Module 3: Natural Monopolies

Market Organization & Public Policy (Ec 731) · George Georgiadis

Market Entry and Monopoly

- Consider the following two period game:
  - In $t = 1$, a "large" number of identical firms *sequentially* decide whether to pay an entry fee $F > 0$ to enter the market.
  - In $t = 2$, the firms that entered, engage in Cournot competition.
- Assume that
  - each firm has product cost $c(q) = cq$; and
  - the inverse demand function $P(Q) = \alpha - \beta Q$.
- From the previous section, we know that if n firms have entered, in $t = 1$, each will set quantity

$$q = -\frac{P(Q) - c'(q)}{P'(Q)} = \frac{\alpha - \beta Q - c}{\beta}$$

  and using that $Q = nq$ yields that $q = \frac{a-c}{\beta(n+1)}$.
- This corresponds to price $P(Q) = \frac{a+cn}{n+1}$.
  - Observe that it decreases in n, and converges to c as $n \to \infty$.
- Each firm's profit is then

$$\pi_n = q(\alpha - \beta nq) - cq = \frac{1}{\beta}\left(\frac{\alpha - c}{n+1}\right)^2$$

  - Observe that $n\pi_n$ decreases (monotonically) with n.
- Suppose n firms have already entered the market. Will the next firm choose to enter or not?

- Yes, if $\pi_{n+1} \geq F$
- No, if $\pi_{n+1} < F$

- Therefore, the equilibrium number of firms that will enter the market (denote n^*) is the largest n such that $\pi_n \geq F$, or equivalently

$$n^* = \left\lfloor \frac{\alpha - c}{\sqrt{\beta F}} - 1 \right\rfloor$$

  - If $F > \frac{(\alpha-c)^2}{9\beta}$, then $n^* = 1$, and we have a monopoly.
  - As $F \to 0$ (*i.e.*, as entry costs vanish), $n^* \to \infty$ (perfect competition).

- *Questions:*
  - What if firms engage in Bertrand competition?
  - What if firms decide whether to enter simultaneously?

Monopoly Regulation

- How can a regulator restore the social optimum?

- Suppose that a regulator taxes monopoly output at rate t.
  - *i.e.*, if the monopolist sets price p, then consumers must pay $p + t$.

- The monopolist chooses p by solving

$$\max_p \{pD(p+t) - c\,(D(p+t))\}$$

- First order condition:

$$\begin{aligned} D(p+t) + D'(p+t)\,(p - c') &= 0 \\ \Longrightarrow [D(p+t) - tD'(p+t)] + D'(p+t)\,(p + t - c') &= 0 \end{aligned}$$

- To restore the social optimum, the price faced by consumers (*i.e.*, $p + t$) must equal marginal cost c'.

- Therefore, we must set $t = \frac{D(p+t)}{D'(p+t)}$.
  - Denoting the competitive price by p_c, we can re-write $t = -\frac{p_c}{\epsilon}$, where $\epsilon = -\frac{p_c D'(p_c)}{D(p_c)}$.
- Observe that because $D' < 0$, $t < 0$; *i.e.*, the regulator must subsidize the monopolist. (Somewhat paradoxical!)
- *Intuition:*
  - The problem with monopoly pricing is that it induces consumers to consume too little.
  - In order to achieve efficiency, we must induce them to consume more, which requires to subsidize the good.
- *Problems:* Determining the proper subsidy requires that the regulator knows (i) the demand elasticity of the monopolist, and (ii) his entire cost curve.
  - Demand information can be obtained through sampling, but this is potentially expensive and inaccurate if the monopolist supplies only a few customers.
  - Cost information is harder to extract, because the monopolist will be reluctant to release accurate estimates of its cost structure.

Regulating a Monopolist with Unknown Costs

Baron and Myerson (Ecta, 1982)

- Setting where the firm has a privately known cost parameter; *i.e.*, its cost is $c(q, \theta)$, where $c_q > 0$ and $c_\theta > 0$.
- Regulator can choose (i) the price p that the firm can charge, and (ii) a subsidy s to be paid to the firm.
  - *Solution Approach:* the firm is asked to report $\tilde{\theta}$, and receives $p\left(\tilde{\theta}\right)$ and $s\left(\tilde{\theta}\right)$.
- Application of the revelation principle.

Laffont and Tirole (JPE, 1986)

- Argue that accounting costs are usually observable to the regulator.
- Study a problem with both moral hazard and adverse selection.

Setup

- Natural monopolist has exogenous cost parameter $\theta \in \{\theta_L, \theta_H\}$. (Define $\Delta\theta = \theta_H - \theta_L > 0$.)
  - Assume that θ is private information of the monopolist.
  - The regulator has beliefs over θ: $\Pr\{\theta = \theta_L\} = \beta$.
- Production cost: $c = \theta - e$, where e stands for "effort" (*e.g.*, investment in cost reduction).
  - Effort has cost $\psi(e) = \frac{e^2}{2}$.
  - Assume that c is contractible.
- The objective of the regulator is to choose the smallest payment $P = c + s$ such that the firm produces the good.
- The payoff of the firm is: $P - c - \psi(e) = P - (\theta - e) - \frac{e^2}{2}$ (if it chooses to produce).

