ECON2103 Microeconomics

Chapter 10 Exercises

Solutions

1.

a. The profit-maximizing output is found by setting marginal revenue equal to marginal cost. Given a linear demand curve in inverse form, $P = 120 - 0.02Q$, we know that the marginal revenue curve has the same intercept and twice the slope of the demand curve. Thus, the marginal revenue curve for the firm is $MR = 120 - 0.04Q$. Marginal cost is the slope of the total cost curve. The slope of $TC = 60Q + 25{,}000$ is 60, so MC is constant and equal to 60. Setting $MR = MC$ to determine the profit-maximizing quantity:

$$120 - 0.04Q = 60, \text{ or}$$

$$Q = 1500.$$

Substituting the profit-maximizing quantity into the inverse demand function to determine the price:

$$P = 120 - (0.02)(1500) = 90 \text{ cents.}$$

Profit equals total revenue minus total cost:

$$\pi = (90)(1500) - (25{,}000 + (60)(1500)), \text{ so}$$

$$\pi = 20{,}000 \text{ cents per week, or \$200 per week.}$$

b. Suppose initially that consumers must pay the tax to the government. Since the total price (including the tax) that consumers would be willing to pay remains unchanged, we know that the demand function is

$$P^* + t = 120 - 0.02Q, \text{ or}$$

$$P^* = 120 - 0.02Q - t,$$

where P^* is the price received by the suppliers and t is the tax per unit. Because the tax increases the price consumers pay for each unit, total revenue for the monopolist decreases by tQ. You can see this most easily by expressing $R = P^*Q$, which means tQ is subtracted from revenue. Marginal revenue, the revenue on each additional unit, decreases by t:

$$MR = 120 - 0.04Q - t$$

where $t = 14$ cents. To determine the profit-maximizing level of output with the tax, equate marginal revenue with marginal cost:

$$120 - 0.04Q - 14 = 60, \text{ or}$$

$$Q = 1150 \text{ units.}$$

Substituting Q into the demand function to determine price:

$$P^* = 120 - (0.02)(1150) - 14 = 83 \text{ cents.}$$

Profit is total revenue minus total cost:

$$\pi = (83)(1150) - [(60)(1150) + 25{,}000] = 1450 \text{ cents, or}$$

$$\$14.50 \text{ per week.}$$

Note**:** The price facing the consumer after the imposition of the tax is 83 + 14 = 97 cents. Compared to the 90-cent price before the tax is imposed, consumers and the monopolist each pay 7 cents of the tax.

If the monopolist had to pay the tax instead of the consumer, we would arrive at the same result. The monopolist's cost function would then be

$$TC = 60Q + 25{,}000 + tQ = (60 + t)Q + 25{,}000.$$

The slope of the cost function is $(60 + t)$, so $MC = 60 + t$. We set this MC equal to the marginal revenue function from part a:

$$120 - 0.04Q = 60 + 14, \text{ or}$$

$$Q = 1150.$$

Thus, it does not matter who sends the tax payment to the government. The burden of the tax is shared by consumers and the monopolist in exactly the same way.

2.

a. To find the marginal revenue curve, we first derive the inverse demand curve. The intercept of the inverse demand curve on the price axis is 18. The slope of the inverse demand curve is the change in price divided by the change in quantity. For example, a decrease in price from 18 to 16 yields an increase in quantity from 0 to 4. Therefore, the slope of the inverse demand is $\frac{\Delta P}{\Delta Q} = \frac{-2}{4} = -0.5$, and the demand curve is therefore

$$P = 18 - 0.5Q.$$

The marginal revenue curve corresponding to a linear demand curve is a line with the same intercept as the inverse demand curve and a slope that is twice as steep. Therefore, the marginal revenue curve is

$$MR = 18 - Q.$$

b. The monopolist's profit-maximizing output occurs where marginal revenue equals marginal cost. Marginal cost is a constant \$10. Setting MR equal to MC to determine the profit-maximizing quantity:

$$18 - Q = 10, \text{ or } Q = 8.$$

To find the profit-maximizing price, substitute this quantity into the demand equation:

$$P = 18 - (0.5)(8) = \$14.$$

Total revenue is price times quantity:

$$TR = (14)(8) = \$112.$$

The profit of the firm is total revenue minus total cost, and total cost is equal to average cost times the level of output produced. Since marginal cost is constant, average variable cost is equal to marginal cost. Ignoring any fixed costs, total cost is $10Q$ or 80, and profit is

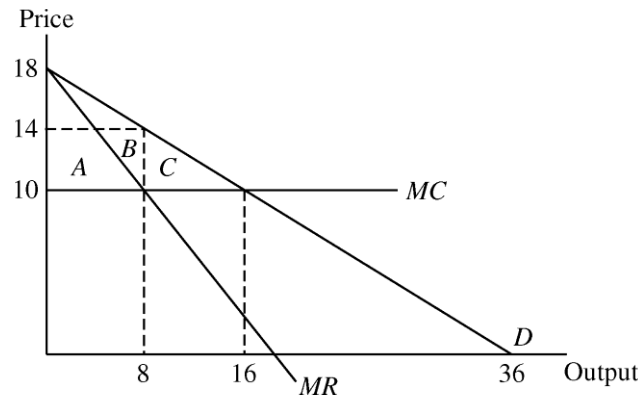
$$\pi = 112 - 80 = \$32.$$

c. For a competitive industry, price would equal marginal cost at equilibrium. Setting the expression for price equal to a marginal cost of 10:

$$18 - 0.5Q = 10, \text{ so that } Q = 16 \text{ and } P = \$10.$$

Note the increase in the equilibrium quantity and decrease in price compared to the monopoly solution.

d. The social gain arises from the elimination of deadweight loss. When price drops from \$14 to \$10, consumer surplus increases by area $A + B + C = 8(14 - 10) + (0.5)(16 - 8)(14 - 10) = \$48$. Producer surplus decreases by area $A + B = 8(14 - 10) = \$32$. So consumers gain \$48 while producers lose \$32. Deadweight loss decreases by the difference, \$48 – 32 = \$16. Thus the social gain if the monopolist were forced to produce and price at the competitive level is \$16.



3.

a. The average revenue curve is the demand curve,

$$P = 700 - 5Q.$$

For a linear demand curve, the marginal revenue curve has the same intercept as the demand curve and a slope that is twice as steep:

$$MR = 700 - 10Q.$$

Next, determine the marginal cost of producing Q. To find the marginal cost of production in Factory 1, take the derivative of the cost function with respect to Q_1:

$$MC_1 = \frac{dC_1(Q_1)}{dQ_1} = 20Q_1.$$

Similarly, the marginal cost in Factory 2 is

$$MC_2 = \frac{dC_2(Q_2)}{dQ_2} = 40Q_2.$$

We know that total output should be divided between the two factories so that the marginal cost is the same in each factory. Let MC_T be this common marginal cost value. Then, rearranging the marginal cost equations in inverse form and horizontally summing them, we obtain total marginal cost, MC_T:

$$Q = Q_1 + Q_2 = \frac{MC_1}{20} + \frac{MC_2}{40} = \frac{3MC_T}{40}, \text{ or}$$

$$MC_T = \frac{40Q}{3}.$$

Profit maximization occurs where $MC_T = MR$. See the figure below for the profit-maximizing output for each factory, total output Q_T, and price P_M.

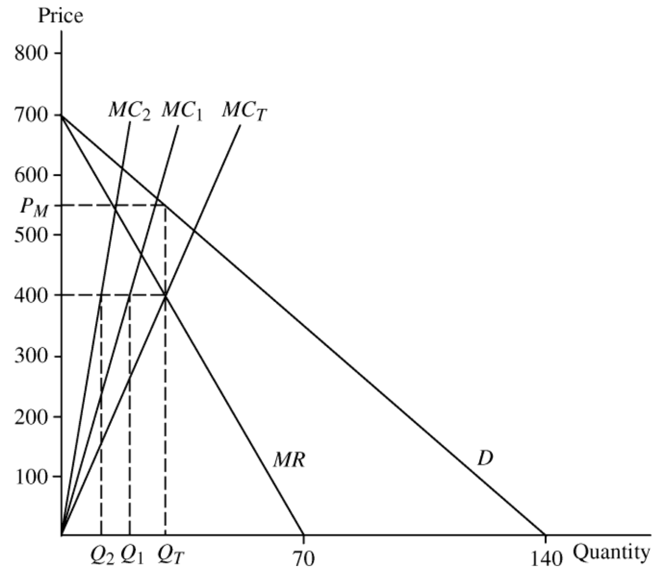


Figure 10.8.a

b. To calculate the total output Q that maximizes profit, set $MC_T = MR$:

$$\frac{40Q}{3} = 700 - 10Q, \text{ or } Q = 30.$$

When $Q = 30$, marginal revenue is $MR = 700 - (10)(30) = 400$. At the profit-maximizing point, $MR = MC_1 = MC_2$. Therefore,

$$MC_1 = 400 = 20Q_1, \text{ or } Q_1 = 20 \text{ and}$$

$$MC_2 = 400 = 40Q_2, \text{ or } Q_2 = 10.$$

To find the monopoly price, P, substitute for Q in the demand equation:

$$P = 700 - 5(30), \text{ or}$$

$$P_M = \$550.$$

c. An increase in labor costs will lead to a horizontal shift to the left in MC_1, causing MC_T to shift to the left as well (since it is the horizontal sum of MC_1 and MC_2). The new MC_T curve will intersect the MR curve at a lower total quantity and higher marginal revenue. You can see this in Figure 10.8.a above. At a higher level of marginal revenue, Q_2 is greater than at the original level of MR. Since Q_T falls and Q_2 rises, Q_1 must fall. Since Q_T falls, price must rise.

