them as excluded instruments would fail to expunge the endogenous component of deregulation. By focusing on the lagged marginal fossil fuel cost and the deregulation of bordering states, I do not incur this simultaneity problem. Second, when compared with 2SLS, a GMM approach minimizes the loss of observations attributable to gaps in the panel,[18] and it produces estimates easier to correct in small

[18]There are 127 observations lost in table 3 because of gaps in the panel.

samples (Windmeijer, 2005). Finally, using a two-step, instead of a one-step approach, and relying on the difference, instead of the system, estimator turn out to be choices irrelevant to the gist of my empirical analysis. Collapsing the moment conditions is, however, key to assure the strongest first-stages and an instrument count below the number of cross sections, which is the rule of thumb that Roodman (2009) suggests (see the Internet appendix).

5.2.2 Main Results

Table 3 compares OLS and GMM estimates of equation (7). There are two key observations. First, as expected, OLS tend to greatly underestimate the cost reduction brought by deregulation. To illustrate, the implied percentage reduction in labor (fossil fuel) input use rises from roughly 3 to 12 (0 to 14) percentage points switching to GMM, and it is always significant at 10 percent or better. Second, deregulation has no significant impact on either the heat rate or the mark-up whether or not the endogeneity of market design is considered.

The consistency of the estimates is confirmed by the following two results. First, the Hansen test, which is the appropriate one with robust standard errors, does not reject the overidentifying restrictions at a level nowhere lower than 24%. These results are in tune with the estimates of the semi-reduced-forms, which explicitly address the concern that the excluded instruments might affect outcomes through channels other than *Deregulation* by including either of the two in both the second- and first-stage regressions (see the Internet appendix). Second, consistent with the validity of the exclusion restriction, the differenced residuals do not display autocorrelation of order three or higher—i.e., up to seventeen—where eighteen is the number of yearly observations in the differenced data. To save space, I only report in table 3 the p-values of the tests of no autocorrelation in the first differences of order two to five. The remaining p-values are available upon request.

5.2.3 Robustness Checks

The Internet appendix gathers the following battery of robustness checks.

First, I include in $\mathbf{Z}_{p,j,t}$ either stepwise or all together the observables discussed in section 5.1.5. The resulting estimates suggest both that the impact of deregulation on outcomes remains similar after considering this rich conditioning set and that none of the observable factors has an economically sizable and statistically significant effect on either the input uses, the inefficiency of fuel usage, or the mark-up of the residential price over the marginal costs.

Second, substituting either the log of the non fossil fuel expenses for *Ln-Emp* or the log of the generation capacity for *Ln-Hr* does not affect the gist of the empirical analysis.

Third, the estimates are qualitatively similar when I substitute *Mc-Fuel*(-3) with any other of the proxies for society's dynamic efficiency concerns discussed above.

Finally, using the forward orthogonal deviations as internal instruments will preserve the size of the sample but will reduce the power of the first-stages (see also footnote 18).

5.2.4 Implications

Overall, the marginal cost savings induced by deregulation brought about equal drops in regulated prices, greatly constraining the firm's ability to reduce the heat rate.[19] This conclusion helps shed light on the slowdown of the deregulation wave and, indeed, estimates available upon request reveal that the likelihood that a state froze or repealed deregulation legislation after 2000 significantly increases with the prospect of dynamic inefficiencies, i.e., with the ratio of the 1999 average heat rate to the 1993 average heat rate. As nicely put by Joskow (2005), the failures of many of these deregulation episodes can be attributed to the fact that politicians "underestimated [the] institutional challenges that must be overcome to introduce successfully [competition. This] underestimation [was] strategic, reflecting efforts by some participants in the policy-making process to feather their own nests."

6 Conclusions

Rather than reviewing my results, I close by highlighting three avenues for future research. First, key extensions to the basic setup are to endogenize the probability of the planner's re-election, study the indirect effect of market pressures working through agency costs (Vives, 2008), analyze the interaction between deregulation and the choice of incentive scheme (Guerriero, 2013), and consider both fixed and stranded costs (Joskow, 2005). Second, my framework can be usefully applied to evaluate the institutions making competition agencies more pro-consumer. Finally, it can be employed to shed more light on non-utility markets like the financial industry (Benmelech and Moskowitz, 2010).

[19] Consistent with this view, Joskow (2006) documents that, between 1998 and 2006, in no state would a new peaking turbine have earned net revenues sufficient to cover the annualized capital costs of its construction.

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Tables

Table 1: Summary of Variables

	Variable	Definition	Statistics
Market design:	*Deregulation*:	1 for states or IOU plants in states that deregulated, beginning in the year of the first deregulation hearing; 0 otherwise.	0.137 (0.344)
	Law:	1 for states or IOU plants in states that deregulated, beginning in the year in which legislation was enacted; 0 otherwise.	0.055 (0.228)
	Deregulation-O:	3 if both *Deregulation* and *Law* equal 1; 2 when only *Deregulation* equals 1; 1 otherwise.	1.192 (0.515)
Marginal costs, inefficiency of fuel usage, and input uses:	*Mc-Fuel*:	Marginal fossil fuel cost in cents per Kwh averaged at the state level. At the plant level, it is obtained by dividing the product of the BTUs of fossil fuel consumption and a composite fossil fuel price index by the generation.	1.889 (1.407)
	Heat-Rate:	Heat rate averaged at the state level. At the plant level, this variable measures the BTUs of fossil fuel consumption necessary to produce one MWh of electric power.	9.523 (2.550)
	Ratio-Mfc:	Ratio of the marginal fossil fuel cost averaged at the state level to the average of the marginal fossil fuel costs prevailing in the bordering states.	1.051 (0.722)
	Ratio-Hr:	Ratio of the heat rate averaged at the state level to the average of the heat rates prevailing in the bordering states.	1.037 (0.476)
	Ln-Emp:	Natural log of the mean number of employees at the plant level.	4.745 (0.804)
	Ln-Btu:	Natural log of the BTUs of fossil fuel consumption at the plant level, calculated as (tons of coal*2000 lbs/ton*BTU/lbs) + (barrels of oil*42 gal/barrel*BTU/gal) + (mcf gas*1000 cf/mcf*BTU/cf).	30.577 (1.282)
	Ln-Hr:	Natural log of the mean heat rate in BTUs of fossil fuel consumption per MWh of electric power produced at the plant level.	2.388 (0.223)
	Mark-Up:	Mean mark-up in cents per Kwh at the plant level defined as the difference between the residential price and the sum of the marginal fossil fuel and the marginal labor costs. The latter is the product of the employees number and the wage bill divided by the generation.	4.962 (6.694)
Political biases:	*Republican*:	1 for states or IOU plants in states in which both state legislatures 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 over state legislatures. The variable equals 0 when no party holds the relative majority in both state legislatures.	0.542 (0.283)
Other controls:	*Deregulation-B*:	Share of bordering states for which *Deregulation* equals 1.	0.141 (0.278)
	Ln-Wage:	Natural log of the wage bill in dollars divided by total employment at the plant level.	10.576 (0.277)
	Ln-Mwhs:	Natural log of the net generation in MWh at the plant level.	14.374 (1.369)

Note: 1. See appendix II for a description of the sources of each variable. The last column reports the mean value and, in parentheses, the standard deviation of each variable. Both are computed building on the sample used in table 2 except for *Ln-Emp*, *Ln-Btu*, *Ln-Hr*, *Mark-Up*, *Ln-Wage*, and *Ln-Mwhs*, when they are calculated employing the sample used in table 3.

Table 2: Endogenous Market Design

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	The dependent variable is the likelihood of *Deregulation*							
Mc-Fuel(-3)	- 0.118 (0.023)***				- 2.241 (1.192)*			
Heat-Rate(-3)		- 0.014 (0.004)***				- 0.099 (0.253)		
Ratio-Mfc(-3)			- 0.114 (0.041)***				- 1.117 (2.035)	
Ratio-Hr(-3)				- 0.148 (0.040)***				- 1.404 (2.418)
Republican	0.023 (0.024)	0.029 (0.024)	0.026 (0.024)	0.025 (0.024)	6.691 (2.073)***	9.596 (2.127)***	8.648 (1.872)***	9.053 (1.969)***
Majority	- 0.055 (0.037)	- 0.064 (0.038)*	- 0.072 (0.037)**	- 0.073 (0.037)**	- 4.732 (2.839)*	- 7.448 (3.205)**	- 6.719 (2.798)**	- 7.206 (2.992)**
Deregulation-B	0.369 (0.018)***	0.407 (0.020)***	0.417 (0.020)***	0.418 (0.020)***	26.834 (5.116)***	35.884 (4.966)***	32.250 (4.018)***	33.872 (5.101)***
Random Effects?	No	No	No	No	Yes	Yes	Yes	Yes
Estimation Procedure	Logit							
Pseudo R^2	0.48	0.46	0.46	0.47				
Log pseudo-likelihood	- 159.61	- 165.64	- 165.64	- 163.47	- 85.27	- 86.33	- 86.39	- 86.31
P-value of Hausman test	0.87	0.61	0.74	0.69	0.99	0.99	0.99	0.99
Number of observations	688	688	688	688	688	688	688	688

Notes:
1. The unit of observation is state per year.
2. The entries are marginal effects.
3. In parentheses are reported the standard errors, which are robust in columns (1) to (4).
4. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.
5. While the FE Logit estimator is consistent but inefficient under both the null and the alternative hypotheses, the Logit and RE Logit estimators are consistent and efficient under the null hypothesis but inconsistent under the alternative one. Hence, rejecting the null hypothesis of the Hausman test in columns (1)-(4) (in columns (5)-(8), i.e., the unobserved state fixed effects are uncorrelated with the other covariates) implies that FE Logit estimator should be preferred to the Logit (RE Logit) one.

