Synopsis of the fifth lecture in ECO 5315 (Monopoly and Oligopoly)

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Introduction

The focus of the fifth lecture in ECO 5315 was upon monopoly and oligopoly, but as a way of introducing these concepts, it is conceptually helpful to think of them in terms of a market structure continuum. The end points on this continuum are perfect competition[1] and monopoly. Monopoly lies on the opposite end of the market structure continuum from perfect competition. In the case of monopoly, rather than have large numbers of firms acting as price takers, one firm acts as a "price maker".[2, 3] The monopolist is a price maker in the sense that its production decisions directly affect market prices. For the monopolist, the market demand curve and the firm demand curve are one and the same. Monopolistic markets are characterized by substantial barriers to entry and exit; consequently, there can be substantial economic profit.

Interesting "intermediate" cases of market structure that fall in between the extremes of perfect competition and monopoly include monopolistic competition and oligopoly. Monopolistically competitive markets[4] have the following characteristics:

- Competitors sell differentiated products; products may be substitutes, but they are not exactly alike. Thus monopolistically competitive firms compete on basis of non-price product differences.
- Firms have a degree of control over price, but no one firm has complete control (as in the case of "pure" monopoly).
- There are limited barriers to entry and exit.

Oligopoly is a market structure characterized by a limited number of firms and high entry barriers.[5] Oligopolistic markets are particularly interesting from a strategic perspective, because managers of oligopolistic firms must consider (and anticipate) the actions of their rivals when they set prices. This stands in stark contrast with the cases of perfect competition and monopoly; in the former case, one does not care what one's competitor does (since everyone is a price taker), and in the latter case, there are no competitors.

Profit Maximization

Irrespective of whether markets are competitively, monopolistically, or oligopolistically structured, the objective of the firm is to maximize profit. Thus the problem that the firm

must solve involves selecting quantity Q such that profit π is maximized. Since $\pi = TR - TC$, this implies that $d\pi/dQ = dTR/dQ - dTC/dQ = 0 \Rightarrow$ marginal $\pi = MR - MC = 0 \Rightarrow MR = MC$! This brings us back to an important price theory result from Chapter 2. Recall equation 2.15 on page 47 of the textbook:

$$MR = dTR/dQ = d(PQ)/dQ = P\frac{dQ}{dQ} + Q\frac{dP}{dQ} = P\left[1 + \frac{Q}{P}\frac{dP}{dQ}\right] = P\left(1 + \frac{1}{\eta}\right).$$

Since we just (re)established the fact that the profit maximizing condition is $MR = MC$, this implies that $MR = MC = dTC/dQ = P(1 + 1/\eta)$ for a profit maximizing firm.

Several important findings come from this analysis. Irrespective of market structure, the profit maximizing quantity decision Q^* will *always* involve a point on the firm demand curve where product demand is price *elastic*. Note that the *revenue maximizing* quantity occurs when the price elasticity of demand is -1 (see Figure 2.7 on p. 46 in the textbook, and also note that the revenue maximizing quantity occurs when marginal revenue (MR) is 0, which implies that $MR = P(1 + 1/\eta) = 0 \Rightarrow \eta = -1$). Assuming the firm incurs non-negative costs when it produces output, in order for $MR > 0$, $\eta < -1$! Furthermore, since $\eta = -\infty$ for perfectly competitive firms, the profit maximizing condition for such a firm is $MR = P(1 + 1/\eta) = P(1 + 1/-\infty) = P = MC$. However, for all other market structures, $MR = MC$, where $P > MC$.

Data from real world product markets appear to fit the predictions of our theory fairly well. We discussed my blog entry entitled "The Price Elasticity of Demand for the iPhone 3G S" and noted that the iPhone's price elasticity of demand of $\eta = -1.43$ is consistent with the notions that 1) Apple has some measure of market power in the market for cellphone devices, and 2) it is maximizing profit in this setting. Furthermore, solving the equation $MC = P(1 + 1/\eta)$ for η, we find that $\eta = P/(MC - P)$, so the "markup" rule (which indicates a pricing strategy for maximizing profit) is $(P - MC)/P = -1/\eta$; in the case of the iPhone, $-1/\eta = -1/(-1.43) = 70\%$!

Oligopoly: the "special case" of duopoly

We finished the lecture by considering several strategy scenarios for duopolies. A duopoly is a special case of oligopoly, where by "few" firms, we mean just two. The reason why we make this assumption is that it helps considerably in simplifying our analysis of strategic interactions between rivals without any loss of generality. Strategy comes into play here because the decisions that I make are conditioned upon what I think my rival's decisions are likely to be. Similarly, my rival's decisions are conditioned upon what she thinks my

decisions are likely to be, and so forth. This is rather like a game of chess where we not only have to anticipate our rival's decisions, but we may even be able to influence her choices.

