Paper 1 Economics Supervision 3: Monopolistic Market Structure, Cartels and Game Theory

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Outline

Why Modelling Monopolies/Cartels

- Limitations of fierce (technically perfect) competition models for modelling markets displaying price-setting powers, profits and markups.
- Accounting for deviations from the perfect competition set-up with many, small, and price-taking firms.

Why Modelling Monopolies/Cartels

- Limitations of fierce (technically perfect) competition models for modelling markets displaying price-setting powers, profits and markups.
- Accounting for deviations from the perfect competition set-up with many, small, and price-taking firms.
  1. Oil and fossil fuels, energy markets
  2. Telecommunications and ICT services.
  3. Education services with few widely recognised providers/boards, e.g. SCUBA diving (PADI, RAID, SSI,...)
  4. Heavy industries and intermediate goods suppliers (Aircraft producers).
  5. Pharma industry, AI
  6. Often, industrial structure in early economic development phase has monopolistic traits: natural monopolies (IRS), sometimes protected infant industries.
  7. Natural monopolies and protected industries.
  8. Labour Unions (?)

Cont'd

- We care about normative/efficiency aspect of these widespread market arrangements. Clearly the PC framework is inadequate for modelling and thinking about these.
  1. What implications does this have for allocative efficiency and welfare? What are the benefits and costs of monopoly as a market structure?
  2. Should these be broken down?
- Also, interested in positive and applied implications:
  1. Existence of profits and equilibrium prices
  2. Sustainability of monopolies
  3. Applications to models attempting to explain industrialisation-led economic development (big push) and economic innovation and failures. To do this, we need a model admitting profits and price-setting to pin down incentives to scale-up or innovate missing in PC. (cf. Acemoglu, 2003).

Monopolistic Market Structure

- Key element for departure from PC case: there are *downward-sloping* demand curves at the firm level (and the firm knows this).
  1. A sustainable cartel can be viewed as a monopolist without loss of generality (see later).
  2. Because the monopolistic firm knows that its production (or pricing decisions) have an impact on the quantity demanded (price) hence profits, a rational firm will choose a level of output optimising profits based on this information (tradeoff).
- Generic demand function at firm level (cont diff):

$$d = q(p)$$

$$\frac{dq}{dp} := q'(p) < 0$$

- Let ϵ_p^q the (absolute value of) the price elasticity of demand

$$\epsilon_p^q = -q'(p)\frac{p}{q}$$

Entry Barriers

- Technically, downward sloping demand curves shared with monopolistic competition (Dixit-Stiglitz).
- Second key difference is that there are some form of *entry barriers*.
  1. Without entry barriers, firms will enter the market until there are zero profits to be made for everyone.
  2. *Entry barriers* can be natural, e.g. arising from IRS/economies of scale and large fixed costs, IRS-driven merger and acquisitions in the lack of regulation policy.
  3. Direct intervention and legislative barriers to entry.
  4. Finally, collusive behaviour in duopolistic/oligopolistic (few producers) market structure (Q2)

Cont'd: IRS and Natural Monopolies

- IRS or Economies of Scale as a source of monopolistic power
- Suppose there are (large) fixed/setup costs f. Model of production function and labour input requirement:

$$F(L) = \max\{0, \phi(l - f)\}$$

$$l(q) = f + \frac{1}{\phi}q$$

- Let wage $w \in \mathbb{R}_+$ so that costs at any (interior) level of output are given by the cost function:

$$C(q) = wl(q) = wf + \frac{w}{\phi}q$$

$$C'(q) > 0$$

- ATCs are

$$C(q)/q = w\left(\frac{f}{q} + \frac{1}{\phi}\right)$$

Cont'd

- Larger firms face lower ATCs than smaller ones $\rightarrow$ agglomerating force: smaller firms might find it optimal to merge into a dominant monopolist firm.
- ATCs for individual firms:

$$ATC^1 = w\left(\frac{f}{q^1} + \frac{1}{\phi}\right) \qquad ATC^2 = w\left(\frac{f}{q^2} + \frac{1}{\phi}\right)$$

- ATCs across two firms and for a merger

$$ATC^c = \frac{w}{q^1 + q^2}\left(2f + \frac{1}{\phi}(q^1 + q^2)\right)$$

$$ATC^m = \frac{w}{q^1 + q^2}\left(f + \frac{1}{\phi}(q^1 + q^2)\right)$$

- Clearly

$$ATC^c > ATC^m$$

Cont'd

- Additionally, profits for a firm choosing to operate must be weakly larger than fixed costs:

$$pq - C(q) \geq= 0$$

$$pq - wf - \frac{w}{\phi}q \geq 0$$

- As f increases (fixed costs/entry costs) get larger, minimum q to break-even increases. That is, the size of the (average) firm gets larger – smaller firms get wiped out/leave the market.
- More detailed models next year. For now, key idea is that IRS/EOS consistent with large fixed/setup costs can explain the existence of monopolies.
- Acemoglu (2003) uses this kind of monopolistic economy to study multiple equilibria models of underdevelopment.
- Unions?

Non IRS-driven/Non-Natural Monopolies

- Direct regulation is an immediate source of monopolistic power. Entry of other firms is prevented by construction (international patents, legal devices, rent-seeking).
- Finally, in oligopolistic scenarios non-competitive or collusive behaviour can lead to monopoly. We study sustainability of cartels later.

Equilibrium with Monopolies/Cartels (Q1)

- What do equilibria under a monopolistic market structure look like? How do they compare to the PC case (allocation, welfare properties).
- **Equilibrium**: a set of prices p and quantities q (allocations) such that consumers are at their optimal quantity demanded given the prices (=utility maximising st budget constrant) and the monopolistic firm's pricing strategy is optimal (= profit maximising).
- Here, we sidestep setting up an solving the representative consumer problem by postulating directly a downward sloping demand function $q(p)$ outlined above. Next slide for details on where this comes from.

Monopolist/Cartel: Profit Maximisation and Markup Condition

- Because the monopolist/cartel knows that it faces the market demand curve, it set price to maximise profits.
- Profit function

$$\pi(p, y) = py - C(y)$$

$$C'(y), C''(y) > 0$$

- Convexity of costs.
- Subject to the constraint (market clearing + optimal demand/consumption):

$$y = q(p)$$

Cont'd

- Solution Approach 1: transform into an unconstrained problem by using constraint

$$\pi(p^*) = \max_{p \in \mathbb{R}+} pq(p) - C(q(p))$$

- Differentiating and setting to zero

$$q(p) + pq'(p) - C'(q)q'(p) = 0$$

$$pq'(p) + q(p) = C'(q)q'(p)$$

$$p + q(p)[q'(p)]^{-1} = C'(q)$$

$$p - p\epsilon_{q,p}^{-1} = C'(q)$$

$$p^* = \frac{\epsilon_{q,p}}{\epsilon_{q,p} - 1} C'(q)$$

- Markup condition:

$$p_m = \mu C'(q_m)$$

Cont'd

- At equilibrium of the economy, price is at some markup over marginal costs.
- Recall demand is downward sloping in price. Then, equilibrium demand is smaller the larger is the markup.
- The PC case as a benchmark.
  1. No price setting power / small firm cannot influence price through output.
  2. Demand infinitely elastic in price (e.g. abundance of close substitutes/competing products... consumers switch away)
- Optimal firm behaviour with PC:

$$p_{pc} = C'(q_{pc})$$

- See whiteboard.

Properties of General Equilibrium Allocations I

- Monopoly price is at a markup over the price in the perfect competition case.

$$p_m > p_{pc}$$

- Output is lower than in monopolistic case than in PC. Why/show?

$$q_m < q_{pc}$$

- There is a natural output loss under monopoly (not requiring any Keynesian devices), stemming from incentive to keep output at bay according to markup condition.
- **Extra**: Natural unemployment/reduced wages effect if we introduce explicitly labour markets.
  1. Suppose lin. tech. With $q_m < q_{pc}$, labour demand is lower in monopolist case.
  2. Comes down to whether real wage is flexible or not.

Properties of General Equilibrium Allocations II

- There are welfare costs to monopoly *relative* to the PC benchmark (all else being the same).
- Because PC achieves an efficient allocation, then the monopolist allocation is inefficient.

$$p > C'(q) = mc$$

- Price per unit larger than marginal costs. Under LNS of preferences, one achieve an allocation with greater utility by reducing the charged price/increasing the market output until just $p = mc$.
- Recall that generally, from consumer optimisation holding at eq. alloc:

$$u'(q) = MU = \lambda p$$

- Hence (normalising), standard inefficiency condition:

$$MU_m > MU_{pc} = mc$$

Cont'd

- Technically, to show this more rigorously we would need to set up and solve a social planner (centralised distribution, no prices/markets) problem to insist on the PC case being necessary (albeit not sufficient) for allocative efficiency.
- More on this in supervision 4. For now, you know that second welfare theorem requires competitive markets. The allocative inefficiency in monopoly case is the other side to the coin to the failure of welfare theorems.
- Put briefly, it requires competitive markets since non-competitiveness/monopolies generate markups, which we know now to be allocatively inefficient.

Producer and Consumer Surplus

- Benchmarks like allocative efficiency/pareto optimality (and also) second best criteria rest on implausible assumptions that we perfectly observe/know preferences.
- PS and CS are more "robust" measures favoured by microeconomists. Let $v(q)$ the inverse demand function (WtP).

$$v(q(p)) = p$$

- CS

$$\mathcal{S}_c = \int_0^{q^*} [v(x) - p^*]dx$$

- PS

$$\mathcal{S}_p = \int_0^{q^*} [p^* - r(x)]dx$$

- Areas between DC and MC/Supply and eq price.

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- Areas between DC and MC/Supply and equlibrium price.

