lecture 5: natural monopoly – regulation under asymmetric information

the story so far

Natural monopoly:

- Definitions
- (Ideal) Pricing solutions
  - Linear:
    - MC pricing
    - AC pricing
  - Non-linear: two-part or multiple-part tariffs
  - Ramsey prices (for multiproduct NM)
- Regulation in practice
  - Rate of return regulation (traditional solution)
  - Incentive regulation:
    - Earnings sharing
    - Price caps
    - Yardstick regulation
    - Loeb Magat mechanism
  - Franchise bidding
  - Rate structure

outline

- Natural monopoly
  - Regulation under asymmetric information
- References

- LT, ch. 1
- Joskow, P. (2007) “Incentive Regulation in Theory and Practice: Electricity Distribution and Transmission Networks,” NBER Chapters, in: Economic Regulation and Its Reform: What Have We Learned? National Bureau of Economic Research, Inc.

Asymmetric information

- Regulators cannot rely on contracts that are contingent on information held only by the firm (or more generally on information not verifiable by a court), e.g., information on costs, profits,...

- There are two types of informational constraints:
  - On actions/endogenous variables - "effort" - not observed by the agency; e.g., number of hours and intensity of work,...– **moral hazard**
  - On exogenous variables – "type"; e.g. technological possibilities, difficulty in implementing some tasks, demand,... – **adverse selection**

Asymmetric information

- Moral hazard and adverse selection (and the loss of control of the regulator) create a demand for information gathering; e.g., audits in public firms and controls in private firms

- But most dimensions of asymmetric information do not show up in accounting statements!

Regulation as an agency relationship

- Regulation can be seen as a Principal-Agent relationship:
  - The firm (Agent) has more information than the regulator (Principal)

Regulation as an agency relationship

problem's ingredients

- A firm's cost opportunities may be high or low
- The regulator does not know the firm's true cost opportunities, but has some information about its probability distribution
- The firm's actual costs depend on (i) its cost opportunities and (ii) decisions made by managers to exploit these opportunities
- Managers may exert more (or less) effort to get more (or less) out of cost opportunities (the > the effort, the lower the actual costs)
- High effort is costly for managers
- The regulator cannot observe effort directly

Regulation as an agency relationship

problem's ingredients

- So, the firm wants to convince the regulator that it is a high cost firm, so that it is allowed to set high prices (to ensure financial viability)
- This is an **adverse selection problem**
- If the regulator can obtain reasonably good information on actual costs, ROR regulation (prices set to equal ex post costs) would solve the adverse selection problem
- But, if this loss of opportunity to earn rents reduces managers' incentives to make effort, costs may rise above efficient levels
- So, bad regulatory incentives may reduce effort; this is a **moral hazard problem**

Regulation as an agency relationship
problem's ingredients

- The regulator will then use a mechanism that takes both problems into account, subject to the firms' financial viability (IR constraint)

- Two polar cases:
  - Setting a fixed price ex-ante and forever (or adjusting with exogenous factors) gives high incentives for effort (and minimizes moral hazard); but, given IR, the regulator has to set high prices, so that rent extraction is poor (full cost of adverse selection)
  - Implement ROR (with no ex post negotiation) that reimburses cost ex post; if audits of expenses are accurate, the firm reveals if it's high or low cost (adverse selection disappears), but there may managerial slack (full cost of moral hazard)

- Trade-off: managerial efficiency vs. rent extraction

Regulation as an agency relationship

problem's ingredients

- The solution is somewhere in between as in a sliding scale
- But, LT show that the regulator can perform better by offering a menu of contracts
- Example: menu with two options: a price cap and a ROR contract; the price cap can be demanding because the ROR option exists (IR is not violated); but if the firm has low cost, choosing the price cap, more rent are conveyed to the consumer
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Regulation as an agency relationship

aims and instruments

The optimal regulation of a monopoly is influenced by many factors:

1. Whether the regulator is benevolent or self-interested
2. The regulator's objective (when he is benevolent)

$$S + \alpha R, \quad \alpha \in [0,1]$$

3. The cost of raising revenue from taxpayers (social cost of public funds) λ
4. The range of policy instruments available (e.g., ability to use public funds/tax firms directly)
5. The regulator's bargaining power
6. The information available to the regulator and the firm
7. The regulator's ability to commit to long-term policies

Regulation as an agency relationship

aims and instruments

LT assume:

