Ecn 100 - Intermediate Microeconomic Theory
University of California - Davis November 13, 2008
Professor John Parman

Midterm 2

You have until 6pm to complete the exam, be certain to use your time wisely. For multiple choice questions, mark your answer on your scantron sheet. Choose only one answer for each multiple choice question; if more than one letter is chosen for a question it will be marked wrong. Write your answers for the short answer section directly on the exam. For the short answer questions, show your work clearly, place a box around final answers and be certain to label any graphs you draw. Final answers may be left as fractions. Non-graphing calculators may be used but they should not be necessary. Remember to put your name and ID number on both the exam (in the spaces provided below) and on the scantron sheet. Good luck!

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

SECTION I: MULTIPLE CHOICE (60 points)

1. For a firm's production technology, the marginal product of labor is increasing as the amount of labor used increases. When graphed with labor on the horizontal axis and output on the vertical axis, the production function will:
   (a) Have a positive slope.
   (b) Have a slope that increases as labor increases.
   (c) Have a slope that decreases as labor increases.
   (d) (a) and (b).
   (e) (a) and (c).

   (d) If the marginal product of labor is increasing, then as labor increases output will increase by larger and larger amounts. So when graphed, output as a function of labor will be increasing and getting steeper and steeper as labor gets larger.

2. Suppose that cars and burgers are the only two goods we consume, we spend all of our money on cars and burgers and when income goes up our consumption of both cars and burgers goes up. If cars are a luxury good, then the income elasticity of demand for burgers must be:
   (a) Between -1 and 0.
   (b) Less than -1.
   (c) Between 0 and 1.
   (d) Greater than 1.

   (c) Knowing that consumption of both goods goes up when income increases tells us that the income elasticity is positive for both goods. If cars are a luxury good, the income elasticity for cars will be greater than one. So the income elasticity of the other good must be less than one (otherwise our spending would go up by more than our income went up which isn't possible).

3. If the price elasticity of demand for newspapers is given by $\epsilon = \frac{-p}{10-p}$ where p is the price of newspapers, what price will maximize revenue?

(a) 0.
(b) 5.
(c) 10.
(d) 15.

(b) To get the revenue-maximizing price, we just set the price elasticity of demand equal to one. When we do this and solve for p, we find that the revenue-maximizing price is \$5.

4. If a firm uses a constant returns to scale technology and has positive fixed costs, then profits will _____. (You can assume the prices of output and inputs remain constant.)

(a) Increase when the levels of all inputs are doubled.
(b) Decrease when the levels of all inputs are doubled.
(c) Remain the same when the levels of all inputs are doubled.
(d) Whether they increase or decrease will depend on the wage and rental rate of capital.

(d) The answer depends on whether the firm is making positive or negative profits on each unit. If the firm's revenue was greater than the variable cost before doubling the outputs, then profits will go up (revenues will double and variable costs will double meaning the difference will double). If revenue was less than variable cost before, then profits will go down (revenues will double and variables costs will double meaning that the money lost by the firm will also double). If the wage and rental rate of capital are such that the revenues exactly equal variable costs, then nothing will happen to profits when inputs are doubled.

5. Suppose that the government proposes two taxes. One is a quantity tax on apples and the other is a value tax on apples. Analysts determine that both taxes will raise the same amount of tax revenue. What can we say for certain about the consumer surplus from apples?

(a) Consumer surplus will be greater under the quantity tax than under the value tax.
(b) Consumer surplus will be greater under the value tax than under the quantity tax.
(c) The change in consumer surplus from either tax will be greater than the change in producer surplus.
(d) The change in consumer surplus will be the same under either tax.

(d) If the two taxes generate the same revenue, then they will lead to the same after-tax quantity and prices for the consumer and producer. So the surplus lost under each tax will be the same. Without knowing more about the supply and demand curves, we cannot say how the change in consumer surplus compares to the change in producer surplus.

