Empirical Approaches to Regulation Theory

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Introduction

- A regulator (public authority) delegates a task to a firm (monopoly).
- Telecommunications, Public transportation, water distribution, wastewater treatment, road construction, etc.
- Objectives are specified in a contract.
- Asymmetric information between the regulator and the firm: Cost efficiency and cost reducing effort.

Introduction

- The new theory of regulation proposes a theoretical framework based on the principle-agent paradigm: Menus of contracts.
- Normative or positive view?
- Laffont and Tirole (1986).
- Empirical experience over the last 20 years.

- Full menus are observed in reality.
- Binary menus.
- Transaction costs versus incentives.
- Auctions versus negotiation.

The new theory of regulation

- Baron and Myerson (1982), Laffont and Tirole (1986).
  See also Laffont (1994) and Laffont and Tirole (1993).
- Principal-agent relationships under asymmetric information on operating costs.
- Incentives for cost reduction and informational rents.
- Second-best output.
- Static framework.
- The principal maximizes social welfare under an incentive compatible constraint $\leftrightarrow$ Revelation principle.

Laffont and Tirole (1986)

- Consider the operation of a public service with cost

$$C = \beta - e$$

where β has a distribution $F(\beta)$ on $[\underline{\beta}, \bar{\beta}]$.

- The operator has a utility function equal to

$$U = t - \psi(\beta - C).$$

- Under asymmetric information, a mechanism $\{t(\tilde{\beta}), C(\tilde{\beta})\}_{\tilde{\beta} \in [\underline{\beta}, \bar{\beta}]}$ induces truthful revelation if

$$\beta \in \underset{\tilde{\beta}}{\operatorname{Arg\,max}} \left\{ t(\tilde{\beta}) - \psi\left(\beta - C(\tilde{\beta})\right) \right\}.$$

Laffont and Tirole (1986)

- Social welfare is defined as

$$S - (1+\lambda)(t+C) + U$$
$$= S - (1+\lambda)(\beta - e + \psi(e)) - \lambda U.$$

- Optimal second-best regulation is the outcome of the regulator's program

$$\text{Max} \int_{\underline{\beta}}^{\overline{\beta}} \{S - (1+\lambda)(\beta - e + \psi(e)) - \lambda U(\beta)\}\, dF(\beta),$$

$$\dot{U}(\beta) = -\psi'(e(\beta)) \quad \forall \beta,$$

$$U(\beta) \geqslant 0 \quad \forall \beta.$$

Laffont and Tirole (1986)

- First order conditions are:

$$\psi'(e^*(\beta)) = 1 - \frac{\lambda}{1+\lambda}\frac{F(\beta)}{f(\beta)}\psi''(e^*(\beta)),$$

$$U^*(\beta) = \int_{\beta}^{\bar{\beta}} \psi'\left(e^*(\tilde{\beta})\right) d\tilde{\beta}.$$

  The most efficient firm exerts the highest effort level and receives the highest rent.

- Fundamental trade-off between rents and allocative inefficiencies.
- A more concrete implementation of these optimal schemes is obtained as follows:

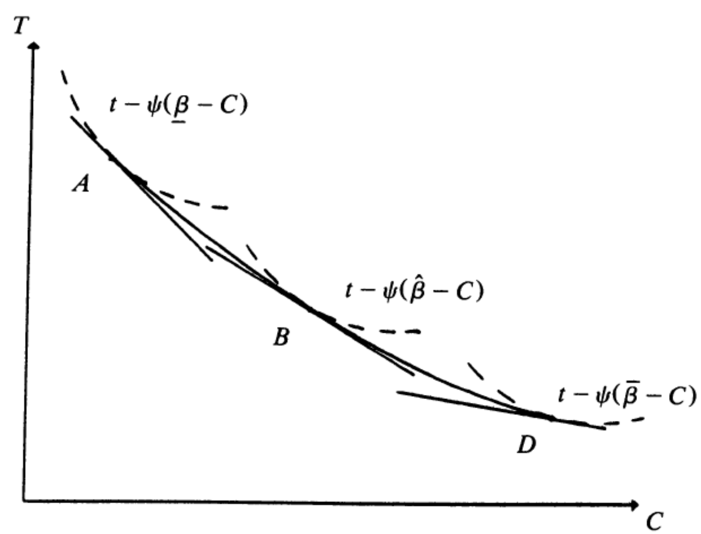
Laffont and Tirole (1986)