1. Whether the regulator is benevolent or self-interested: benevolent
2. The regulator's objective: $S + R$
3. The cost of raising revenue from taxpayers (social cost of public funds) $\lambda > 0$
4. The range of policy instruments available (e.g., ability to use public funds/tax firms directly): transfers are allowed
5. The regulator's bargaining power: all
6. The information available to the regulator and the firm: firm knows everything; regulator knows actual costs, but not cost opportunities and effort to reduce costs (*ex ante* knows probability distribution on cost opportunities)
7. The regulator's ability to commit to long-term policies: no need

Regulation as an agency relationship

taxonomy

Power	**Are transfers allowed?**	
	Yes (Procurement)	**No (Regulation)**
High (firm residual claimant)	Fixed-price contract	Price-caps
Intermediate (cost or profit sharing)	Incentive contract	Incentive regulation
Low	Cost-plus	Rate-of-return (ROR) regulation

Regulation as an agency relationship

LT approach

- Regulators use accounting (cost or profit) and demand (prices, quantity, quality) data to monitor a firm's performance; we assume these data are observable

- Our focus is on cost-reimbursement rules that:
  - Reduce the firm's rent (as the government bears part of the costs) but
  - Reduce the firm's incentives to reduce costs

Regulation as an agency relationship

LT approach

- We will start by looking at cases in which the regulator can make transfers to the firm (procurement contracts)
- In a typical procurement contract, we assume that the government reimburses costs C and gives transfer $t = a - bC$, $0 < b < 1$
- (So, the firm receives $C + t = a + (1-b)C$)
- "b" is the power of the incentive scheme: the bigger "b," the bigger the firm's incentives to decrease costs

Regulation as an agency relationship

taxonomy

Power	**Are transfers allowed?**	
	Yes (Procurement)	**No (Regulation)**
High (firm residual claimant)	Fixed-price contract (b=1, a=assess. of efficient high costs)	Price-caps
Intermediate (cost or profit sharing)	Incentive contract (0<b<1, 0<a<AEHC)	Incentive regulation (Performance Based Regulation - PBR)
Low	Cost-plus (a=b=0)	Rate-of-return (ROR) regulation

Regulation as an agency relationship
roadmap

- Model 1: cost reimbursement problem when q = 1 (project with fixed dimension), two types of firms
- Model 2: cost reimbursement problem when q = 1, continuum of firms
- Model 3: cost reimbursement + pricing problem when q >1, two types of firms
- Model 4: transfers are not allowed

Regulation as an agency relationship
roadmap

- Model 1: cost reimbursement problem when q = 1 (project with fixed dimension), two types of firms
- Model 2: cost reimbursement problem when q = 1, continuum of firms
- Model 3: cost reimbursement + pricing problem when q >1, two types of firms
- Model 4: transfers are not allowed

Model 1

assumptions

- $C = \beta - e$ where β is the efficiency or adverse selection (AS) and e is the effort or moral hazard (MH) parameter
- β is βl (effic.) with probability v and βh (ineff.) w. prob. 1-v
- C is observable and verifiable (it's an AS problem)
- Firm's rent $U = t - f(e)$, where t are the regulator's transfers and f describes the disutility of effort; $f' > 0$, $f'' > 0$, $f(0)=0$ (*)
- $W = S - (1 + \lambda)(C + t) + U$, where S is cons. surplus and λ represents distortions (**)

Model 1

complete information benchmark

- β is known, so that e is known
- Agency's problem: $\text{Max}_{\{e,U\}}$ W s.t. $U \geq 0$