6. A firm uses workers, electricity and machines to produce output. Currently, machines are a fixed input, electricity is a quasi-fixed input, and the firm is maximizing profits by hiring 100 workers. If electricity were a fixed input rather than a quasi-fixed input, the profit-maximizing number of workers hired by the firm in the short run will be:

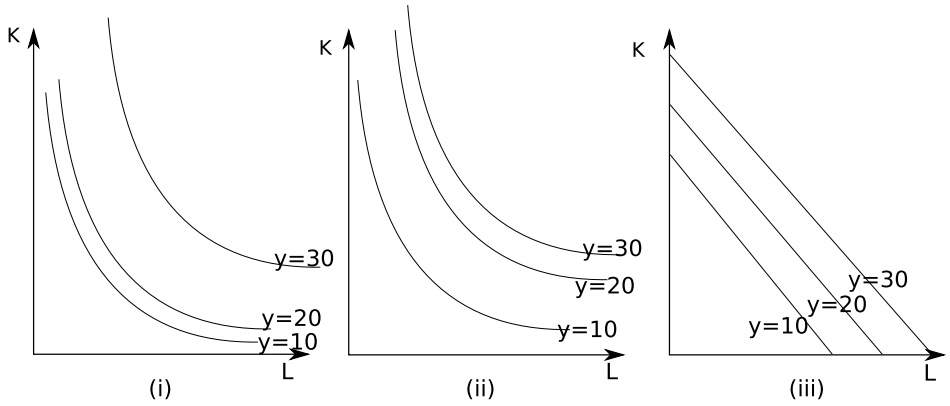
(a) Greater than 100.
(b) Equal to zero.
(c) Greater than or less than 100.

(d) Equal to 100.

(d) If the firm is producing, then profits will be the same whether electricity is a fixed input or a quasi-fixed input. If the firm shuts down, profits will be higher when electricity is a quasi-fixed than when it is a fixed input. If the firm decided to produce when electricity was quasi-fixed, then profits were higher when producing than when shutting down and saving money on electricity. Therefore profits must also be higher when producing than when shutting down and not saving money on electricity. So the firm will end up at the same level of production and same number of workers when electricity becomes a fixed input.

7. If labor is the only input used by a firm and a graph of output as a function of labor, with labor on the horizontal axis, is upward sloping and getting flatter as labor gets larger, then a graph of costs as a function of output, with output on the horizontal axis, will be:
   (a) Upward sloping and getting flatter as output gets larger.
   (b) Upward sloping and getting steeper as output gets larger.
   (c) Downward sloping and getting flatter as output gets larger.
   (d) Downward sloping and getting steeper as output gets larger.

   (b) If output as a function of labor gets flatter as labor gets larger, it will take more and more workers to produce additional units of output. So the cost of producing an additional unit when output is high will be larger than when output is low, implying a cost function that gets steeper as output gets larger.



Use the graphs above of the isoquants for three different production technologies to answer questions 8 through 10.

8. Which of the production technologies exhibit increasing returns to scale (at least for the output levels shown)?
   (a) (i)
   (b) (ii)
   (c) (iii)
   (d) None of the production technologies exhibit increasing returns to scale.

(b) As output gets larger, the isoquants are getting closer together implying that the increase in inputs needed to get additional output is getting smaller and smaller at higher levels of output.

9. For production technology (iii), capital and labor are:
   (a) Perfect complements in production.
   (b) Perfect substitutes in production.
   (c) Fixed factors of production.
   (d) None of the above.

   (b) The technical rate of substitution is constant for these isoquants, implying that we can always substitute labor for capital at a constant rate to maintain the level of output.

10. Which of the graphs depict a production technology with a diminishing technical rate of substitution?
    (a) (i).
    (b) (ii).
    (c) (i) and (ii).
    (d) (i), (ii) and (iii).

    (c) We can tell these production technologies exhibit diminishing technical rate of substitution because the isoquants get flatter as we move to higher levels of labor. The third graph depicts a case of constant technical rate of substitution.

11. If peanut butter and jelly are complements, then we can say for certain that:
    (a) We will consume either all peanut butter or all jelly.
    (b) The price elasticity of demand for peanut butter will be positive.
    (c) The cross price elasticity of demand for jelly will be positive.
    (d) The cross price elasticity of demand for peanut butter will be negative.

    (d) If two goods are complements, an increase in the price of one good will lead to a decrease in the demand for the other good.

12. If y is a Giffen good and the price of y increases, then:
    (a) The substitution effect for y will be positive.
    (b) The magnitude of the substitution effect will be smaller than the magnitude of the income effect.
    (c) The sign of the subsitution effect and the income effect will be the same.
    (d) Not enough information.

    (b) For Giffen goods, the net effect of a prict increase is an increase in demand. However, the substitution effect will always be negative when the price increases, so the income effect will have to be positive and larger in magnitude than the substitution effect to create an overall increase in demand.