$$t(\beta) = U^*(\beta) + \psi(e^*(\beta)) = t(\beta(C)) = T(C).$$

Optimal regulation can be implemented through the transfer function $T(C)$. Operators self-select themselves.

- This function can be replaced by the family of its tangents:

$$t(C, C^a) = a(C^a) - b(C^a)(C - C^a).$$



Laffont and Tirole (1986)

- Main lesson (I): The second-best solution can be decentralized through a menu (a continuum) of linear contracts.
- The operator picks up the contract which corresponds to its real "type".
- Fixed-price and cost-plus contracts are two extreme cases.
- Main lesson (II): The regulator is sophisticated.
- Computational ability.
- Knows the agent's disutility function.
- Main lesson (III): The regulator maximizes social welfare. Absence of political capture.

Regulation and procurement: Positive representation

- Binary instead of full menus.
- Empirical tests:
- Current regulatory schemes are full menus.
- Current regulatory schemes are fixed-price or cost-plus contracts.
- Renegotiation.
- Incentives versus transaction costs.
- Auctions versus negotiation.

Binary menus

- Full menus are difficult to implement in reality
  - The regulator is not able to specify the agent's disutility function.
  - Calculating the optimal menu is technically complex.
- Binary menus are frequent:
  - US Department of Defense and weapons contractors.
  - Federal Communications Commission and Regional Bell Operating Companies.
  - Construction industry.
  - Public transportation.

Binary menus

- Menus of 2 contracts:
- Are easy to understand and calculate.
- Have lower informational requirements. The principal should be able to
  - describe the likely distribution and density of costs.
  - evaluate the efficiency gains to be obtained if fixed-price instead of cost-plus.
- The principal guarantees that all types of the agent participate by offering a cost-plus.
- It extracts rent and create incentives for the low-cost types using a fixed-price.

Binary menus

- Rogerson (2003) and Chu and Sappington (2007).
- Simple menus of cost-plus and fixed-price contracts.
- Capture a substantial share of the gains achievable by the fully optimal menu: At least 75%.
- Theoretical exercise.
- Initial assumptions: Agent's disutility of effort quadratic and agent's type is distributed uniformly.
- What could be obtained if this initial assumptions were relaxed?

Empirical tests: Full menus

Wolak (1994)

- Analyze regulation of private water utilities.
- For every district, the California Public Utilities Commission (CPUC) chooses a price for water, an access fee per meter, and a rate of return on capital to satisfy firms' revenue requirement
- Data from a sample of Class A California water utilities for the period 1980 to 1988.
- Private information regulator-utility interaction a la Baron and Myerson (1982): Costs are not observed ex-post.
- Labor is the source of private information:

$$Q_i = f\left(K_i, L_i^*, E_i, \varepsilon_q(i) \mid \beta\right),$$

$$L_i^* \doteq L_i / d(\theta_i)$$

Empirical tests: Full menus

- The regulator (and the econometrician) knows only $\mathrm{F}(\theta)$.
- The optimal input mix is a solution to:

$$\min_{\mathrm{L},\,\mathrm{E}} w\,\mathrm{L} + pe\,\mathrm{E} \text{ subject to } \mathrm{Q} = f\left(\mathrm{K},\, \mathrm{L},\, \mathrm{E},\, \theta,\, \varepsilon_q \,|\, \beta\right).$$

which leads to the dual cost function:

$$\mathrm{TC} = \mathrm{CVC}\left(pe,\, w,\, \theta,\, \mathrm{K},\, \mathrm{Q},\, \varepsilon_q,\, \eta_{\mathrm{L}},\, \eta_{\mathrm{E}} \,|\, \beta\right) + r_i\,\mathrm{K}_i.$$

- The regulator announces price and fee schedules as a function of the utility's capital stock selection.
- These schedules are chosen to maximize expected total welfare, subject to:
- Expected profits for all possible utility types are nonnegative.
- All types of utilities find it in their best interest to truthfully reveal their private information through their capital stock selection.

