Midterm 2 - Solutions

You have until 3:20pm to complete the exam, be certain to use your time wisely. Answer all questions directly on the exam. You must show all of your work to receive full credit. Non-graphing calculators may be used. You may leave answers as fractions. Unless a problem says otherwise, you can assume that firms can produce fractions of units and charge non-integer prices (so a firm could produce 82.4 units and sell at a price of $5.325 per unit). Remember to put your name on the exam. Good luck!

Name: **ID Number:**

1. (20 points) There are two firms that are competing to provide cable access for Williamsburg. Firm A plans to install inexpensive infrastructure that has low initial costs for installation but then high marginal costs for adding customers. Firm B plans to install more expensive infrastructure that will have higher initial installation costs but then lower marginal costs. The average cost and marginal cost functions for the two firms are given by:

$$AC_A(y) = 50 - \frac{1}{12}y \tag{1}$$

$$AC_B(y) = 40 - \frac{1}{14}y \tag{2}$$

$$MC_A(y) = 50 - \frac{1}{6}y \tag{3}$$

$$MC_B(y) = 40 - \frac{1}{7}y \tag{4}$$

The demand function for cable as a function of price (p) is given by:

$$D(p) = 200 - 2p \tag{5}$$

(a) Explain why it is more efficient to have a single cable company operate in Williamsburg than to have both cable companies operate. Be certain to make specific reference to the cost functions above to justify your answer.

> Both of the average cost functions are decreasing functions of quantity. So the more customers served by one firm, the lower the average costs are of serving those customers. These economies of scale suggest that total costs will be lowest by having all of the customers served by a single firm (rather than splitting them between the two firms and having higher average costs at each of these two firms).
>
> In this particular case, it should be firm B that provides all of the cable service. Notice that the largest possible number of customers is 200 (this is the demand when price is zero). At this quantity, firm B has lower average costs than firm

A ($25.71 versus $33.33). At a quantity of zero firm B also has lower average costs ($40 versus $50). So at every quantity between 0 and 200, firm B has lower average costs and those average costs are decreasing. This means that it will always be cheaper to have firm B produce everything rather than having firm B produce less (moving to a higher average cost) and firm A produce a positive quantity (with higher average costs than firm B).

(b) At what price would firm A just break even? At what price would firm B just break even?

To find the price at which a firm breaks even, we need to find where price is equal to average cost. To do this, we can set the average cost function equal to the inverse demand function. So the first thing we need to do is get the inverse demand function:

$$D(p) = 200 - 2p$$

$$y = 200 - 2p(y)$$

$$p(y) = 100 - \frac{1}{2}y$$

Now we can find the break even prices for each firm:

$$AC_A(y_A) = p(y_A)$$

$$50 - \frac{1}{12}y_A = 100 - \frac{1}{2}y_A$$

$$\frac{5}{12}y_A = 50$$

$$y_A = 120$$

$$p_A = p(y_A)$$

$$p_A = 100 - \frac{1}{2}120$$

$$p_A = 40$$

$$AC_B(y_B) = p(y_B)$$

$$40 - \frac{1}{14}y_B = 100 - \frac{1}{2}y_B$$

$$\frac{6}{14}y_B = 60$$

$$y_B = 140$$

$$p_B = p(y_B)$$

$$p_B = 100 - \frac{1}{2}140$$

$$p_B = 30$$

(c) Suppose that the franchise is auctioned off in the following way. The Williamsburg regulator starts at a price of $100 (the price at which demand hits zero). If both firms are willing to provide service at that price, the regulator lowers the price by $5 and sees if both firms are still willing to provide service. This process continues, with the price being lowered in $5 increments, until there is only one firm willing to provide service at the price. That firm wins the franchise and has to provide service at that last price. Which firm would win the rights to the cable franchise and what would the firm's profits be?

   We have already done most of the work to solve this problem. We know that firm A will earn positive profits at any price above $40 and that firm B will earn positive profits at any price above $30. So firm A will drop out of the bidding when the price falls below $40. The first price offered by the regulator below $40 will be $35. At this price, firm B is still willing to provide service. So firm B will win the contract and provide service at a price of $35. To figure out the firm's profits, we simply need to find the number of customers at this price and the average cost at this price:

$$y = D(35) = 200 - 2 \cdot 35$$

$$y = 130$$

$$AC_B(130) = 40 - \frac{1}{14}130$$

$$AC_B(130) = 30.71$$

$$\pi = y \cdot (p - AC(y))$$

$$\pi = 130 \cdot (35 - 30.71)$$

$$\pi = 557.70$$

2. (a) (10 points) The graph below shows market demand for laptops and the marginal cost curve for a single firm. Suppose that a firm discovers a major invention that lowers marginal costs (they are still constant with respect to quantity). The firm is able to keep its new invention private. Use the graph to show how the effect of this invention on market price will differ depending on whether the industry was initially competitive or whether the firm was initially a monopoly. You should clearly label the change in price if the industry was competive, the change in price if the industry was a monopoply, and any relavant points or curves you used to find those changes.
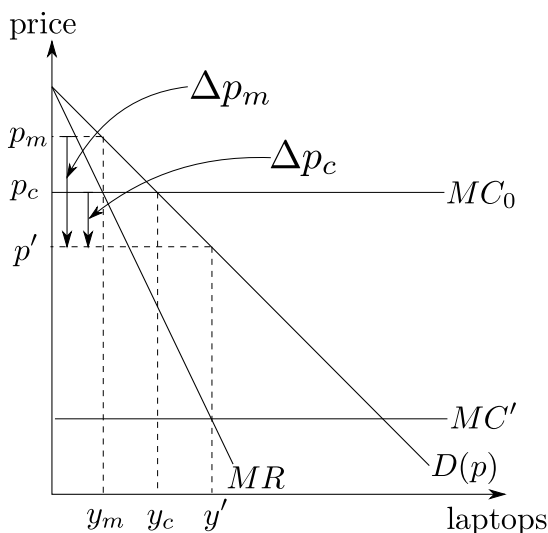
The original price if the market is competitive will be determined by where the marginal cost curve and demand curves intersect. The is the point (y_c, p_c) in the graph. If the firm is initially a monopolist, the initial quantity will be where the marginal revenue curve intersects the marginal cost curve and the price will be determined by the demand curve at this quantity. This initial monopoly outcome is the point (y_m, p_m) on the graph. The invention will shift the marginal cost curve down. Because the invention is a major invention, the marginal cost curve will shift below the point where y_c intersects the marginal revenue curve. The intersection of this new marginal cost curve and the marginal revenue curve will determine the new quantity (y') and the new price will be whatever consumers are willing to pay at that quantity (p'). The decrease in price is shown on the graph for both the monopoly and the competitive case. Notice that the drop in price is larger for the case where the firm was already a monopoly before innovation took place.

(b) (10 points) On the graph below, show the change in consumer surplus resulting from the invention. Assume that the industry was initially competitive, the invention was a major invention and the firm can keep the invention private. Clearly label any relevant points and curves.

price

$\Delta CS(+)$

p_c — — — — MC_0

p'

MC'

MR $D(p)$

y_c y' laptops
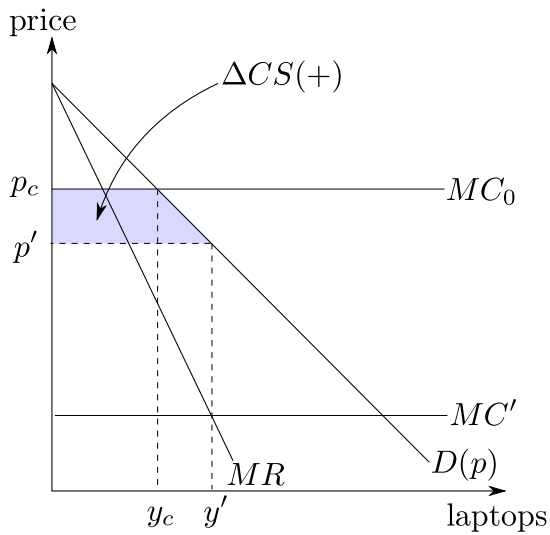
Consumers were originally at the point (y_c, p_c). After the invention occurs, consumers move to the higher quantity y' at the lower price p'. The change in consumers surplus will be the area under the demand curve between the original price and the new price, shown on the graph as the area shaded in blue. Note that this is an increase in consumer surplus.

3. (15 points) A local politician argues that prescription drug prices are too high and that we should place price caps on prescription drugs. Explain two different reasons why this proposal could lead to less efficient outcomes in the market for prescription drugs in the long run.

   The first issue is the deadweight loss that is generated by any price cap. By capping the price of prescription drugs below the market price, companies will supply a quantity that is less than the efficient quantity. There will be units that would produce a marginal benefit to consumers greater than the marginal cost of producers that do not get produced. This implies that total surplus will be smaller than total surplus at the efficient quantity.

   The second issue is more specific to the pharmaceutical industry. Placing caps on the prices of drugs lowers the expected profits from creating a new drug. If the drop in expected profits is large enough, companies may no longer consider it worth investing in research and development to create new dugs. This would lead to a loss of all of the surplus associated with those new drugs.