13. If a firm uses inputs x and y to produce output and y is fixed in the short run, then the firm can maximize profits in the short run by setting the marginal product of x equal to:

(a) The price of x divided by the price of y.
(b) The price of y divided by the price of x.
(c) The price of y divided by the price of output.
(d) The price of x divided by the price of output.

(d) Setting MP_x equal to p_x divided by the price of output will lead to the level of x at which the production function is tangent to an isoprofit line, meaning that the firm is reaching the highest profit level possible.

14. The demand curve for chips is a downward sloping line and the supply curve for chips is an upward sloping line. If a quantity tax is placed on chips, we can say for certain that the dead weight loss generated by the tax will:

(a) Increase as the tax increases.
(b) First increase and then decrease as the tax increases.
(c) Depend on whether the tax was placed on consumers or producers.
(d) Be smaller than the revenue from the tax.

(a) Increasing the tax will move us further from the initial equilibrium price and quantity and increase the deadweight loss. The deadweight loss will be the same regardless of whether the tax is placed on consumers or producers. At low levels of the tax, it is possible that the deadweight loss will be smaller than the tax revenue but this can change as the size of the tax increases (since deadweight loss will continue to increase but eventually tax revenue will begin to fall).

15. A firm's production function is $f(K, L) = 10K^{\frac{1}{2}}L^{\frac{1}{2}}$. The wage rate is \$10 the rental rate of capital is \$5. In the short run capital is fixed. If the firm is using 16 workers in the short run and is producing 200 units of output, what are the firm's fixed costs? (You can assume that the firm is maximizing profits.)

(a) \$25.
(b) \$100.
(c) \$125.
(d) \$160.
(e) \$185.

(c) In the short run, the fixed costs are coming from whatever the fixed inputs are, in this case capital. We can plug $L = 16$ and $f(K, L) = 200$ into the above equation to find that $K = 25$. The cost of 25 units of capital is \$125.

16. Suppose that a firm uses a production technology that uses capital and labor as inputs, exhibits diminishing technical rate of substitution, diminishing marginal product of labor and diminishing marginal product of capital. In the short run, capital is fixed. An increase in the rental rate of capital will ____ labor used in the short run and ____ labor used in the long run. (Assume that in the long run, the firm wants to maintain the same level of output as before the price change.)

(a) Increase, decrease.
(b) Decrease, increase.
(c) Not change, decrease.

(d) Not change, increase.
(e) Not change, not change.

(d) In the short run, the level of labor depends only on the wage and the price of output. In the long run, the higher rental rate of capital will lead the firm to substitute away from capital towards labor.

17. A firm uses capital and labor to produce output and has standard, convex isoquants. On a graph with labor on the horizontal axis and capital on the vertical axis, the slope of the the isoquant at the firm's current choice of inputs is greater than the wage divided by the rental rate of capital. The firm can maintain the same level of output and decrease costs by:

(a) Increasing capital and increasing labor.
(b) Decreasing capital and decreasing labor.
(c) Increasing capital and decreasing labor.
(d) Decreasing capital and increasing labor.

(d) If the isoquant is steeper than the ratio of wage to the rental rate of capital, then more output is produced by spending an additional dollar on labor than on capital. So costs can be reduced while maintaining the current level of output by using less capital and more labor.

18. A consumer always spends all of his money on x and y. When the price of good x increases, the substitution effect for good y will:

(a) Be negative if x and y are complements.
(b) Be negative if x and y are substitutes.
(c) Be positive only if x and y are complements.
(d) Be positive whether x and y are substitutes or complements.

(d) The substitution effect will be positive because y is now relatively cheaper. The sign of the net effect on y (the substitution effect plus the income effect) will depend on whether x and y are substitutes or complements.

19. The decrease in producer surplus resulting from a quantity tax will:

(a) Be larger if the tax is placed on consumers.
(b) Be larger if the tax is placed on producers.
(c) Be larger if demand is very elastic.
(d) Be larger if demand is very inelastic.

(c) When demand is very elastic, the tax burden on producers is greater meaning that the price received by producers will go down by a greater amount compared to a case of inelastic demand. Given the same supply curve, the lower the price received by producers is the lower the producer surplus.

20. The demand curve for donuts is a downward sloping line and the supply curve for donuts is an upward sloping line. If a quantity tax is placed on consumers, we can say for certain that it will generate tax revenue that is:

(a) