**Perfect Competition**

1. Suppose that a competitive firm’s marginal cost of producing output q is given by . Assume that the market price of the firm’s product is $9.
2. What level of output will the firm produce?

The firm should set the market price equal to marginal cost to maximize its profits:

9 = 3 + 2q, or q = 3.

1. What is the firm’s producer surplus?

Producer surplus is equal to the area below the market price, i.e., $9.00, and above the marginal cost curve, i.e., 3 + 2q. Because MC is linear, producer surplus is a triangle with a base equal to 3 (since q = 3) and a height of $6 (9 − 3 = 6). The area of a triangle is (1/2) × (base) × (height). Therefore, producer surplus is (0.5)(3)(6) = $9.

A diagram of a production line

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1. Suppose that the average variable cost of the firm is given by . Suppose that the firm’s fixed costs are known to be $3. Will the firm be earning a positive, negative, or zero profit in the short run?

Profit is equal to total revenue minus total cost. Total cost is equal to total variable cost plus fixed cost. Total variable cost is equal to . At q = 3, AVC(q) = 3 + 3 = 6, and therefore: TVC = (6)(3) = $18.

Fixed cost is equal to $3. Therefore, total cost equals TVC plus TFC, or

C = $18 + 3 = $21.

Total revenue is price times quantity:

R = ($9)(3) = $27.

Profit is total revenue minus total cost:

π = $27 − 21 = $6.

Therefore, the firm is earning positive economic profits. More easily, you might recall that profit

equals producer surplus minus fixed cost. Since we found that producer surplus was $9 in part b, profit equals 9 − 3 or $6.

1. A firm produces a product in a competitive industry and has a total cost function

and a marginal cost function .

At the given market price of $20, the firm is producing 5 units of output. Is the firm maximizing its profit? What quantity of output should the firm produce in the long run?

If the firm is maximizing profit, then price will be equal to marginal cost. P = MC results in

20 = 4 + 4q, or q = 4. The firm is not maximizing profit; it is producing too much output. The current level of profit is:

,

and the profit maximizing level is:

.

Given no change in the price of the product or the cost structure of the firm, the firm should produce q = 0 units of output in the long run since economic profit is negative at the quantity where price equals marginal cost. The firm should exit the industry.

**Monopoly**

1. Suppose that an industry is characterized as follows:

*C* = 100 + 2*q*2 each firm’s total cost function

*MC* = 4*q* firm’s marginal cost function

*P* = 90 − 2*Q* industry demand curve

*MR* = 90 − 4*Q* industry marginal revenue curve

1. If there is *only one firm* in the industry, find the monopoly price, quantity, and level of profit.

If there is only one firm in the industry, then the firm will act like a monopolist and produce at

the point where marginal revenue is equal to marginal cost:

90 − 4*Q* = 4*Q*

*Q* = 11.25.

For a quantity of 11.25, the firm will charge a price *P* = 90 − 2(11.25) = $67.50. Profit = *PQ* − *C* =

$67.50(11.25) − [100 + 2(11.25)2] = $406.25.

1. Find the price, quantity, and level of profit if the industry is competitive.

If the industry is competitive, price will equal marginal cost. Therefore 90 − 2*Q* = 4*Q*, or *Q* = 15.

At a quantity of 15, price is equal to *P* = 90 − 2(15) = $60. The industry’s profit is $60(15) −

[100 + 2(15)2] = $350.

**Game Theory**

1. We can think of U.S. and Japanese trade policies as a prisoners’ dilemma. The two countries are considering policies to open or close their import markets. The payoff matrix is shown below.

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **Japan** | |
|  |  | **Open** | **Close** |
| **US** | **Open** | **10, 10** | **5, 5** |
| **Close** | **-100, 5** | **1, 1** |

Assume that each country knows the payoff matrix and believes that the other country will act in its own interest. Does either country have a dominant strategy? What will be the equilibrium policies if each country acts rationally to maximize its welfare?

Open is a dominant strategy for both countries. If Japan chooses Open, the U.S. does best by choosing Open. If Japan chooses Close, the U.S. does best by choosing Open. Therefore, the U.S. should choose Open, no matter what Japan does. If the U.S. chooses Open, Japan does best by choosing Open. If the U.S. chooses Close, Japan does best by choosing Open. Therefore, both countries will choose to have Open policies in equilibrium.

1. BuyRight is a chain of grocery stores operating in small cities throughout the southwestern United States. BuyRight’s major competition comes from another chain, Acme Food Stores. Both firms are currently contemplating their advertising strategy for the region. The possible outcomes are illustrated by the payoff matrix below.