Table 3: Endogenous Market Design and Outcomes — OLS Versus GMM

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				The dependent variable is:				
	Ln-Emp	*Ln-Emp*	*Ln-Btu*	*Ln-Btu*	*Ln-Hr*	*Ln-Hr*	*Mark-Up*	*Mark-Up*
Deregulation	- 0.030	- 0.127	- 0.001	- 0.151	0.003	- 0.119	- 0.076	0.761
	(0.005)***	(0.032)***	(0.004)	(0.080)*	(0.004)	(0.080)	(0.081)	(2.206)
Republican	- 0.005	- 0.0003	- 0.004	0.005	- 0.005	0.003	0.066	- 0.008
	(0.004)	(0.004)	(0.003)	(0.007)	(0.003)*	(0.007)	(0.074)	(0.242)
Majority	- 0.014	- 0.007	- 0.005	0.009	0.002	0.014	- 0.100	- 0.102
	(0.007)**	(0.008)	(0.009)	(0.014)	(0.009)	(0.014)	(0.157)	(0.278)
Ln-Wage	- 0.119	- 0.060						
	(0.044)***	(0.048)						
Ln-Mwhs	0.027	0.024	0.857	0.850				
	(0.007)***	(0.007)***	(0.020)***	(0.021)***				
Estimation procedure	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM
Instrument count		24		23		22		22
P-value of the Hansen test		0.52		0.33		0.24		0.35
P-value of the test for no								
AR(2)	0.04	0.54	0.51	0.05	0.77	0.18	0.91	0.87
AR(3)	0.75	0.35	0.67	0.11	0.68	0.26	0.30	0.30
AR(4)	0.50	0.27	0.38	0.78	0.86	0.72	0.40	0.40
AR(5)	0.61	0.71	0.97	0.90	0.48	0.39	0.37	0.37
in the first differences								
Number of observations	7429	7429	7429	7429	7429	7429	7429	7429

Notes:
1. The unit of observation is plant-epoch per year.
2. In parentheses are reported the robust standard errors, which are also corrected following Windmeijer (2005) in columns (2), (4), (6), and (8) where a two-step difference GMM procedure is employed.
3. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.
4. All specifications consider also *Scrubber* and plant and year fixed effects.
5. In columns (2), (4), (6), and (8), the endogenous variable is *Deregulation*, and the excluded instruments are *Deregulation-B* and *Mc-Fuel*(-3). Moment conditions are collapsed to have only one instrument column per year.
6. The null hypothesis of the Hansen test of overidentifying restrictions is that the instruments, as a group, are exogenous.
7. The Arellano-Bond test for serial correlation is applied to the differenced residuals. A test rejecting the null hypothesis of no serial correlation of order l in the differenced residuals detects serial correlation of order *l-1* in levels.

APPENDIX (NOT FOR PUBLICATION)

I Proofs

First, I provide formal proofs of the implications of the basic model.

Basic Setup

Underinvestment: Regulation Versus Competition

The socially optimal $\hat{I}^{j,*}$ maximizes the expected social welfare less investment costs under full information, i.e., $\hat{I}^{R,*} = \arg\max_{I\geq 0} (1/2)\left[(1+I)\,S(c_L) + (1-I)\,S(c_H)\right] - \psi(I)$ and $\hat{I}^{C,*} = \arg\max_{I\geq 0} \frac{(1+I)^2}{4} S(c_L) + \frac{(1-I)^2+2-2I^2}{4} S(c_H) + \frac{1-I^2}{2}\alpha\Delta q(c_H) - 2\psi(I)$.[20] The unique and interior optimal investment levels are, then, defined by $\psi'\left(I^{R,*}\right) = (1/2)\left[S(c_L) - S(c_H)\right]$ and $\psi'\left(\hat{I}^{C,*}\right) = \frac{1+\hat{I}^{C,*}}{4}\left[S(c_L) - S(c_H)\right] - \frac{\hat{I}^{C,*}\alpha\Delta q(c_H)}{2}$. Hence, $0 < \hat{I}^{C,*} < \hat{I}^{R,*} < 1$, where the last inequality follows from the assumption $\lim_{I\to 1} 2\psi'(I) \geq S(c_L) - S(c_H)$. The unique and interior solutions to problems (1) and (2) are implicitly defined by $\psi'\left(\hat{I}^{R}\right) = \frac{\Delta q(\hat{c}_H)}{2}$ and $\psi'\left(\hat{I}^{C}\right) = \left(1-\hat{I}^{C}\right)\frac{\Delta q(c_H)}{4}$. Since $\frac{S(c_L)-S(c_H)}{2} > \frac{\Delta q(\hat{c}_H)}{2}$ and $\frac{1+I}{4}\left[S(c_L) - S(c_H)\right] - \frac{I\alpha\Delta q(c_H)}{2} > \frac{1+(1-2\alpha)I}{4}\Delta q(c_H) \geq \frac{(1-I)}{4}\Delta q(c_H)$, $I^{j,*} > I^{j}$. $I^R > I^C$ when $2q(\hat{c}_H) > q(c_H)$, which is true under assumption A1. With inelastic demand indeed, a fall in price from $\hat{c}_H$ to c_H implies $\left|\frac{q(\hat{c}_H)-q(c_H)}{\left(1+\hat{I}^R\right)\left(1-\hat{I}^R\right)^{-1}(1-\alpha)\Delta}\frac{c_H+\left(1+\hat{I}^R\right)\left(1-\hat{I}^R\right)^{-1}(1-\alpha)\Delta}{q(\hat{c}_H)}\right| < 1 \leftrightarrow q(\hat{c}_H)\frac{c_H+2\left(1+\hat{I}^R\right)\left(1-\hat{I}^R\right)^{-1}(1-\alpha)\Delta}{c_H+\left(1+\hat{I}^R\right)\left(1-\hat{I}^R\right)^{-1}(1-\alpha)\Delta} > q(c_H)$. A fortiori, it must be the case that $2q(\hat{c}_H) > q(c_H)$.

Inequality (3) in Details

To obtain inequality (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 $\frac{d\left(W^C-W^R\right)}{d\alpha} = -\frac{d\hat{I}^R}{d\alpha}\left[\frac{S(c_L)-S(\hat{c}_H)}{2} - \frac{1-\alpha}{1-\hat{I}^R}\Delta q(\hat{c}_H)\right] + \left[1-\left(\hat{I}^C\right)^2\right]\frac{\Delta q(c_H)}{2} - \left(1-\hat{I}^R\right)\frac{1+\hat{I}^R}{1-\hat{I}^R}\frac{\Delta q(c_H)}{2}$.
By totally differentiating the first order condition to problem (1), I obtain that

[20] Under full information, regulation is the optimal market design whenever $\frac{2\left(1+\hat{I}^{R,*}\right)-\left(1+\hat{I}^{C,*}\right)^2}{4}S(c_L) + \frac{2\left(1-\hat{I}^{R,*}\right)-3+2\hat{I}^{C,*}-\left(\hat{I}^{C,*}\right)^2}{4}S(c_H) - \frac{1-\left(\hat{I}^{C,*}\right)^2}{2}\alpha\Delta q(c_H) > \psi\left(\hat{I}^{R,*}\right) - 2\psi\left(\hat{I}^{C,*}\right)$.

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

Since $S(c_L) - S(\hat{c}_H) - 2\frac{1-\alpha}{1-\hat{I}^R}\Delta q(\hat{c}_H) > \alpha \Delta q(\hat{c}_H)$ then, a sufficient condition for $\frac{d\left(W^C - W^R\right)}{d\alpha} < 0$ is that $\left[1 - \left(\hat{I}^C\right)^2\right] q(c_H) < \left(1 + \hat{I}^R\right) q(\hat{c}_H)$.[21] This last inequality is true whenever $2\left(\hat{I}^C\right)^2 + \hat{I}^R - 1 > 0$, being $2q(\hat{c}_H) > q(c_H)$ and a fortiori $2\left(\hat{I}^C\right)^2 + \hat{I}^C - 1 > 0$. Under assumption A2, $\hat{I}^C > 1/2$, and, thus, $2\left(\hat{I}^C\right)^2 + \hat{I}^C - 1 > 0$ and $\frac{d\left(W^C - W^R\right)}{d\alpha} < 0$.

Proof of Proposition 2

The probability of adopting competition falls with $\left(1 + \hat{I}^R\right) q(\hat{c}_H) - \left[1 - \left(\hat{I}^C\right)^2\right] q(c_H) > 0$ and, thus, with $\chi_{\tilde{m}}$ and $\tilde{x}(\chi_{\tilde{m}} - \lambda)$. Furthermore, party s chooses competition less often, $\frac{\partial \tilde{x}(\chi_s - \lambda)}{\partial x_s} = (\chi_s - \lambda)(\rho_s - \rho_r) > 0$, and $\frac{\partial \tilde{x}(\chi_r - \lambda)}{\partial x_r} = (\chi_r - \lambda)(\rho_r - \rho_s) > 0$.

Alternative Regulated Market Designs

Next, I consider key alternative assumptions about the regulated market scenario.

The Regulator's Implicit Incentives

Typically, the regulated firm's rent is determined by the information-gathering activity of regulators who are "rewarded based on [this] observable performance [...] through an implicit reward scheme that contains specific restrictions rather than an optimal explicit contract" (Alesina and Tabellini, 2007). In the US electricity industry case, this scheme takes the form of either election or appointment. To evaluate the impact of these implicit incentives on market design, I consider the following version of the basic setup.

In $t = 1$, the planner offers the firm a menu of (t_i, p_i) pairs conditional on the firm's report and a signal on c_i that he observes in $t = 4$ but not on investment. Under rule $s = \{E, A\}$, the signal works as follows. For $c_i = c_L$, the planner sees c_L, implements the full information contract with probability $\gamma_s \in [0, 1]$, and remains uniformed otherwise. For $c_i = c_H$, he always remains uninformed. Whenever uninformed, he asks the firm its type. The technology of the observable precision is $\gamma_s = \theta e_s$, where $e_s \in [0, 1]$ is the regulator's information-gathering effort and $\theta \in [0, 1]$ is her ability distributed independently of e_s and

[21] When cost-reducing investment entails monetary costs, the expression in the first bracket of the equation for $d\left(W^C - W^R\right)/d\alpha$ is supplemented by $-\psi'\left(\hat{I}^R\right) = -\Delta q(\hat{c}_H)/2$ and can, thus, be negative. Even in such a case, however, the model results stand, provided that ψ'' is sufficiently large and, thus, $d\hat{I}^R/d\alpha$ is small.

according to a truncated normal density g with mean $\bar{\theta}$. In $t = 4$, first the regulator chooses the effort, then she privately learns θ, next the signal is observed by the planner, and the precision is realized, finally the regulator is rewarded based on γ_s and the rule s.