We considered four ways in which duopolists might behave and implications for market outcomes. The four scenarios that we considered were 1) price war, 2) collusion, 3) simultaneous decision-making, and 4) leader-follower decision-making. For all four scenarios, we made the following assumptions:

1. *Market Demand*: $P = 53 - Q$
2. *Firm 1's Cost Function:* $TC_1 = 5Q_1$
3. *Firm 2's Cost Function:* $TC_2 = 0.5Q_2^2$

The details behind the calculations for these four scenarios are all laid out in the 5th lecture note. In what remains, I will describe the logical structure of the four scenarios, as well as the market outcomes that one can expect.

Case 1: *Price War*

Under the price war scenario, firms 1 and 2 are each independently trying to select price-quantity pairs which maximize market share. So long as price exceeds marginal cost, both firms are willing to produce more, which in turn causes the market price to fall. The "equilibrium" in this case occurs when price is equal to marginal cost for one or both firms. Thus, they bid price down until $P = MC$ for 1 or both firms. Of the four scenarios, the price war scenario produces the largest total quantity, lowest price for the market, and lowest profit for the incumbent firms (specifically, $Q_1 = 43$, $Q_2 = 5$, $Q = Q_1 + Q_2 = 43 + 5 = 48$, $P = \$5$, $\pi_1 = \$0$, $\pi_2 = \$12.5$, and $\pi = \pi_1 + \pi_2 = 0 + 12.5 = \$12.5$).

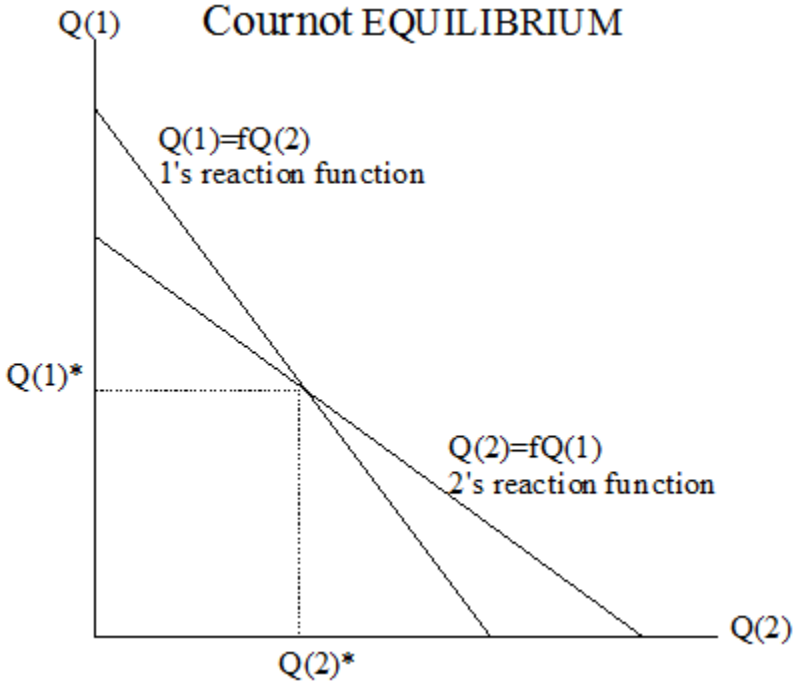
Case 2: *Collusion*

Under the collusion scenario, firms 1 and 2 get together and explicitly agree to jointly maximize value *as if* the duopoly is really a 2-plan monopoly. The equilibrium under collusion occurs when the marginal costs for firms 1 and 2 are equal to each other and also equal to marginal revenue for the joint firm. Of the four scenarios, the collusion scenario (not surprisingly) produces the smallest total quantity, highest price for the market, and highest total industry profit (specifically, $Q_1 = 19$, $Q_2 = 5$, $Q = Q_1 + Q_2 = 19 + 5 = 24$, $P = \$29$, $\pi_1 = \$456$, $\pi_2 = \$132.5$, and $\pi = \pi_1 + \pi_2 = 456 + 132.5 = \$588.5$).

Case 3: *Simultaneous Decision-Making* (*Cournot Equilibrium*)

Under the Cournot scenario, firms 1 and 2 do not cooperate. However, they make simultaneous profit-maximizing decisions, conditioned by what they believe each other's

"best response" is in terms of a profit-maximizing output choice. Thus, firm 1 makes its profit maximizing output choice given the choice of firm 2, and similarly, firm 2 makes its profit maximizing output choice given the choice of firm 1.



