PAI 897 **Professor David Popp**
Solutions to Problem Set #5 **Fall 2024**

1. a) The marginal benefit of placing an ad in a newspaper is the additional revenue raised by that ad, which is equal to 75 cents per reader:

$$MB = 0.75R$$

b) There are two costs to placing an ad in a newspaper. One is the $5,000 necessary to place the ad. The second is the charge per reader, which equals 50 cents. If we consider the combined costs to be the marginal cost of placing an ad in a paper (that is, the combined costs are the costs necessary to place one more ad), we can express this as:

$$MC = 5{,}000 + 0.5R$$

c) It is worth placing a newspaper ad as long as the marginal benefit of placing the ad (the additional revenue we will receive, as expressed in part (a)) is at least equal to the marginal cost of placing the ad (as expressed in part (b)). Note that this is similar to our intuition about profit maximization, except that here we are focusing on the additional revenue raised and the costs of raising this revenue. We can find the minimum number of readers by finding where MB = MC.

$$MB = 0.75R = 5{,}000 + 0.5R = MC$$
$$0.25R = 5{,}000$$
$$R = 20{,}000$$

It is worth placing an ad in a paper if there are at least 20,000 readers in the city.

d) In part (c), we found that the organization should place ads in all cities with at least 20,000 readers. Thus, we should place ads in Albany, Binghamton, and Syracuse.

To check our answer, we can use the expressions from parts (a) and (b) to calculate the marginal benefits and marginal costs of placing an ad in each city.

City	Number of readers	MB	MC
Albany	35,000	$26,250	$22,500
Binghamton	21,000	$15,750	$15,500
Syracuse	25,000	$18,750	$17,500
Ithaca	15,000	$11,250	$12,500

Ads will be profitable in each city where the marginal benefit of placing the ad exceeds the marginal cost of placing an ad.

2. a) The fixed costs are the costs that do not change as the number of attendees changes. This includes the speaker fees, the fee for the exhibit hall, and the $2,000 cost of preparation and marketing. The total fixed costs are $10,000 (= $2,500 + $1,000 + $2,500 + $2,000 + $2,000). If 1,000 people attend, the average fixed costs are **$10**.

b) Variable costs are the costs that do change as the number of attendees changes. These are all the costs labeled "per person." Total variable costs per person are **$55**. This is the average variable cost. Note that since these are per person costs, you do not need to divide by the number of attendees. The average variable cost is the same no matter how many attend. Because it is the same, it is also the marginal cost of an attendee.

c) To break even, the price must equal the average total cost. This is equal to the average fixed cost plus the average variable cost. Thus, to break even, charge a price of **$65**.

d) The average fixed cost is now fixed costs divided by 1,250. The fixed costs do not change if some people skip the reception. Thus, average fixed costs = $10,000/1,250 = **$8**.

e) The evening reception costs $25. Thus, average variable costs for those not attending the reception are **$30** (= $55 - $25).

f) Once again, you want price to equal average total cost. However, this varies by participant. In essence, each person should pay for their share of the fixed cost (e.g. average fixed costs) plus the marginal cost of their attendance. Those who attend the reception are charged **$63** (= $8 + $55). Those who don't attend are **$38** (= $8 + 30). Note that the difference is $25, which is the cost of the evening reception. However, even those attending the reception now get a lower price, since the fixed costs are spread across more people.

3. a) Fixed costs are $30. We know this because the firm must pay these costs even if it produces no output.

b) From the description of the broomstick market, we conclude that Wanda's Witchcraft Accessories operates in a perfectly competitive market. Thus, Wanda is a price taker. Since her actions will have no influence on the price, she decides to produce as long as the price is greater than or equal to the marginal cost. Thus, if the price falls in between two marginal costs, choose the lower quantity, since the higher one will cost more money than it will make. In each case, her profits are total revenue - total cost, where total revenue equals price x quantity.

i) Since this is a perfectly competitive firm, the equilibrium quantity is found in each example by finding where MC = P. In this case, Q = 5. Profits = TR – TC = (5)(40) – 140 = $60.