To illustrate, the regulator maximizes $G^s(e_s) - C(e_s)$, where the effort cost function is such that $C(0) = 0$, $C' > 0$, $C'(0) < \infty$, $C'' > 0$, $\lim_{e_s \to 1} C'(e_s) = \infty$. $G^s(e_s)$ captures the regulator's implicit incentives. Following Alesina and Tabellini (2007), elected officials want to maximize the probability of delivering a precision higher than that assured by an averaged talented regulator in order to be re-elected, whereas appointed ones are career-concerned, i.e., they wish to maximize the perception that society will form about their ability after having observed γ_s and calculated $e_s^{\exp}$. Starting with appointment, $G^A(e_A) = \mathrm{E}\left[E\left(\theta \left| \gamma_A, e_A^{\exp}\right.\right)\right]$, where $\mathrm{E}[\cdot]$ denotes the regulator's unconditional expectation over γ_A, E is society's conditional expectation over θ, and $e_A^{\exp}$ labels society's expectation over effort. Instead, voters realize that the alternative to the incumbent regulator is one with an average talent exerting effort $e_E^{\exp}$. Thus, they re-elect the incumbent regulator when γ_E exceeds the threshold $\tilde{\gamma}_E = \bar{\theta} e_E^{\exp}$. Then, the incumbent regulator chooses effort by taking the voters' expectations as given and, thus, by maximizing $G^E(e_E) = \Pr\{\gamma_E \geq \tilde{\gamma}_E\}$ net of effort costs.

For a given equilibrium effort $\hat{e}_s$, society estimates θ as $\gamma_s/\hat{e}_s$. Hence, a rise in $\hat{e}_s$ 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. The only difference is that under election the effect of a rise in effort on the estimated talent is combined with the impact $g\left(\bar{\theta}\right)$ of an increase in the estimated talent on the probability of re-election. The larger this last term is, the more effective effort is in swaying votes and assuring a higher probability of victory. If the term is not too small or $g\left(\bar{\theta}\right) > 1$, election leads to a larger effort, and the impact of a reform towards election is isomorphic to a rise in γ. I focus on this scenario. The expected social welfare in the supervision regime S is then

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

where $\hat{c}_H^S \equiv c_H + \frac{1+\hat{I}^{R,S}}{1-\hat{I}^{R,S}}(1-\gamma)(1-\alpha)\Delta$. The planner's choice is described by inequality (3) with $\hat{c}_H^S$ in place of $\hat{c}_H$, and the equilibrium investment under regulation falls with the precision of the signal, which, in turn, reduces the firm's rent. As a result, the probability that the planner selects competition falls with γ and,[22] thus, with a reform towards election, provided that the demand is sufficiently inelastic.[23] This reform has three effects on W^R. First, a more precise signal crowds out investment. Second, the higher probability of low cost induces more limited allocative inefficiencies. Finally, more information reduces the odds of a rent. The first negative effect prevails on the two positive ones if the demand is sufficiently inelastic and, thus, investment is very sensitive to the chance of a rent. Propositions 1 and 2 continue to hold true as inequalities (3) and (4) evaluated at $\hat{c}_H^S$ suggest.

Regulatory Commitment

When the investment is contractible, the regulator solves the concave problem

$$\max_{I^{R,C}\geq 0, p_L^C \geq 0, p_H^C \geq 0} \frac{1+\hat{I}^{R,C}}{2} \left\{S\left(p_L^C\right) + \left(p_L^C - c_L\right) q\left(p_L^C\right)\right\} + \frac{1-\hat{I}^{R,C}}{2} \left\{S\left(p_H^C\right) + \left(p_H^C - \hat{c}_H\right) q\left(p_H^C\right)\right\} - \psi\left(I^{R,C}\right),$$

where the apex C labels the contractibility regime. While the pricing rule is the same as in the no-commitment case—i.e., $\hat{p}_L^C = c_L$ and $\hat{p}_H^C = \hat{c}_H$, the investment level is directly selected by the regulator and implicitly defined by $\psi'\left(\hat{I}^{R,C}\right) = (1/2)\left[S\left(c_L\right) - S\left(\hat{c}_H\right)\right] > (\Delta/2)\, q\left(\hat{c}_H\right) = \psi'\left(\hat{I}^R\right)$. Thus, $\hat{I}^{R,C} > \hat{I}^R$ and a fortiori regulation displays a dynamic advantage over competition. Therefore, the model message remains true.

When the investment is, instead, non contractible, the regulator focuses on rules of the type $C \to t\left(I, C\right)$, and the firm chooses the investment level. The expected social welfare is

$$\nu\left[(\Delta/2)\, q\left(p_L^{NC}\right) - \psi'\left(\hat{I}^{R,NC}\right)\right] + \frac{1+\hat{I}^{R,NC}}{2}\left[S\left(p_L^{NC}\right) + \left(p_L^{NC} - c_L\right) q\left(p_L^{NC}\right)\right] + \frac{1-\hat{I}^{R,NC}}{2}\left[S\left(p_H^{NC}\right) + \left(p_H^{NC} - \hat{c}_H\right) q\left(p_H^{NC}\right)\right] - \psi\left(I^{R,NC}\right),$$

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[22] To illustrate, $\hat{I}^{R,S}$ equals $\arg\max_{I\geq 0} (1/2)\left(1+I\right)\left(1-\gamma\right)\Delta q\left(\hat{c}_H^S\left(\hat{I}^{R,S}\right)\right) - \psi\left(I\right)$, and it is implicitly defined by $\psi'\left(\hat{I}^{R,S}\right) = \left(1-\gamma\right)\left(\Delta/2\right) q\left(\hat{c}_H^S\right)$. Hence, $\frac{d\hat{I}^i}{d\gamma} < 0$ since $\left[\frac{(1-\gamma)^2(1-\alpha)\Delta^2 q'\left(\hat{c}_H^S\right)}{\left(1-\hat{I}^{R,S}\right)^2} - \psi''\left(\hat{I}^{R,S}\right)\right] d\hat{I}^{R,S} + \left[-\frac{\Delta q\left(\hat{c}_H^S\right)}{2} - \frac{\left(1+\hat{I}^{R,S}\right)(1-\gamma)(1-\alpha)\Delta^2 q'\left(\hat{c}_H^S\right)}{2\left(1-\hat{I}^{R,S}\right)}\right] d\gamma = 0$, and the expression in the second square bracket is negative because $-\frac{q'\left(\hat{c}_H^S\right)\left(1+\hat{I}^{R,S}\right)\left(1-\hat{I}^{R,S}\right)^{-1}(1-\gamma)(1-\alpha)\Delta}{q\left(\hat{c}_H^S\right)} < -\frac{q'\left(\hat{c}_H^S\right)\hat{c}_H^S}{q\left(\hat{c}_H^S\right)} < 1$ under assumption A1.

[23] It does if $-\frac{d\hat{I}^{R,S}}{d\gamma}\left[S\left(c_L\right) - S\left(\hat{c}_H^S\right) - 2\frac{1-\alpha}{1-\hat{I}^R}\left(1-\gamma\right)\Delta q\left(\hat{c}_H\right)\right] - \left(1+\hat{I}^{R,S}\right)\left(1-\alpha\right)\Delta q\left(\hat{c}_H^S\right)$ is positive, which is the case if $2\left(1+\hat{I}^{R,S}\right)\left(1-\alpha\right)\Delta q\left(\hat{c}_H^S\right) < \frac{\Delta q\left(\hat{c}_H^S\right) + \left(1+\hat{I}^{R,S}\right)\left(1-\hat{I}^{R,S}\right)^{-1}(1-\gamma)(1-\alpha)\Delta^2 q'\left(\hat{c}_H^S\right)}{\psi''\left(\hat{I}^{R,S}\right) - \left(1-\hat{I}^{R,S}\right)^{-2}(1-\gamma)^2(1-\alpha)\Delta^2 q'\left(\hat{c}_H^S\right)}\left(\alpha+\gamma-\alpha\gamma\right)\Delta q\left(\hat{c}_H^S\right)$ or $\varepsilon_{p,q} = -\frac{q'\left(\hat{c}_H^S\right)\hat{c}_H^S}{q\left(\hat{c}_H^S\right)} < \bar{\varepsilon}_{p,q} \equiv \frac{\hat{c}_H^S\left(1-\hat{I}^{R,S}\right)(\alpha+\gamma-\alpha\gamma)\Delta - 2\hat{c}_H^S\left[1-\left(\hat{I}^{R,S}\right)^2\right](1-\alpha)\psi''\left(\hat{I}^{R,S}\right)\left[q\left(\hat{c}_H^S\right)\right]^{-1}}{\frac{1+\hat{I}^{R,S}}{1-\hat{I}^{R,S}}(1-\gamma)(1-\alpha)\Delta^2\left[2(1-\gamma)(1-\alpha)+\left(1-\hat{I}^{R,S}\right)(\alpha+\gamma-\alpha\gamma)\right]}$.

where C labels the non contractibility regime and ν is the shadow price of the moral hazard in investment constraint. As a consequence, the c_H-type's allocation is distorted even more to take care of such constraint, but regulation maintains its dynamic advantage over competition. This pattern leaves unchanged the model predictions.

A Positive Shadow Cost of Public Funds

For $\lambda > 0$, the pricing rule is of the Ramsey type and implicitly defined by $\upsilon(p) \equiv p + \lambda(1+\lambda)^{-1} q(p)[q'(p)]^{-1} = c$ or $p = \upsilon^{-1}(c)$. Hence, $\frac{\partial p}{\partial c} > 0$.[24] A reasoning akin to that developed in the proof of proposition 1 implies that investment is still larger under regulation. The impact of α on the probability of choosing competition is now given by

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

which is negative if $\left[1-\left(\hat{I}^C\right)^2\right] q(c_H) < \left(1+\hat{I}^R\right) q(\hat{c}_H)\frac{\partial p(\hat{c}_H)}{\partial c}$ since $\frac{\partial\hat{I}^R}{\partial\alpha} > 0$.[25] This sufficient condition is true if $2\left(\hat{I}^C\right)^2 + \left(1+\hat{I}^R\right)\frac{\partial p(\hat{c}_H)}{\partial c} - 2 > 0$ or $\hat{I}^C > \bar{\hat{I}}^C$,[26] which, in turn, is the case for $\psi'\left(\bar{\hat{I}}^C\right) \leq \left(1-\bar{\hat{I}}^C\right)(\Delta/4)\, q(p(\hat{c}_H))$. This is a version of assumption A2.

Alternative Competitive Market Designs

Next, I consider key alternative assumptions about the competitive market scenario.

A Generic Number of Bertrand Competitors

The expected social welfare equals $\left\{1-\left\{\left[\frac{1-\hat{I}^C(n)}{2}\right]^n + n\frac{1+\hat{I}^C(n)}{2}\left[\frac{1-\hat{I}^C(n)}{2}\right]^{n-1}\right\}\right\} S(c_L) + \left\{\left[\frac{1-\hat{I}^C(n)}{2}\right]^n + n\frac{1+\hat{I}^C(n)}{2}\left[\frac{1-\hat{I}^C(n)}{2}\right]^{n-1}\right\} S(c_H) + \alpha n\frac{1+\hat{I}^C(n)}{2}\left[\frac{1-\hat{I}^C(n)}{2}\right]^{n-1}\Delta q(c_H)$, where $\hat{I}^C(n)$ is the equilibrium investment when n firms compete. Hence, regulation keeps its dynamic advantage if it continues to assure the larger marginal returns from investment. Since

[24] $\frac{\partial p}{\partial c} = -\frac{-(1+\lambda)q'(p)}{(1+\lambda)q''(p)(p-c)+(1+2\lambda)q'(p)} = \frac{1}{[(1+\lambda)q''(p)(p-c)+\lambda q'(p)][(1+\lambda)q'(p)]^{-1}+1} > 0$ since the first order condition of the regulator's problem prescribes that $(1+\lambda)\,q'(p)(p-c) + \lambda q(p) = 0$.

[25] After having totally differentiated the first order condition to problem (1), it immediately follows that $\left[\frac{2(1-\alpha)\Delta^2 q'(\hat{c}_H)}{2\left(1-\hat{I}^R\right)^2}\frac{\partial p(\hat{c}_H)}{\partial c} - \psi''\left(\hat{I}^R\right)\right] d\hat{I}^R - \frac{\left(1+\hat{I}^R\right)\Delta^2 q'(\hat{c}_H)}{2\left(1-\hat{I}^R\right)}\frac{\partial p(\hat{c}_H)}{\partial c} d\alpha = 0 \rightarrow \frac{\partial\hat{I}^R}{\partial\alpha} > 0$.

[26] A fall in price from $p(\hat{c}_H)$ to c_H implies that $\left|\frac{q(p(\hat{c}_H)) - q(c_H)}{p(\hat{c}_H) - c_H}\frac{p(\hat{c}_H)}{q(p(\hat{c}_H))}\right| < 1 \leftrightarrow q(p(\hat{c}_H))\frac{2p(\hat{c}_H) - c_H}{p(\hat{c}_H)} > q(c_H)$.

again $2q(\hat{c}_H) > q(c_H)$, this is the case when $\frac{1+\hat{I}^R}{4} > \frac{1+\hat{I}^C(2)}{2}\frac{1-\hat{I}^C(2)}{2} \geq \frac{1+\hat{I}^C(n)}{2}\left[\frac{1-\hat{I}^C(n)}{2}\right]^{n-1}$. This chain of inequalities holds true since $\frac{\partial}{\partial n}\left[\frac{1-\hat{I}^C(n)}{2}\right]^{n-1} = \ln\left[\frac{1-\hat{I}^C(n)}{2}\right]\left[\frac{1-\hat{I}^C(n)}{2}\right]^{n-1} < 0$, being $\ln\left[\frac{1-\hat{I}^C(n)}{2}\right] < 0$. Hence, the marginal return from investment under competition $\left[\frac{1-\hat{I}^C(n)}{2}\right]^{n-1}$ is maximized at $n = 2$, and the model message remains true for all n.

Cournot Competition

As Vives (2008), I assume that $P' < 0$ and $P' + P''q_{\tilde{i}}(c_1, c_2) < 0$, where P is the inverse demand and $q_{\tilde{i}}(c_1, c_2)$ is the output of firm $\tilde{i} = \{1, 2\}$ when firm 1 has type c_1 and firm 2 has type c_2. Let $[P(q_1(c_1, c_2) + q_2(c_1, c_2)) - c_{\tilde{i}}]\, q_{\tilde{i}}(c_1, c_2) \equiv \pi_{\tilde{i}}(c_1, c_2)$ be the profit of firm $\tilde{i}$. Then, each firm's best reply is downward sloping, $\frac{dq_{\tilde{i}}(c_1,c_2)}{dq_{-\tilde{i}}(c_1,c_2)} < 0$, $\frac{d^2\pi_{\tilde{i}}(c_1,c_2)}{dc_{\tilde{i}}dq_{-\tilde{i}}(c_1,c_2)} > 0$, and by supermodularity $\pi_{\tilde{i}}(c_L, c_H) - \pi_{\tilde{i}}(c_L, c_L) > \pi_{\tilde{i}}(c_H, c_H) - \pi_{\tilde{i}}(c_H, c_L)$. Moreover, in a symmetric equilibrium of the simultaneous Cournot game where each firm picks $\left(I^C, q_{\tilde{i}}\right)$ in $t = 2$, $\tilde{I}^C$ maximizes $\frac{\left(1+I^C\right)\left(1+\tilde{I}^C\right)}{4}\pi_{\tilde{i}}(c_L, c_L) + \frac{\left(1+I^C\right)\left(1-\tilde{I}^C\right)}{4}\pi_{\tilde{i}}(c_L, c_H) + \frac{\left(1-I^C\right)\left(1+\tilde{I}^C\right)}{4}\pi_{\tilde{i}}(c_H, c_L) + \frac{\left(1-I^C\right)\left(1-\tilde{I}^C\right)}{4}\pi_{\tilde{i}}(c_H, c_H) - \psi\left(I^C\right)$, and it is implicitly defined by $\psi'\left(\tilde{I}^C\right) = \frac{\left(\pi_{\tilde{i}}(c_L,c_L)-\pi_{\tilde{i}}(c_H,c_H)\right)}{4} + \frac{\left(\pi_{\tilde{i}}(c_L,c_H)-\pi_{\tilde{i}}(c_H,c_L)\right)}{4} + \frac{\tilde{I}^C}{4}\left(\pi_{\tilde{i}}(c_H, c_H) - \pi_{\tilde{i}}(c_H, c_L) + \pi_{\tilde{i}}(c_L, c_L) - \pi_{\tilde{i}}(c_L, c_H)\right)$. The term pre-multiplied by $\frac{\tilde{I}^C}{4}$ is negative, whereas the other two terms are positive and approximately null when the elasticity of demand is sufficiently small. In this case indeed, the mark-up of $P(c_1, c_2)$ over $c_{\tilde{i}}$ is so large that the profit is insensitive to the type realization and, thus, investment is irrelevant.[27] Hence, $\tilde{I}^C$ is bounded to be very small or even 0 under a condition similar to assumption A1. Since investment is still larger under regulation, propositions 1 and 2 continue to stand as a glance at inequalities (3) and (4) immediately reveals.

II Sample Construction and Data Sources

Sample Construction

Following Fabrizio et al. (2007), I have eliminated the plants with mean capacity below 100 MW or with three years of operation at a scale not greater than 100 MW, those with missing or nonpositive data, those identified as outliers by the Stata dfbeta diagnostic, and those in states for which I do not observe the political biases. Hence, there are no observations

[27] The equilibrium output is implicitly defined by $\varepsilon_{p,q}^{-1}(c_1, c_2)\, P(c_1, c_2) = 2\left(P(c_1, c_2) - c_{\tilde{i}}\right)$, where $\varepsilon_{p,q}(c_1, c_2)$ is the elasticity of the demand when firm 1 has type c_1 and firm 2 has type c_2. If $\varepsilon_{p,q}(c_1, c_2)$ is sufficiently small, then both $P(c_1, c_2)$ and $P(c_1, c_2) - c_{\tilde{i}}$ are insensitive to the cost distribution.

for Alaska, District of Columbia, Hawaii, Idaho, Nebraska, Rhode Island, Tennessee, and Vermont. Moreover, I have imputed 46 data points using the foregoing observation.

Data Sources

Institutions.—Information about the deregulation initiatives come from: 1. EIA (2003); 2. EIA, 2000. *The Changing Structure of the Electric Power Industry: 2000 An Update.* Washington, DC: EIA; 3. EIA, 2002. *Status of State Electric Industry Restructuring Activity.* Washington, DC: EIA; 4. Edison Electric Institute (EEI), 2001. *Electric Competition in the States.* Washington, DC: EEI; 5. National Association of Regulatory Utility Commissioners (NARUC), 1995-1996. *Utility Regulatory Policy in the United States and Canada, Compilation.* Washington, DC: NARUC; 6. Council of State Governments (CSG), 1999. *Restructuring the Electricity Industry.* Lexington, KY: CSG; 7. PUC websites.

IOU operating data.—Data on the fossil fuel inputs, heat rate, number of employees, non-fuel expenses, capacity, and generation are collected from the "UDI O&M Production Cost" database, which also reports whether the plant had a FGD scrubber and if it was divested. Data on sales, revenues, and the generation shares come from: 1. EEI, 1995. *Historical Statistics of the Electric Utility Industry, 1960-1992.* Washington, DC: EEI; 2. EEI, 1993-1999. *Statistical Yearbook of the Electric Utility Industry.* Washington, DC: EEI. Finally, the composite fossil fuel price index is collected from: EIA, 1999. *Annual Energy Review.* Washington, DC: EIA. Data on the industry annual wage bill come from the "Pay & Benefits" database. The electric utility sector SIC code is 4911.

Political biases.—Data on the incumbent's preferences and hold on power are collected from: CSG, 1981-1999. The Book of the States. Lexington, KY: CSG.

Performance based regulation.—Data on incentive regulation come from Guerriero (2013).

References

Alesina, A., Tabellini, G., 2007. 'Bureaucrats or Politicians? Part I: a Single Policy Task.' *American Economic Review*, 97: 169-179.

III Supplementary Tables

Table I: Summary of Variables

	Variable	Definition and Sources	Statistics
Market design:	*Deregulation-C*:	Share of remaining US states having held the first deregulation hearing.	0.137 (0.210)
	Deregulation-W:	*Deregulation* averaged over bordering states and weighted by their population size.	0.165 (0.322)
	Law-B:	Share of bordering states for which *Law* equals 1.	0.053 (0.166)
Marginal costs	*Ratio-Mfc-W*:	Ratio of the marginal fossil fuel cost averaged at the state level to the average of the marginal fossil fuel costs prevailing in the bordering states weighted by their population size.	1.147 (0.810)
	Ratio-Hr:	Ratio of the heat rate averaged at the state level to the average of the heat rates prevailing in the bordering states weighted by their population size.	1.160 (0.682)
Outcomes:	*Ln-Nfe*:	Natural log of the annual non-fuel production expenses in dollars at the plant level. Non-fuel expenses are calculated as the total production expenses less fossil fuel expenses.	16.068 (0.929)
	Ln-Capacity:	Natural log of the plant capacity expressed in MW.	6.374 (0.851)
Other controls:	*PBR*:	1 for states adopting broad-based forms of incentive regulation; 0 otherwise.	0.103 (0.304)
	Divestiture:	Share of plants divested because of deregulation averaged at the state level.	0.258 (0.408)
	Capacity:	Capacity in MW averaged at the state level.	654.459 (268.598)
	Nuclear-Share:	Share of generation from nuclear sources averaged at the state level.	0.181 (0.192)
	Residential-Price:	Revenues from sales to residential users in cents per Kwh averaged at the state level.	7.573 (1.874)

Note: 1. See appendix II for each variable sources. The last column reports the mean value and, in parentheses, the standard deviation of each variable. Both are computed building on the sample used in columns (1) to (4) of tables II, III, and IV and in the entire tables V to X except for the cases of *Ln-Nfe* and *Ln-Capacity*, when they are calculated using the sample employed to obtain the remaining estimates.

Table II: Measuring Deregulation With *Law*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	The dependent variable is:							
	the likelihood of *Law*				*Ln-Emp*	*Ln-Btu*	*Ln-Hr*	*Mark-Up*
Law					- 0.118 (0.041)***	- 0.264 (0.134)**	- 0.259 (0.136)*	- 13.215 (14.878)
Mc-Fuel(-3)	- 0.043 (0.014)***							
Heat-Rate(-3)		- 0.003 (0.003)						
Ratio-Mfc(-3)			- 0.005 (0.015)					
Ratio-Hr(-3)				- 0.025 (0.024)				
Republican	0.011 (0.018)	0.014 (0.019)	0.014 (0.019)	0.014 (0.019)	- 0.005 (0.004)	- 0.002 (0.004)	- 0.002 (0.004)	0.160 (0.250)
Majority	- 0.052 (0.025)**	- 0.057 (0.025)**	- 0.057 (0.025)**	- 0.059 (0.025)**	- 0.005 (0.009)	0.020 (0.019)	0.030 (0.020)	1.496 (1.717)
Law-B	0.235 (0.030)***	0.247 (0.032)***	0.248 (0.032)***	0.249 (0.031)***				
Ln-Wage					- 0.086 (0.050)*			
Ln-Mwhs					0.024 (0.007)***	0.850 (0.020)***		
Estimation Procedure	Logit	Logit	Logit	Logit	Two-Step Difference GMM			
Pseudo R^2	0.38	0.36	0.36	0.36				
Log pseudo-likelihood	- 103.07	- 105.97	- 106.20	- 105.75				
Instrument count					24	23	22	22
P-value of the Hansen test					0.01	0.29	0.55	0.53
P-value of the test for no								
AR(2)					0.02	0.16	0.27	0.36
AR(3)					0.18	0.78	0.84	0.30
AR(4)					0.99	0.15	0.43	0.41
AR(5)					0.50	0.95	0.31	0.36
in the first differences								
Number of observations	688	688	688	688	7429	7429	7429	7429

Notes:
1. The unit of observation in columns (1) to (4) (columns (5) to (8)) is state (plant-epoch) per year.
2. The entries are marginal effects in columns (1) to (4) and semi-elasticities otherwise.
3. In parentheses are reported the standard errors, which are robust in columns (1) to (4) and corrected following Windmeijer (2005) in columns (5) to (8).
4. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.
5. The specifications in columns (5) to (8) consider also *Scrubber* and plant-epoch and year fixed effects.
6. In columns (5) to (8), the endogenous variable is *Law*, and the excluded instruments are *Law-B* and *Mc-Fuel*(-3). Moment conditions are collapsed to have only one instrument column per year.
7. The null hypothesis of the Hansen over-identification test is that the instruments, as a group, are exogenous.
8. The Arellano-Bond test for serial correlation is applied to the differenced residuals. A test rejecting the null hypothesis of no serial correlation of order *l* in the differenced residuals detects serial correlation of order *l-1* in levels.

Table III: Weighting Neighboring States by Population Size

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	The dependent variable is:							
	the likelihood of *Deregulation*				*Ln-Emp*	*Ln-Btu*	*Ln-Hr*	*Mark-Up*
Deregulation					- 0.122	- 0.234	- 0.198	- 0.075
					(0.036)***	(0.112)**	(0.113)*	(4.811)
Ratio-Mfc-W(-3)	- 0.078		- 0.627					
	(0.029)***		(1.452)					
Ratio-Hr-W(-3)		- 0.063		- 0.774				
		(0.028)**		(1.448)				
Republican	0.023	0.023	7.631	7.523	- 0.0005	0.009	0.007	0.042
	(0.024)	(0.024)	(1.736)***	(2.101)***	(0.004)	(0.008)	(0.008)	(0.391)
Majority	- 0.067	- 0.067	- 5.947	- 5.780	- 0.007	0.014	0.020	- 0.036
	(0.036)*	(0.036)*	(2.514)**	(2.715)**	(0.008)	(0.015)	(0.016)	(0.448)
Deregulation-W	0.349	0.350	22.442	22.437				
	(0.012)***	(0.011)***	(3.213)***	(4.643)***				
Ln-Wage					- 0.063			
					(0.049)			
Ln-Mwhs					0.024	0.848		
					(0.007)***	(0.020)***		
Random Effects	No	No	Yes	Yes				
Estimation Procedure	Logit	Logit	Logit	Logit	Two-Step Difference GMM			
Pseudo R^2	0.47	0.46						
Log pseudo-likelihood	- 163.049	- 163.687	- 95.122	- 95.222				
Instrument count					24	23	22	22
P-value of the Hansen test					0.53	0.82	0.53	0.37
P-value of the test for no								
AR(2)					0.46	0.02	0.06	0.90
AR(3)					0.42	0.02	0.08	0.30
AR(4)					0.30	0.54	0.27	0.40
AR(5)					0.71	0.76	0.33	0.37
in the first differences								
Number of observations	688	688	688	688	7429	7429	7429	7429

Notes:
1. The unit of observation in columns (1) to (4) (columns (5) to (8)) is state (plant-epoch) per year.
2. The entries are marginal effects in columns (1) to (4) and semi-elasticities otherwise.
3. In parentheses are reported the standard errors, which are also corrected following Windmeijer (2005) in columns (5) to (8) where a two-step difference GMM procedure is employed.
4. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.
5. The specifications in columns (5) to (8) also consider *Scrubber* and plant-epoch and year fixed effects.
6. In columns (5) to (8), the endogenous variable is *Deregulation*, and the excluded instruments are *Deregulation-B-W* and *Mc-Fuel*(-3). Moment conditions are collapsed to have only one instrument column per year.
7. The null hypothesis of the Hansen over-identification test is that the instruments, as a group, are exogenous.
8. The Arellano-Bond test for serial correlation is applied to the differenced residuals. A test rejecting the null hypothesis of no serial correlation of order *l* in the differenced residuals detects serial correlation of order *l-1* in levels.

Table IV: Considering Country-Wide Imitation Effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				The dependent variable is:				
		the likelihood of *Deregulation*			*Ln-Emp*	*Ln-Btu*	*Ln-Hr*	*Mark-Up*
Deregulation					- 0.036	- 0.023	- 0.011	0.223
					(0.015)**	(0.014)*	(0.014)	(0.396)
Mc-Fuel(-3)	- 0.159							
	(0.027)***							
Heat-Rate(-3)		- 0.026						
		(0.004)***						
Ratio-Mfc(-3)			- 0.078					
			(0.047)*					
Ratio-Hr(-3)				- 0.135				
				(0.048)***				
Republican	0.011	0.012	0.015	0.012	- 0.003	- 0.002	- 0.003	0.018
	(0.025)	(0.025)	(0.026)	(0.026)	(0.004)	(0.003)	(0.003)	(0.087)
Majority	- 0.063	- 0.067	- 0.079	- 0.080	- 0.014	- 0.005	0.001	- 0.063
	(0.045)	(0.045)	(0.045)*	(0.045)*	(0.007)**	(0.009)	(0.010)	(0.141)
Deregulation-C	0.645	0.747	0.724	0.728				
	(0.038)***	(0.038)***	(0.038)***	(0.038)***				
Ln-Wage					- 0.113			
					(0.046)**			
Ln-Mwhs					0.025	0.854		
					(0.007)***	(0.021)***		
Estimation Procedure	Logit	Logit	Logit	Logit		Two-Step Difference GMM		
Pseudo R^2	0.40	0.40	0.37	0.38				
Log pseudo-likelihood	- 182.53	- 184.92	- 192.840	- 190.636				
Instrument count					24	23	22	22
P-value of the Hansen test					0.03	0.07	0.07	0.38
P-value of the test for no								
AR(2)					0.04	0.45	0.72	0.90
AR(3)					0.75	0.70	0.68	0.30
AR(4)					0.50	0.31	0.75	0.40
AR(5)					0.63	0.99	0.46	0.37
in the first differences								
Number of observations	688	688	688	688	7429	7429	7429	7429

Notes:
1. The unit of observation in columns (1) to (4) (columns (5) to (8)) is state (plant-epoch) per year.
2. The entries are marginal effects in columns (1) to (4) and semi-elasticities otherwise.
3. In parentheses are reported the standard errors, which are also corrected following Windmeijer (2005) in columns (5) to (8) where a two-step difference GMM procedure is employed.
4. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.
5. The specifications in columns (5) to (8) consider also *Scrubber* and plant-epoch and year fixed effects.
6. In columns (5) to (8), the endogenous variable is *Deregulation*, and the excluded instruments are *Deregulation-C* and *Mc-Fuel*(-3). Moment conditions are collapsed to have only one instrument column per year.
7. The null hypothesis of the Hansen over-identification test is that the instruments, as a group, are exogenous.
8. The Arellano-Bond test for serial correlation is applied to the differenced residuals. A test rejecting the null hypothesis of no serial correlation of order l in the differenced residuals detects serial correlation of order l-1 in levels.

Table V: Endogenous Market Design — Logit With Observables

	(1)	(2)	(3)	(4)	(5)	(6)
			The dependent variable is the likelihood of *Deregulation*			
Mc-Fuel(-3)	- 0.116	- 0.101	- 0.112	- 0.117	- 0.329	- 0.286
	(0.023)***	(0.022)***	(0.024)***	(0.025)***	(0.073)***	(0.080)***
Republican	0.022	0.041	0.035	0.039	0.010	0.005
	(0.024)	(0.031)	(0.022)	(0.027)	(0.049)	(0.046)
Majority	- 0.055	- 0.054	- 0.035	- 0.032	- 0.121	- 0.072
	(0.037)	(0.035)	(0.031)	(0.032)	(0.090)	(0.062)
Deregulation-B	0.372	0.346	0.297	0.288	0.511	0.148
	(0.019)***	(0.020)***	(0.022)***	(0.023)***	(0.063)***	(0.075)**
PBR(-3)	- 0.026			- 0.088		- 0.257
	(0.042)			(0.100)		(0.085)***
Divestiture(-3)		0.052		0.010		0.189
		(0.024)**		(0.032)		(0.048)***
Capacity(-3)		- 0.0000		0.00004		- 0.0001
		(0.0001)		(0.00005)		(0.0001)
Nuclear-Share(-3)		0.139		- 0.043		- 0.397
		(0.060)**		(0.064)		(0.133)***
Residential-Price(-3)			0.041	0.044		0.120
			(0.007)***	(0.008)***		(0.014)***
P-value for year dummies					0.30	0.00
Estimation Procedure				Logit		
Pseudo R^2	0.48	0.51	0.56	0.57	0.31	0.54
Log pseudo-likelihood	- 159.42	- 151.15	- 134.10	- 132.21	- 138.06	- 92.09
Number of observations	688	688	688	688	301	301

Notes:
1. The unit of observation is state per year.
2. The entries are marginal effects.
3. In parentheses are reported the robust standard errors.
4. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.

Table VI: Endogenous Market Design — RE Logit With Observables

	(1)	(2)	(3)	(4)	(5)	(6)
			The dependent variable is the likelihood of *Deregulation*			
Mc-Fuel(-3)	- 2.225	- 3.234	- 1.605	- 1.447	- 0.828	- 0.527
	(1.318)*	(1.473)**	(2.121)	(2.613)	(3.068)	(4.068)
Republican	8.121	8.025	7.805	12.123	3.061	2.901
	(2.093)***	(2.235)***	(2.449)***	(3.136)***	(3.010)	(3.216)
Majority	- 5.299	- 5.448	- 5.984	- 10.167	- 5.288	- 6.021
	(3.186)*	(3.342)*	(3.764)	(4.290)**	(4.421)	(5.238)
Deregulation-B	33.447	30.096	34.486	54.025	15.633	9.619
	(4.466)***	(4.328)***	(5.340)***	(8.305)***	(4.388)***	(5.002)**
PBR(-3)	1.371			- 1.917		- 8.183
	(2.019)			(3.593)		(9.492)
Divestiture(-3)		8.566		6.150		9.255
		(3.429)**		(5.190)		(5.345)*
Capacity(-3)		0.006		0.003		- 0.004
		(0.004)		(0.007)		(0.007)
Nuclear-Share(-3)		- 0.448		- 16.147		- 19.063
		(4.058)		(8.210)**		(9.598)**
Residential-Price(-3)			7.271	9.786		6.379
			(1.256)***	(1.723)***		(1.156)***
P-value for year dummies					0.00	0.00
Random Effects?	Yes	Yes	Yes	Yes	Yes	Yes
Estimation Procedure				Logit		
Log pseudo-likelihood	- 84.32	- 83.49	- 68.14	- 66.77	- 60.00	- 47.90
Number of observations	688	688	688	688	301	301

Notes: 1. The unit of observation is state per year.
2. The entries are marginal effects.
3. In parentheses are reported the standard errors.
4. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.

Table VII: Endogenous Market Design — Probit

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				The dependent variable is the likelihood of *Deregulation*				
Mc-Fuel(-3)	- 0.105				- 1.159			
	(0.022)***				(0.646)*			
Heat-Rate(-3)		- 0.012				- 0.038		
		(0.004)***				(0.122)		
Ratio-Mfc(-3)			- 0.097				- 0.494	
			(0.038)**				(1.050)	
Ratio-Hr(-3)				- 0.129				- 0.695
				(0.039)***				(1.213)
Republican	0.030	0.035	0.034	0.034	3.920	4.208	4.231	4.276
	(0.023)	(0.023)	(0.023)	(0.023)	(0.892)***	(0.938)***	(0.947)***	(0.940)***
Majority	- 0.069	- 0.078	- 0.084	- 0.087	- 2.819	- 3.346	- 3.349	- 3.374
	(0.036)*	(0.035)**	(0.035)**	(0.035)**	(1.401)**	(1.363)**	(1.368)**	(1.371)**
Deregulation-B	0.378	0.419	0.426	0.427	16.046	15.626	15.700	15.958
	(0.019)***	(0.022)***	(0.022)***	(0.021)***	(2.069)***	(2.518)***	(2.506)***	(2.632)***
Random Effects?	No	No	No	No	Yes	Yes	Yes	Yes
Estimation Procedure					Logit			
Pseudo R^2	0.48	0.46	0.46	0.47				
Log pseudo-likelihood	- 158.39	- 165.64	- 165.64	- 163.47	- 84.55	- 86.62	- 86.69	- 86.50
Number of observations	688	688	688	688	688	688	688	688

Notes: 1. The unit of observation is state per year.
2. The entries are marginal effects.
3. In parentheses are reported the standard errors, which are robust in columns (1) to (4).
4. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.

Table VIII: Endogenous Market Design — Ordered Logit

	(1)	(2)	(3)	(4)
		The dependent variable is *Deregulation-O*		
Mc-Fuel(-3)	0.251			
	(0.076)***			
Heat-Rate(-3)		0.930		
		(0.053)		
Ratio-Mfc(-3)			0.328	
			(0.171)**	
Ratio-Hr(-3)				0.694
				(0.318)
Republican	1.209	1.302	1.270	1.292
	(0.376)	(0.406)	(0.396)	(0.400)
Majority	0.551	0.495	0.472	0.467
	(0.253)	(0.226)	(0.213)*	(0.215)*
Deregulation-B	192.304	275.445	316.780	285.693
	(84.219)***	(120.528)***	(140.854)***	(122.541)***
Estimation procedure		Ordered Logit		
Pseudo R^2	0.39	0.38	0.38	0.37
Log pseudo-likelihood	- 231.09	- 238.08	- 236.63	- 238.72
Number of observations	688	688	688	688

Notes: 1. The unit of observation is state per year.
2. The entries are odds ratios.
3. In parentheses are reported the robust standard errors.
4. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.

Table IX: Endogenous Market Design — Exponential Survival

	(1)	(2)	(3)	(4)
		The dependent variable is *Deregulation*		
Mc-Fuel(-3)	0.256			
	(0.104)***			
Heat-Rate(-3)		0.887		
		(0.060)*		
Ratio-Mfc(-3)			0.418	
			(0.306)	
Ratio-Hr(-3)				0.421
				(0.304)
Republican	1.390	1.441	1.467	1.396
	(0.726)	(0.812)	(0.785)	(0.791)
Majority	0.473	0.339	0.343	0.318
	(0.377)	(0.241)	(0.252)	(0.223)*
Deregulation-B	20.850	28.834	36.857	33.143
	(11.293)***	(16.012)***	(18.942)***	(18.217)***
Estimation procedure		Exponential Survival		
Log pseudo-likelihood	- 18.14	- 20.96	- 21.19	- 21.27
Number of observations	598	598	598	598

Notes:
1. The unit of observation is state per year.
2. The entries are hazard ratios.
3. In parentheses are reported standard errors allowing for clustering by state.
4. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.