First Best

- Suppose that the regulator knows θ.
- The regulator's problem then is:

$$\begin{aligned} \min_{P,e} \quad & P \\ \text{s.t.} \quad & P - (\theta - e) - \frac{e^2}{2} \geq 0 \end{aligned}$$

- This problem has solution: $e^* = 1$ and $P^* = \theta + \frac{1}{2}$.
  - Let $s = P - c = P - \theta + e$ denote the subsidy. Observe that $s^* = \frac{3}{2}$ (independent of θ).
  - $P(\theta = \theta_H) > P(\theta = \theta_L)$: If the regulator does not know θ, then the firm would like "convince" the regulator that $\theta = \theta_H$ to elicit a larger payment.

Adverse Selection

- The regulator would like to design a "menu" of contracts $\{s_L, c_L\}$ and $\{s_H, c_H\}$ such that a firm with cost parameter θ_i will choose contract $\{s_i, c_i\}$ and exert effort $e_i = \theta_i - c_i$.
  - Implemented using a price $P_i = s_i + c_i$.
  - Then the firm's payoff is $P_i - c_i(e_i) - \frac{e_i^2}{2} = s_i - \frac{e_i^2}{2}$.
- The regulator solves the following problem:

$$
\begin{aligned}
\min_{s_L, e_L, s_H, e_H} \quad & \beta(s_L - e_L) + (1-\beta)(s_H - e_H) + [\beta\theta_L + (1-\beta)\theta_H] \\
\text{s.t.} \quad & s_L - \frac{e_L^2}{2} \geq 0 \quad (IR_L) \\
& s_H - \frac{e_H^2}{2} \geq 0 \quad (IR_H) \\
& s_L - \frac{e_L^2}{2} \geq s_H - \frac{(e_H - \Delta\theta)^2}{2} \quad (IC_L) \\
& s_H - \frac{e_H^2}{2} \geq s_L - \frac{(e_L + \Delta\theta)^2}{2} \quad (IC_H)
\end{aligned}
$$

  - The first two inequalities are participation constraints.
  - The next two are incentive constraints: if a firm with θ_L reports θ_H, then it must exert effort $e = \theta_H - c_L = \Delta\theta - e_L$.
- First best has the same effort level and the same subsidy for both types (θ_L and θ_H), but a higher actual cost for $\theta = \theta_H$.
  - Incentive problem arises, because the efficient type (*i.e.*, $\tilde{\theta} = \theta_L$) wants to mimic the inefficient type to collect the same subsidy while expending only effort $e^* - \Delta\theta$, and achieving actual cost c_H.
- *Claim:* The (IR_L) and (IC_H) are obsolete, while (IR_H) and (IC_L) bind.
  - $s_H - \frac{e_H^2}{2} \geq 0 \Longrightarrow s_H - \frac{(e_H - \Delta\theta)^2}{2} \geq 0 \Longrightarrow s_L - \frac{e_L^2}{2} \geq 0$, so (IR_L) is obsolete.
  - Add (IC_H) and (IC_L) to find $e_H \leq e_L + \Delta\theta$. So $s_H - \frac{e_H^2}{2} > s_L - \frac{e_H^2}{2} \geq s_L - \frac{(e_L + \Delta\theta)^2}{2}$, so (IC_H) is obsolete.
  - Suppose (IR_H) is slack. Then decrease s_H to increase the regulator's payoff until it binds. Note also that this relaxes (IC_L)

- Suppose (IC_L) is slack. Then decrease s_L to increase the regulator's payoff until it binds.

- Therefore:
$$s_H - \frac{e_H^2}{2} = 0 \quad \text{and} \quad s_L - \frac{e_L^2}{2} = s_H - \frac{(e_H - \Delta\theta)^2}{2} \tag{1}$$

- Re-writing the objective function using these equalities yields
$$\min \left\{ \beta \left(\frac{e_L^2}{2} - e_L + \frac{e_H^2}{2} - \frac{(e_H - \Delta\theta)^2}{2} \right) + (1-\beta) \left(\frac{e_H^2}{2} - e_H \right) \right\}$$

- First-order conditions:
  - $e_L = 1 = e^*$
  - $e_H = 1 - \frac{\beta}{1-\beta}\Delta\theta < e^*$
  - *Note:* Assume that $\frac{\beta}{1-\beta}\Delta\theta < 1$.

- We can now solve for the subsidies s_L and s_H using (1).

- *Intuition:*
  - The "low" type would like to imitate the "high" type, but not vice verse.
  - So for IC, mechanism gives inefficient incentives to the "high" type and lower his payoff to make it undesirable to the "low" type to imitate him.
  - Give efficient incentives to the "low" type.

References

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