
Midterm 1

You have until 1:50pm 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 (no graphing calculators or phones can 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. (15 points) Two cell phone companies are planning to merge. As a result of the merger, the Herfindahl-Hirschman Index for the cell phone industry would increase substantially.

- (a) Explain why the federal government would likely try to block the merger. Be certain to specifically address the concerns the government may have related to the effects of the merger on efficiency and equity in the cell phone market.

Given that the HHI will increase substantially, the new merged firm will make the cell phone market significantly more concentrated. With the reduced competition in the cell phone market, the federal government would be worried about the merged firm charging higher prices, providing lower quantities of service, and stifling innovation in the market. All of these effects would serve to decrease the efficiency of the market: there would be customers no longer served for whom the marginal benefit of cell phone service exceeds the marginal costs of providing service. The increase in prices and decrease in quantity and quality of service would not only be inefficient, it would also represent a transfer of surplus from consumers to producers. This transfer could be viewed by the government as leading to an inequitable distribution of surplus.

- (b) Provide an argument that the cell phone companies may make to the federal government suggesting that the merger should be allowed to go through.

The cell phone companies would likely base their argument for the merger on the notion of economies of scale. The companies would claim that a single larger firm would be more efficient than two separate firms. The basis for this claim would be things like the cost savings resulting from not having redundant infrastructure or customer service centers, not duplicating research and development efforts, and so on.

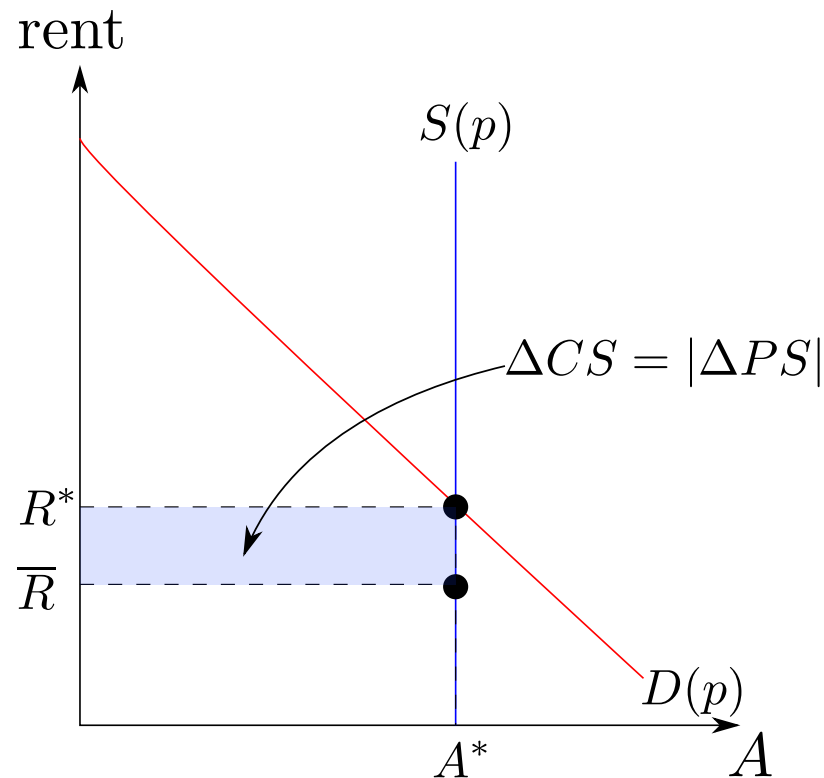
- (c) How would the definition of the relevant market affect the federal government's analysis of the merger? If the market were defined to include all telephone service rather than just cell phone service, how might the government's conclusions change?

The definition of the market directly affects the estimation of how concentrated the market will be after the merger and how much competition will remain. A narrowly defined market will make the merged firm look quite large relative

to the overall market, heightening the government's concerns over a lack of competition. However, expanding the market definition will make the merged firm look smaller relative to the overall market (the size of the merged firm isn't changing so dividing that firm size by a larger market size will make the firm look smaller). If the government were to expand the definition of the market by including things like land lines, it would make the merged firm look smaller and reduce the government's concerns about lack of competition leading to higher prices and lower quantity or quality of service, potentially leading to government to allow the merger.

2. (15 points) Suppose that the supply of apartments in Williamsburg is completely inelastic. In other words, the same quantity of apartments, A^* , will be rented out no matter what the market rent is. The demand curve for apartments is linear and downward sloping.

