

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

Carmine Guerriero

Website: <http://sites.google.com/site/carminегuerrieroshomepage/>

ACLE and Department of Economics, University of Amsterdam

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Research Questions: Efficiency.

Many economists have long maintained that **not only competition assures allocative efficiency but that it also deliver dynamic advantages** (Raith, 2003; Baggs and de Bettignies, 2007): thus, regulation is enhanced in response to powerful **special interests** (Stigler, 1971; Glaeser and Shleifer, 2003; Aghion et al. 2009; Pinotti, 2009) or in quite **specific technological environments** (Baumol and Klevorich, 1970).



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Can we save regulation from economists?—i.e. **Could we prove that, generally, a benevolent government should choose between competition and regulation optimally trading off static and dynamic efficiency?**



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From an empirical point of view:

- Even if there is evidence (Alesina et al, 2005; Bushnell and Wolfram, 2005; Zhang, 2007; Parker, Kirkpatrick and Zhang, 2008; Craig and Savage, 2010) that deregulation can deliver lower input uses and costs, **no previous paper has evaluated its determinants**;
- Other works (Ka and Teske, 2002; Duso and Röller, 2003; Knittel, 2006; Zhang, 2007; Craig and Savage, 2010) provide **evidence but no theoretical justification** of the relevance of the forces discussed here in explaining regulation. Exceptions: Guerriero (2009, 2010).



Main Contributions and Plan of the Talk.

Three main contributions:

1. Building on a long literature on incentives and competition (Laffont and Tirole, 1993; Armstrong and Sappington, 2006) I prove that in general—whenever demand is inelastic and investment is sufficiently efficient—the choice between regulation and competition reduces to a static versus dynamic efficiency trade-off;



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2. Thus, deregulation is more likely when the rents left by regulation are lower and the reformer's dynamic efficiency concerns are weaker;



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2. Thus, deregulation is more likely when the rents left by regulation are lower and the reformer's dynamic efficiency concerns are weaker;
3. This is consistent with American states electricity market data. Also, considering the endogeneity of regulatory reforms to technological and political forces implies that the medium-term cost-reduction due to restructuring is stronger than that documented by previous analyses (Fabrizio, Rose and Wolfram, 2008).



An Example: Deregulation in the U.S. Electricity Market.

Increasing competitive pressures: Until the beginning of the 1980s, PUC have set prices in order to assure a specific return on investment after recouping all operating costs recognized as reimbursable during rate reviews. Next, some experimentation with incentive regulation and, finally, more radical reforms from the mid-1990s. Today IOUs own only a small fraction of total generating and transmission capacity and retail rates are linked to the equilibrium price arising within **auction-based wholesale markets** (Fabrizio, Rose and Wolfram, 2008).



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Public officials' incentives: **The details of reforms are decided during rate reviews initiated by the PUC or required by the government** in order to have a particular reform implemented (EIA, 2003). Within these **open quasi-judicial hearings, commissioners, who are either elected or appointed, cover an information gathering role** (Gormley, 1983; Friedman, 1991).



Set Up.

The **representative demand** is $q(p)$ at price $p \geq 0$ with $q'(p) < 0$; the gross surplus is $S(q(p)) = \int_p^\infty q(x) dx$; $q(p)$ and p are common knowledge.



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Production is assured by either one firm under regulation or two under competition. The average and marginal unknown cost c equal c_L w. p. 1/2 and c_H w. p. 1/2. Let $\Delta \equiv c_H - c_L > 0$. The costs are uncorrelated, and a firm maximize the rent U .—i.e. the sum of profits $\pi(p, c) \equiv q(p)(p - c)$ and a transfer $t \geq 0$ under regulation. The transfer brings social costs $1 + \lambda$ with $\lambda \geq 0$.



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With $\alpha \in [0, 1]$ measuring society's dynamic efficiency concerns, social welfare is $S(p) + \alpha U - (1 + \lambda)t = S(p) + (1 + \lambda)\pi(p, c) - (1 + \lambda - \alpha)U = w(p, c) - (1 + \lambda - \alpha)U$. Assume $\lambda = 0$ in the following.



Timing.