ii) With a price of $25, Wanda produces 4 broomsticks. Profits are (4)(25) – 100 = $0.

iii) With a price of $15, Wanda produces 2 broomsticks. Profits are (2)(15) – 55 = -$25. Note that there are losses here. However, since Wanda's losses are less than her fixed costs, she should stay in business. Notice that the price is greater than the average variable cost at this point. Intuitively, Wanda stays in business because she is making enough money to cover her variable costs and at least some of her fixed costs.

iv) At a price of $10, Wanda is indifferent between operating or shutting down, as she will just cover her variable costs. We know this because the price equals the lowest AVC for any quantity. If she does operate, it would be at a quantity of 1 broomstick. At this point, her profits would be (1)(10) – 40 = -$30. Thus, she will be out $30 whether she decides to shut down or to operate.

c) In the long run equilibrium, all firms are making zero profits, and are thus at the minimum of their average total cost curves. In this case, this occurs at a quantity of 4 broomsticks, at a price of $25. [Note that although the average total cost is also at 25 at a quantity of 3 broomsticks, this occurs because we are working with whole numbers only. Since MC < P at a quantity of 3, Wanda can produce the fourth broomstick without losing money.]

4. a) First, Luigi needs tires. Each set costs $50. Since he sells 100 sets, these cost $5,000 (= 50x100). In addition, his assistant costs $3,000/month, and his equipment costs $1,000/month. Finally, we need to consider the opportunity cost of his time. If he didn't run the tire shop, Luigi could work at the local junkyard for $500/month. We need to include this opportunity cost in our calculation. Thus, his total costs are:

tires	$5,000
assistant	$3,000
equipment	$1,000
opportunity costs	$500
TOTAL	**$9,500**

b) Each set of tires sells for $100. Since Luigi sells 100 sets of tires per month, he earns **$10,000** (= 100 x 100).

c) The rent should be set so that people such as Luigi are indifferent between working at the factory or running a shop. Since we have already accounted for the opportunity cost of Luigi's time in part (a), this means that the rent should be such that Luigi earns zero economic profits. If it were any lower, more people would want to rent space, driving up the costs.

Given revenues of $10,000 and other economic costs of $9,500, zero economic profits occur when the rent is **$500/month**.

d) After the ramp is built, Luigi sells 150 sets of tires per month at $120 per set. This yields **$18,000** of revenue per month (= 150 x $120).

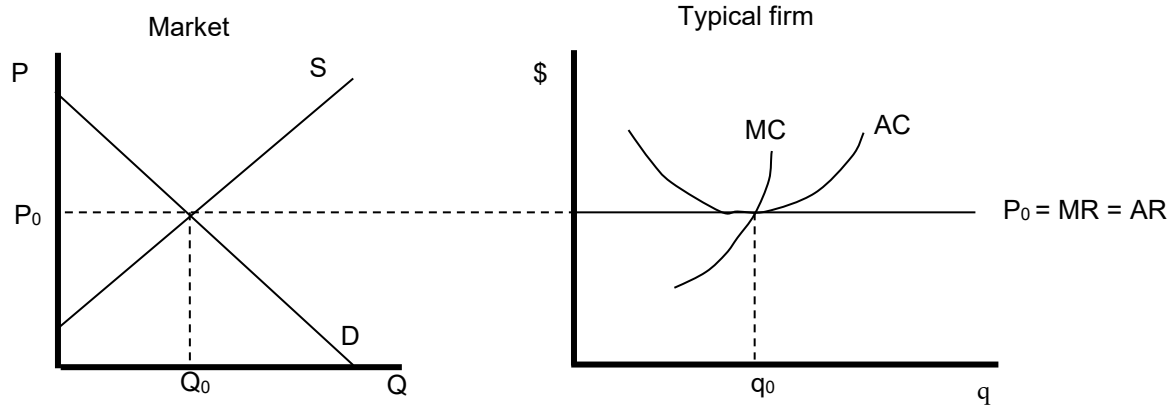
e) Except for opportunity cost, his costs are higher. He now needs 150 sets of tires, which cost $7,500. His labor equipment costs are also higher. Thus, his new total costs are:

tires	$7,500
assistant	$6,000
equipment	$2,000
opportunity costs	$500
TOTAL	**$16,000**

