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
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
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) \( \lambda \)
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

<table>
<thead>
<tr>
<th>Power</th>
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</tr>
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<tbody>
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<td><strong>High</strong> (firm residual claimant)</td>
<td>Yes <em>(Procurement)</em></td>
</tr>
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<td></td>
<td>Fixed-price contract</td>
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<td>Incentive contract</td>
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<td>Cost-plus</td>
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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
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**

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<td>Intermediate (cost or profit sharing)</td>
<td>Incentive contract (0&lt;b&lt;1, 0&lt;a&lt;AEHC)</td>
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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 $\beta$ is the efficiency or adverse selection (AS) and $e$ is the effort or moral hazard (MH) parameter.

- $\beta$ is $\beta_l$ (effic.) with probability $v$ and $\beta_h$ (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 $\lambda$ represents distortions (**).
Model 1
complete information benchmark

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

\[ f(\beta l - C) = 0 \]
\[ t - f(\beta h - C) = 0 \]
To find $t(C)$, we use a direct mechanism $[t(\beta), C(\beta)]$ (Revelation Principle).

The agency offers contract $[t(\beta), C(\beta)]$ when the firm announces $\beta$ (i.e., offers two contracts $[t_l, C_l]$ and $[t_h, C_h]$).

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 $\sigma(.)$
- Let $\sigma^*(\beta)$ be $\beta$’s optimal strategy when faced with the mechanism that associates to each $\sigma$ cost $C(\sigma)$ and transfer $t(\sigma)$
- Consider now the direct revelation mechanism that associates with the announcement of $\bar{\beta}$ the pair $\{C(\sigma^*(\bar{\beta})), t(\sigma^*(\bar{\beta}))\}$
- It is in the best interest of the firm to announce $\bar{\beta} = \beta$
Model 1
problem

o Agency’s problem:

\[
\begin{align*}
\text{Max}_{\{tl, th, Cl, Ch\}} & \ E(W) \ s.t. \\
UL &= tl - f(\beta l - Cl) \geq 0 \ (\text{IR } \beta l) \\
Uh &= th - f(\beta h - Ch) \geq 0 \ (\text{IR } \beta h) \\
tl - f(\beta l - Cl) &\geq th - f(\beta l - Ch) \ (\text{IC } \beta l) \\
th - f(\beta h - Ch) &\geq tl - f(\beta h - Cl) \ (\text{IC } \beta h)
\end{align*}
\]

o Remarks:

- (IR \( \beta l \)) is satisfied when (IR \( \beta h \)) and (IC \( \beta l \)) are
- \( Ch \geq Cl \) (monotonicity)
- IR \( \beta h = 0 \) (othw th could be reduced and the condition would still be satisfied)
- IC \( \beta l \) is also active (same argument)
- IC \( \beta h \) to be ignored and checked later
Model 1
problem

- **Agency’s problem:**

\[
\begin{align*}
\text{Max}_{\{tl, th, Cl, Ch\}} & \quad E(W) \quad \text{s.t.} \\
U_l &= tl - f(\beta_l - Cl) \geq 0 \quad \text{(IR } \beta_l) \\
U_h &= th - f(\beta_h - Ch) = 0 \quad \text{(IR } \beta_h) \\
tl - f(\beta_l - Cl) &= th - f(\beta_l - Ch) \quad \text{(IC } \beta_l) \\
\text{th} - f(\beta_h - Ch) &\geq tl - f(\beta_h - Cl) \quad \text{(IC } \beta_h) \\
\end{align*}
\]

- **Remarks:**
  - (IR \( \beta_l \)) is satisfied when (IR \( \beta_h \)) and (IC \( \beta_l \)) are
  - \( Ch \geq Cl \) (monotonicity)
  - \( IR \ \beta_h = 0 \) (othw th could be reduced and the condition would still be satisfied)
  - IC \( \beta_l \) is also active (same argument)
  - IC \( \beta_h \) to be ignored and checked later
Model 1

solution

(IR $\beta h$): $th = f(\beta h - Ch) = f(eh)$

(IC $\beta l$): $tl = th + f(el) - f[eh - (\beta l - \beta h)]$

Therefore:

- The efficient firm’s rent is
  $U(\beta l) = f(eh) - f(eh - \Delta \beta) = \Phi(eh)$, with $\Phi > 0$ and $\Phi' > 0$

- And we have
  $th = f(eh)$ and $tl = f(el) + \Phi(eh)$

(So, increasing the inefficient firm’s effort implies increasing the efficient firm’s rent!)
To determine: \(eh, el\)

The agency’s problem becomes:

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

F.O.C. imply

\[
f'(el) = 1 \implies el = e^*
\]

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

Concluding: we have a menu of contracts with

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

The distortion in \(e\) grows with \(\lambda\) and \(v\).
Model 1

solution
Model 1 solution
Model 1

If only the efficient firm produces, the contract is such that:
\[ f'(e_l) = 1 \text{ and } U_l = 0 \]

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

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

\[
v[S - (1 + \lambda)(f(e_l) + \beta l - e_l) - \lambda \Phi(e_h)] +
\]

\[(1 - v)[S - (1 + \lambda)(f(e_h) + \beta h - e_h)]\]
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