# Midterm 1 - 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 (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. (20 points) The state legislature is considering passing legislation to help Virginia farmers by setting a price floor on crop prices. The price floor simply means that no one is allowed to buy or sell crops at a price below the price floor. It does not guarantee that farmers will be able to sell all of their output (they are still limited by customer demand).

   (a) Use a graph with quantity of crops on the horizontal axis and price on the vertical axis to demonstrate the effects this price floor will have on the price and quantity of crops sold, producer surplus, consumer surplus, and total surplus. You can assume that the demand curve is a downward sloping line, the supply curve is an upward sloping line, and the price floor is set above the unregulated equilibrium price.
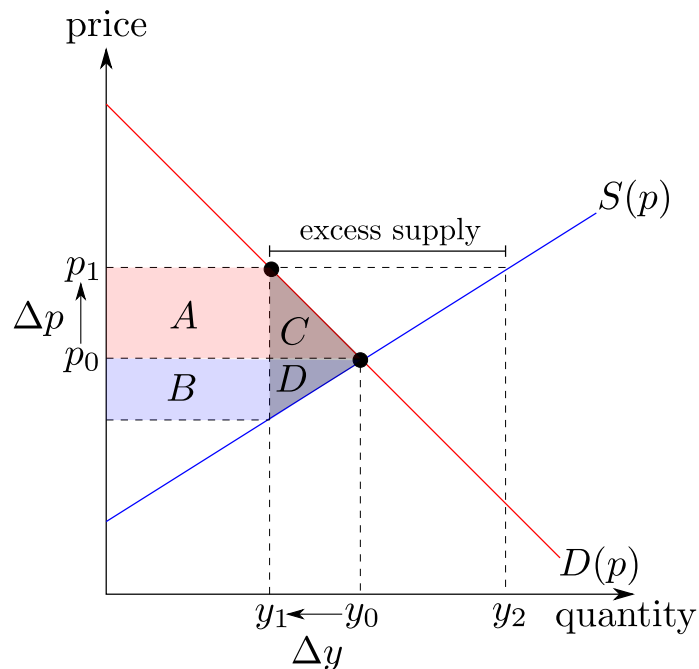
   On the graph above, the initial equilibrium price and quantity are at the intersection of the supply and demand curves. This is the point (y_0, p_0). The

price floor is set above this initial equilibrium price at p_1. At the price of p_1, producers are willing to sell a quantity of y_2 but consumers only demand the amount y_1, so y_1 units will be sold making the equilibrium after the price floor the point (y_1, p_1). The changes in producer, consumer and total surplus can be expressed in terms of the areas A, B, C and D:

$$\Delta CS = -A - C$$

$$\Delta PS = A - D$$

$$\Delta TS = -C - D$$

(b) Explain whether the price floor makes the market for crops more or less efficient.

This price floor makes the market inefficient. The price floor generates a dead-weight loss, decreasing total surplus by the amount $C + D$, which means the market is less efficient than the case of no price floor.

(c) Explain whether the price floor makes the market for crops more or less equitable.

Your answer to this question depends on how you define equitable in this par-ticular situtation. The price floor has transferred surplus from consumers to producers. This transfer of surplus is given by the area A on the graph. If you believe it is fairer for farmers to get a greater portion of the total surplus than consumers, you may believe that this outcome is more equitable. However, even if that is the case, the price floor is also redistributing surplus among farmers. A significant portion of farmers are willing to sell at the regulated price but cannot find willing customers (this excess supply is shown on the graph). These farmers are receiving no surplus. So part of the increase in surplus for farmers who do get to sell their crops is coming at the expense of these farmers who can no longer find buyers for their crops even though they could before the price floor was in place. It is harder to argue that this is an equitable outcome.