$t = 1$.—At the Constitutional table, society learns the nature of the regulatory environment; next, she chooses between regulation and competition on the base of the expected welfare under the two conducts and a preference shock $\delta \in [-\infty, \infty]$ with density f and $E(\delta) = 0$ (Mulligan and Shleifer, 2005; Aghion et al., 2009; Pinotti, 2009). **Under regulation, a menu of (t, p) pairs** are offered to the monopoly; the contract is conditional on the firm's report of c . Under competition, **firms compete a' la Bertrand** serving all the market at c_H when able to undercut the competitor, and splitting the market otherwise.



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$t = 2$.—The monopoly or each oligopoly commit **an unobservable investment of cost $\psi(I) \geq 0$ such that the probability of c_L becomes $(1 + I)/2$** ; $\psi(\cdot)$ is strictly increasing and strictly convex. The regulator cannot commit to reimburse investment.



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$t = 4$.—While under regulation the firm executes the contract if she finds it acceptable, under competition the Bertrand pricing game is played.



Pricing: Regulation Versus Competition.

Regulation.—Exploiting the **revelation principle** (Myerson, 1979), she optimally offers the firm a menu of (p_i, t_i) contracts with $i \in \{L, H\}$ contingent on the firm's report of c . The equilibrium envisions a binding low cost firm's IC constraint or $q(p_L)(p_L - c_L) + t_L = q(p_H)(p_H - c_L) + t_H$ and a binding high cost firm's IR constraint so that: $U_H = 0$ and $U_L = \Delta q(p_H)$. The expected social welfare is:



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$$\frac{1+\hat{\gamma}^R}{2} [w_L(p_L, c_L) - (1 + \lambda - \alpha) \Delta q(p_H)] + \frac{1-\hat{\gamma}^R}{2} [w_H(p_H, c_H)] =$$

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Competition.—The expected social welfare is:

$$\frac{(1+\hat{\gamma}^C)^2}{4} S(c_L) + \frac{(1-\hat{\gamma}^C)^2 + 2 - 2(\hat{\gamma}^C)^2}{4} S(c_H) + \frac{1 - (\hat{\gamma}^C)^2}{2} \alpha \Delta q(c_H).$$



Cost Reducing Investments: Regulation Versus Competition.

Under competition: $\hat{I}^C = \arg \max_{I \geq 0} (1/4) (1 + I) (1 - \hat{I}^C) \Delta q(c_H) - \psi(I)$.



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Provided that A1— $\varepsilon_{p,q} = -q'(p)p/q(p) < 1$ —holds, it is true that:
 $2q(\hat{c}_H^I) > q(c_H)$ and, in turn, that $I^R > I^C$.



The Static Versus Dynamic Efficiency Trade Off.

For $\delta = 0$ competition prevails if: $\frac{(1+\hat{i}^C)^2}{4} S(c_L) +$
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► Static Efficiency.



Strategic Deregulation.

The reformer is an incumbent party \tilde{m} : either the pro-shareholder R or the pro-consumer D . Ex post the firm eventually commits an investment of fixed cost $\bar{I} > 0$, expected value $\pi\bar{I}$ with $\pi \equiv \bar{\pi}\delta + \underline{\pi}(1 - \delta) > 0$ and $\bar{\pi} > 0 > \underline{\pi}$. Next \tilde{m} faces an election with exogenous winning probabilities $x_{\tilde{m}}$ and the winner m implements an aid $\rho_m > 0$ proportional to the firm's rent and paid out to the firm if the investment is committed. Only c_L invests if $(1 + \rho_m) \hat{U}^j + \underline{\pi}\bar{I} \geq 0$.



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\tilde{m} evaluates the ex-post PC at the shadow price $\chi_{\tilde{m}}$ and the aid $\rho_m\hat{U}^j$ at the shadow price of public funds $\lambda = 0$. $\tilde{x} \equiv \rho_D x_D + \rho_R x_R$ and **A.3**: $\rho_R > \rho_D$; $\chi_R > \lambda > \chi_D$.



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P2: Under assumptions A1, A2 and A3, the probability that competition is selected falls with the reformer hold on power $x_{\tilde{m}}$ and is greater if she is pro-consumer.



Information: Regulators' Implicit Incentives.

