

1. The demand function is $Q_d = 20 - \frac{1}{2}P$, and the supply function is $P = 10 + Q_s$.
 - a. What is the market equilibrium price and quantity?
 - b. What is the consumer surplus, producer surplus, dead weight loss (DWL) and the total surplus?
 - c. Is the resource allocation efficient? Why?

Now suppose a price ceiling of 15 is set by the government.

- d. What is the price and quantity traded in the market?
- e. What is the consumer surplus, producer surplus, DWL, and the total surplus?
- f. Is the resource allocation efficient? Why?

Now suppose instead of the price ceiling, a price floor of 25 is set by the government.

- g. Re-answer the questions of d. e. f.

Now suppose instead of the price floor or ceiling, the government imposes a new consumption tax of \$2 per unit.

- h. Re-answer the question of d. e. f.
- i. What is the tax revenue?

Now suppose the government double the tax rate to \$4 per unit.

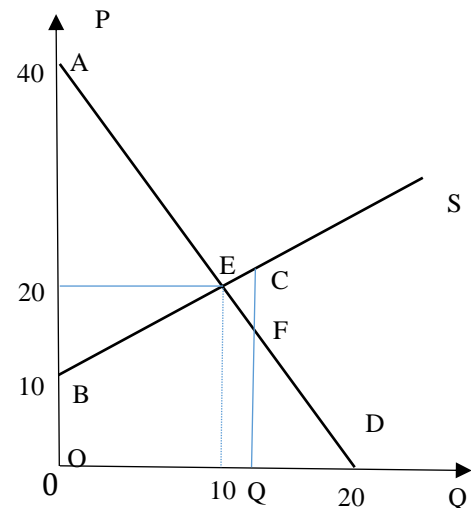
- j. What is the tax revenue? Does the higher tax rate increase the tax revenue?
- k. What is the DWL? Does the higher tax rate increase the DWL?

Answer:

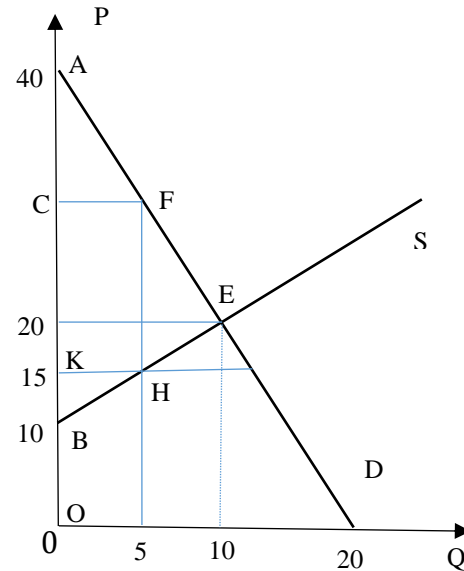
- a. In equilibrium $Q_d = Q_s \equiv Q$. So $20 - \frac{1}{2}P = P - 10 \Rightarrow P = 20, Q = 10$.
- b. $CS = \frac{1}{2}(40 - 20)10 = 100$, $PS = \frac{1}{2}(20 - 10)10 = 50$, $SS = CS + PS = 100 + 50 = 150$.
 $DWL = 0$.
- c. Yes, it is efficient.

For any quantity traded larger than the equilibrium quantity 10, I will show that the SS is smaller. Suppose the quantity traded is $Q > 10$ (see the graph). Then $SS = \text{total value to the consumers} - \text{total cost of producers} = \text{area AOQF} - \text{area BOQC} = \text{area ABE} - \text{area EFC}$.

When the quantity traded is equal to 10, the total surplus $SS = \text{area ABE}$. So when the quantity traded is Q , SS is smaller. Similarly we can show that when the quantity traded is smaller than 10, the SS is smaller than the area ABE too. Therefore when the quantity traded is equal to 10, SS is maximized.

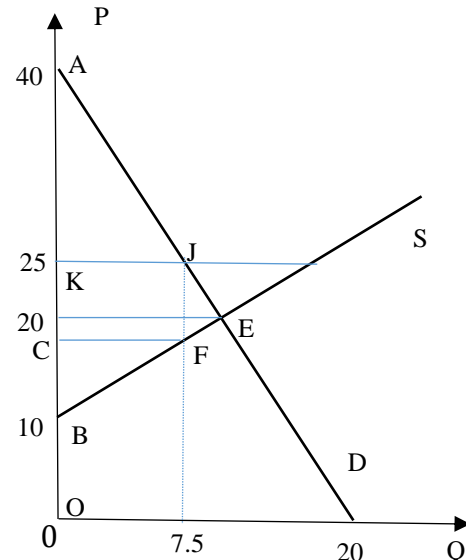


- d. The equilibrium price $P=20$ from above. So when there is a price ceiling equal to 15, the market price becomes 15. The quantity is determined by the supply here. $Q = P - 10 = 5$.
- e. The value of C is determined by the demand curve: $P = 40 - 2Q_d = 40 - 2 * 5 = 30$. So $C=30$.
 $CS = \text{area AKHF} = \text{area ACF} + \text{area CKHF} = \frac{1}{2} (40 - 30) * 5 + (30 - 15) * 5 = 100$.
 $PS = \text{area KBH} = \frac{1}{2} (15 - 10) * 5 = 12.5$
 $SS = CS + PS = 100 + 12.5 = 112.5$
 $DWL = \text{area FHE} = \frac{1}{2} (30 - 15) (10 - 5) = 37.5$.
 You can also get DWL by using the maximum of SS you get above: $DWL = 150 - 112.5 = 37.5$.
- f. No it is not efficient because DWL is positive.

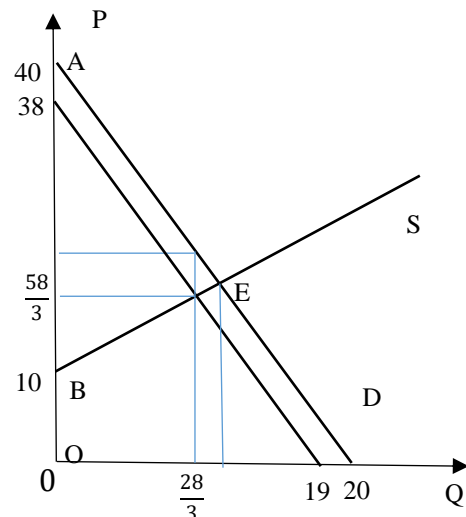


- g. Since the equilibrium price is $10 < 25$, so with the price floor the market price becomes 25. At this price the market quantity traded is determined by the demand curve: $Q = 20 - \frac{1}{2} P = 20 - \frac{1}{2} * 25 = 7.5$.

$CS = \text{area AKJ} = \frac{1}{2} (40 - 25) * 7.5 = 56.25$
 The value of C is determined by the supply curve: $P = 10 + 7.5 = 17.5$.
 $PS = \text{area KBFJ} = \text{area KCFJ} + \text{area CBF} = (25 - 17.5) * 7.5 + \frac{1}{2} * (17.5 - 10) * 7.5 = 84.375$
 $SS = CS + PS = 56.25 + 84.375 = 140.625$.
 $DWL = 150 - 140.625 = 9.375$.
 No it is not efficient because the DWL is positive.



- h. With the new consumption tax, the real demand function becomes: $Q_d = 20 - \frac{1}{2} (P + 2) \Leftrightarrow P = 38 - 2Q_d$. The supply function is still the same: $P = 10 + Q_s$. Then we can solve for the new equilibrium price and quantity: $10 + Q = 38 - 2Q \Rightarrow Q = \frac{28}{3}, P = \frac{58}{3}$.
 $CS = \frac{1}{2} \left(38 - \frac{58}{3} \right) * \frac{28}{3} \approx 87$.
 $PS = \frac{1}{2} \left(\frac{58}{3} - 10 \right) * \frac{28}{3} \approx 43.6$
- i. Tax revenue $= \frac{28}{3} * 2 \approx 18.7$
 $SS = CS + PS + \text{Tax} = 87 + 43.6 + 18.7 = 149.3$
 $DWL = 150 - 149.3 = 0.7$



- j. With the new consumption tax, the real demand function becomes: $Q_d = 20 - \frac{1}{2}(P + 4) \Leftrightarrow P = 36 - 2Q_d$. The supply function is still the same: $P = 10 + Q_s$. Then we can solve for the new equilibrium price and quantity: $10 + Q = 36 - 2Q \Rightarrow Q = \frac{26}{3}, P = \frac{56}{3}$.
- $$CS = \frac{1}{2} \left(36 - \frac{56}{3} \right) * \frac{26}{3} \approx 75.$$
- $$PS = \frac{1}{2} \left(\frac{56}{3} - 10 \right) * \frac{26}{3} \approx 37.6$$
- k. Tax revenue = $\frac{26}{3} * 4 \approx 34.7$. So at this tax rate level, a higher rate increases the tax revenue.
- l. $SS = CS + PS + \text{Tax} = 75 + 37.6 + 34.7 = 147.3$
 $DWL = 150 - 147.3 = 2.7$. So a higher tax rate increases the DWL.

2. What does the Allocation of Resources refer to?

Answer:

The allocation of resources answers three questions:

- how much of each good is produced
- which producers produce it
- which consumers consume it

3. (Based on a tutorial problem 3 in Tabrizi econ302 2016) There are 3 movie tickets available to be sold to 5 persons with the following WTPs, and assume there is no selling cost.

A	B	C	D	E
20	16	10	7	2

- a) How many tickets should be allocated in an efficient allocation? To whom?
- b) The seller may use the following different mechanisms to sell the tickets. In each case explain how many tickets will be sold, to whom, at what prices, and whether the outcome is efficient.
- Sell the tickets through price-taking agents on a competitive market.
 - Allow the buyers to negotiate the prices and trade among themselves.
 - Sell the tickets through a monopolist (ticket master) who sets the same price to everyone.
 - Sell the tickets at a price of \$ 2 each.

Answer:

- a. In an efficient allocation all 3 tickets should be sold, to the people who have the highest WTPs. So A, B, and C should have the tickets. If D or E has the ticket, it is easy to find a Pareto improvement: C or D would trade the ticket with the person among A, B, C who does not have a ticket and both will be better off.
- b. See the following:

- In this cases all 3 tickets will be sold, to A, B, and C, at a price $10 \leq P < 7$. The outcome is efficient because the tickets go to people who value them most.
- The outcome is the same as above, and it is efficient.
- The monopolist would pick a price to maximize its profit. Since there are only three tickets, it is easy to see that the price must be higher than 10 (including 10).
 - If in the outcome only A buys the ticket, the best price for the monopolist is to set $P=20$. In this case the profit is 20.
 - If in the outcome A and B, and only A and B buy the ticket, the best price is that $P=16$. In this case the profit is $16 \times 2 = 32$.
 - If in the outcome A, B, and C all get the ticket, the best price is that $P=10$. In this case the profit is $10 \times 3 = 30$.

From the above analysis, the monopolist will set the price $P=16$ so that the profit is 32. The outcome is not efficient because only two tickets are sold and there is still demand for the last ticket, and there is not cost of selling here (we assume it is 0). A Pareto improvement can be found: If the monopolist does not have to set the same price to everyone, he can set a lower price (for example, $P=10$) to sell the last ticket to C and both parties will be better off.

- In this cases all three tickets will be sold. Since the price is so low, all five people are willing to buy and may get the ticket. Because both D and C have a chance of getting the ticket, the outcome is not efficient.

4. (Based on problem 9 in Ch8 of Mankiw's book)

Suppose the Canadian government decides that it needs to raise an additional \$100 million in tax revenues. One Cabinet minister argues for a tax on all soft drinks. A second Cabinet minister argues for a tax on cola only, since this would give consumers a choice of paying the tax (by drinking cola) or avoiding it (by switching to another soft drink).

- Which market has the more elastic supply and demand curves: the market for cola, or the market for all soft drinks?
- To raise the same \$100 million in revenue, which would require a higher rate: a tax on cola, or a tax on all soft drinks?
- Which would cause a larger deadweight loss: a tax on cola, or a tax on all soft drinks?
- Which would be the better tax? Explain.

Answer:

- The market for cola would have more elastic supply and demand curves because consumers will have access to alternative substitutes if the price of cola changes.
- The tax rate would have to be higher for those goods that have elastic supply and demand curves, such as cola. A marginal increase in the tax rate on all soft drinks will yield a higher tax revenue for government as consumers and producers are less responsive to price changes.
- The deadweight loss of a tax would be greater, the greater the elasticities of supply and demand, in this case, a tax on cola.
- From a government's point of view, the better tax would be the one placed on the market for all soft drinks if this market faces inelastic demand and supply curves.

However, it is uncertain if consumers will dramatically change their consumption of soft drinks and go to alternative substitutes, such as water, coffee, tea, etc.

5. (Mankiw ch8 P4) Suppose that the government imposes a tax on heating oil.
- Would the deadweight loss from this tax likely be greater in the first year after it is imposed or in the fifth year? Explain.
 - Would the revenue collected from this tax likely be greater in the first year after it is imposed or in the fifth year? Explain.

Answer:

- The deadweight loss from a tax on heating oil is likely to be greater in the fifth year after it is imposed rather than the first year. In the first year, the elasticity of demand is fairly low, as people who own oil heaters are not likely to get rid of them right away. But over time, they may switch to other energy sources, and people buying new heaters for their homes will more likely choose gas or electric, so the tax will have a greater impact on quantity.
- The tax revenue is likely to be higher in the first year after it is imposed than in the fifth year. In the first year, demand is more inelastic, so the quantity does not decline as much and tax revenue is relatively high. As time passes and more people substitute away from oil, the equilibrium quantity declines, as does tax revenue.

6. What is the maximum willingness to pay (WTP)?

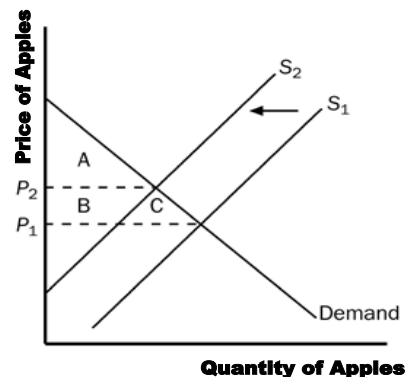
Answer:

The maximum willingness to pay shows the maximum price a consumer is willing to pay for one unit of a good, so WTP is equal to the value this consumer receives from consuming one unit of the good. The demand curve shows the WTP of all consumers in the market.

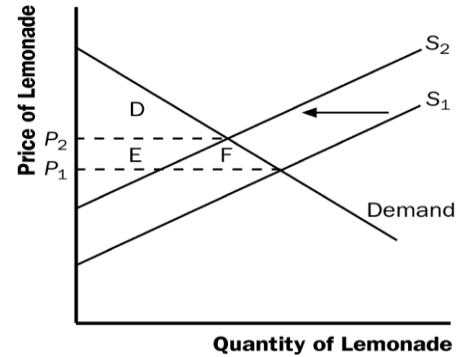
7. (Mankiw ch7 p1) A drought in Nova Scotia reduces the apple harvest. What happens to consumer surplus in the market for apples? What happens to consumer surplus in the market for apple juice? Illustrate your answers with diagrams.

Answer:

If a drought in Nova Scotia reduces the apple harvest, the supply curve for apples shifts to the left, as shown in the graph. The result is a rise in the price of apples and a decline in consumer surplus from $A + B + C$ to just A . So consumer surplus declines by the amount $B + C$.



In the market for apple juice, the higher cost of apples reduces the supply of apple juice, as shown in Figure 6. The result is a rise in the price of apple juice and a decline in consumer surplus from $D + E + F$ to just D , a loss of $E + F$. Note that an event that affects consumer surplus in one market often has effects on consumer surplus in related markets.



8. What kind of return to scale does a natural monopolist have? Why?

Answer:

IRS (increasing return to scale). A natural monopolist has decreasing average cost (AC) when the quantity is between 0 and the current market quantity. So if there are more than one firms in the market, they would be better off if they merge into one new firm that fulfils all the market demand because the AC of the new firm will be lower. That's why a natural monopoly arises. Mathematically a decreasing AC (in quantity) is equivalent to an increasing return to scale. So a natural monopolist has IRS.

9. What is the first, second, and third degree price discrimination? Give an example for each case. Is the resource allocation efficient in each case?

Answer:

First degree price discrimination: The monopolist sets the price to each consumer equal to his maximum willingness to pay. The resource allocation is efficient here. To use this pricing policy the monopolist must know the WTP of all its customers, so in reality it is true usually when the monopolist has only a few customers. For example a top designer may charge different prices to his a few customers and set the prices equal to their WTPs.

Second degree price discrimination: The firm gives a discount if a customer buys more. Not efficient usually. For example, a firm gives a wholesaler of its product a volume discount.

Third degree price discrimination: The monopolist charges different prices to different groups. Usually not efficient. For example the local hair designer (a local monopolist) charges different price for men haircut from women haircut.

10. Most monopolies are created by the government through patents, copyrights, etc. If the monopoly is a "market failure", why do we still have so many patents?

Because the high monopoly profit provides firms with the necessary incentive to innovate, which is the key reason why our economy grows. Also the monopoly profit make it possible for firms to invest in R&D, so that they have the capability of innovating.

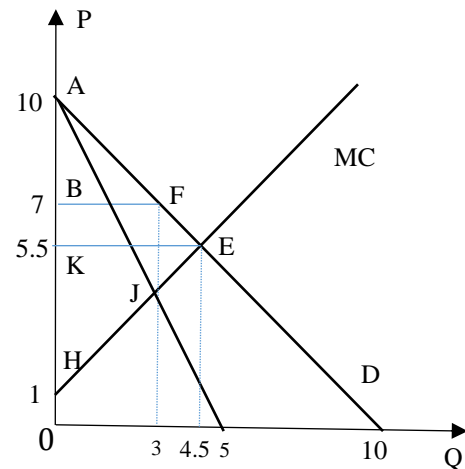
11. The demand function is $P = 10 - Q$, and a monopolist has $MC = Q + 1$.

- What is the quantity the monopolist chooses to produce? What is the price? Is the price elasticity positive? Larger than 1?
- At the above price, what is the consumer surplus, producer surplus, and the total surplus?
- What is the mark-up?

- d. At which quantity and price is the market efficient (in terms of resource allocation)? Why? What is the CS, PS, SS, and DWL here?
- e. What is the DWL of the monopoly market?
- f. If the monopolist has a fixed cost $FC = 10$. What is the monopolist's profit?
- g. If the monopolist decides to use two-part tariffs pricing, how would it set the prices? What is the CS, PS, SS, and DWL? Is the outcome efficient (in terms of resource allocation)?

Answer:

- a. $MR = 10 - 2Q$. At the optimal, we have $MR = MC \Leftrightarrow 10 - 2Q = Q + 1 \Rightarrow Q = 3, P = 7$.
Yes, at the optimal quantity the price elasticity is larger than 1. (elastic)
- b. $CS = \text{area ABF} = \frac{1}{2} (10-7) \cdot 3 = 4.5$
The value of J is equal to MC at $q=3$, so $J = 3+1=4$.
 $PS = \text{area BHJF} = (7-4) \cdot 3 + \frac{1}{2} (4-1) \cdot 3 = 13.5$
 $SS = CS + PS = 4.5 + 13.5 = 18$
- c. $\text{Mark-up} = \frac{P-MC}{MC} = \frac{7-4}{4} = 75\%$
- d. The efficient quantity is determined by the intersection point of the MC curve and the demand curve, or $P = MC \Leftrightarrow 10 - Q = Q + 1 \Rightarrow Q = 4.5$. At this quantity the price $P = 10 - 4.5 = 5.5$.



- At this quantity the resource allocation is efficient because at this quantity the total surplus is maximized. For any quantity larger than 4.5, we can show that the total surplus is smaller than the area AHE, the total surplus when the quantity is equal to 4.5. See the answer to p1 part c for the details of the proof. Similarly we can prove that for any quantity smaller than 4.5, the total surplus is smaller than the area AHE.
- $CS = \text{area AKE} = \frac{1}{2} (10 - 5.5) \cdot 4.5 = 10.125$.
 $PS = \text{area KHE} = \frac{1}{2} (5.5 - 1) \cdot 4.5 = 10.125$.
 $SS = CS + PS = 2 \cdot 10.125 = 20.25$. $DWL = 0$.
- e. The dead weight loss in the monopoly market $DWL = (SS \text{ from d.}) - (SS \text{ from b.}) = 20.25 - 18 = 2.25$.
 - f. The profit of the monopolist $= PS - FC = 13.5 - 10 = 3.5$
 - g. The two-part tariff includes a fixed fee F and a unit price P . To maximize its profit, the firm should set the output equal to the efficient output, then set $F = CS$ at the efficient quantity to grab all consumer surplus, and $P = MC$ at the efficient quantity. So $F = 10.125$ (from d. above). $P = MC$ at $Q=4.5 = 5.5$. Under the two-part tariff, $CS = 0$, and $PS = SS = \text{area AHE} = 20.25$. Please note that in its PS the area AKE is from the fixed fee, and the area KHE is from the per unit tax P .
 $DWL=0$, and the outcome is efficient.

12. A monopolist has $MC = 2$, and the demand function is $Q = 20 - 2P$.
- What is the price elasticity at any quantity Q ?
 - If the monopolist uses the linear pricing, how would it set the price and quantity? What is its profit? What is the CS, PS, and DWL? Is the outcome efficient? What is the mark-up? Is the price elasticity at the optimal quantity positive? Larger than 1?
 - If the monopolist uses the two-part tariffs, how would it set the prices? What is the quantity sold and the profit? What is the CS, PS, and DWL? Is the outcome efficient?
 - If the monopolist uses the first degree price discrimination, how would it set the prices? What is quantity sold and the profit? What is the CS, PS, and DWL? Is the outcome efficient?

Answer:

We can rewrite the demand function: $P = 10 - \frac{1}{2}Q$.

- The price elasticity $\epsilon_p = \left| \frac{1}{\text{slope}} \right| \left(\frac{p}{Q} \right) = \frac{1}{\frac{1}{2}} \left(\frac{p}{Q} \right) = \frac{2p}{Q} = \frac{2(10 - \frac{1}{2}Q)}{Q} = \frac{20 - Q}{Q}$.
- $MR = 10 - Q$. At the optimal $MR = MC \Leftrightarrow 10 - Q = 2 \Rightarrow Q = 8$. $P = 6$.

$$CS = \text{area BJK} = \frac{1}{2} (10-6) \cdot 8 = 16.$$

$$PS = \text{area KHFJ} = (6-2) \cdot 8 = 32.$$

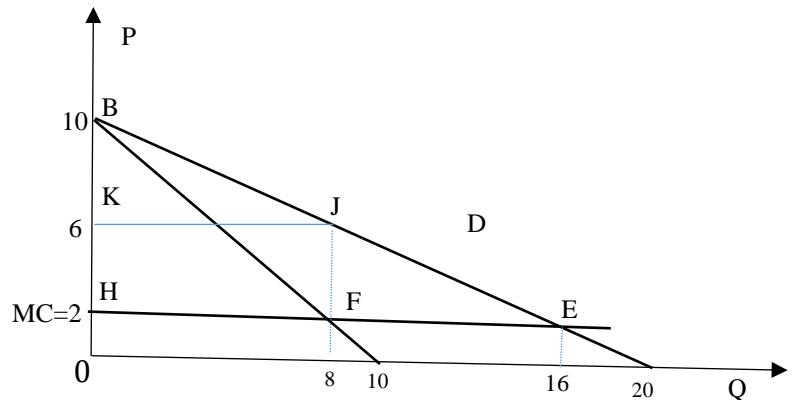
$$DWL = \text{area JFE} = \frac{1}{2} (6-2) \cdot (16-8) = 16 > 0. \text{ So the outcome is not efficient.}$$

$$\text{Profit} = PS = 32.$$

$$\text{Markup} = \frac{P-MC}{MC} = \frac{6-2}{2} = 200\%.$$

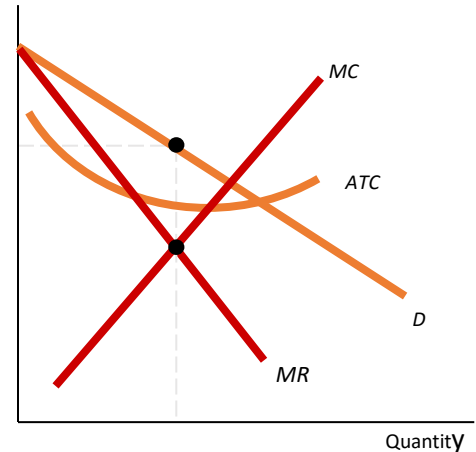
The price elasticity at $Q=8$ is larger than 1. From a. $\epsilon_p = \frac{20-8}{8} = \frac{12}{8} > 1$.

- Assume the fixed fee is F and the per-unit price is P . To maximize its profit, the monopolist should set the output $Q = 16$, the quantity at the intersection point of MC and D curve. In order to get this output it should set the per-unit price $P = (MC \text{ at } 16) = 2$. It should set $F = (CS \text{ when the output is } 16) = \text{area BHE} = \frac{1}{2} (10-2) \cdot 16 = 64$.
 $PS = SS = F = 64$. Profit = $PS = 64$. $CS = 0$. $DWL = 0$. The outcome is efficient.
- If it uses the first degree price discrimination, the monopolist should set the price to each consumer equal to his WTP, which is described by the demand curve D . Then $CS = 0$, $PS = \text{area BHE} = 64$. $DWL = 0$. The outcome is efficient.



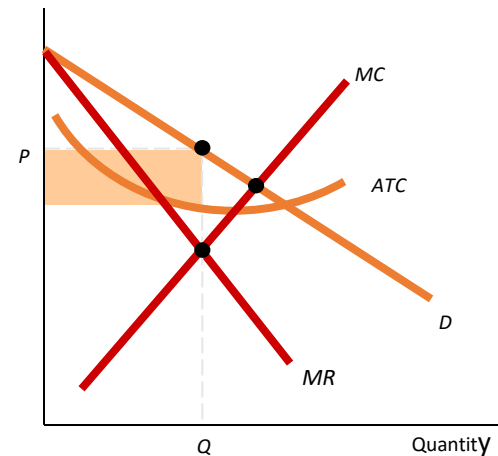
13. In the graph,

- Please label the quantity Q , price P , the CS, PS, and the profit of the monopolist.
- Is the PS equal to the profit? Why?
- Also show the DWL, the price and the quantity that maximize the social welfare in the graph.
- If the monopolist uses the two-part tariffs, show the fixed fee, and the price it charges in the graph.



Answer:

- Please see the graph on the right.
The optimal quantity Q is determined by the intersection point of MC and MR curves. The optimal price P is determined by the point on the D curve at Q . The profit is shown by the shaded rectangle.
- From the graph, $PS > \text{profit}$. It is true because the fixed cost $FC > 0$, and $PS = \text{profit} + FC$.
- DWL is equal to the area of the triangle with three black points as its three vertices. The price and quantity that maximize the SS is determined by the intersection point of MC and D curves. (Labels in the graph skipped here.)
- $F = \text{area of the triangle that is below } D, \text{ above efficient price, with } Q \text{ from } 0 \text{ to efficient quantity.}$
 $P = \text{efficient price.}$
(Labels skipped.)



14. What is the supply curve of a monopoly market? Why?

Answer:

There is no supply curve in a monopoly market. The monopolist has the power of picking the price that maximizes its profit. So only the optimal price is possible, and then the optimal quantity is determined by the demand curve.

15. If Boeing and Airbus plan to merge, they need to get the permission of the U.S. federal government by law. Do you support this law? Explain with the theory you have learned.

Answer:

Yes. First if the two firms merge, we will have a monopolist, and the resource allocation is farther away from being efficient and the DWL is increased. Second, the current market has only these two big players and their profits are high enough to support their R&D. Third, if they merge, the consumers will be worse off. (You may think of other reasons.)

(If your answer is no, you need to give your arguments based on the theories you learned.)

16. If the government wanted to encourage a monopoly to produce the socially efficient quantity, should it use a per-unit tax or a per unit subsidy? Explain how this tax or subsidy would achieve the socially efficient level of output. Among the various interested parties— the monopoly firm, the monopoly's consumers, and other taxpayers—who would support the policy and who would oppose it?

Answer:

As we discussed in the class, a per-unit tax will further reduce the output and increases the inefficiency. A per-unit subsidy, however, will increase the output and increase the efficiency. If the subsidy is high enough, it can be set such that the optimal output of the monopolist is equal to the efficient output. If a per-unit subsidy is given, the monopoly firm of course is better off. The consumers are also better off because the price is lower. Other taxpayers would oppose it because they need to pay more tax.

17. (Mankiw, ch15, p11) The residents of the town Ectenia all love economics, and the mayor proposes building an economics museum. The museum has a fixed cost of \$2,400,000 and no variable costs. There are 100,000 town residents, and each has the same demand for museum visits: $Q^D = 10 - P$, where P is the price of admission.
- Graph the museum's average-total-cost curve and its marginal-cost curve. What kind of market would describe the museum?
 - The mayor proposes financing the museum with a lump-sum tax of \$24 and then opening the museum free to the public. How many times would each person visit? Calculate the benefit each person would get from the museum, measured as consumer surplus minus the new tax.
 - The mayor's anti-tax opponent says the museum should finance itself by charging an admission fee. What is the lowest price the museum can charge without incurring losses? (Hint: Find the number of visits and museum profits for prices of \$2, \$3, \$4, and \$5.)
 - For the break-even price you found in part (c), calculate each resident's consumer surplus. Compared with the mayor's plan, who is better off with this admission fee, and who is worse off? Explain.
 - What real-world considerations absent in the above problem might argue in favor of an admission fee?

Answer:

- The following Figure 9 shows the average-total-cost and marginal-cost curves. Since the marginal cost is zero for all visitors, the MC curve is horizontal, coinciding with the horizontal axis. This ATC cost curve is specific to a natural monopoly.

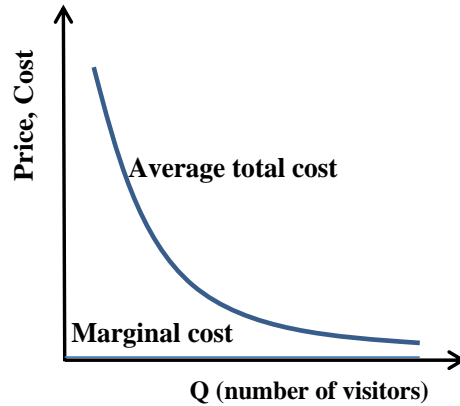


Figure 9

- b. If $P = 0$, each person visits the museum 10 times. Each person gets consumer's surplus equal to $10 \times 10/2 = \$50$ and has to pay \$24, so that the net benefit is $\$50 - \$24 = \$26$.
- c. Profit = Total Revenue – Total Cost. The following table shows revenues and profits for a few prices. It shows that the lowest price for which profit is zero is \$4.

P	$Q=10-P$	$TR=P \times Q \times 0.1$ (millions)	$TC=2.4$ (millions)	Profit= $TR-TC$ (millions)
\$2	8	\$1.6	\$2.4	-\$0.8
\$3	7	\$2.1	\$2.4	-\$0.3
\$4	6	\$2.4	\$2.4	\$0.0
\$5	5	\$2.5	\$2.4	\$0.1

- d. A resident's consumer's surplus when the price is \$4 is equal to $(10 - 4) \times (10 - 4)/2 = \18 . Consumers are worse off because their consumer's surplus is less than in the case of a flat tax. Nobody is better off; therefore, the "fee-per-visit" alternative is inferior to the flat-tax one.
- e. If some people have lower demand for visits to the museum, or if the marginal costs are not zero (the museum needs cleaning, security, and management), then the analysis may yield significantly different results.
18. (Mankiw, ch15, review question 7) Describe the two problems that arise when regulators tell a natural monopoly that it must set a price equal to marginal cost.

Answer:

When regulators tell a natural monopoly that it must set price equal to marginal cost, two problems arise. The first is that, because a natural monopoly has a constant marginal cost that is less than average cost, setting price equal to marginal cost means that the price is less than

average cost, so the firm will lose money. The firm would then exit the industry unless the government subsidized it. However, getting revenue for such a subsidy would cause the government to raise other taxes, increasing the deadweight loss. The second problem of using costs to set price is that it gives the monopoly no incentive to reduce costs.

19. Give two examples of monopolies of different types. For each of them tell the type of the monopoly and explain why the monopoly arises, and how to treat it.

Answer:

Skipped. Please check the textbook. Please note that doing nothing is a treatment too.