- (a) Graph the supply and demand curves for apartment rentals in Williamsburg. On your graph, label the equilibrium quantity of apartments and rent in the absence of any government regulation.



We are told that A^* apartments are always supplied regardless of what the market price is. The supply curve is therefore a vertical line at the quantity of A^* and the equilibrium quantity must be A^* (as this is the only quantity that will ever be supplied). Equilibrium rent, R^* on the graph, will be determined by where the demand curve intersects this vertical supply curve.

- (b) Suppose that the city council decides that the equilibrium rent is too high and imposes a rent ceiling of \bar{R} . Assuming \bar{R} is below the equilibrium rent in part (a), show the effects of this rent ceiling on the equilibrium rent and quantity of apartments on your graph.

The equilibrium quantity will still be A^* . However, the equilibrium rent is now constrained by the rent ceiling and will be equal to \bar{R} as shown on the graph. So the rent has fallen but the quantity of apartments rented out has remained the same.

- (c) Has the rental market become less efficient? Be certain to explain your answer.

The rental market was efficient before the rent ceiling and remains efficient after. The same quantity of apartments is being rented out so there is no change in total surplus, only transfers of surplus from one group to another.

This peculiar case is the result of the vertical supply curve. One way to interpret the supply curve is the following: for every apartment up to A^* , the landlords are willing to rent it out for any positive rent. For any apartment after A^* , the landlord has essentially an infinite reservation rent (no finite rent will convince a landlord to rent out an apartment past A^*). So for every apartment up to A^* , as long as there is a consumer that values the apartment more than zero, renting out that apartment will generate a net benefit to society. For every apartment after A^* , any customer's willingness to pay will be far less than the minimum a landlord would be willing to accept so renting out the apartment would generate a net loss to society. It is therefore efficient to rent out exactly A^* apartments. This occurs both with and without the rent ceiling so both cases are efficient. The only thing that has changed with the rent ceiling is that some producer surplus was transferred to consumer surplus as shown on the graph above.

3. (30 points) There are two ham stores in Williamsburg. Both stores have constant marginal costs equal to \$20 per ham and no fixed costs. The inverse demand function for hams is given by:

$$p(H) = 200 - H \quad (1)$$

where H is the number of hams consumed. Suppose that the two stores compete on price with one another. If they announce the same price, they split demand equally between them. If they announce different prices, the store offering the lower price gets all of the demand (and must provide as many hams as customers want at that price).

- (a) What will the equilibrium price of a ham be and what will individual firm profits be?

As long as a firm can undercut the other firm's price and still earn positive profits, they will do so to capture all of the demand rather than split demand in half. So the two firms will undercut each other's prices all the way down to the point where price equals marginal cost. This means that the equilibrium price will be \$20 and firm profits will be zero (the price is just covering the costs on each unit).

- (b) Suppose that firm A knows that firm B will go out of business and stay out of business if the market price is ever at or below \$15. Explain how firm A could use predatory pricing to increase the present value of the firm's stream of profits.

Firm A could initially set its price at \$15. Firm A would capture all of the market demand at that price and drive firm B out of business. In this initial period, firm A would lose \$5 on each unit sold (at a price of \$15, total demand would be 185 hams so firm A would lose \$925). However, in each future period firm A could act as a monopolist charging the monopoly price and earning monopoly profits. So the predatory pricing strategy here would be to price just low enough to drive firm B out in the first period, take one period of losses as a result, and charge the monopoly price from that point on hopefully earning enough profits to make up for the initial losses.

- (c) Now suppose that firm B would go out of business if the price drops to \$15 but will return once they see a price at which they could earn positive profits. So if the price is \$15 in period 1, the firm will drop out of the market entirely for period 2 and stay out as long as prices stay low. However, if they see the price rise to a level in period t that would earn them positive profits, they will return to the market in period $t + 1$ and remain in the market from that point on. Write down an expression giving the present value of firm A 's profits from predatory pricing. Assume that when firm B is in the market, it will charge the equilibrium price from part (a).