2. (20 points) The graph below shows the demand curve for DVD rentals (R) in Williamsburg and the average cost and marginal cost curves for a single rental store.
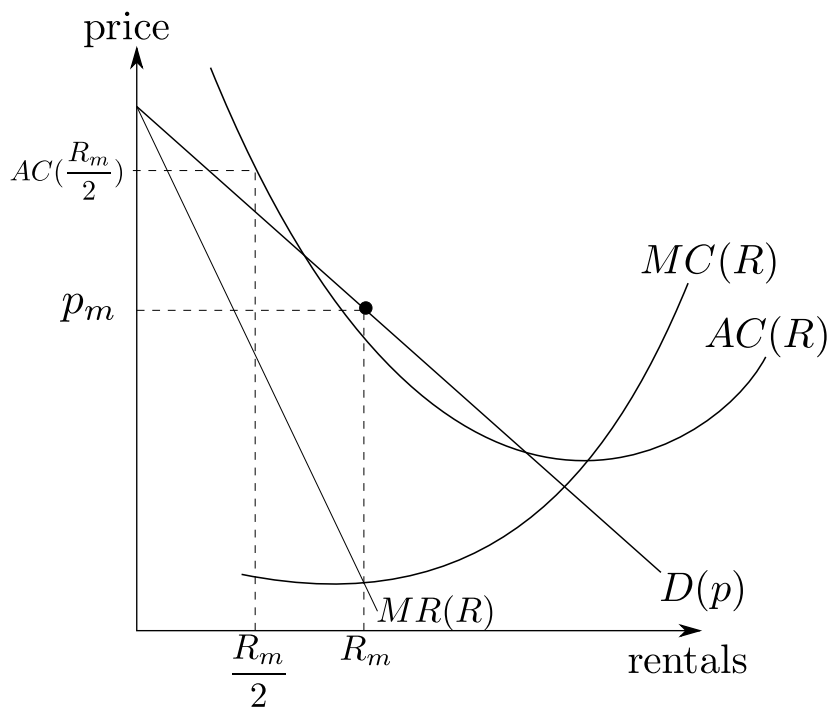

(a) On the graph above, show the equilibrium price and quantity of DVD rentals if the rental store acts as a monopolist and maximizes profits.

> The firm will produce at the quantity where marginal revenue is equal to marginal cost. The marginal revenue curve for a monopolist facing a linear demand curve will be a straight line with the same intercept as the demand curve and a slope that is twice as steep. This marginal revenue curve is shown on the graph. The monopoly quantity, R_m, will be where this marginal revenue curve intersects the marginal cost curve. The monopolist will charge p_m, the price that consumers are willing to pay at R_m based on their demand curve.

(b) Explain whether the video store will be a natural monopoly. You should include references to the graph in your explanation. Be certain to clearly label any features of the graph that you use in your explanation.

> Suppose that a second firm considers entering the industry charging the same price as the current monopolist and taking half of the customers. This means that each firm will be renting $\frac{1}{2}R_m$ videos and renting them at a price of p_m. From the graph, it is clear that the average costs at a quantity of $\frac{1}{2}R_m$ are greater than p_m so the firms will be losing money on each video they rent. The potential entrant will realize that profits will be negative if it enters the market

and will therefore decide not to enter. This means that the video store will be a natural monopoly.
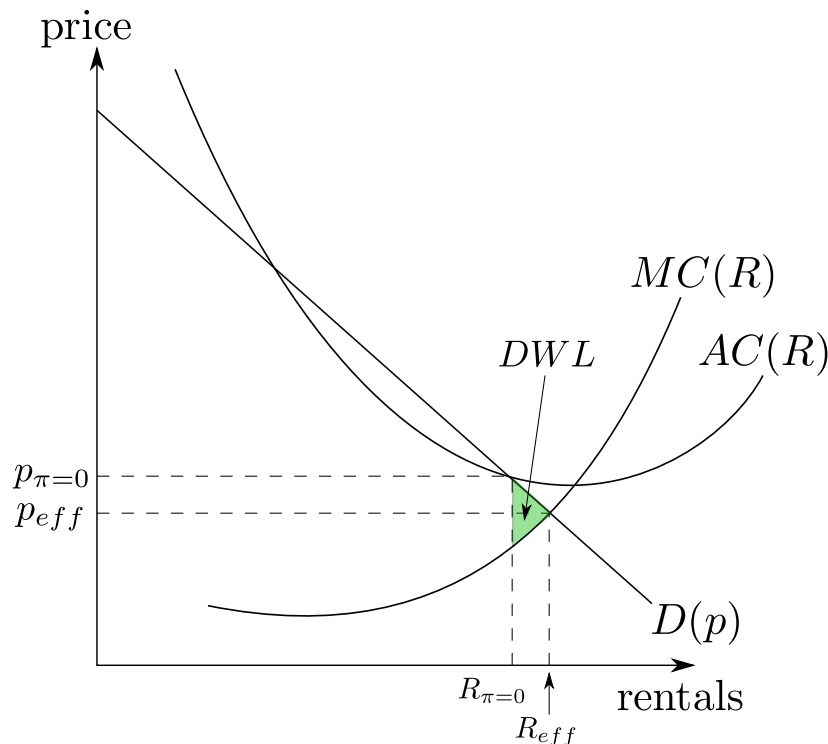
(c) On the graph above (it is identical to the original graph) show the largest quantity a regulator could force the rental store to rent such that the store will still choose to stay in busines. Assume that the store will go out of business if it is earning negative profits. Also assume that the regulator does not subsidize the store and prices at any given quantity are determined by the demand curve.

> The regulator will not be able to force the video store to rent at any quantities where profits are negative. Therefore the largest quantity that the regulator can force the store to rent is where profits hit zero or where the average cost curve intersects the demand curve. The quantity and price at this point are labelled on the graph as $R_{\pi=0}$ and $p_{\pi=0}$.

(d) On the graph, show the deadweight loss that results from being at the outcome in part (c) rather than the efficient outcome.

> The efficient outcome will be where the marginal cost curve intersects the demand curve. For all of the units to the left of this point, the marginal benefit of consuming the unit exceeds the marginal cost of producing it and therefore the unit increases total surplus. For all of the units to right of this point, the marginal cost exceeds the marginal benefit and producing it would lower total surplus. This point is labelled on the graph as (R_{eff}, p_{eff}). The deadweight loss resulting from being at $(R_{\pi=0}, p_{\pi=0})$ is equal to the area between the demand curve and the marginal cost curve between $R_{\pi=0}$ and R_{eff}.

3. (10 points) Suppose that there are several major construction companies that bid for large government contracts. Each time there is a new construction project, the government solicits sealed bids from all of the construction companies. Whichever company submits the lowest bid wins the contract and completes the project for the price they bid. There is a new contract to be bid on every one to two months.

   (a) Describe how collusion might take place in this scenario and how the result of the bidding process would differ if collusion did take place.

   > The firms could collude be engaging in bid rigging. They would all agree to submit high bids with the exception of one firm that would submit a slightly lower bid. This would allow a firm to win the contract at a much higher price than would occur without collusion. Because there are new contracts coming every one to two months, they would be able to rotate who wins each contract so that all of the firms benefit from the collusion. This would lead to substantially higher prices paid by the government and much higher profits for the construction companies.

   (b) Would collusion be more or less likely if the number of major construction companies increases? Fully explain your answer.

   > Collusion would be harder to coordinate if the number of construction companies were larger. The bid rigging described above only works if every firm agrees to it. More firms would mean more effort to get everyone in on the bid rigging scheme. It would also reduce the frequency with which each firm gets to win the bid, increasing the incentives for a firm to cheat so that they could win the current contract at the expense of losing out on the future profits from collusion.

4. (10 points) The state legislature is considering an ad campaign to discourage teenage smoking. Discuss the information you would need in order to assess whether the money spent on this campaign will lead to a net benefit for society. In other words, explain what you would need to know to do a thorough cost-benefit analysis of the ad campaign.

> In order to do a cost-benefit analysis of the campaign, you would need to know the costs of the ad campaigns both in terms of the exact dollar amounts and the time periods in which the costs would be incurred, the benefits of the campaign in dollar amounts and the time periods in which they are received, and the proper discount rate to use. For the costs, this information should be fairly straightforward. It is simply a matter of how much money will be spent and when it will be spent. For the benefits, the information is much more difficult. The benefits will likely be in the form of health benefits at a much later point in time. You would need to figure out what the expected health benefits are, when those health benefits are likely to be realized, and how to translate those health benefits into dollar amounts.