Empirical tests: Full menus

- Structural cost function.
- Economies of scale are overestimated if a more traditional cost function is considered in place of the asymmetric information model.
- See Brocas, Chan, and Perrigne (2006) as well.

- Models based on the Laffont and Tirole (1986) optimal schemes:

- Gasmi, F., Laffont, J.J. and W.W. Sharkey (1995 and 1999).
- Wunsh (1994).

Note: These studies use simulations.

Fixed-price and cost-plus regimes

Gagnepain and Ivaldi (2002)

- Empirical model of costs regulation; asymmetric information; French urban transport industry.
- Transport operators and local governments (regulators) are tied together by a regulatory mechanism.
- Two main types of contracts in practice: Cost-plus (no incentives) and Fixed-price (Perfect incentives).
- Incentives and cost reduction: Cost-reduction effort depends on contract.

- Fixed-price: $U = s^{FP} + p(y)y - C(Y, w, K, e, \theta | \beta) - \psi(e)$.

$$-C_e(.) = \psi'(e).$$

Fixed-price and cost-plus regimes

- Cost-plus: Optimal effort is 0.
- Functional forms are parametric:

$$C = \beta_0 w_l^{\beta_l} w_m^{\beta_m} Y^{\beta_Y} K^{\beta_K} \exp[(\theta - e)].$$

$$\psi(e) = \exp(\alpha e) - 1$$

- Structural cost function:

$$\ln C = \xi^{FP}\left(c_0 + \beta_l' \ln w_l + \beta_m' \ln w_m + \beta_k' \ln K + \beta_Y' \ln Y + \gamma\theta_j\right) + \xi^{CP}\left(\ln \beta_0 + \beta_l \ln w_l + \beta_m \ln w_m + \beta_k \ln K + \beta_Y \ln Y + \theta\right).$$

Fixed-price and cost-plus regimes

- Once the technology of the industry is known, design the optimal menu of contracts in a situation of perfect information.

$$\Delta W^f = W(y^f, \phi(y^f), e^f, \theta) - W^a$$

- See also Dalen and Gomez-Lobo (1997).

Contract renegotiation

- Contractual relationships are ongoing processes in an ever changing environment.
- Several periods.
- Asymmetric information. New information on demand and cost.
- Theoretical literature (Williamson, 1985, Dewatripont, 1989, Laffont and Martimort, 2002, Fudenberg and Tirole, 1990):
  - Positive impact because it improves contracting ex post.
  - Perverse effects on parties ex ante incentives.
  - Renegotiation imposes costs, which prevent from achieving the efficient solution that can be reached under full commitment.

Contract renegotiation

- Gagnepain, Ivaldi and Martimort (2010): Urban transportation in France.
- Dynamic model to explain the choice of contracts.
- Principals are not sophisticated: They use contract choice for future renegotiation (not cost observation) ⇨ Tractable theoretical model in a dynamic horizon.
- Recover the welfare gains and their distribution in case contracting under full commitment were feasible.
- These gains are significant and operators would indeed be the winner if contract length was extended.

Contract renegotiation

Features of the industry:

- Contracts: Cost-plus and fixed-price.
- Subsidies follow different patterns over time.
- Constant if series of fixed-price contracts.
- Higher if fixed-price following cost-plus (compared to other fixed-price).
- Can be rationalized under limited commitment. Revisited here in a context of a two-item menu and a continuum of possible realizations of costs.
- Menu: Long term fixed-price contract, or cost-plus followed by a fixed-price contract, or long term cost plus contract.