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **Acme Foods** | |
|  |  | **Increase Advertising** | **Don’t Increase Advertising** |
| **BuyRight** | **Increase Advertising** | **20, 15** | **35, -5** |
| **Don’t Increase Advertising** | **2, 30** | **25, 25** |

Entries in the payoff matrix are profits. BuyRight’s profit is before the comma, Acme’s is after

the comma.

1. Describe what is meant by a dominant strategy.

A dominant strategy is one that is optimal regardless of the rival’s strategy.

1. Given the payoff matrix above, does each firm have a dominant strategy?

For both firms, the dominant strategy is to increase advertising.

If Acme increases advertising, Buy-Right earns 20 by increasing, 2 by not increasing.

Profit is higher for Buy-Right by increasing, regardless of Acme’s choice. The same can be shown to be true for Acme.

1. Under what circumstances would there be no dominant strategy for one or both firms?

Either or both firms would not have a dominant strategy if their best choice depended

on the choice of their rival.

1. Consider two firms, X and Y, that produce super computers. Each can produce the next generation super computer for the military (M) or for civilian research (C). However, only one can successfully produce for both markets simultaneously. Also, if one produces M, the other might not be able to successfully produce M, because of the limited market. The following payoff matrix illustrates the problem.

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **Firm Y** | |
|  |  | **M** | **C** |
| **Firm X** | **M** | **2, 1** | **2, 2** |
| **C** | **1, 1** | **3, 2** |

Find the Nash equilibrium, and explain why it is a Nash equilibrium.

The Nash equilibrium occurs at the bottom right on the C,C position. Firm Y has a dominant strategy to always target the civilian research market, and Firm X’s does not have a dominant strategy. However, Firm X’s best response to Firm Y’s dominant strategy is to also target the civilian market. In this position, each firm does its best given what the other firm does.

**Oligopoly**

1. **Consider two firms facing the demand curve *P*** = **50** − **5*Q*, where *Q*** = ***Q*1** + ***Q*2. The firms’ cost functions are *C*1(*Q*1)** = **20** + **10*Q*1 and *C*2(*Q*2)** = **10** + **12*Q*2.**
2. **Suppose both firms have entered the industry. What is the joint profit-maximizing level of output? How much will each firm produce?**

If the firms collude, they face the market demand curve, so their marginal revenue curve is:

*MR* = 50 − 10*Q*.

Set marginal revenue equal to marginal cost (the marginal cost of Firm 1, since it is lower than that of Firm 2) to determine the profit-maximizing quantity,

*Q*: 50 − 10*Q* = 10, or *Q* = 4.

Substituting *Q* = 4 into the demand function to determine price:

*P* = 50 − 5(4) = $30.

The question now is how the firms will divide the total output of 4 among themselves. The joint profit-maximizing solution is for Firm 1 to produce all of the output because its marginal cost is less than Firm 2’s marginal cost. We can ignore fixed costs because both firms are already in the market and will be saddled with their fixed costs no matter how many units each produces. If

Firm 1 produces all 4 units, its profit will be

π1 = (30)(4) − (20 + (10)(4)) = $60.

The profit for Firm 2 will be:

π2 = (30)(0) − (10 + (12)(0)) = −$10.

Total industry profit will be:

π*T*= π1 + π2 = 60 − 10 = $50.

Firm 2, of course, will not like this. One solution is for Firm 1 to pay Firm 2 $35 so that both earn a profit of $25, although they may well disagree about the amount to be paid. If they split the output evenly between them, so that each firm produces 2 units, then total profit would be $46 ($20 for Firm 1 and $26 for Firm 2). This does not maximize total profit, but Firm 2 would prefer it to the $25 it gets from an even split of the maximum $50 profit. So there is no clear-cut answer to this question.

1. **What is each firm’s equilibrium output and profit if they behave noncooperatively? Use the Cournot model. Draw the firms’ reaction curves and show the equilibrium.**

In the Cournot model, Firm 1 takes Firm 2’s output as given and maximizes profits. Firm 1’s

profit function is

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Setting the derivative of the profit function with respect to *Q*1 to zero, we find Firm 1’s reaction function:

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Similarly, Firm 2’s reaction function is A black numbers and symbols

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To find the Cournot equilibrium, substitute Firm 2’s reaction function into Firm 1’s reaction

function:

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Substituting this value for *Q*1 into the reaction function for Firm 2, we find

*Q*2 = 2.4.

Substituting the values for *Q*1 and *Q*2 into the demand function to determine the equilibrium price:

*P* = 50 − 5(2.8 + 2.4) = $24.

The profits for Firms 1 and 2 are equal to

π1 = (24)(2.8) − (20 + (10)(2.8)) = $19.20, and

π2 = (24)(2.4) − (10 + (12)(2.4)) = $18.80.

The firms’ reaction curves and the Cournot equilibrium are shown below.

A diagram of a firm reaction curve

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