L. Monopoly: The First (or Last) Firm

A. A market is said to be completely *monopolized* whenever the supply side of the market is entirely controlled by a single firm or single (perfect) cartel composed of all firms in the market.

i. A single firm may control an entire market for a variety of reasons: (i) First, a monopoly position may reflect its pioneering *entry* into a new market. New markets arise because of innovation (the creation of new products: the first light bulb or telephone company) or by innovative delivery of some existing service to a previously unserved population of consumers. Transactions or production costs may have in the past made purchases of specific products prohibitively expensive. (The first strawberry store in Greenland after refrigerated transport developed).

ii. Second, firms may acquire monopoly power as a consequence of superior efficiency which causes all other firms to *exit* from the market.

a. The case of natural monopoly is a special case of this phenomena.

b. *Natural monopoly* does not require a specific firm to be more efficient than all others, only that a single firm can more efficiently serve the entire market than several smaller firms because of economies of scale in production and/or distribution.

c. Here the market in question can support, at most, a single efficiently sized firm.

iii. Third, firms may acquire monopoly power as a consequence of economic regulation: exclusive franchises granted by governments and enforced by laws. [Regulatory barriers to entry.] For example, patent rights grant firms a temporary monopoly as a type of reward for the development of new products or productiong procedures. Various licensing, permits, and special tax rules may create monopoly by ruling out entry of new firms. (Local governments often sell off exclusive rights to provide cable services within community boundaries. Similar franchises have been granted electric power companies and telephone companies in the past.)

iv. Fourth, reputation and/or significant requirements for fixed capital may make entry into markets dominated by relatively efficient firms problematic. [Economic or technological barriers to entry.]

v. Fifth, firms may control a unique resource that is unavailable to other firms which is a necessary input into the production of a particular good.

B. In the real world, the cases of interest for students and regulators of market structure generally involve firms that have significant control over a particular market, but not exclusive control.

a. Various indices are used to measure market concentration: CR4, the Herfindalh index, etc .

b. (Modern examples of very concentrated industries include: IBM mainframe computers, Boeing passenger jet aircraft, Intel microprocessors, or Microsoft operating systems and, more recently, office software. Classic examples include Alcoa Aluminum and Standard Oil during the late nineteenth and early twentieth century.)

C. Unlike perfectly competitive firms, monopoly firms face both output and pricing decisions. A monopolist faces a downward sloping demand curve for its product.

i. The geometry and mathematics of the monopolist's optimization problem are both straightforward, if you know the firm's demand curve and its total cost function.

ii. Example: Let $P = p(Q, Y)$ be the firm's inverse demand function. (An inverse demand function goes from quantities into prices rather than prices into quantities.) Let $C=c(Q,w,r)$ be the firm's total cost function.

a. Its profit is $\Pi = PQ - C = p(Q, Y)Q - c(Q, w, r)$

b. Differentiating with respect to Q and setting the result equal to zero yields:

$$P + Q P_Q - C_Q = 0 \quad \text{or} \quad P - Q P_Q = C_Q \quad \text{e. g. MR = MC at } Q^*$$

c. The price at which the profit maximizing output will be sold has implicitly been determined insofar as the inverse demand curve captures the effect of production on prevailing market price. The profit maximizing price is $P^* = p(Q^*, Y)$.

d. The comparative statics of the monopoly firm can be analyzed using the implicit function theorem and implicit function differentiation rule. For example, from 'b:" $Q^* = q(w, r, Y)$ and $Q^*_Y = [P_Y + QP_{YQ}] / - [2P_Q + QP_{QQ} - C_{QQ}] > 0$ if the profit function is strictly concave and $P_{YQ} < 0$.

e. The envelop theorem can similarly be applied to characterize the effects of changes in factor prices or variables that affect demand on monopoly profits.

iii. In the special case where the demand curve and marginal cost curves are linear, there are a number of interesting special properties of the monopolist optimal pricing problem. For example, the MR curve will intersect the horizontal axis exactly half way to the point where the demand curve intersects it.

D. In cases where monopolists sell their outputs at a uniform price, the monopolist produces an output below that which maximizes social net benefits.

a. Recall that a perfectly competitive market produced exactly the level that maximized social net benefits.

b. Using the competitive result as a benchmark, monopolistic markets can be said to impose a *deadweight loss* on consumers within its market. (That is to say, some output valued above its cost is not produced by a monopolist.) [See Harberger.]

c. Regulation and antitrust actions are aimed, at least partly, at changing the market structure to allow these unrealized gains to trade to be realized as a consequence of competition (or a "socially responsible" price regulation).

i. It has been argued by Tullock, Krueger, and Posner that the true deadweight loss of monopoly is actually far greater than that represented by the Harberger triangle, in most case. DWL should include resources expended in the socially unproductive activity of securing a monopoly privilege (as in lobbying for market barriers of one sort or another). These "Tullock," rent-seeking, or dynamic losses may, in the limit, consume all of the monopoly profit realized by the successful monopolist.

ii. It also bears noting that the Harberger deadweight loss arises only because the monopolist is unable to perfectly price discriminate (charge a price equal to each person's marginal benefit from every unit of the good sold).

a. However, the Tullock/Posner losses would continue to accrue in this case as well.

b. Firm's would in this case be *even more* interested in securing monopoly privileges, and would waste even more resources attempting to obtain monopoly power via regulation.

iii. (However, t*he politics* of anti-trust law, and other monopoly regulation, probably has more to do with efforts to lower consumer prices than with ending Harberger or Tullock losses.)

LI. Duopoly

A. In any case where a monopolist exists as a consequence of innovative entry, there is the possibility that a second firm will enter the market subsequently. This changes a monopoly market into a *duopoly market*, e.g. a market with two firms.