Contract renegotiation

- Operators self-select themselves ⇨ Match the cumulative distribution of the inefficiency to an empirical probability of accepting a fixed-price contract.

- Accept the long-term fixed-price contract if

$$\Theta_G = \left[\underline{\theta}, b_1 + k + \frac{(1-\beta)}{\beta}(b_2 - b_3)\right]$$

- Accept a fixed-price contract only in the second period.

$$\Theta_I = [b_1 + k + \frac{(1-\beta)}{\beta}(b_2 - b_3), b_3 + k]$$

- Those with type $\Theta_B = [b_3 + k, \bar{\theta}]$ always choose the long term cost-plus contract.

Contract renegotiation

- The principal updates his beliefs over the firm’s type following its first-period decision.
- Write long-term renegotiation-proof contracts.

- Then simulate welfare gains if perfect commitment instead of renegotiation.

Contract renegotiation

- Challenge Rogerson's results through an empirical test: Simulate the welfare gains that could be obtained if a full optimal menu is implemented instead ⇨ Laffont and Tirole (1986).
- Investigate whether the major source of benefits in contract design comes either from extending contract length or from better designing cost reimbursement rules.

Contract renegotiation

Perfect commitment
(Normative framework)

Limited commitment
(Positive framework)

Binary menu
Gagnepain Ivaldi Martimort (2010)

Binary menu
Gagnepain Ivaldi Martimort (2010)

Full Menu
Gagnepain Ivaldi Martimort (2011)

Contract renegotiation

- French urban transportation industry.
- The binary menu captures 27.7% of the welfare achievable by the full menu.
- To design good cost reimbursement rules is the important issue.

- Welfare increases by 5.5 million Euros if full menu in place of binary menu.
- Welfare increases by 2.1 million Euros if perfect commitment (binary menu) instead of limited commitment.

Incentives versus transaction costs

- Problem of ex post adaptations rather than ex ante screening.
- Trade-off between ex ante incentives and ex post transaction costs due to costly renegotiation: Complex project are run under cost-plus contracts (low level of design completeness) while simple projects are regulated with fixed-price regimes (high level of design completeness).
- Bajari and Tadelis (2001)
- The building construction industry in the U.S.
- No asymmetric information. However, uncertainty about design changes after the contract is signed and production begins: Design failures, changes in regulatory requirements; changes in environmental conditions etc.

Incentives versus transaction costs

- Banerjee and Duflo (2000).
- Choice of contracts in the Indian customized software industry.
- Fixed-price or cost-plus contracts.
- The agent’s reputation affects the choice of contract: Older firms are more likely to be engaged in cost-plus contracts.
- Older firms do on average larger and more complex products than young firms.

Auctions versus negotiation

- More complex projects—for which ex ante design is hard to complete and ex post adaptations are expected—are more likely to be negotiated, whereas simpler projects will be awarded through competitive bidding.
- Bajari, McMillan, and Tadelis (2008)
- Contracts awarded in the building construction industry in Northern California from 1995 to 2001.
- More potential bidders increase the benefits of using an auction.
- Negotiated contracts are more likely to be allocated to more reputable and experienced sellers.
- *See also*: Yvrande, Chong and C. Staropoli (2010): Construction industry. All public procurement contracts awarded between 2005 and 2007 in France.

Related topics

- Bajari, Houghton, and Tadelis (2007): Structural estimation of adaptation costs. Highway construction in California.
- Levin and Tadelis (2010): Local governments in the U.S. are more likely to provide complex (in terms of size and design) services themselves and delegate simpler tasks to private operators.

Conclusion

- The new theory of regulation uses mechanism design to model principle-agent relationships in a context of asymmetric information.
- The regulator screens the seller by offering a menu of contracts.
- This literature is normative.
- It offers a very powerful tool to design:
- Second best optimal contracts if the principal is uninformed.
- First-best optimal contracts if the principal has managed to collect information.
- Need for sophisticated regulatory agencies. Politicians may not be able to achieve such tasks.

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