Now things are a little different. Firm A would still have to charge \$15 in the first period if it wanted to drive firm B out of the market. However, firm A would only have one period after that to earn positive profits as firm B will reenter the market once firm A charges anything above \$20. Once firm B reenters, price will go back to \$20 and profits will go back to zero. During the one period where firm A is a monopoly, it will set the monopoly price and sell the monopoly quantity (the price and quantity at which marginal revenue

equals marginal cost):

$$MR(H_m) = MC(H_m)$$

$$200 - 2H_m = 20$$

$$180 = 2H_m$$

$$H_m = 90$$

$$p_m = p(H_m)$$

$$p_m = 200 - 90$$

$$p_m = 110$$

Now we know all of the relevant prices and quantities to calculate the present value of predatory pricing. Recognizing that the profit in a given period is the profit per unit in that period, p_t minus 20, times the quantity in that period, H_t , the present value of profits from predatory pricing are:

$$PV_\pi = \sum_{t=0}^{\infty} \frac{(p_t - 20) \cdot H_t}{(1+r)^t}$$

$$PV_\pi = \frac{(15 - 20) \cdot 185}{(1+r)^0} + \frac{(110 - 20) \cdot 90}{(1+r)^1} + \sum_{t=2}^{\infty} \frac{(20 - 20) \cdot 90}{(1+r)^t}$$

$$PV_\pi = -925 + \frac{8100}{1+r}$$

- (d) If the interest rate is 20 percent, will firm *A* engage in predatory pricing? Be certain to show all work necessary to justify your answer.

Plugging in an interest rate of 0.20 gives us the following present value for profits from predatory pricing:

$$PV_\pi = -925 + \frac{8100}{1.2}$$

$$PV_\pi = 5825$$

So if the firm engages in predatory pricing, the present value of its stream of profits will be \$5,825. If it does not engage in predatory pricing, it will earn zero profits in every period. Clearly predatory pricing is more profitable in this case.

- (e) Given your answer to part (d), should the government make an effort to regulate predatory pricing? Would your answer change if the interest rate were higher? Would your answer change if the interest rate were lower?

From the previous part, we found that the firm will use predatory pricing. This will lead to a loss in total surplus in the second period when the firm acts as a monopolist. If the government is concerned with maximizing total surplus it would want to pass regulation to prevent this predatory pricing. You may wonder if the loss in total surplus in the second period is made up for by the lower prices in the first period when firm *A* prices below cost. Remember that

the efficient outcome was where price is equal to marginal cost. When the firm prices below cost, it is actually reducing total surplus (it is producing units that cost more to make than what they are worth to consumers). So there is a loss in total surplus in both the first and second period.

If the interest rate were lower, the answer would not change. A lower interest rate would make the present value of profits from predatory pricing even larger, making it even more likely that the firm will attempt predatory pricing. There would still be a role for government regulation. However, a higher interest rate would reduce the present value of profits from predatory pricing by reducing the present value of the positive profits in the second period. If the interest rate were sufficiently high, the present value of profits from predatory pricing could actually become zero or negative in which case the government would not need to regulate.

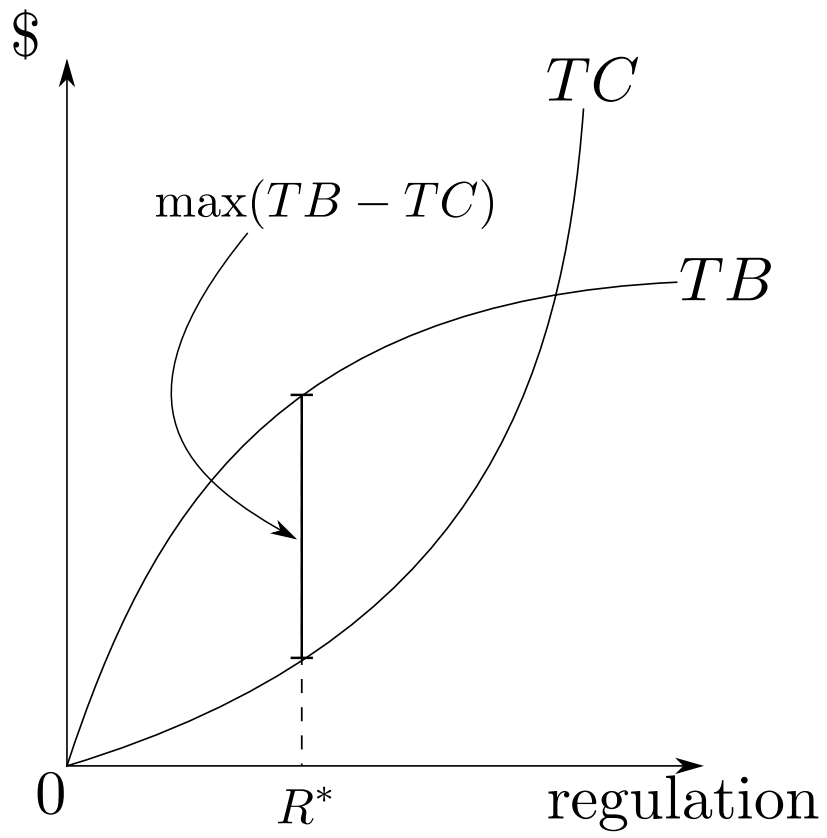
4. (10 points) Consider the graph below showing the total costs (TC) and total benefits (TB) of government regulation in a particular industry. The horizontal axis measures the amount of regulation (zero would mean no regulation is taking place) and the vertical axis is measuring costs and benefits in dollars.

- (a) On the graph, show where the optimal level of regulation would be. Explain why your chosen level of regulation is optimal.

The regulator wants to maximize the net benefit of regulation. In other words, the regulator wants to make the difference between total benefits and total costs as large as possible. The level of regulation that accomplishes that is where the distance between the two curves is at its largest. This point is labeled R^* on the graph. While going to higher levels of regulation would generate greater benefits, the additional costs would outweigh the additional benefits and the net benefit would actually go down.

- (b) Explain why the total benefit curve has a diminishing slope while the total cost curve has an increasing slope as the level of regulation gets larger.

The slopes of these curves are just the marginal benefit of regulation and the marginal cost of regulation. When choosing what regulations to enact, we will choose the cheapest and highest impact regulations first. So at low levels of regulation, the marginal benefit of additional regulation is quite high (we have many regulations to choose from so we will choose the one with the most impact) and the marginal cost of additional regulation is fairly low (we have many regulations to choose from so we will tend to choose the cheapest first). As we begin to use up the easy regulation options, we will be left to choose between options with smaller marginal benefits and higher marginal costs. So as we increase levels of regulation, moving from the low-cost, high-impact regulations to high-cost, low-impact regulations will increase marginal costs while decreasing marginal benefits giving us a concave total benefit curve and a convex total cost curve.



5. (30 points) There is a single firm (firm A) producing stereos for the local market. The inverse demand function for stereos is given by:

$$p(S) = 100 - S \quad (2)$$

where $p(S)$ is the price per stereo customers are willing to pay for S stereos. The total cost function, $C(S)$, and the marginal cost function, $MC(S)$, for the firm are:

$$C_A(S_A) = \frac{1}{4}S_A^2 \quad (3)$$

$$MC_A(S_A) = \frac{1}{2}S_A \quad (4)$$

Currently this market is not regulated and the firm acts as a monopolist.

- (a) Assuming the firm maximizes profits, what price will the firm charge, how many stereos will the firm sell and what will total surplus be?

The firm will act as a monopolist and produce at the quantity where marginal revenue equals marginal cost. First, we need to get the marginal revenue function:

$$R(S_A) = p(S_A) \cdot S_A$$

$$R(S_A) = (100 - S_A) \cdot S_A$$

$$R(S_A) = 100S_A - S_A^2$$

$$MR(S_A) = \frac{dR(S_A)}{dS_A}$$

$$MR(S_A) = 100 - 2S_A$$

Now we can set marginal revenue equal to marginal cost:

$$MC(S_A) = MR(S_A)$$

$$\frac{1}{2}S_A = 100 - 2S_A$$

$$\frac{5}{2}S_A = 100$$

$$S_A = 40$$

Plugging this back into the inverse demand function will give us the price the firm will charge:

$$p(40) = 100 - 40$$

$$p(40) = 60$$

So the monopoly price will be \$60 and the monopoly quantity will be 40 stereos. The consumer surplus will be the area below the demand curve, above the price up to the quantity purchased:

$$CS = \frac{1}{2}(100 - 60)(40 - 0)$$

$$CS = 800$$

The firm profits will be:

$$\pi = R(S_A) - C(S_A)$$

$$\pi = 60 \cdot 40 - \frac{1}{4} \cdot 40^2$$

$$\pi = 2000$$

So total surplus is \$2800, the sum of consumer and producer surplus.

- (b) Now suppose that a second firm (firm B) with identical cost functions enters the market. The two firms compete on quantity. Market price is then determined by whatever consumers are willing to pay at a quantity of $S_A + S_B$. Write down firm A 's profit maximization problem now that it is competing with firm B .