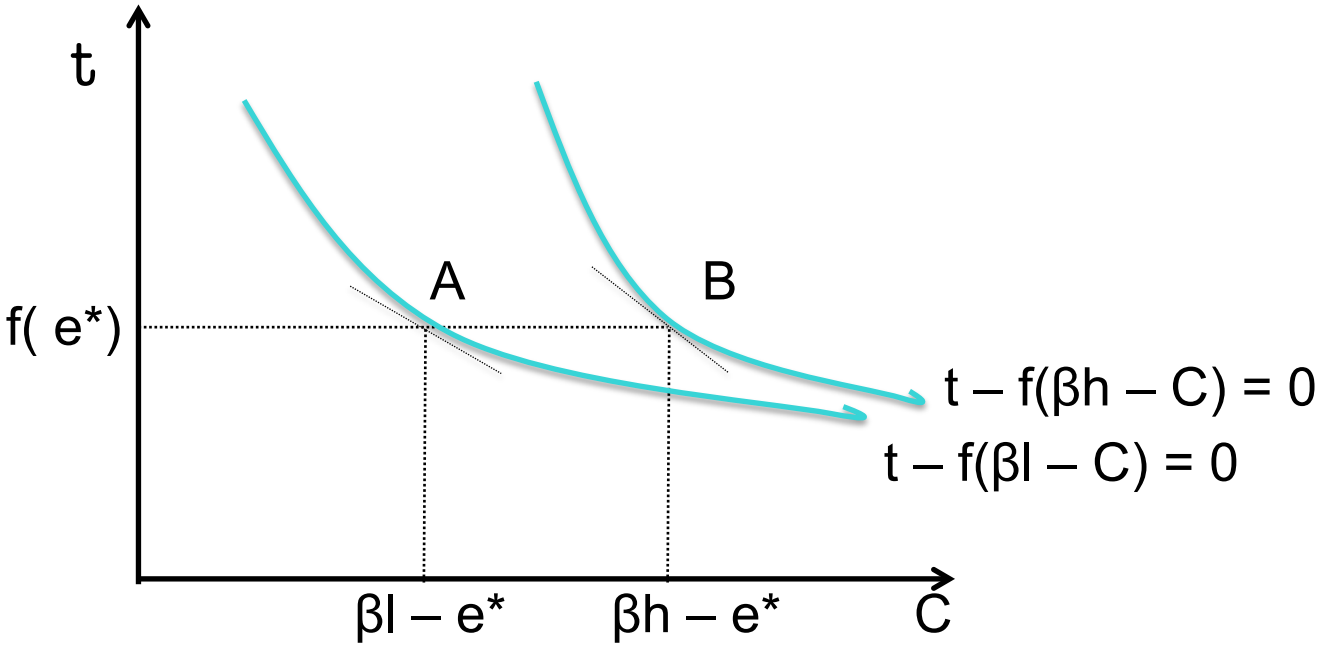
  solution: $U = 0$ and e^* s.t. $f'(e^*) = 1$ (MC of e = MB of e)

Using a fixed-price contract ($b = 1$): $t = a - (\beta - e)$, we obtain the first-best:

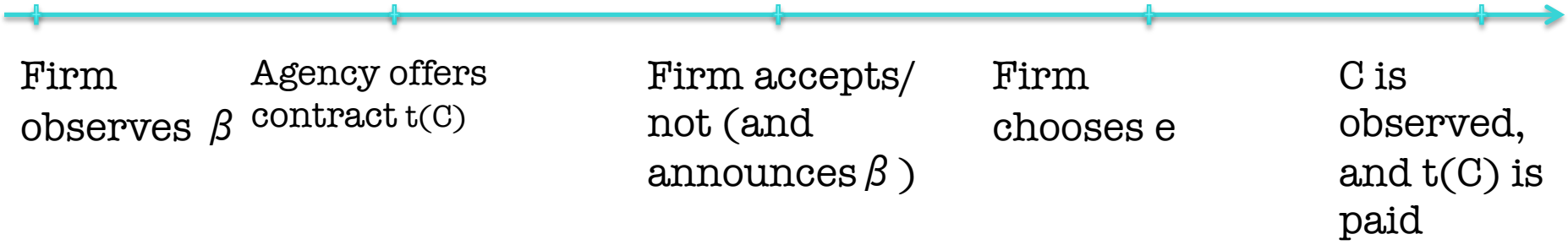
- The firm solves: $\text{Max}_{\{e\}}\ U = a - (\beta - e) - f(e)$ to obtain e^* (the firm internalizes all cost reductions)
- And $a = f(e^*) + (\beta - e^*)$

Model 1

complete information benchmark



Model 1
problem



- To find t(C), we use a direct mechanism [t(β), C(β)] (**Revelation Principle**)
- The agency offers contract [t(β), C(β)] when the firm announces β (ie, offers two contracts [tl,Cl] and [th,Ch])
- Rmk: the complete information contracts A and B cannot be offered as the efficient firm would pretend to be inefficient

D-tour

the revelation principle

- A regulatory mechanism induces a game in which the firm plays a strategy σ(.)
- Let σ*(β) be β's optimal strategy when faced with the mechanism that associates to each σ cost C(σ) and transfer t(σ)
- Consider now the direct revelation mechanism that associates with the announcement of $\overline{\beta}$ the pair $\{C(\sigma*(\overline{\beta})), t(\sigma*(\overline{\beta}))\}$
- It is in the best interest of the firm to announce $\overline{\beta} = \beta$

Model 1
problem

- Agency's problem:

$$\text{Max}_{\{tl,th.,Cl,Ch\}}\ E(W) \text{ s.t.}$$

$$Ul = tl - f(\beta l - Cl) \geq 0 \quad (IR\ \beta l)$$

$$Uh = th - f(\beta h - Ch) \geq 0 \quad (IR\ \beta h)$$

$$tl - f(\beta l - Cl) \geq th - f(\beta l - Ch) \quad (IC\ \beta l)$$

$$th - f(\beta h - Ch) \geq tl - f(\beta h - Cl) \quad (IC\ \beta h)$$

- Remarks:
  - (IR βl) is satisfied when (IR βh) and (IC βl) are
  - $Ch \geq Cl$ (monotonicity)
  - IR βh=0 (othw th could be reduced and the condition would still be satisfied)
  - IC βl is also active (same argument)
  - IC βh to be ignored and checked later