4.

a. *MMMT* should offer enough t-shirts so that $MR = MC$. In the short run, marginal cost is the change in *SRTC* as the result of the production of another t-shirt, that is, $SRMC = 5$, the slope of the *SRTC* curve. Demand is:

$$Q = \frac{10{,}000}{P^2},$$

or, in inverse form,

$$P = 100Q^{-1/2}.$$

Total revenue is $TR = PQ = 100Q^{1/2}$. Taking the derivative of *TR* with respect to Q, $MR = 50Q^{-1/2}$. Equating *MR* and *MC* to determine the profit-maximizing quantity:

$$5 = 50Q^{-1/2}, \text{ or } Q = 100.$$

Substituting $Q = 100$ into the demand function to determine price:

$$P = (100)(100^{-1/2}) = \$10.$$

The profit at this price and quantity is equal to total revenue minus total cost:

$$\pi = 10(100) - [2000 + 5(100)] = -\$1500.$$

Although profit is negative, price is above the average variable cost of 5, and therefore the firm should not shut down in the short run. Since most of the firm's costs are fixed, the firm loses $2000 if nothing is produced. If the profit-maximizing (that is, loss-minimizing) quantity is produced, the firm loses only $1500.

b. In the long run, marginal cost is equal to the slope of the *LRTC* curve, which is 6.

Equating marginal revenue and long run marginal cost to determine the profit-maximizing quantity:

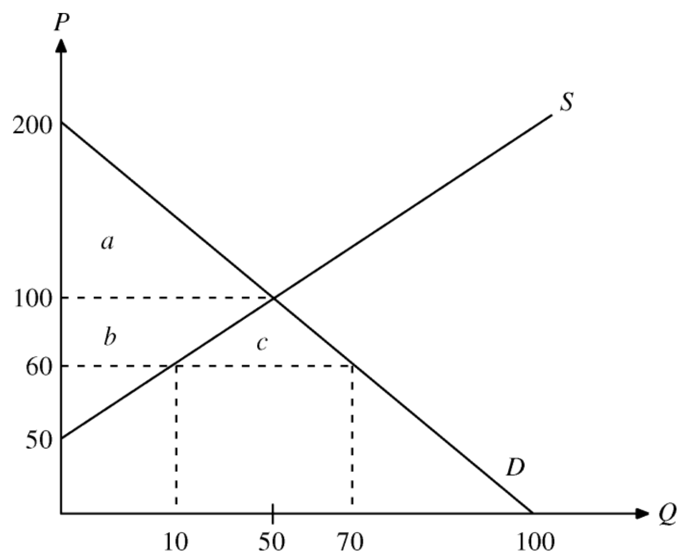
$$50Q^{-1/2} = 6, \text{ or } Q = 69.444$$

Substituting $Q = 69.444$ into the demand equation to determine price:

$$P = (100)(69.444)^{-1/2} = (100)(1/8.333) = 12$$

Total revenue is $TR = 12(69.444) = \$833.33$ and total cost is $LRTC = 6(69.444) = \$416.67$. Profit is therefore $\$833.33 - 416.67 = \$416.66$. The firm should remain in business in the long run.

c. In the long run, *MMMT* can change all its inputs when it changes output level. Therefore, *LRMC* includes the costs of all inputs that are fixed in the short run but variable in the long run. These costs do not appear in *SRMC*. As a result we can expect *SRMC* to be lower than *LRMC* in many cases.



5.

a. The supply curve is equivalent to the average expenditure curve. With a supply curve of $W = 1000 + 75n$, the total expenditure is $Wn = 1000n + 75n^2$. Taking the derivative of the total expenditure function with respect to the number of TAs, the marginal expenditure curve

is $ME = 1000 + 150n$. As a monopsonist, the university would equate marginal value (demand) with marginal expenditure to determine the number of TAs to hire:

$$30{,}000 - 125n = 1000 + 150n, \text{ or } n = 105.5.$$

Substituting $n = 105.5$ into the supply curve to determine the wage:

$$1000 + 75(105.5) = \$8{,}912.50 \text{ annually.}$$

b. With an infinite number of TAs at \$10,000, the supply curve is horizontal at \$10,000. Total expenditure is 10,000(n), and marginal expenditure is 10,000. Equating marginal value and marginal expenditure:

$$30{,}000 - 125n = 10{,}000, \text{ or } n = 160.$$