Ecn 100 - Intermediate Microeconomics
University of California - Davis July 28, 2010
Instructor: John Parman

Final - Solutions

You have until 3:50pm to complete this exam. Be certain to put your name, id number and section on both the exam and your scantron sheet and fill in test form A on the scantron. Answer all multiple choice questions on your scantron sheet. Choose the single best answer for each question; if you fill in multiple answers for a question you will be marked wrong. Answer the short answer questions directly on the exam. You must show your work for full credit. Answers may be left as fractions. Please place a box around final answers when appropriate. Good luck!

Name: **ID Number:** **Section:**

SECTION I: MULTIPLE CHOICE (60 points)

1. A competitive firm is currently maximizing profits by producing 10 units of output. If the firm is losing \$100 (profits are -\$100), which of the following must be true?
   (a) The firm's fixed costs are greater than or equal to \$100.
   (b) The firm's fixed costs are less than or equal to \$100.
   (c) The firm's fixed costs are equal to \$100.
   (d) None of the above.

   (a) If the firm's fixed costs were less than \$100, they could shut down and lose less money than they are currently losing meaning that they wouldn't currently be maximizing profits.

2. A competitive market has a linear, downward sloping demand curve and a linear, upward sloping short run supply curve. Currently, the market is in a long run equilibrium with an equilibrium price of \$10. If a quantity tax of \$4 is placed on consumers, the new equilibrium price received by sellers will:
   (a) Be less than \$6 in the short run and between \$6 and \$10 in the long run.
   (b) Be between \$6 and \$10 in the short run and between \$6 and \$10 in the long run.
   (c) Be equal to \$10 in the short run and between \$6 and \$10 in the long run.
   (d) Be between \$6 and \$10 in the short run and equal to \$10 in the long run.

   (d) In the short run, the price paid by consumers will increase by a fraction of the tax and the price received by sellers will decrease by a fraction of the tax. In the long run, firms will leave the industry driving the price received by the sellers back up to the breakeven price (\$10).

3. Which of the following is definitely true at the efficient quantity in a market with one firm?
   (a) Profits are maximized.
   (b) Profits are equal to zero.
   (c) Consumer surplus is maximized.
   (d) The sum of consumer and producer surplus is maximized.

(d) By definition, the efficient quantity is where total surplus is maximized. It does not mean that either consumer surplus is at its maximum or producer surplus is at its maximum, simply that their sum is at its maximum.

4. Suppose that when the price of capital increases relative to the price of labor, a profit-maximizing firm chooses to keep using the same ratio of capital to labor as before (both capital and labor are variable inputs and their prices are always positive). Which of the following could be the firm's production function?

   (a) $f(K, L) = KL$.
   (b) $f(K, L) = K^{\frac{1}{2}} L^{\frac{1}{2}}$.
   (c) $f(K, L) = K + L$.
   (d) All of the above.

   (c) For any convex isoquant, a change in the slope of the isocost line will move the point of tangency between the isoquant and isocost line, leading to a new capital-labor ratio. For the linear production function, the isoquant is a straight line meaning that we are likely at a corner solution using only one input. A change in the relative prices of the inputs may not move us from that corner solution.

5. Suppose that at a firm's current level of output, average costs are \$4 per unit and marginal costs are \$5 per unit. If the firm produces one more unit:

   (a) Average costs will increase.
   (b) Average variable costs will increase.
   (c) Both (a) and (b).
   (d) Neither (a) nor (b).

   (c) If marginal costs are above average costs, the next unit will add more to total costs than the previous average, increasing the average. The same logic holds for average variable costs and since average variable costs are less than or equal to average costs, if marginal costs are greater than average costs they are also greater than average variable costs.

6. In a competitive industry with identical firms, the current market price is \$10, the number of firms is 100 and the breakeven price is \$5. In the long run:

   (a) The market price will be \$10 and the number of firms will be greater than 100.
   (b) The market price will be \$10 and the number of firms will be less than 100.
   (c) The market price will be \$5 and the number of firms will be greater than 100.
   (d) The market price will be \$5 and the number of firms will be less than 100.

   (c) Since the current price is above the breakeven price, firms are earning positive profits. This will cause other firms to enter the industry, increasing the number of firms and driving down the price until it is equal to the breakeven price of \$5.

7. A firm's only two inputs are wood and steel. If the marginal product of wood is positive and constant and the marginal product of steel is positive and constant, the firm's isoquants on a graph with wood on the horizontal axis and steel on the vertical axis will be:

   (a) Downward sloping and getting flatter from left to right.