5. (10 points) Suppose that the government currently uses traditional rate of return regulation to regulate a local utility company. Explain why switching to price cap regulation may lead to the local utility company operating more efficiently.

> The problem with rate of return regulation is that if a firm finds ways to operate more efficiently (raising the firm's rate of return), the prices will eventually be adjusted to bring the firm's rate of return back to the original level. Therefore any gains from becoming more efficient are just temporary. Under price cap regulation, the prices the firm can charge are independent of the firm's costs. If the firm can reduce its costs by becoming more efficient, it will get to retain all of the additional profits since the prices will not be adjusted. The firm then has very strong incentives to reduce costs and operate more efficiently. These incentives can be strengthened further but incorporating a steady decline into the regulated prices. If the firm does not become more efficient over time, it will receive lower and lower rates of return because of the steadily decreasing prices. This places added pressure on the firm to innovate.

6. (20 points) Below is an equation giving total costs for a mattress manufacturer as a function of the number of mattresses (M) produced:

$$C(M) = 100M + 10M^2 \tag{1}$$

Given this cost function, the marginal cost function of the manufacturer is:

$$MC(M) = 100 + 20M \tag{2}$$

The inverse demand function for mattresses is given by:

$$p(M) = 700 - 10M \tag{3}$$

(a) Write down the equation for the average costs of the mattress manufacturer as a function of the number of mattresses produced.

$$AC(M) = \frac{C(M)}{M}$$

$$AC(M) = \frac{100M + 10M^2}{M}$$

$$AC(M) = 100 + 10M$$

(b) Given your average cost function in part (a), explain whether this mattress manufacturer experiences economies of scale or diseconomies of scale and whether it would be more efficient to have a single manufacturer or multiple manufacturers in this industry.

Notice that as M gets larger, average costs get larger. This means that there are diseconomies of scale. It would be more efficient to have multiple manufacturers producing output. This would lead to lower levels of output for each firm and therefore lower average costs.

(c) Find the efficient quantity of mattresses.

The efficient quantity will be where the marginal cost curve intersects the demand curve. We can solve for this quantity by setting the marginal cost function equal to the inverse demand function:

$$MC(M) = p(M)$$

$$100 + 20M = 700 - 10M$$

$$30M = 600$$

$$M_{eff} = 20$$

(d) Find the quantity of mattresses that will be produced if the manufacturer acts as a profit-maximizing monopolist.

The monopolist will maximize profits by producing at the quantity where marginal revenue equals marginal cost. To find this quantity, we first need to find the marginal revenue function. In the case of a linear demand curve, the marginal revenue is the same as the inverse demand function only with the slope coefficient doubled. More generally, we can find the marginal revenue function by taking the derivative of revenue with respect to M:

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

$$R(M) = (700 - 10M) \cdot M$$

$$R(M) = 700M - 10M^2$$

$$MR(M) = \frac{dMR(M)}{dM} = 700 - 20M$$

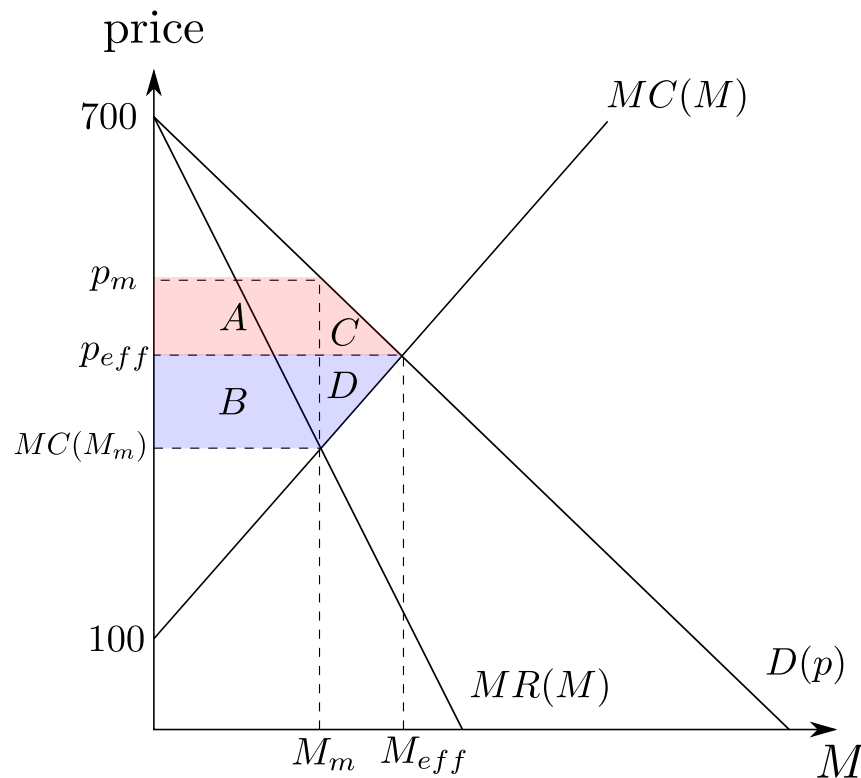Now we can set marginal cost equal to marginal revenue and solve for the monopoly quantity:

$$MC(M) = MR(M)$$

$$100 + 20M = 700 - 20M$$

$$40M = 600$$

$$M_m = 15$$

(e) Calculate the change in consumer surplus and the change in producer surplus when switching from the efficient quantity to the monopolist quantity.

The graph above shows the relevant changes in prices and quantity. At the efficient quantity of 20 mattresses, the price would be $700 - 10 \cdot 20$, or \$500. At the monopoly quantity of 15 mattresses, the price would be $700 - 10 \cdot 15$, or \$550. The marginal cost of the firm at the monopoly quantity is $100 + 20 \cdot 15$, or \$400. Now we have all of the information we need to calculate the changes in consumer and producer surplus:

$$\Delta CS = -A - C$$

$$\Delta CS = -(15 - 0)(550 - 500) - \frac{1}{2}(20 - 15)(550 - 500)$$

$$\Delta CS = -875$$

$$\Delta PS = A - D$$

$$\Delta PS = (15 - 0)(550 - 500) - \frac{1}{2}(20 - 15)(500 - 400)$$

$$\Delta PS = 500$$

7. (10 points) There are only two firms in an industry, firm A and firm B. The total cost and marginal cost functions of the firms are given by:

$$C_A(y_A) = 50y_A \tag{4}$$

$$C_B(y_B) = 60y_B \tag{5}$$

$$MC_A(y_A) = 50 \tag{6}$$

$$MC_B(y_B) = 60 \tag{7}$$

The two firms compete on price. Whichever firm announces the lowest price captures all of the market demand. If they announce the same price, they each get one half of the total market demand. You can assume that the demand curve is a downward sloping line.

(a) If firms can only charge integer prices (so they could charge $9 or $10 but not $9.50), what will the equilibrium price be?

To try to capture the entire market, the firms will keep undercutting each other on price until they reach $60. At this point, if firm B drops its price any further, it would lose money. Firm A is still making positive profits. Firm A will drop its price to $59 to capture the entire market demand and earn $9 in profit on every unit sold.

(b) Explain why this equilibrium is inefficient.

At this equilibrium, the marginal cost of producing another unit ($50) is still below the marginal benefit of another unit ($59). Therefore total surplus could be increased by producing additional units. That means total surplus is not being maximized at the current equilibrium and the equilibrium is inefficient.

(c) Suppose that a regulator controls entry and exit into the market. There are firms of both types that would be willing to try competing in the market if given permission. The regulator is considering two approaches to improving efficiency in the market. The regulator can use tax revenues to subsidize the current two firms in order to reach the efficient quantity. Alternatively, the regulator can allow an additional firm of each type to enter the market. Which approach should the regulator choose and why?

Using taxes to pay for subsidies introduces a new source of inefficiency, in particular the taxes distorting the behavior of whoever is being taxed. If the regulator were to allow another A type firm to enter the market, competition between the two A type firms would drive the price down to the efficient price of $50 without any need for subsidies. Therefore it would be most efficient to allow the entry of another firm rather than using subsidies to get more production out of the current firms.