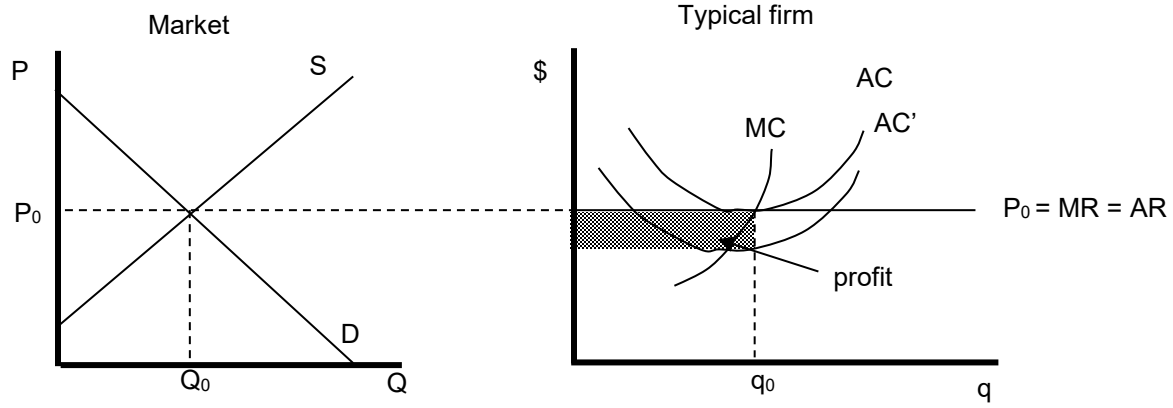
f) As before, the rent needs to be enough so that Luigi earns zero economic profits, so that he is indifferent between running the shop or working at the junkyard. With revenues of $18,000 and other economic costs of $16,000, this means rent should be **$2,000/month**.

Note that, in the long run, it is the landowners, not Luigi, who benefit from the additional traffic that comes to Radiator Springs. The additional traffic increases demand for shops. Since the zoning restrictions leave no additional land to build on, the supply of available land for stores is fixed. Thus, the price of land goes up until the additional profits that could be made go back to zero. The highway ramp raises the value of the land, but not Luigi's economic profits.

5. a) In long-run equilibrium, firms are making zero economic profits. The price must be equal to the marginal cost at the point where MC intersects the AC curve.