(b) Downward sloping and getting steeper from left to right.
(c) Upward sloping and linear.
(d) Downward sloping and linear.

(d) The slope of an isoquant will be the ratio of the marginal product of wood to the marginal product of steel with a minus sign out front. This ratio will be constant implying linear isoquants.

8. Currently, there is a \$2 quantity tax on soda that is generating \$200 in tax revenue and \$50 in deadweight loss. The demand curve is downward sloping and the supply curve is upward sloping. If the tax is increased to \$4:

(a) Tax revenue will definitely increase.
(b) Deadweight loss will definitely increase.
(c) Both (a) and (b).
(d) Neither (a) nor (b).

(b) Deadweight loss will increase because an increase in the tax will lead to a lower quantity. The consumer surplus and producer surplus on those units that are no longer sold will be lost. Tax revenue may increase or decrease, it depends on whether the extra tax revenue on the units still sold is greater on the lost tax revenue from the units that are no longer sold.

9. A store offering a senior citizen discount of 10% is an example of:

(a) Bundling.
(b) Price discrimination.
(c) A two-part tariff.
(d) None of the above.

(b) This is a form of third degree price discrimination. Different consumers are being charged different prices but the price per unit for a particular consumer is constant no matter how many units are purchased.

10. In the short run there are two types of firms in a competitive industry, with ten of each type. Type A firms have a shutdown price of \$10 and a marginal cost curve with a slope of 10. Type B firms have a shutdown price of \$15 and a marginal cost curve with a slope of 15. The short run industry supply curve will:

(a) Have a vertical intercept of \$15.
(b) Have a kink at \$15 with a slope of 10 to the left of the kink.
(c) Have a kink at \$15 with a slope of less than 10 to the right of the kink.
(d) Have a vertical intercept of \$25.

(c) There will be a kink at \$15 because the B type firms will enter the market when the price climbs above \$15 (below \$15 there are only A type firms). The industry supply curve will be flatter than any of the individual supply curves.

11. In the short run, a firm's capital is fixed at 10 units and it costs the firm \$200 to produce 20 units of output. In the long run:

(a) It costs the firm at least \$200 to produce 20 units of output.

(b) It costs the firm at most \$200 to produce 20 units of output.
(c) The firm will use at least 10 units of capital to produce 20 units of output.
(d) The firm will use at most 10 units of capital to produce 20 units of output.

(b) In the long run, the firm can do exactly what they did in the short run and produce 20 units for \$200. However, they may be able to do better by choosing a different level of capital. So the firm's costs of producing 20 units should be no more than \$200 and potentially less.

12. If a firm has no fixed costs, which of the following is definitely true?

(a) It's average cost curve will be a straight line.
(b) It's average cost curve will be identical to its average variable cost curve.
(c) It's profits will be greater than it's producer surplus.
(d) It's marginal cost curve will be a straight line.

(b) If there are no fixed costs, total costs are the same as variable costs and average cost is the same as average variable cost.

13. If the marginal product of labor is positive but diminishing, doubling the amount of labor used while holding all other inputs constant will:

(a) Exactly double output.
(b) More than double output.
(c) Increase output but by less than double.
(d) Decrease output.

(c) Increasing labor will increase output since labor has a positive marginal product. However, since the marginal product of labor is diminishing, the second group of workers will increase output by less than the first group of workers, so output will less than double.

14. In a competitive industry in which firms have upward sloping marginal cost curves, a permanent shift of the demand curve to the right will:

(a) Lead to a decrease in market price in the short run.
(b) Lead to an increase in market price in the short run.
(c) Lead to a decrease in market price in the long run.
(d) Lead to an increase in market price in the long run.

(b) The shift in the demand curve will have no effect on the long run price since the long run price is determined by the breakeven price for the firms. In the short run, the shift in the demand curve will lead to a movement up and to the right along the short run supply curve, leading to a higher short run price.

15. Suppose that a firm uses a fixed proportions technology where capital and labor are the only two inputs and two units of capital and one unit of labor are needed to produce each unit of output. Which of the following is true assuming the firm always produces a postive quantity of output?

(a) The cost-minimizing ratio of capital to labor will depend on how large the wage is relative to the rental rate of capital.

(b) The cost-minimizing ratio of capital to labor will depend on the quantity of output being produced.
(c) The firm uses a constant returns to scale technology.
(d) The marginal product of capital is always positive.

