Econ100A Spring 2004

HW 5: Oligopoly and Pollution

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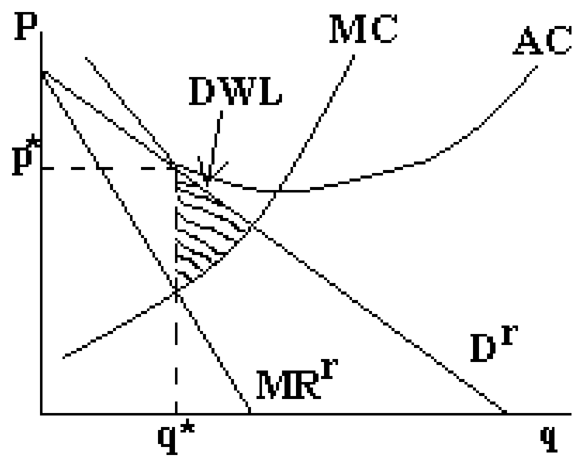
1. Explain briefly (a paragraph of words and perhaps a diagram should suffice) why, in a monopolistically competitive equilibrium with homogenous goods, the industry produces too little output. (What do you mean by “too little”?)

Monopolistically competitive firms are price setters. They choose quantity to maximize profits and then charge the highest price consumers are willing to pay for that quantity. With the usual assumptions that the monopolistically competitive firm faces a downward-sloping residual demand and an upward-sloping marginal cost curve, the monopolistically competitive firm chooses a quantity where p>MC. Thus, there are quantities not being produced where consumers' willingness to pay for the good is greater than the cost to the firm of additional production. In other words, monopolistic competition creates a dead weight loss to society relative to the perfectly competitive equilibrium, which is the socially efficient (dead weight loss minimizing) outcome. The industry produces too little output in that it produces a quantity lower than the socially efficient level.

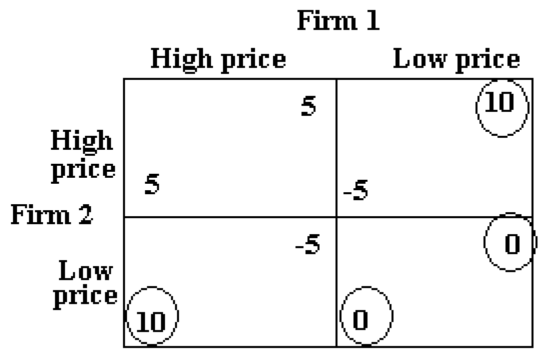


2. Suppose each of two firms must simultaneously choose to set either a high price or a low price. The normal-form representation of this game is

		Firm 1: High price	Firm 1: Low price
Firm 2	High price	5 5	10 -5
	Low price	-5 10	0 0

where the profits are shown in the cells. How many Nash Equilibria are there? Identify each and explain why it is a Nash equilibrium.

Using the circle the best response technique for finding Nash Equilibria produces,



Thus, only (low price, low price) is a Nash equilibrium since only here each player is playing her best response to the other player's strategy.

Alternatively, you might notice that charging a low price here is always better than charging a high price no matter what quantity the other firm is producing. Thus, choosing a low price is a dominant strategy for both firms. Players must play a dominant strategy in a Nash equilibrium; otherwise, they would have an incentive to change their strategy.

3. Can the combined profits of oligopolistic firms ever be higher than those of a monopoly with the same costs as those of firms combined?

No. Oligopolistic firms maximize combined profits by colluding. With collusion, the oligopolistic firms choose the total quantity of production that makes combined MR = combined MC. This is the same choice that a monopolist makes! Thus, the maximum combined profit of oligopolistic firms at most equal to the monopoly profit, and it can never be higher.

Alternatively, (proof by contradiction) suppose that the combined profits of oligopolistic firms could be higher than those of a monopoly with the same costs as those of the firms combined. Since the monopolist can act as if it is an oligopolistic firm (by competing with itself), it would maximize profit in the same way as the oligopolistic firms. Thus, the monopolist must make at least the profit of the combined oligopolistic firms. This contradicts the supposition, thus the supposition must be false.

4. All potential firms in an industry have the same cost function, $C(q_i) = 25 + 10q_i$. Market demand is $Q = 110 - p$. The firms engage in a Cournot game.

A. If there are two oligopolistic firms in the industry, what are the equilibrium price, quantity per firm, total quantity, profit per firm, and total profit?

Equilibrium price is 43⅓, quantity per firm is 33⅓, total quantity is 66⅔, profit per firm is 1086 1/9, and total profit is 2172 2/9.

In a Cournot game firms choose their quantity of production to maximize their own profit. Firm 1 chooses q1 such that MR1 = MC1. Rewrite market demand as q1 + q2 = 110 – p. So, p = 110 – q1 – q2. Since demand is linear, using the usual trick (twice slope and same intercept) MR1 =

110 – 2q1 – q2. Taking the derivative of C(q1) with respect to q produces MC1 = 10. Now setting MR1 = MC1, 110 – 2q1 - q2 = 10. Thus, q1* = 50 – q2/2. Since the firms are identical, q1* = q2* = q*. Thus, q* = 50 – q*/2. q* = 33⅓. Each firm produces 33⅓ units, so total market quantity is 66⅔. Filling Q* = 66⅔ into the demand curve produces equilibrium price, p* = 43⅓. Each firm makes a profit = TR – TC = 43⅓ (33⅓) – 25 – 10(33⅓) = 1086 1/9. Thus, total profit is (2)1086 1/9 = 2172 2/9.*

B. If, instead, this industry is monopolistically competitive, what are the equilibrium price, firm output, total output, profit per firm, and number of firms?