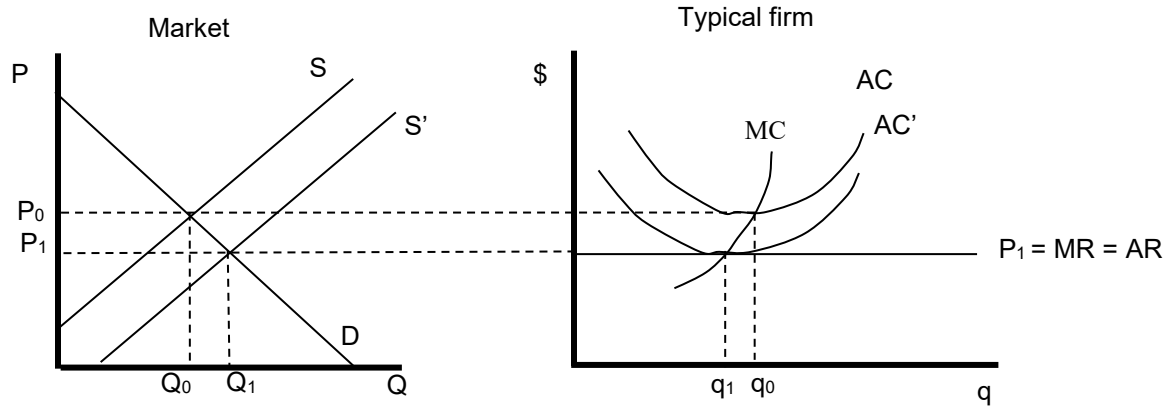


b) The subsidy reduces the cost of land. Since this is a fixed cost, it shifts the AC curve, but not the MC curve. Since marginal costs do not change, there is no change in the supply curve in the short run, nor is there a change in the output produced by each farm. The equilibrium price and quantity remains unchanged. Since the price is the same, but costs are lower, the individual firms now earn a profit.



A common mistake here is to shift the supply curve, either instead of or in combination with the average cost curve. Remember that the supply curve is derived from marginal costs. Because marginal costs haven't changed, the supply curve doesn't shift here. It will in part c, when more firms enter in response to higher profits. Moreover, shifting supply out *without also shifting average costs* results in a lower price, so that firms lose money, rather than make a profit.

c) This will not be a long-run equilibrium. Since profits are being made, more firms will enter the industry. As supply shifts out, the equilibrium price will fall and the equilibrium quantity will increase. This will occur until the price is low enough that each firm again earns zero economic profits using the new AC curve.



d) Because the Chinese firms have such a large share of the international market, the lower price will affect the price of solar panels throughout the world. Similarly, because the U.S. producers are small relative to the rest of the world, they will be price takers. As a result, in response to China's exports, U.S. solar panel producers will also have to lower their prices. If they are unable to also lower their costs, they will be driven out of business.

Indeed, this example is based on a recent trade dispute between the U.S. and China. U.S. firms have been harmed by the lower price of solar panels. The U.S. claims that the Chinese subsidies violate trade law because they promote exports. China claims the subsidies are an environmental policy, which is allowed under international trade agreements.

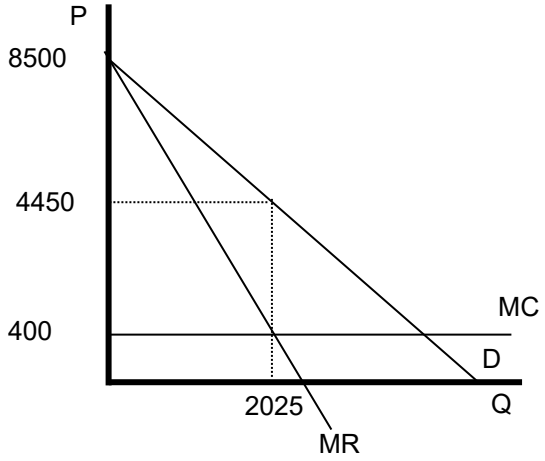
6. a) Profits are maximized where MR=MC. If the state acts as a monopolist, the marginal revenue curve will bisect the demand curve. Thus, MR = 8,500 - 4Q.

$$MR = 8{,}500 - 4Q = 400 = MC$$
$$8{,}100 = 4Q$$
$$Q = 8{,}100/4 = \mathbf{2{,}025}$$

To get the price, we need to look at the demand curve, to see how much citizens are willing to pay for 2,025 rides on the Hyperloop. We get:

$$P = 8{,}500 - 2(2{,}025)$$
$$\mathbf{P = \$4{,}450}$$

The graph for this market is shown below. Note that the equilibrium quantity is found where MC=MR, and the price is found from the demand curve. The price charged is how much consumers are willing to pay for 2,025 riders.



b) To calculate the profit, note that we need to consider the fixed cost. Thus, profit is not just the producer surplus from the graph. Rather, we must calculate profit as total revenue minus total cost. Total costs include the per unit costs (= 2,025 rides at $400 per ride) plus the fixed costs:

$$\text{profit} = TR - TC$$
$$\text{profit} = PxQ - TC$$
$$\text{profit} = (4{,}450)(2{,}025) - 400(2{,}025) - 1{,}500{,}000$$
$$\text{profit} = \mathbf{\$6.701{,}250}$$

c) To completely eliminate this deadweight loss, the state should set the price equal to marginal cost. We find the new quantity by equating marginal cost and demand:

$$8{,}500 - 2Q = 400$$
$$8{,}100 = 2Q$$
$$\mathbf{Q = 4{,}050}$$
$$\mathbf{P = 400}$$