Model 1
problem

- Agency's problem:

$$\text{Max}_{\{tl,th.,Cl,Ch\}}\ E(W) \text{ s.t.}$$

$$Ul = tl - f(\beta l - Cl) \geq 0 \quad (IR\ \beta l)$$

$$Uh = th - f(\beta h - Ch) = 0 \quad (IR\ \beta h)$$

$$tl - f(\beta l - Cl) = th - f(\beta l - Ch) \quad (IC\ \beta l)$$

$$th - f(\beta h - Ch) \geq tl - f(\beta h - Cl) \quad (IC\ \beta h)$$

- Remarks:
  - (IR βl) is satisfied when (IR βh) and (IC βl) are
  - Ch ≥ Cl (monotonicity)
  - IR βh=0 (othw th could be reduced and the condition would still be satisfied)
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Model 1

solution

(IR βh): $t_h = f(\beta h - C_h) = f(e_h)$

(IC βl): $t_l = t_h + f(e_l) - f[e_h - (\beta l - \beta h)]$

Therefore:

- The efficient firm's rent is

  $U(\beta l) = f(e_h) - f(e_h - \Delta\beta) = \Phi(e_h)$, with $\Phi > 0$ and $\Phi' > 0$

- And we have

  $t_h = f(e_h)$ and $t_l = f(e_l) + \Phi(e_h)$

(So, increasing the inefficient firm's effort implies increasing the efficient firm's rent!)

Model 1

solution

To determine: eh, el

The agency's problem becomes:

$$\text{Max}_{\{eh,el\}}\ E(W) = v[S - (1+\lambda)(f(el) + \beta l - el) - \lambda U l] + (1-v)[S - (1+\lambda)(f(eh) + \beta h - eh) - \lambda U h]$$

F.O.C. imply

$$f'(el) = 1 \Rightarrow el = e^*$$

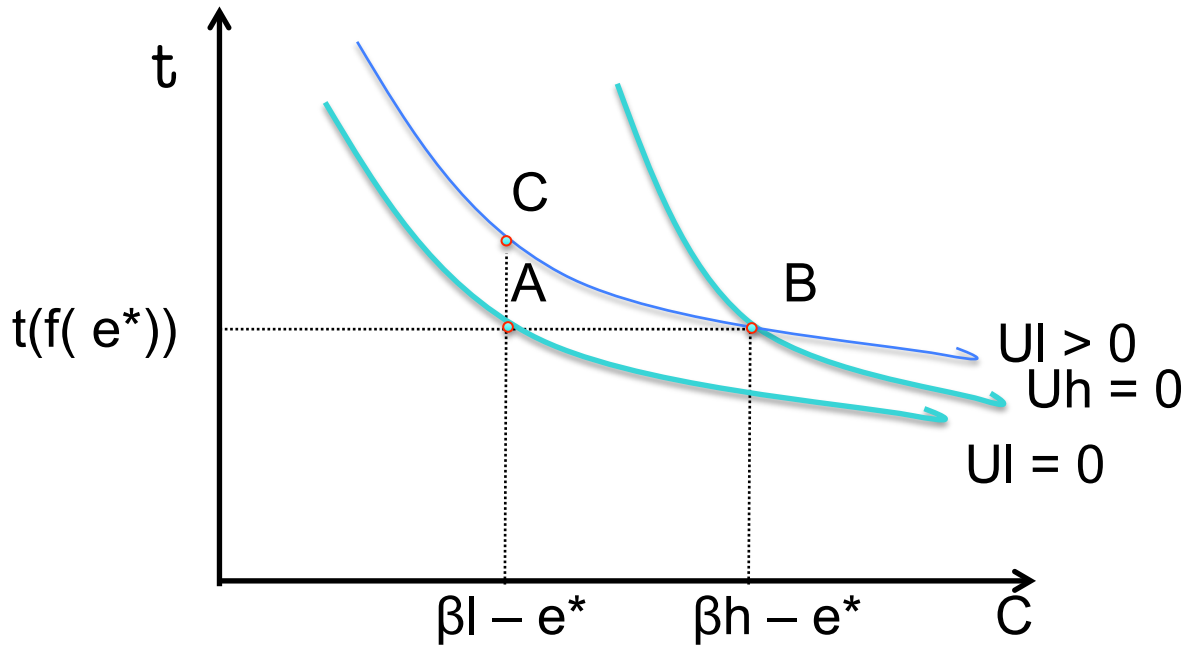
$$f'(eh) = 1 - \frac{\lambda}{1+\lambda}\frac{v}{1-v}\Phi'(e) < 1 \Rightarrow eh < e^*$$

Concluding: we have a menu of contracts with

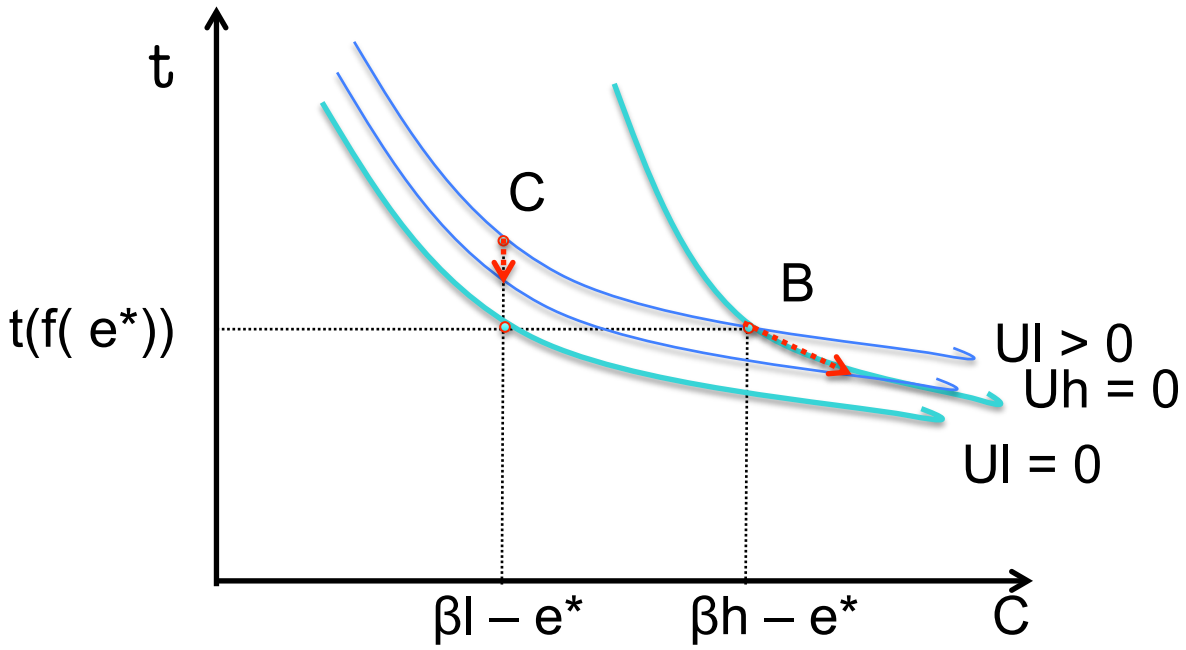
$$eh < e^*;\ el = e^*;\ Uh = 0;\ Ul > 0$$

The distortion in e grows with λ and v.

Model 1
solution



Model 1
solution



Model 1

solution

- If only the efficient firm produces, the contract is such that:

$$f'(el) = 1 \text{ and } Ul = 0$$

- So, it is better to have just the efficient firm producing when

$$v[S - (1 + \lambda)(f(e^*) + \beta l - e^*)] >$$

$$v[S - (1 + \lambda)(f(el) + \beta l - el) - \lambda\Phi(eh)] + (1 - v)[S - (1 + \lambda)(f(eh) + \beta h - eh)]$$

Model 1
to sum up

- With complete information,
  - the agency can use a **fixed-price contract** with b = 1
  - e = e*
  - U = 0 (the agency extracts all the rent)

- With asymmetric information,
  - the agency offers a **menu of (two) contracts**
  - The efficient firm's effort is e*, but the inefficient firm's effort is distorted
  - The efficient firm obtains positive rents, whereas the inefficient firm gets 0 utility
  - There's a **trade-off** between inducing effort and giving rent

Conclusion

- In the last 15 years incentive regulation theory has developed considerably, but practical implementation has lagged behind
- Price caps are the most common form of incentive regulation; but
  - Only seldom best instrument in theory
  - Include ratchets that reduce the power of incentives
  - Not simple: defining relevant capital and operating costs is difficult
  - Information burden is similar to that of ROR
  - Accompanied by other incentive schemes for quality
- Formal offers of menus are rare, though the give and take of regulatory negotiations may be a substitute