4. (10 points) Williamsburg currently has the efficient level of electricity generating capacity. In other words, the marginal costs of electricity on units beyond the current capacity would exceed the marginal benefits to consumers of those units. Currently, peak demand for electricity is substantially larger than off-peak demand. Over the next year, several people are going to buy electric cars that need to be charged. To handle this additional demand for electricity, the city can either expand capacity or run an ad campaign convincing electric car owners to charge their cars during off-peak hours. Which approach should Williamsburg take? Be certain to fully explain your answer. Assume that electric car owners have the same marginal benefit from charging their cars whether they do it during peak or off-peak hours.

   The main difference between the two approaches is that the marginal cost of providing the electricity during peak hours will be greater than the marginal cost of providing ethe electricity during off-peak hours because of the additional costs associated with expanding capacity. Since the marginal benefit from car charging is the same whether it is done during peak hours or off-peak hours, the net benefit to society will be greatest if the charging takes place during the off-peak hours: marginal benefit is the same in both cases but marginal cost is lower during peak hours so the difference between marginal benefit and marginal cost will be greater during off-peak hours. Therefore it makes sense to use the ad campaign rather than expand capacity. The only way it would make more sense to expand capacity is if the cost of the ad campaign were greater than the difference in total surplus between having the cars charged during peak hours versus off-peak hours.

5. (25 points) The graph below shows the total research and development costs for a firm ($C(I)$) as a function of the level of innovation (I) that takes place as a result of that research. The graph also shows the present value of the future profits the firm will receive from innovation ($PV(\pi_I)$) as a function of the level of innovation. This present value of the profits from innovation assumes a 20 year patent length and zero profits for the firm after the patent runs out. These profits do not take into account the research and development costs.

Note that the level of innovation rises linearly with research and development spending up to the level of innovation I^*. After that point, innovation still rises linearly with research and development spending but at a different rate.
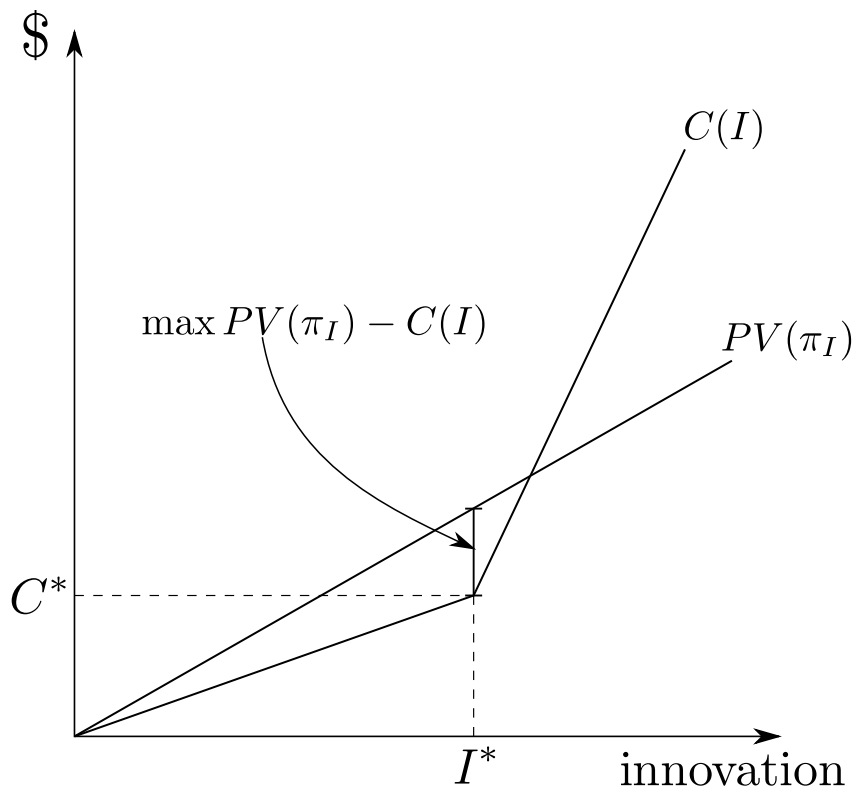
(a) Show on the graph what the firm's optimal amount of spending on research and development is and what the firm's level of innovation will be as a result of that spending.