Unfortunately, at this price, the state will lose money, because of the fixed costs:

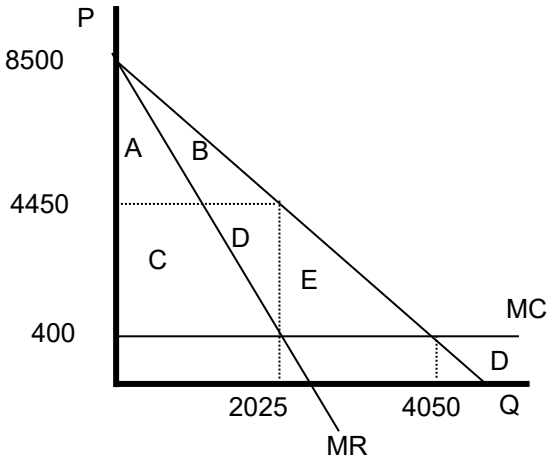
$$\text{profit} = TR - TC$$
$$\text{profit} = PxQ - TC$$
$$\text{profit} = (400)(4{,}050) - 400(4{,}050) - 1{,}500{,}000$$
$$\text{profit} = \mathbf{-\$1{,}500{,}000}$$

d) Consumer surplus is the area above the price and below demand. With monopoly pricing, it is equal to areas A and B. This area is a triangle with base of 2,025, and a height of 4,050 (= 8,500 – 4,450). Thus, consumer surplus = 0.5(2,025)(4,050) = **$4,100,625**.

The producer surplus under a monopoly is areas C and D. This is a rectangle with a length of 2025 and a width of 4050 (= 4450-400). It's area = (150)(450) = **$8,201,250**. Note that this is equivalent to the profits made relative to variable cots (e.g. ignoring the fixed costs).

There is no producer surplus in the case of marginal cost pricing. The consumer surplus with marginal cost pricing includes areas A, B, C, D, and E. This triangle has a base of 4,050 and a height of 8,100 (= 8,500-400). Its area = 0.5(4,050)(8,100) = **$16,402,500**.

The sum of consumer and producer surplus with monopoly pricing is $12,301,875. The difference between the consumer surplus with marginal cost pricing and this sum is **$4,100,625.** This represents the deadweight loss, which is area E on the graph. This area is a triangle with base of 2,025 (= 4,050 – 2,025) and a height of 4,050 (= 4,450 – 400). Thus, the deadweight loss = 0.5(2,025)(4,050) = **$4,100,625**.



e) The problem with marginal cost pricing is that it does not cover the fixed costs of the Hyperloop. One solution would be average cost pricing, where the price equals the average cost of each ride provided. This way, the price covers both the marginal cost of $400 per ride and each person's share of the fixed costs, allowing the state to break even. While there is some deadweight loss associated with average cost pricing, the deadweight loss will be less than with monopoly pricing.

Another possibility is to consider price discrimination. For example, low income users could be charged the marginal cost of the Hyperloop, and higher income users could be charged a higher price. This second price simply needs to be high enough so that it covers the fixed costs as well as the marginal costs of the Hyperloop. Another price discrimination idea suggested by several students is to vary the price by time of day. Users could be charged more to ride the Hyperloop during peak demand periods. Not only does this pricing scheme bring in more money when demand is high, it also discourages riders from using the Hyperloop when it is overcrowded due to heavy demand.

Finally, tiered pricing is another option. Each ride could be priced at marginal cost, but users could also be charged an annual membership fee for access to the Hyperloop. The membership fee could be set based on the number of riders to cover the fixed costs of the Hyperloop.