The big difference is that now the price depends not only on S_A but also on S_B . Firm A 's problem is to maximize profits by choosing a level of S_A subject to whatever firm B has chosen for S_B :

$$\max_{S_A} R(S_A, S_B) - C(S_A)$$

$$\max_{S_A} p(S_A, S_B) \cdot S_A - C(S_A)$$

$$\max_{S_A} (100 - (S_A + S_B)) \cdot S_A - \frac{1}{4} S_A^2$$

$$\max_{S_A} 100S_A - S_A^2 - S_A \cdot S_B - \frac{1}{4} S_A^2$$

$$\max_{S_A} 100S_A - S_A \cdot S_B - \frac{5}{4} S_A^2$$

- (c) Find an expression giving firm A 's profit maximizing quantity as a function of the number of stereos firm B produces.

The profit maximizing S_A can be found by taking the derivative of the above profit function with respect to S_A and setting it equal to zero:

$$\frac{d\pi_A}{dS_A} = 100 - S_B - \frac{5}{2} S_A$$

$$0 = 100 - S_B - \frac{5}{2} S_A$$

$$\frac{5}{2} S_A = 100 - S_B$$

$$S_A = 40 - \frac{2}{5} S_B$$

- (d) Solve for the new equilibrium price and quantity of stereos now that firm B has entered the market. By how much has the arrival of the second firm changed total surplus?

Since both firms are identical, they will end up producing the same amount in equilibrium ($S_A = S_B$). So we can simply substitute S_A in for S_B in the above equation for firm A 's optimal quantity to solve for an actual value:

$$S_A = 40 - \frac{2}{5}S_A$$

$$\frac{7}{5}S_A = 40$$

$$S_A = \frac{200}{7}$$

So the total quantity will be twice this amount, or $\frac{400}{7}$. Plugging this quantity into the inverse demand function will give us the price:

$$p\left(\frac{400}{7}\right) = 100 - \frac{400}{7}$$

$$p\left(\frac{400}{7}\right) = \frac{300}{7}$$

Total surplus will be the sum of consumer surplus and both firms' profits:

$$TS = CS + \pi_A + \pi_B$$

$$TS = \frac{1}{2}(100 - p(S_A + S_B))(S_A + S_B - 0) + p(S_A + S_B)S_A - C_A(S_A) + p(S_A + S_B)S_B - C_B(S_B)$$

$$TS = \frac{1}{2} \left(100 - \frac{300}{7}\right) \left(\frac{400}{7} - 0\right) + \frac{300}{7} \cdot \frac{200}{7} - \frac{1}{4} \left(\frac{200}{7}\right)^2 + \frac{300}{7} \cdot \frac{200}{7} - \frac{1}{4} \left(\frac{200}{7}\right)^2$$

$$TS \approx 3673.5$$

So the change in total surplus is:

$$\Delta TS = TS_{duo} - TS_{mon}$$

$$\Delta TS = 3673.5 - 2800$$

$$\Delta TS = 873.5$$

- (e) Going back to the case of a single firm, suppose the government is considering two different approaches to reducing the inefficiencies generated by a monopoly. The first would be to spend money on an ad campaign to get a second firm to enter the market, leading to the outcome you solved for in part (d). The second approach would be to let firm A remain a monopoly but require firm A to produce at the duopoly price and quantity from part (d). The costs of monitoring firm A under this approach would be identical to the costs of the ad campaign under the other approach. Assuming the government cares only about maximizing total surplus, which regulatory approach should it take? Be certain to justify your answer.

We already know how total surplus would change going from monopoly to duopoly, it would increase from \$2800 to \$3673.5. The one thing we haven't found is what total surplus would be if we had a single firm producing at the duopoly price and quantity. This is simply the consumer surplus and the single firm's profits at that quantity and price:

$$TS = CS + \pi_A$$

$$TS = \frac{1}{2}(100 - p_{duo})(S_{duo} - 0) + p_{duo} \cdot S_{duo} - C_A(S_{duo})$$

$$TS = \frac{1}{2} \left(100 - \frac{300}{7} \right) \left(\frac{400}{7} - 0 \right) + \frac{300}{7} \cdot \frac{400}{7} - \frac{1}{4} \left(\frac{400}{7} \right)^2$$

$$TS \approx 3265.3$$

Notice that the total surplus is lower than in the duopoly case. So if the costs of the two regulatory approaches are the same, the government would choose the ad campaign as it would lead to a higher total surplus. The reason that it leads to a higher total surplus in this case is that the firm has increasing marginal costs. For any given total quantity, it will be cheaper to have two firms split the production between them rather than have one firm produce the entire quantity.