Equilibrium price is 15, quantity per firm is 5, total quantity is 95, profit per firm is 0, and the number of firms is 19.

Since all firms make the same decision, let's just focus on firm 1's profit maximizing decision. Rewrite market demand as p = 110 – q1 – (n-1)q_{oth}, where q_{oth} is the quantity produced by the other (identical) firms. Firm 1's MR1 = 110 – 2q1 – (n-1)q_{oth} using the usual trick. Calculate MC1 = 10 by taking the derivative of the total cost function. To profit maximize firm 1 sets MR1 = MC1. Since each firm is identical, each makes the same profit maximizing decision. Thus q1 = q^*_{oth} and for simplicity let's call each of these q* (each firm's profit maximizing quantity). Back to MR = MC, 110 – 2q* - (n-1)q* = 10. Solving for q*,* ***q* = 100/(n + 1)****. This equation ensures that our q* is each firm's profit maximizing quantity.*

We now have one equation that relates 2 of our 3 unknowns (q, p*, and n). We need two more equations to identify all three. Turn to the demand function and rewrite it in terms of q*, p*, and n to produce :* ***p* = 110 – nq****. *This equation ensures that market demand is satisfied.*

To get our last equation, use the no profit condition for monopolistic competition p = AC. Find AC by dividing total quantity by q, producing AC = 25/q + 10. Setting p = AC,* ***p* = 25/q* + 10****. This equation ensures that our monopolistically competitive firms are making no profits (which must be true in equilibrium.)*

To summarize, we've found three equations that relate three unknowns, so all we have left to do is to solve them algebraically:

(1) q* = 100/(n + 1) [from MR=MC]
(2) p* = 110 – nq* [from demand]
(3) p* = 25/q* + 10 [from p=AC]

(There are many ways to solve these equations. I will suggest what I think is the simplest.)

Set (2) equal to (3), producing 110 –nq = 25/q* + 10. Substitute (1) in for q*, producing*

$$110 - 100n/(n+1) = 25(n+1)/100 + 10$$
$$100 - 100n/(n+1) = 25(n+1)/100$$
$$400 - 400n/(n+1) = (n+1)$$
$$400(n+1) - 400n = (n+1)^2$$
$$400 = (n+1)^2$$
$$n+1 = 20, \text{ so } n=19.$$

Fill n=19 into (1) to get q = 100/(20) = 5.*
Fill q=5 into (3) to get p* = 25/5 + 10 = 15.*
Total quantity = nq = 19*5= 95*
Profit per firm = 0 since this was one of the conditions that we imposed.

C. How would the values in (B) change if a franchise tax of $75 were imposed on each firm?

Equilibrium price is 20, quantity per firm is 10, total quantity is 90, profit per firm is 0, and the number of firms is 9.

The franchise tax raises total cost for a firm to C(q) = 100 + 10q. Since marginal cost is the same as in part B, equation (1) is the same as in part B. Demand is the same as in part B, so equation (2) is the same. Average cost = 100/q + 10, so equation (3) becomes p* = 100/q* + 10. We now have:*

(1) q* = 100/(n + 1) [from MR=MC]
(2) p* = 110 – nq* [from demand]
(3) p* = 100/q* + 10 [from p=AC]

(Again, there are many ways to solve these equations. I will suggest what I think is the simplest.)

Set (2) equal to (3), producing 110 –nq = 100/q* + 10. Substitute (1) in for q*, producing*
$$110 - 100n/(n+1) = 100(n+1)/100 + 10$$
$$100 - 100n/(n+1) = (n+1)$$
$$100(n+1) - 100n = (n+1)^2$$
$$100 = (n+1)^2$$
$$n+1 = 10, \text{ so } n=9.$$

Fill n=9 into (1) to get q = 100/(10) = 10.*
Fill q=10 into (3) to get p* = 100/10+ 10 = 20.*
Total quantity = nq = 9*10= 90*
Profit per firm = 0 since this was one of the conditions that we imposed.

4. Compare and contrast the views on pollution controls of President Bush and Senator Kerry. In particular, what are their views on using markets to deal with pollution and on how to determine the appropriate tradeoff between pollution and productivity? [One source of information that you may use (but do not have to) is the article that can be found at are.berkeley.edu/courses/ECON100A/Pollution. The article is reproduced in *.jpg format—you'll probably have to play around with the size of the image to be able to read it. Read the files in numerical order.]

Note that answers may vary.

(from the NY Times Magazine article posted at the link above) The article describes a "cap-and-trade" market system to deal with pollution. Policy makers set an overall highest amount of

pollution allowed (the cap) and then distribute pollution rights to corporations who can trade these rights. Those corporations who want to pollute more than the rights they were given have to buy rights from other corporations who have excess rights. This scheme encourages corporations with the highest productivity levels to pay for the right to pollute; it also encourages corporations with lower productivity levels to reduce their pollution and thus be able to sell their rights.

Both candidates express an interest in preserving the environment and promoting American business. In general, Senator Kerry calls for tighter environmental regulations while President Bush creates policies that favor corporations more. Note that neither candidate's website contains much economic information related to environmental decisions.
http://www.georgewbush.com/Environment/
http://www.johnkerry.com/issues/energy/

5. (added in lecture) Is 4.3 billion a reasonable final account balance after 93 cents is invested in a savings account at 2.25% interest for 1000 years?

Yes. Using the formula, $\text{future value} = \text{present value}*(1+i)^t$,

$$FV = PV*(1+i)^t$$

$$FV = .93(1.0225)^{1000} = 4{,}283{,}508{,}449.71,$$

which is approximately 4.3 billion.