In $t = 2$ the Constitutional table directly offers the firm (t, p) pairs conditional also on a signal on c observed by the regulator between $t = 3$ and $t = 4$. If $c = c_L$ w. p. $\gamma \in [0, 1]$ the Constitutional table sees c_L and w. p. $1 - \gamma$ she remains uninformed. If $c = c_H$, she always remains uninformed. This time $W^{R,S} = \frac{1+\hat{I}^{R,S}}{2} S(c_L) + \frac{1-\hat{I}^{R,S}}{2} S(\hat{c}_H^{I,S})$ where $\hat{c}_H^{I,S} \equiv c_H + (1 + \hat{I}^{R,S}) (1 - \hat{I}^{R,S})^{-1} (1 - \gamma) (1 - \alpha) \Delta$. The monopoly invests $\hat{I}^{R,S} = \arg \max_{I \geq 0} (1/2) (1 + I) (1 - \gamma) \Delta q \left(\hat{c}_H^{I,S} (\hat{I}^{R,S}) \right) - \psi(I)$.



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P3: Under A1 and if $\varepsilon_{p,q} < \bar{\varepsilon}_{p,q}$, the probability of adopting competition rises with the precision of the signal γ and, in particular, when the regulator is elected.

► Information.



Extensions.

The qualitative message of the model—**deregulation is more likely when the rents left by regulation are lower and the reformer's dynamic efficiency concerns are weaker**—continues to hold whenever:



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1. The social cost of public funds is positive;
2. Investments are contractible;
3. Costs are correlated or a the number of firms is higher than two;
4. The competition is a' la Cournot.

Remark: The trick is to prove that **the impact of α and γ on \hat{I}^R and \hat{c}_H^I are unaffected and that regulation preserves its dynamic advantage.**



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► Robustness.



Testable Predictions.

Prediction 1: The likelihood of a reform toward more competition will fall:

1. with society's concerns for cost-reducing investments;
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Prediction 2: Production costs could be either greater or lower under competition.

Why? Because competition will assure a lower expected ex ante cost whenever:

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

$$\leftrightarrow \frac{1-2(I^R-I^C)-(I^C)^2}{4} (c_L - c_H) < 0$$



Dataset and Dependent Variables.

Reforms.—All states held hearings between 1993 and 1998; 23 states and the District of Columbia enacted legislation between 1996 and 2000.

Data-set.—All the large fossil-fuel steam and combined cycle gas turbine generating plants for which data were reported to the FERC over the 1981-1999 period and enough observations on the quality of information gathering and political competition are available: 8,059 observations on 503 plant-epochs—i.e. years when the plant capacity was “stable”—in 43 states (Fabrizio, Rose and Wolfram, 2007).



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Institutions.—*Deregulation* equals one for plants in states that restructured beginning in the year of the first hearing and zero otherwise. **Remark:** Similar results with *Law* or when the ordered logit with dependent *Der_Ord* is studied.



Choice of Proxies and Methodology.

Society's investment concerns.—The following marginal cost measures: *MC_Labor*, the marginal labor cost in cents of dollar per Kwh of generation and the marginal fossil fuel cost in cents of dollar per Kwh of generation—*MC_Fuel*. The following three input uses aggregated at the state level and lagged of three years: the natural log of the number of employees *Ln_Emp*, the natural log of the total non-fuel production expenses in dollars *Ln_Nfe* and the natural log of the total Btus of fuel consumption *Ln_Btu*.

Political competition.—*Majority*: share of seats held by the majority party averaged across both houses; *Republican* equals one if both houses were under Republican control, 0 otherwise.

Efficiency of information gathering.—*Reg_Elec* equal to one where the public utility commissioners are elected and zero otherwise.



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Methodology: Logit with dependent *Deregulation*; focus on **marginal effects**—the percentage variation in the likelihood of the dependent when the control rises by one percentage point.



Table 1: Determinants of Deregulation — Logit.