The key to solving the Cournot problem is to determine what firm 1's and firm 2's "reaction" functions are. Firm 1 is interested in maximizing profit, which is $\pi_1 = PQ - 5Q_1$, where $Q = Q_1 + Q_2$. Since $Q = Q_1 + Q_2$, this implies that firm 1's profit maximizing decision concerning Q_1 must explicitly take in consideration firm 2's decision concerning Q_2. Firm 1's reaction function is obtained by setting its marginal profit equation equal to 0 and solving for Q_1 in terms of Q_2. Similarly, firm 2 is interested in maximizing profit, which is $\pi_2 = PQ - 0.5Q_2^2$. Firm 2's reaction function is obtained by setting its marginal profit equation equal to 0 and solving for Q_2 in terms of Q_1. Thus firm 1's reaction function is $Q_1 = 24 - \frac{1}{2}Q_2$, and firm 2's reaction function is $Q_2 = 17\frac{2}{3} - \frac{1}{3}Q_1$. These reaction functions are shown in the graph above. The y-intercept for firm 1's reaction function is 24, and its x-intercept is 48. The y-intercept for firm 2's reaction function is 17⅔, and its x-intercept is 53. The Cournot equilibrium involves the following set of parameters: $Q_1 = 18.2$, $Q_2 = 11.6$, $Q = Q_1 + Q_2 = 18.2 + 11.6 = 29.8$, $P = \$23.2$, $\pi_1 = \$331.2$, $\pi_2 = \$201.8$, and $\pi = \pi_1 + \pi_2 = 331.2 + 201.8 = \$533$). Thus the Cournot model predicts that total quantity will be less than what it is under a price war, but greater than what it would be with collusion. Furthermore, the market price falls between the prices that would obtain under the price war and collusion cases. Finally, this example clearly illustrates the fragility of cartels. Firm 1 would clearly prefer to collude since its profit is $456 if it colludes and only $331.2 if it functions as a Cournot competitor. However, firm 2 has incentives not to collude and instead act as a Cournot competitor, since profits under collusion are $132.5, versus profits under Cournot of $201.8.

Case 4: *Leader-Follower decision-making* (*Stackelberg Equilibrium*)

Under the Stackelberg scenario, firm 1 is the leader and firm 2 is the follower. Firm 1 moves first and decides upon Q_1. Subsequently, firm 2 observes firm 1's choice concerning

Q_1 and selects Q_2. However, in making her choice concerning Q_1, firm 1 anticipates that firm 2's choice of Q_2 will depend upon firm 1's choice of Q_1.

Being the leader, firm 1 substitutes firm 2's reaction function Q_2 = 17⅔ - ⅓ Q_1 into her total revenue function and finds that the profit maximizing value for Q_1 = 22.75. Thus, Q_2 = 17⅔ - ⅓(22.75) = 10.09. Thus, the Stackelberg equilibrium involves the following set of parameters: $Q_1 = 22.75$, $Q_2 = 10.09$, $Q = Q_1 + Q_2 = 22.75 + 10.9 = 32.84$, P = \$20.16, $\pi_1 = \$344.9$, $\pi_2 = \$152.5$, and $\pi = \pi_1 + \pi_2 = 331.2 + 201.8 = \$497.2$). Thus in this case, the Stackelberg model predicts that total quantity will be greater, price will be lower, and total industry profits will be lower than under the Cournot model. You can see here that firm 1 has incentives to try to become the industry leader, since it earns higher profits if it is the leader and firm 2 is the follower. Firm 2 would prefer to remain as a Cournot competitor, since it earns higher profits under Cournot than under Stackelberg. We used these facts to illustrate an historical situation (from 2002) in which it appeared that Boeing and Airbus were operating as Cournot Competitors, but that Airbus tried to assume industry leadership, much to the chagrin of Boeing!

Endnotes

[1] Perfectly competitive markets are characterized by market structures in which many firms produce identical products with no control whatsoever over price. Furthermore, entry and exit barriers are non-existent; thus firms are free to come and go as they please. No one firm has any market power; consequently, firms in a perfectly competitive market cannot affect prices by changing their production decisions. Rather, they take prices as given. Therefore, firm-specific demand curves are perfectly elastic, but market demand curves are not.

[2] "Natural" monopolies may occur in situations where the long-run average cost curve is always declining; i.e., there are no diseconomies of scale. Public utility firms are often cited as examples of natural monopoly.

[3] More recently (during the past 15 years or so), Microsoft has had repeated confrontations with the US Federal Trade Commission, the US Department of Justice, and European Community-equivalent regulatory organizations involving anti-trust regulatory actions. In these actions, Microsoft is often characterized by the news media as a monopolistic firm, although it might be more accurate to characterize Microsoft as an *oligopolistic* firm, since the markets in which it competes are (at least in principle) contestable; e.g., in the operating system space, you have Mac OS, various flavors of Unix, Linux, etc., and in the office suite space, you have open-source software (e.g., Star-office and Google Office software).

[4] Common examples of monopolistically competitive markets include the markets for restaurants, cereal, clothing, shoes, service industries, etc.

[5] "Obvious" examples of oligopoly include automobiles, airlines, pharmaceuticals, express mail, soft drinks (e.g., Coke and Pepsi), razors (e.g., Gillette and Schick), drugstores (e.g., Walgreens and CVS), mobile phone networks (e.g., AT&T, Verizon, Sprint, T-Mobile), etc.