> The firm will want to invest at the point with the greatest net profits. In other words, they will want to find the level of innovation at which the difference between the present value of profits from innovation and the research and development costs is largest. On the graph, this is where the distance between the two curves is at its largest (focusing only on the region where the present value of profits curve is above the research and development costs curve). This

occurs at the level of innovation I^*. The spending on research and development needed to achieve I^* is given by the cost curve and labeled as C^* on the graph.
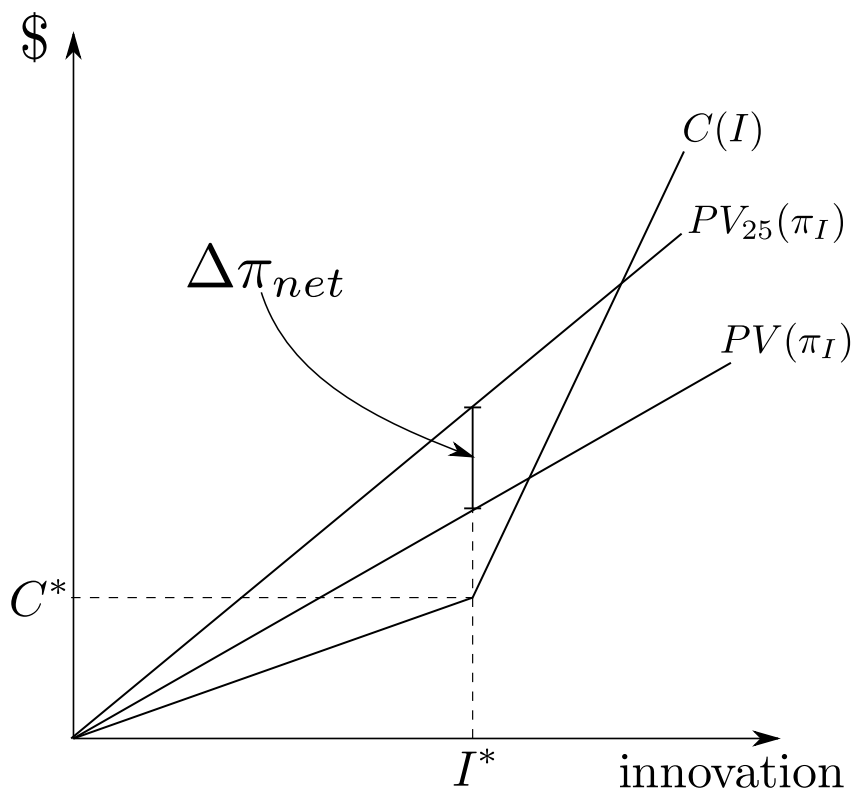
(b) Suppose that the government increases the patent length from 20 years to 25 years. Use the graph to show the effect this policy change will have on the firm's research and development spending, the level of innovation that takes place and the firm's net profits from that innovation.

The increase in patent length will rotate the present value of profits from innovation curve up (longer patent length means more years of profits at any given level of innovation). However, the gap between the present value of profits and research and development costs is still largest at I^* meaning that the firm will still spend C^* on research. The only thing that has changed is the net profits the firm will receive from innovation. The change in these net profits is labeled on the graph.

(c) Given you answers in parts (a) and (b), how would you recommend the government change patent length in order to achieve a more efficient outcome? Be certain to fully explain your reasoning and any additional assumptions you are making.

In this particular case, increasing patent length increases the profits of firms but does not generate additional innovation. So longer patent lengths would actually

reduce total surplus from more periods of deadweight loss as the firm acts as a monopoly without generating any additional surplus through greater innovation. It makes sense then to reduce patent lengths. However, you can't just reduce them to zero. The firm still needs to make some profit. The patent length needs to be just long enough for the present value of profits from innovation curve to be above the research and development cost curve at I^*.

6. (10 points) Suppose that the goal of regulators in the United States is to maximize the total surplus of American consumers and American firms. They do not care about the welfare of firms or consumers outside of the United States. Given these goals, a politician proposes that we continue to enforce patents and copyrights held by American firms but that we do not enforce patents and copyrights held by foreign firms. The politician claims that this would increase consumer surplus and would only harm foreign firms. Do you agree that this change in policy would increase total surplus in the United States? Be certain to fully explain your answer.

   The problem is that the politician is not taking into account the incentives of foreign firms to create new ideas and make them available to American markets. If foreign firms do not receive patents or copyrights, they will not be able to generate the monopoly profits that make investing in new ideas worthwhile for the firm. If the United States is a major source of these profits, failing to enforce copyrights and patents in the United States would lead to less innovation by foreign firms. This would lead to a reduction in consumer surplus for American consumers because these new innovations never get introduced.

   There are a variety of other issues you could address in your response. Among them are whether the decline in competition due to foreign innovation influences the investment decisions of domestic firms, whether foreign countries would change the way thtat they enforce patents and copyrights held by American companies, whether American firms can improve upon foreign innovations when they don't have to worry about violating patents, etc.