B. There are three widely used models of duopoly: (1) *Cournot* (based on symmetric quantity competition), (2) *Bertrand* (based on symmetric price competition), and (3) *Stackelberg* (based on asymmetric quantity competition with a first and second mover).

i. The first and last of these models are more broadly used, although the Bertrand model yields more simple and direct predictions about pricing and output.

C. In the **Cournot** model (some times called Cournot / Nash duopoly), two firms produce identical goods and make their *output* decisions independently of one another. Each takes the other's output given, and selects its own best output given that assumption given the *downward sloping market demand curve* for the product in question. Total output and market price are represented as equilibria to the "noncooperative" production game between the two firms.

i. The above monopoly model can be easily modified to characterize the decision of Cournot duopolist "firm a". Now: $\Pi^a = PQ^a - C = p(Q^a+Q^b, Y)Q^a - c(Q^a, w, r)$

a. Differentiating with respect to Q^a and setting the result equal to zero yields:
$P + Q\,P_{Qa} - C_{Qa} = 0$ or $P + Q\,P_{Qa} = C_{Qa}$ again $MR = MC$ at Q^{a*}

b. but this time the MR and therefore Q^{a*} varies with the output of the other firm, Q^b.
$Q^{a*} = q^a(Q^b, w, r, Y)$ (This function is called variously Firm a's reaction function or its best reply function.)

c. In equilibrium both firms are simultaneously maximizing profits
and $Q^{a**} = q^a(Q^{b**}, w, r, Y)$ while $Q^{b**} = q^b(Q^{a**}, w, r, Y)$

d. Geometrically this occurs at the intersection of the two firm's best reply curves.

e. Total output increases relative to the monopoly market and prices fall.

ii. The latter can be easily illustrated with a linear illustration.

a. Let $C = cQ$ and let $P = XY - eQ$

b. The monopolist produces where $XY - 2eQ = c$ which requires $Q = [XY - c] / [2e]$

c. Cournot duopolist "a" sets its output to satisfy $(XY - eQ^b - 2eQ^a) = c$ which in the symmetric equilibrium implies that $Q^{a**} = [XY - c] / [3e]$ and that *total output is* $Q = 2[XY - c] / [3e]$ which is clearly a sixth larger than the monopolist realized.

D. The **Bertrand** model assumes that each firm competes on price. In effect, each firm bids for the business of consumers in a market with homogeneous products.

a. If consumers have complete information, each firm can secure essentially the entire market by charging a price just below that of its competitor.

b. A sequence of profit maximizing prices offers, thus, declines, until in the end, neither firm earns a positive economic profit.

c. In the case where each produces via constant returns to scale, this implies that the prevailing market *price under a duopoly is exactly the same as that of a perfectly competitive* market.

E. In the **Stackelburg** model, the first mover (leader) tries to take account of the likely output decision of the other firm (the second mover or follower) when making its output decision. In effect it chooses its profit maximizing output given the "reaction function" of its competitor.

i. Let "a" be the leader. Now: $\Pi^a = PQ^a - C = p(Q^a+Q^b, Y)Q^a - c(Q^a, w, r)$ but Qb rather than being taken as given is anticipated to be the quantity required by firm b's reaction function, $Q^b = q^b(Q^a, w, r, Y)$.

ii. The first order condition for the leader becomes: $P + Q\,(P_Q\,(1 + Q^b{}_{Qa}) - C_{Qa} = 0$

iii. Note that the marginal revenue function now includes the effect of firm b's change in output on the prevailing price, as well as the firm a's own effect on price.

LII. Imperfect Competition: a Cournot Extension

A. The Cournot duopoly model provides a very natural method of modelling the effects of entry. One can easily extend the model to include 3, 4, 5 ... N firms. The result will be market prices and output that more and more conform to the perfectly competitive result.

B. The linear case provides a very clear illustration of the effect of entry on market equilibria.
Let $C = cQ$ and let $P = XY - e\,[Q^a + (N-1)Q^o]$

i. The first order condition that characterizes maximal profits for firm "a" is now
$(XY - e(N-1)Q^o - 2eQ^a) = c$

ii. Firm a's reaction function is thus: $Q^a = [XY - e(N-1)Q^0 - c\,] / 2e$

iii. and the Cournot Nash equilibrium output for a typical firm at the symmetric equilibrium is : $Q^* = [XY - c] / (N+1)e$ and total output is N times as large:
$Q^* = \{[XY - c] / e\}\,\{N/(N+1)\}$

iv. As N approaches infinity, the total output approaches the competitive equilibrium. *Perfect Competition, thus, is a Limiting Case of entry in a Cournot / Nash type model.*

C. In general there are a wide variety of models of imperfect competition, which vary mainly with respect to the manner in which players anticipate or fail to anticipate reactions of other players in the game. [The so-called conjectural variation.]

LIII. Homework Problems

A. Use a linear version of the Stackelberg model to determine whether the leader or follower has a larger market share and profit.

B. Critique the Bertrand model. Are two firms always sufficient to generate marginal cost pricing? Why or why not?

C. Use a Cournot-type model to represent a two person rent-seeking game. Assume that two parties compete for complete control of a market by making campaign contributions to elected officials who control the monopoly license. Suppose that the probability of gaining the monopoly privilege, $P_1 = p(R_1, R_2)$, increase with ones own contribution, R_1, but falls with that of other firm's, R_2.

i. Characterize the equilibrium level of rent seeking engaged in by two firms who could realize a profit of Π dollars if they win the monopoly privilege.

ii. Discuss why behavior in such games tends to be suboptimal from the point of view of the participants and society at large. Are their cases where rent-seeking efforts do not generate a dead weight loss?