The dependent variable is the likelihood of a reform toward:

	Deregulation	Deregulation
<i>MC_Labor</i> (-3)	- 0.008 (0.013)	
<i>MC_Fuel</i> (-3)		- 0.082 (0.013)***
<i>Republican</i>	0.034 (0.029)	0.018 (0.020)
<i>Majority</i>	- 0.075 (0.037)**	- 0.038 (0.027)
<i>Elec_Reg</i>	- 0.015 (0.027)	0.001 (0.017)
<i>Der_Nei</i>	0.410 (0.052)***	0.256 (0.047)***
Pseudo R^2	0.45	0.48
Log Pseudo-Likelihood	- 169.13	- 159.60
Number of Observations	688	688

- Notes:
1. Robust standard errors—z distribution—in parentheses;
 2. The entries are marginal effects;
 3. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.



Table 2: Deregulation — Logit (Alternative Proxies).

The dependent variable is the likelihood of a reform toward:

	Deregulation	Deregulation	Deregulation
<i>Ln_Emp(-3)</i>	- 0.036 (0.009)***		
<i>Ln_Nfe(-3)</i>		- 0.009 (0.003)***	
<i>Ln_Btu(-3)</i>			- 0.005 (0.001)***
<i>Republican</i>	0.028 (0.027)	0.028 (0.028)	0.027 (0.028)
<i>Majority</i>	- 0.071 (0.036)**	- 0.070 (0.037)*	- 0.068 (0.037)*
<i>Elec_Reg</i>	- 0.006 (0.025)	0.007 (0.027)	0.009 (0.028)
<i>Der_Nei</i>	0.394 (0.053)***	0.418 (0.052)***	0.414 (0.052)***
Pseudo R^2	0.46	0.46	0.46
Log Pseudo-Likelihood	- 164.81	- 166.54	- 165.83
Number of Observations	688	688	688

- Notes:
1. Robust standard errors—z distribution—in parentheses;
 2. The entries are marginal effects;
 3. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.



Methodology.

Examine whether deregulation pushes the firm to use a better mix of inputs given prices, estimating by OLS and GMM the input use equations (Fabrizio, Rose and Wolfram, 2007):

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

$N_{p,t}$ is Ln_Emp or Ln_Nfe or Ln_Btu ;

$Q_{p,t}^N$ is the annual net MWh generation for plant p in year t ;

$P_{p,t}^N$ is the price of the input $N_{p,t}$ —i.e., the BLS annual wage bill in dollars divided by total employment for Ln_Emp or Ln_Nfe and none for Ln_Btu ;

$\mathbf{x}_{p,t}^N$ gathers the determinants of deregulation which cannot be excluded by the input use equation and a dummy for the presence of a FGD scrubber;

$\gamma_{p,t}^N$ is the dummy *Deregulation*; α_p^N are plant fixed effects; δ_t^N are time effects.



A World of Biases.

Notice that **the bias could go either way**:

- it could be **positive** because deregulation could correlate with unobserved low cost-reducing effort by a state with weak cost reducing investment concerns;



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- it could be **positive** because deregulation could correlate with unobserved low cost-reducing effort by a state with weak cost reducing investment concerns;
- it could be **negative** because deregulation could correlate with unobserved forces increasing the efficiency of the information gathering technology and, in turn, lowering the firm's cost reducing investments under regulation.



Table 3: Input Use Equations — OLS Versus Difference GMM.

<i>The dependent variable is:</i>			
	<i>Ln_Emp</i>	<i>Ln_Nfe</i>	<i>Ln_Btu</i>
<i>Deregulation</i>	- 0.069 (0.010)***	- 0.106 (0.013)***	- 0.021 (0.007)***
Estimation	OLS		
Number of obs.	8059	8059	8059
<i>Deregulation</i>	- 0.130 (0.027)***	- 0.115 (0.039)***	- 0.073 (0.046)
Estimation	Two-step difference GMM		
Excluded Instruments	dependent lagged three periods and <i>Der_Nei</i>		
Instruments count	25	25	25
AR(2) in first differences	0.58	0.93	0.26
Hansen test	0.57	0.28	0.76
Number of observations	7429	7429	7429



Standing on the Shoulders of the Giants.

The relevance of regulatory institutions to economic development is key especially in a period of liberalization (Newbery, 2000). Yet, the determinants of these settings are still poorly understood: here, I developed and tested a property right—on sunk investments—theory of “endogenous market institutions” (Guerriero [2009, 2010]).