Table X: Endogenous Market Design — Allowing Clustering by State

	(1)	(2)	(3)	(4)
		The dependent variable is the likelihood of *Deregulation*		
Deregulation				
Mc-Fuel(-3)	- 0.118			
	(0.031)***			
Heat-Rate(-3)		- 0.014		
		(0.006)**		
Ratio-Mfc(-3)			- 0.114	
			(0.062)*	
Ratio-Hr(-3)				- 0.148
				(0.064)**
Republican	0.023	0.029	0.026	0.025
	(0.043)	(0.044)	(0.045)	(0.044)
Majority	- 0.055	- 0.064	- 0.072	- 0.073
	(0.066)	(0.066)	(0.064)	(0.065)
Deregulation-B	0.369	0.407	0.417	0.418
	(0.037)***	(0.040)***	(0.037)***	(0.037)***
Estimation Procedure		Logit		
Pseudo R^2	0.48	0.46	0.46	0.47
Log pseudo-likelihood	- 159.61	- 165.64	- 165.64	- 163.47
Number of observations	688	688	688	688

Notes:
1. The unit of observation is state per year.
2. The entries are marginal effects.
3. In parentheses are reported standard errors allowing for clustering by state.
4. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.

Table XI: Endogenous Market Design and Outcomes — Semi-Reduced-Forms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				The dependent variable is:				
	Ln-Emp	*Ln-Emp*	*Ln-Btu*	*Ln-Btu*	*Ln-Hr*	*Ln-Hr*	*Mark-Up*	*Mark-Up*
Deregulation	- 0.115	- 0.165	- 0.248	- 0.157	- 0.240	- 0.103	- 12.046	1.583
	(0.038)***	(0.067)**	(0.127)**	(0.078)**	(0.130)*	(0.074)	(13.983)	(1.334)
Republican	- 0.001	0.0004	0.010	0.008	0.008	0.002	0.720	- 0.002
	(0.004)	(0.007)	(0.009)	(0.007)	(0.009)	(0.006)	(0.839)	(0.078)
Majority	- 0.008	0.003	0.016	0.007	0.024	0.008	0.996	- 0.241
	(0.008)	(0.010)	(0.016)	(0.015)	(0.017)	(0.014)	(1.228)	(0.222)
Ln-Wage	- 0.069	- 0.083						
	(0.050)	(0.067)						
Ln-Mwhs	0.024	0.021	0.848	0.862				
	(0.007)***	(0.007)***	(0.020)***	(0.022)***				
Deregulation-B	- 0.015		0.051		0.064		4.521	
	(0.023)		(0.053)		(0.055)		(4.916)	
Mc-Fuel(-3)		0.003		- 0.0003		- 0.001		- 0.100
		(0.002)*		(0.005)		(0.005)		(0.084)
Estimation procedure				Two-step Difference GMM				
Instrument count	24	22	23	21	22	20	22	20
P-value of the test for no								
AR(2)	0.39	0.17	0.03	0.09	0.05	0.27	0.38	0.19
AR(3)	0.50	0.05	0.03	0.04	0.06	0.39	0.33	0.35
AR(4)	0.31	0.48	0.50	0.51	0.18	0.30	0.40	0.28
AR(5)	0.69	0.08	0.77	0.46	0.35	0.46	0.36	0.08
in the first differences								
Number of observations	7429	5802	7429	5802	7429	5802	7429	5802

Notes:
1. The unit of observation is plant-epoch per year.
2. In parentheses are reported the robust standard errors that are corrected following Windmeijer (2005).
3. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.
4. All specifications consider also *Scrubber* and plant-epoch and year fixed effects.
5. The endogenous variable is *Deregulation*, and the excluded instrument is *Mc-Fuel*(-3) (*Deregulation-B*) in columns (1), (3), (5), and (7) (columns (2), (4), (6), and (8)). Moment conditions are collapsed to have only one instrument column per year.
6. The Arellano-Bond test for serial correlation is applied to the differenced residuals. A test rejecting the null hypothesis of no serial correlation of order *l* in the differenced residuals detects serial correlation of order *l-1* in levels.

Table XII: Endogenous Market Design and Outcomes — Controlling For Observables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Panel A. The dependent variable is:							
	Ln-Emp	*Ln-Emp*	*Ln-Emp*	*Ln-Emp*	*Ln-Btu*	*Ln-Btu*	*Ln-Btu*	*Ln-Btu*
Deregulation	- 0.107	- 0.109	- 0.106	- 0.109	- 0.130	- 0.144	- 0.129	- 0.147
	(0.026)***	(0.028)***	(0.026)***	(0.028)***	(0.050)***	(0.056)**	(0.050)***	(0.058)***
PBR(-3)	0.002			0.001	0.018			0.016
	(0.008)			(0.007)	(0.011)*			(0.010)
Divestiture(-3)		0.012		0.012		0.033		0.032
		(0.007)*		(0.007)*		(0.014)**		(0.014)**
Capacity(-3)		0.019		0.020		- 0.016		- 0.015
		(0.038)		(0.038)		(0.020)		(0.020)
Nuclear-Share(-3)		0.015		0.014		0.013		0.008
		(0.027)		(0.026)		(0.032)		(0.033)
Residential-Price(-3)			0.004	0.002			0.017	0.013
			(0.005)	(0.004)			(0.007)**	(0.006)**
Estimation procedure	Two-Step Difference GMM							
Instrument count	23	25	23	27	23	25	23	27
P-value of the Hansen test	0.30	0.22	0.29	0.21	0.51	0.43	0.46	0.40
P-value of the test for no								
AR(2)	0.94	0.99	0.97	0.99	0.05	0.04	0.06	0.04
AR(3)	0.13	0.16	0.15	0.17	0.04	0.04	0.05	0.04
AR(4)	0.99	0.89	0.96	0.88	0.36	0.30	0.28	0.26
AR(5)	0.05	0.06	0.06	0.06	0.40	0.53	0.53	0.61
in the first differences								
Number of observations	5802	5802	5802	5802	5802	5802	5802	5802
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Panel B. The dependent variable is:							
	Ln-Hr	*Ln-Hr*	*Ln-Hr*	*Ln-Hr*	*Mark-Up*	*Mark-Up*	*Mark-Up*	*Mark-Up*
Deregulation	- 0.051	- 0.062	- 0.054	- 0.066	0.024	0.195	0.054	0.217
	(0.049)	(0.057)	(0.050)	(0.058)	(1.712)	(2.066)	(1.647)	(2.049)
PBR(-3)	0.010			0.009	- 0.095			- 0.152
	(0.006)*			(0.005)	(0.661)			(0.449)
Divestiture(-3)		0.018		0.018		0.050		0.048
		(0.014)		(0.014)		(0.552)		(0.539)
Capacity(-3)		0.010		0.010		- 0.321		- 0.319
		(0.018)		(0.018)		(1.038)		(1.021)
Nuclear-Share(-3)		0.037		0.033		0.975		0.995
		(0.033)		(0.034)		(1.046)		(1.050)
Residential-Price(-3)			0.011	0.009			- 0.012	- 0.070
			(0.007)	(0.006)			(0.287)	(0.233)
Estimation procedure	Two-Step Difference GMM							
Instrument count	23	25	23	27	23	25	23	27
P-value of the Hansen test	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P-value of the test for no								
AR(2)	0.88	0.78	0.89	0.70	0.14	0.13	0.14	0.13
AR(3)	0.70	0.71	0.72	0.71	0.37	0.36	0.37	0.36
AR(4)	0.15	0.12	0.15	0.12	0.27	0.27	0.27	0.27
AR(5)	0.54	0.56	0.63	0.65	0.07	0.08	0.07	0.08
in the first differences								
Number of observations	5802	5802	5802	5802	5802	5802	5802	5802

Notes:
1. The unit of observation is plant-epoch per year.
2. In parentheses are reported the robust standard errors that are corrected following Windmeijer (2005).
3. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.
4. All specifications also consider *Republican*, *Majority*, *Scrubber*, and plant-epoch and year fixed effects. Moreover, the specifications in columns (1) to (4) (columns (5) and (8)) in panel A include also *Ln-Wage* and *Ln-Mwhs* (*Ln-Mwhs*). *PBR*, *Divestiture*, and *Capacity* are defined at the plant level.
5. The endogenous variable is *Deregulation*, and the excluded instruments are *Deregulation-B* and *Mc-Fuel*(-3). Moment conditions are collapsed to have only one instrument column per year.
6. The null hypothesis of the Hansen test of overidentifying restrictions is that the instruments, as a group, are exogenous.
7. The Arellano-Bond test for serial correlation is applied to the differenced residuals. A test rejecting the null hypothesis of no serial correlation of order l in the differenced residuals detects serial correlation of order l*-1* in levels.

Table XIII: Endogenous Market Design and Non-Fuel Expenses — OLS Versus GMM

	(1)	(2)	(3)	(4)	(5)
			The dependent variable is:		
	Ln-Nfe	*Ln-Nfe*	*Ln-Nfe*	*Ln-Nfe*	*Ln-Nfe*
Deregulation	- 0.029	- 0.153	- 0.073	- 0.128	- 0.096
	(0.008)***	(0.057)***	(0.042)*	(0.053)**	(0.045)**
Republican	0.001	0.007	0.003	0.006	0.004
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
Majority	0.034	0.043	0.036	0.041	0.039
	(0.014)**	(0.015)***	(0.014)**	(0.015)***	(0.015)***
Ln-Wage	0.126	0.202	0.162	0.189	0.173
	(0.090)	(0.094)**	(0.092)*	(0.093)**	(0.092)*
Ln-Mwhs	- 0.011	- 0.015	- 0.011	- 0.014	- 0.012
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Estimation procedure	OLS		Two-step Difference GMM		
Instrument count		24	24	24	24
P-value of the Hansen test		0.43	0.10	0.28	0.17
P-value of the test for no					
AR(2)	0.99	0.77	0.97	0.89	0.99
AR(3)	0.09	0.09	0.07	0.08	0.07
AR(4)	0.46	0.73	0.58	0.69	0.63
AR(5)	0.41	0.32	0.37	0.33	0.35
in the first differences					
Number of observations	7429	7429	7429	7429	7429

Notes:
1. The unit of observation is plant-epoch per year.
2. In parentheses are reported the robust standard errors, which are also corrected following Windmeijer (2005) in columns (2)-(5).
3. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.
4. All specifications also consider *Scrubber* and plant-epoch and year fixed effects.
5. In columns (2)-(5), the endogenous variable is *Deregulation* and the excluded instruments are two: one is *Deregulation-B*, and the other is *Mc-Fuel*(-3) in column (2), *Ratio-Mfc*(-3) in column (3), *Heat-Rate*(-3) in column (4), and *Ratio-Hr*(-3) in column (5). Moment conditions are collapsed to have only one instrument column per year.
6. The null hypothesis of the Hansen over-identification test is that the instruments, as a group, are exogenous.
7. The Arellano-Bond test for serial correlation is applied to the differenced residuals. A test rejecting the null hypothesis of no serial correlation of order *l* in the differenced residuals detects serial correlation of order *l-1* in levels.

Table XIV: Endogenous Market Design and Capacity — OLS Versus GMM

	(1)	(2)	(3)	(4)	(5)
			The dependent variable is:		
	Ln-Capacity	*Ln-Capacity*	*Ln-Capacity*	*Ln-Capacity*	*Ln-Capacity*
Deregulation	- 0.001	- 0.008	- 0.012	- 0.005	- 0.007
	(0.001)	(0.008)	(0.008)	(0.008)	(0.008)
Republican	0.001	0.001	0.001	0.001	0.0008
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Majority	0.002	0.003	0.003	0.002	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Ln-Mwhs	0.010	0.009	0.009	0.009	0.009
	(0.003)***	(0.002)***	(0.002)***	(0.002)***	(0.002)***
Estimation procedure	OLS		Two-step Difference GMM		
Instrument count		23	23	23	23
P-value of the Hansen test		0.28	0.39	0.23	0.28
P-value of the test for no					
AR(2)	0.15	0.18	0.30	0.16	0.19
AR(3)	0.27	0.29	0.30	0.28	0.29
AR(4)	0.61	0.64	0.63	0.64	0.64
AR(5)	0.82	0.99	0.86	0.92	0.99
in the first differences					
Number of observations	7429	7429	7429	7429	7429

Notes:
1. The unit of observation is plant-epoch per year.
2. In parentheses are reported the robust standard errors, which are also corrected following Windmeijer (2005) in columns (2)-(5).
3. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.
4. All specifications also consider *Scrubber* and plant-epoch and year fixed effects.
5. In column (2)-(5), the endogenous variable is *Deregulation*, and the excluded instruments are two: one is *Deregulation-B* and the other is *Mc-Fuel*(-3) in column (2), *Ratio-Mfc*(-3) in column (3), *Heat-Rate*(-3) in column (4), and *Ratio-Hr*(-3) in column (5). Moment conditions are collapsed to have only one instrument column per year.
6. The null hypothesis of the Hansen over-identification test is that the instruments, as a group, are exogenous.
7. The Arellano-Bond test for serial correlation is applied to the differenced residuals. A test rejecting the null hypothesis of no serial correlation of order *l* in the differenced residuals detects serial correlation of order *l-1* in levels.

Table XV: Endogenous Market Design and Outcomes — Alternative Instruments

	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A. The dependent variable					
	Ln-Emp	*Ln-Emp*	*Ln-Emp*	*Ln-Btu*	*Ln-Btu*	*Ln-Btu*
Deregulation	- 0.083	- 0.123	- 0.082	- 0.095	- 0.148	- 0.095
	(0.026)***	(0.030)***	(0.026)***	(0.047)**	(0.071)**	(0.048)**
Republican	- 0.003	- 0.0005	- 0.003	0.001	0.005	0.001
	(0.004)	(0.004)	(0.004)	(0.004)	(0.006)	(0.004)
Majority	- 0.011	- 0.007	- 0.011	0.002	0.009	0.002
	(0.007)	(0.008)	(0.007)	(0.011)	(0.013)	(0.011)
Ln-Wage	- 0.086	- 0.063	- 0.085			
	(0.045)*	(0.047)	(0.045)*			
Ln-Mwhs	0.025	0.024	0.025	0.853	0.851	0.853
	(0.007)***	(0.007)***	(0.007)***	(0.020)***	(0.021)***	(0.020)***
Estimation procedure	Two-Step Difference GMM					
Instrument count	24	24	24	23	23	23
P-value of the Hansen test	0.14	0.49	0.14	0.99	0.41	0.98
P-value of the test for no						
AR(2)	0.11	0.47	0.11	0.17	0.05	0.17
AR(3)	0.90	0.39	0.91	0.38	0.10	0.39
AR(4)	0.44	0.28	0.44	0.46	0.77	0.46
AR(5)	0.68	0.71	0.68	0.99	0.91	0.99
in the first differences						
Number of observations	7429	7429	7429	7429	7429	7429
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel B. The dependent variable is:					
	Ln-Hr	*Ln-Hr*	*Ln-Hr*	*Mark-Up*	*Mark-Up*	*Mark-Up*
Deregulation	- 0.083	- 0.120	- 0.083	- 0.184	0.732	- 0.032
	(0.045)*	(0.072)*	(0.047)*	(1.055)	(2.576)	(1.186)
Republican	0.0003	0.003	0.0003	0.004	- 0.003	- 0.0007
	(0.004)	(0.006)	(0.004)	(0.086)	(0.298)	(0.095)
Majority	0.011	0.014	0.011	0.019	- 0.102	0.008
	(0.011)	(0.014)	(0.011)	(0.155)	(0.318)	(0.164)
Estimation procedure	Two-Step Difference GMM					
Instrument count	22	22	22	22	22	22
P-value of the Hansen test	0.71	0.29	0.72	0.16	0.37	0.17
P-value of the test for no						
AR(2)	0.32	0.17	0.33	0.90	0.87	0.90
AR(3)	0.47	0.25	0.47	0.30	0.30	0.30
AR(4)	0.94	0.69	0.95	0.40	0.40	0.40
AR(5)	0.44	0.39	0.44	0.37	0.37	0.37
in the first differences						
Number of observations	7429	7429	7429	7429	7429	7429

Notes:
1. The unit of observation is plant-epoch per year.
2. In parentheses are reported the robust standard errors that are corrected following Windmeijer (2005).
3. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.
4. All specifications also consider *Scrubber* and plant-epoch and year fixed effects.
5. The endogenous variable is *Deregulation*, and the excluded instruments are two; one is *Deregulation-B* and the other is *Ratio-Mfc*(-3) in columns (1) and (4), *Heat-Rate*(-3) in columns (2) and (5), and *Ratio-Hr*(-3) in columns (3) and (6). Moment conditions are collapsed to have only one instrument column per year.
6. The null hypothesis of the Hansen over-identification test is that the instruments, as a group, are exogenous.
7. The Arellano-Bond test for serial correlation is applied to the differenced residuals. A test rejecting the null hypothesis of no serial correlation of order *l* in the differenced residuals detects serial correlation of order *l-1* in levels.

Table XVI: Endogenous Market Design and Outcomes — Alternative GMM Estimators

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	The dependent variable is:							
	Ln-Emp	*Ln-Emp*	*Ln-Btu*	*Ln-Btu*	*Ln-Hr*	*Ln-Hr*	*Mark-Up*	*Mark-Up*
Deregulation	- 0.069	- 0.139	0.002	0.002	- 0.0001	0.066	- 0.868	3.070
	(0.017)***	(0.153)	(0.017)	(0.028)	(0.016)	(0.032)**	(0.126)***	(0.569)***
Republican	- 0.002	0.042	- 0.004	0.001	- 0.006	0.008	0.035	0.196
	(0.004)	(0.021)**	(0.002)*	(0.004)	(0.002)***	(0.007)	(0.046)	(0.118)*
Majority	- 0.010	- 0.191	- 0.008	- 0.008	0.001	0.055	0.207	0.894
	(0.007)	(0.088)**	(0.007)	(0.023)	(0.008)	(0.028)**	(0.082)**	(0.474)*
Ln-Wage	- 0.088	0.761						
	(0.044)**	(0.346)**						
Ln-Mwhs	0.019	0.369	0.886	0.922				
	(0.006)***	(0.018)***	(0.018)***	(0.005)***				
Estimation procedure	Two-Step Difference	Two-Step Orthogonal Deviation	Two-Step Difference	Two-Step Orthogonal Deviation	Two-Step Difference	Two-Step Orthogonal Deviation	Two-Step Difference	Two-Step Orthogonal Deviation
Instrument count	39	27	38	26	37	25	37	25
P-value of the Hansen test	0.16	0.35	0.19	0.65	0.22	0.63	0.45	0.18
P-value of the test for no								
AR(2)	0.08		0.51		0.69		0.86	
AR(3)	0.94		0.69		0.76		0.30	
AR(4)	0.47		0.36		0.84		0.40	
AR(5)	0.67		0.81		0.47		0.37	
in the first differences								
Number of observations	7429	8059	7429	8059	7429	8059	7429	8059

Notes:
1. The unit of observation is plant-epoch per year.
2. In parentheses are reported the robust standard errors that are corrected following Windmeijer (2005).
3. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.
4. All specifications also consider *Scrubber* and plant-epoch and year fixed effects.
5. The endogenous variable is *Deregulation*, and the excluded instruments are *Deregulation-B* and *Mc-Fuel*(-3). Moment conditions are collapsed to have only one instrument column per year in columns (1), (3), (5), and (7).
6. The null hypothesis of the Hansen over-identification test is that the instruments, as a group, are exogenous.
7. The Arellano-Bond test for serial correlation is applied to the differenced residuals. A test rejecting the null hypothesis of no serial correlation of order *l* in the differenced residuals detects serial correlation of order *l-1* in levels.