Producer and Consumer Surplus

- Relationship to marginal utility (quasilinear preferences case) and marginal cost curve.
- Note $r(x)$ and $v(x)$ respectively decrease and increase in quantity... marginal surplus from extra unit gets smaller as we increase quantity.
- It is zero at equilibrium price by construction of equilibrium. This is where triangle shape comes from.
- CS in Monopolist case
- PS in Monopolist case.
- Deadweight loss (Harbenger Costs)
- Rents from monopoly (Tullock's rectangle)

Inefficiency and Regulation Policy

- Costs to allocative efficiency and output (relative to PC benchmark).
- Regulation policy attempts to restore efficiency by limiting monopolistic behaviour opportunities.
- Always a good idea? Anything offsetting inefficiency relative to PC benchmark?
- No obvious answer... my take.

Inefficiency and Regulation Policy

- Distinction between regulation of existing markets and regulation of potential/infant markets.
- We know from models of IRS there is a case for monopolies based on productive efficiency (natural monopolies). Especially if entry costs are very large (ATCs...). Perhaps true of some "heavy" sunk costs industries.
- Price regulation with NM might be unsustainable in the long run (exit).

Cont'd

- Some argue profits accruing to monopolist in excess of PC case can be used for $R\&D$ (dynamic efficiency). Then regulation of such market might harm innovation.
- However, extent to which such extra profits due to monopoly might be directed to innovation rather than wasteful rent-seeking is debatable.
- Likely to be more prevalent where monopoly does not arise (or continues to exists) due to natural entry barriers (IRS/EOS) in a deregulated environment, but from intervention (licenses, exclusive economic rights).
- **Tullock, 1967**: (1) Monopoly profits are endogenous to existence of monopoply rights (cf. PC case), (2) They are contestable/rivalrous resources.

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Cont'd

- On the other hand, at least in short run, de-regulation of existing markets different from de-regulation of potential new markets.
- This is the case where opportunities to instate a monopoly and extract profits creates an incentive to expand the variety of goods or intermediate inputs in the economy. (Cf. Grossman and Helpman, Krugman, Acemoglu).
- Key concept in model of innovation and economic diversification (see P7 next year).
- There, the PC benchmark might be an incorrect or misleading one for cost-benefit analysis of monopoly.
- The "deadweight" loss might not have to be included in cost-benefit analysis because the PC case is an off-equilibrium counterfactual (it never happens).

Game Theoretic Analysis of Cartels (Q2)

- We analysed key aspects of monopolies/cartels: (i) sources, (ii) equilibria, (iii) welfare properties, (iv) implications for regulation policy.
- We said cartels can be analysed as moonopolists as long as they are sustainable.
- Here we look at sustainability of cartels through game theory.
- More generally, we are looking at emergence of collusive or cooperative behaviour in non-cooperative games.
- Non-cooperative games: talk is cheap, and no *external* commitment devices to ensure cooperation. Cooperation emerges iff cooperating is in the best interests of each individual.

Game Theoretic Concepts for One-Stage Games

- *Game*: a triplet containing a set of players $I = 1, ..i, ..N$, a strategy set S_i for each player, and a payoff function $u : S \to \mathbb{R}_+$ for each player.
- *Pure Strategy*: one and only one strategy is chosen and played/sticked to.
- *Strategic/Strategy Profile*: a list of strategies (one for each player) $\mathbf{s} = \{s_i\}_{i \in I}$ where $\forall i, \quad s_i \in S_i$.

Solution Techniques/Devices

- *Dominant Strategy*. For all $\mathbf{s}_{-i} \in \prod_{j \neq i} S_j$

$$u(s_i, \mathbf{s}_{-i}) \geq u(s_i', \mathbf{s}_{-i})$$

  for all $s_i' \neq s_i \in S_i$
- A game in which each player has a dominant strategy has a simple solution. It is the outcome in which every player plays the dominant strategy.
- Games without dominant strategies $\rightarrow$ **Nash Equilibrium**.
- Not actually needed for the game in the problem sheet. But can show that all dominant strategies equilibria are also Nash Equilibria (the reverse is NOT true).

Cont'd

- Nash Equilbrium is a solution concept/device for a game.
- Defined as a strategic profile in which all players strategies are mutual best responses.
- Let E_{nash} the set of Nash equilbria for a game. Then

$$\mathbf{s}^*(s_1^*, ..., s_N^*) \in E_{Nash}$$

$$\iff \forall i \in I, u(s_i^*, s_{-i} = s_{-i}^*) \geq u(s_i', s_{-i} = s_{-i}^*) \quad \forall s_i' \neq s_i^*$$

- Rational Expectations Eq.
- Easy to see that (1) dominant strategy equilibria are NEs, and (2) there can be multiple NEs.
- Why? Because optimality of strategy under NE device is contingent on the path of play/other agents actions, and does not require anything as to off-equilibrium performance of the strategy.

Cont'd

- In the game, solution is non-cooperation.
- *collective rationality* vs *individual rationality*
- Investment in public goods and ecological conservation problems.
- Repeating the game.

Small Cartel Members

- Small cartel members might have be incentivised exceed their cartel production quotas.
- Key intuition: a small cartel member will be unable to significantly affect prices through output decisions. Hence can increase output selling at cartel price.
- Violations/deviations from collusive agreement less likely to be detected.
- Production theory and firm behaviour: the firm can be viewed as a price taker *at the cartel price*.
- Game Theory: a small cartel member has a higher probability of going undetected (small relative to market output).