(c) The ratio of capital to labor will always be two to one since two units of capital are always needed for each unit of labor. Any fixed proportions technology is a constant returns to scale technology (note that if $f(x,y) = min(ax, by)$, $f(\lambda x, \lambda y) = min(a\lambda x, b\lambda y) = \lambda min(ax, by) = \lambda f(x,y)$). The marginal product of capital is zero whenever you already have at least twice as much capital as labor.

SECTION II: SHORT ANSWER (40 points)

1. (12 points) In order to produce a table, a firm can use either one unit of metal or two units of wood no matter how many tables have already been produced or how many units of metal and wood have already been used. A firm can produce fractions of tables and use fractions of units of inputs (for example, half a unit of metal could be used to produce half a table).

   (a) Write down a production function that gives the number of tables produced (T) as a function of the number of units of metal (M) and wood (W) used.

   Based on the description, metal and wood are perfect substitutes: metal can always be substituted for wood at a rate of one to two. This gives us the following linear production function:

   $$T = f(M, W) = M + \frac{1}{2}W$$

   Note that the coefficients are important here. They have to match up with the statement above. In other words, if M is increased by one unit, output should go up by one unit (giving us the coefficient of one in front of M) and if W is increased by one unit, output should go up by half a unit since it takes two units of wood to get one unit of output (giving us the coefficient of one half in front of W).

   (b) Suppose that the price of a unit of wood is \$5 and the price of a unit of metal is \$4. Write down a function that gives a firm's minimum costs as a function of the number of tables produced (T).

   We are dealing with a perfect substitutes technology which means we have a constant technical rate of substitution. If the ratio of the input prices is different than the technical rate of substitution we will end up using only one input. In this case, the ratio of the input prices $\frac{p_M}{p_B}$ is $\frac{4}{5}$ while the ratio of the marginal products $\frac{MP_M}{MP_W}$ is $\frac{1}{\frac{1}{2}}$ or 2. So a unit of metal produces more relative to a unit of wood than it costs relative to a unit of wood. We will therefore use all metal. Knowing this allows us to write our demand for M as a function of output (W as a function of output is simply zero):

   $$T = f(M, W)$$

   $$T = f(M, 0)$$

   $$T = M + \frac{1}{2}0 = M$$

   $$M(T) = T$$

   Now we have everything we need to write costs as a function of T:

   $$C(T) = p_M M(T) + p_W W(T)$$

   $$C(T) = 4 \cdot T + 5 \cdot 0$$

   $$C(T) = 4T$$

(c) The market demand for tables is given by:

$$D(p) = 500 - 25p \tag{1}$$

The input prices are the same as in part (b). If the market for tables is perfectly competitive, what will the long run equilibrium price and market quantity of tables be?

In the long run, the price will be equal to the breakeven price where firms earn zero profits. Using the cost function from part (b), we can see that average costs are constant and equal to \$4. So when the market price is \$4, firms will earn zero profits. Any price below that will lead to negative profits and any price above that will lead to positive profits. So the long run equilibrium price is \$4. To get the long run equilibrium quantity, we simply need to plug this price into the demand function:

$$D(4) = 500 - 25 \cdot 4$$

$$D(4) = 400$$

So long run equilibrium price is \$4 and long run equilibrium quantity is 400.

2. (14 points) A firm using capital and labor as its two inputs has the following production function:

$$f(K, L) = K^{\frac{1}{3}} L^{\frac{2}{3}} \tag{2}$$

(a) Derive expressions for the marginal product of labor, the marginal product of capital and the technical rate of substitution.

$$MP_L = \frac{df(K, L)}{dL} = \frac{2}{3} K^{\frac{1}{3}} L^{-\frac{1}{3}}$$

$$MP_K = \frac{df(K, L)}{dK} = \frac{1}{3} K^{-\frac{2}{3}} L^{\frac{2}{3}}$$

$$TRS = -\frac{MP_L}{MP_K} = -\frac{\frac{2}{3} K^{\frac{1}{3}} L^{-\frac{1}{3}}}{\frac{1}{3} K^{-\frac{2}{3}} L^{\frac{2}{3}}} = -2\frac{K}{L}$$

Note that you could also have set up the technical rate of substitution with the marginal product of capital in the numerator and the marginal product of labor in the denominator. If you chose to do it this way, you should have found the technical rate of substitution to be equal to $-\frac{L}{2K}$.

(b) The firm currently has 8 workers. It cannot fire the workers or hire additional workers in the short run. It can change its level of capital in the short run. If the price of output is \$9, the wage is \$6 and the rental rate of capital is \$12, how many units of capital will the firm use in the short run in order to maximize profits?

In order to maximize profits, the firm will set the value of the marginal product of capital (the variable input) equal to the price of a unit of capital:

$$p \cdot MP_K = r$$

$$p\frac{1}{3} K^{-\frac{2}{3}} L^{\frac{2}{3}} = r$$

Plugging in our values for p, r and L will allow us to solve for the value of K:

$$9\frac{1}{3} K^{-\frac{2}{3}} 8^{\frac{2}{3}} = 12$$

$$3K^{-\frac{2}{3}} 4 = 12$$

$$K^{-\frac{2}{3}} = 1$$

$$K = 1$$

(c) If the prices of capital and labor remain the same as in part (b), what will the ratio of capital to labor be for the firm in the long run (assuming they produce a positive amount of output)?

In the long run, the firm can vary both capital and labor. To minimize costs, they will choose the levels of capital and labor where the isoquant is tangent to an isocost line. Setting up this tangency condition gives us the following:

$$\frac{w}{r} = \frac{MP_L}{MP_K}$$

$$\frac{w}{r} = 2\frac{K}{L}$$
$$\frac{6}{12} = 2\frac{K}{L}$$
$$\frac{1}{4} = \frac{K}{L}$$

So the firm will use one unit of capital to every four units of labor in the long run.

3. (14 points) The inverse demand for burgers (B) is given by:

$$p(B) = 50 - B \tag{3}$$

There is only one firm that sells burgers. The costs of the firm are given by:

$$C(B) = 5B^2 + 10B \tag{4}$$

(a) What price will this single firm charge, how many burgers will it sell and what will its profits be?

The firm will maximize profits by setting marginal cost equal to marginal revenue. To do this, we first need to find marginal revenue:

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

$$R(B) = (50 - B)B = 50B - B^2$$

$$MR(B) = \frac{dMR(B)}{dB} = 50 - 2B$$

Now we can set marginal revenue equal to marginal cost:

$$MR(B) = MC(B)$$

$$50 - 2B = 10B + 10$$

$$40 = 12B$$

$$B = \frac{10}{3}$$

To get the price the firm will charge, we can plug this quantity into the inverse demand function:

$$p(\frac{10}{3}) = 50 - \frac{10}{3} = \frac{140}{3}$$

Now we have everything we need to calculate profits:

$$\pi = p \cdot B - C(B)$$

$$\pi = \frac{140}{3} \cdot \frac{10}{3} - 5 \cdot \left(\frac{10}{3}\right)^2 - 10 \cdot \frac{10}{3}$$

$$\pi = \frac{1400}{9} - \frac{500}{9} - \frac{300}{9} = \frac{600}{9}$$

$$\pi = \frac{200}{3}$$

(b) What is the socially efficient quantity of burgers?

At the socially efficient quantity, any unit for which the marginal benefit to consumers exceeds the marginal cost to the producer should be produced. This means that all units up to the point where the demand curve (showing the marginal benefit of the consumers) and the marginal cost curve intersect. To solve for this quantity, we simply set the marginal cost curve equal to the inverse demand curve:

$$MC(B) = p(B)$$
$$10B + 10 = 50 - B$$
$$11B = 40$$
$$B = \frac{40}{11}$$

Notice that this socially efficient quantity is slightly larger than the quantity the monopolist decided to produce.

(c) Suppose that the government wanted to get the firm to produce at the socially efficient quantity by offering a subsidy per unit of the amount S. So if the monopolist sells units at a price of p, it will actually receive $p + S$ in revenue on each unit. Find the level of S that would lead the monopolist to produce the socially efficient quantity.

The monopolist is still going to determine quantity by setting marginal revenue equal to marginal cost. The difference is that now the monopolist's marginal revenue includes both the marginal revenue from consumers (the same $MR(B)$ as before) and the subsidy from the government. So the monopolist will determine quantity by solving the following equation:

$$MR(B) + S = MC(B)$$
$$50 - 2B + S = 10B + 10$$
$$12B = 40 + S$$
$$B = \frac{40}{12} + \frac{S}{12}$$

Note that if we set the subsidy equal to zero, this equation gives us the exact same monopoly output we found in part (a). The government wants the subsidy that will lead the monopolist to produce at the efficient quantity. To see how big this subsidy must be, we can simply plug the efficient quantity into the equation above and solve for S:

$$\frac{40}{11} = \frac{40}{12} + \frac{S}{12}$$
$$S = 12 \cdot \frac{40}{11} - 40$$
$$S = 40(\frac{12}{11} - 1)$$
$$S = \frac{40}{11}$$