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Avenues for further research:

- What about **service quality** (see Ajodhia and Hakvoort, [2005])?
- **Endogenize the probability of reelection** after a regulatory reform? Ask the “terminated” ex governor Gray Davis.
- Endogenous impact of competitive pressures in **other markets** as the pharmaceutical or commercial banking ones.



Institutional Choice With No Investments.

Competition is chosen when $W^C > W^R + \delta$ that, for $\delta = 0$, rewrites as:

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

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



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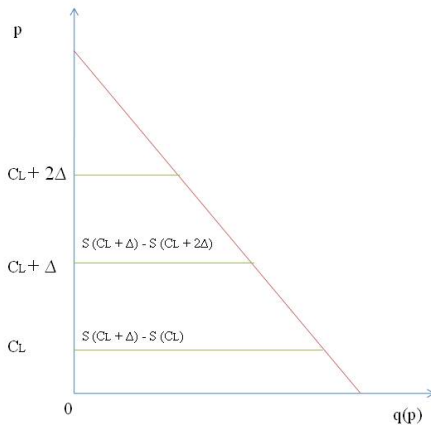
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$$2[S(c_H) - S(\hat{c}_H)] + 2\alpha \Delta q(c_H) > [S(c_L) - S(c_H)].$$

Lemma 1: For $\delta = 0$, competition always outperforms regulation when $2[S(c_L + \Delta) - S(c_L + 2\Delta)] > S(c_L) - S(c_L + \Delta)$. Also, the probability of adopting competition rises with society's investment concerns α .



Inelastic Demand.



The Information Gathering Technology.

$\gamma_j = \theta e_j$ where $\theta \in [0, 1]$ is the random ability, $e_j \in [0, 1]$ is the effort, and $j = \{A, E\}$ indexes implicit incentives. θ has mean $\bar{\theta}$ and is drawn from a density g .



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The regulator maximizes: $P + \tau [B(e_j) - (1 - K) C(e_j)]$ where $C' > 0$, $C'' > 0$, $B^E(e_E) = \Pr \{e_E \geq \bar{\theta} e^{\text{exp}}\}$, $B^A(e_A) = E_\theta [E_\theta(\theta | \gamma_A, e_A^{\text{exp}})]$.



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Whenever $g(\bar{\theta}) > 1$, elected regulators exert more effort than appointed ones do.

◀ Return 2



Robustness: Regulation.

A positive shadow cost of public funds.—The **equilibrium Ramsey pricing rule** is: $p_i + \lambda (1 + \lambda)^{-1} q(p_i) [q'(p_i)]^{-1} \equiv \Psi(\lambda, p_i) = c_i$ with $\Psi_1 > 0$ and $\Psi_2 > 0$ whenever $q(p_i)$ is log-concave. **Provided that the demand is sufficiently inelastic:**

1. **Competition will lead to an higher extent of underinvestment;**
2. **The impact of society's investment concerns and the efficiency of the information gathering technology on \hat{I}^R and \hat{c}_H^I will have the same sign but it will be pre multiplied by $\Psi_2(\hat{p}_i) > 0$;**
3. **Also, the regulation dynamic advantage will remain.**



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Contractible Investments.—Provided that **the individual rationality constraint is imposed under regulation, investment would still be inefficient when contractible—except in the case of $\lambda = 0$ —and the rule giving price as a function of marginal cost would be unaffected (Laffont and Tirole, 1993):** for a sufficiently inelastic demand, the model's message would go through.



Robustness: Competition.

Correlated Costs.—A correlation between the firms' costs ρ greater than $1/2$ would only affect the welfare under competition and not \hat{I}^R and \hat{c}_H^I . Also, ρ would increase the regulation dynamic advantage.



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Cournot Competition.—At symmetric equilibria and for the same level of costs:

- On one side, Cournot competition will decrease investments because output will be lower than the Bertrand output; on the other side, it will foster them because output choices are strategic substitutes. **Cournot competition may induce more cost-reduction (see Vives, [2008]); yet, under regularity conditions, the regulation dynamic advantage would be preserved;**
- Neither \hat{I}^R nor \hat{c}_H^I would be affected.

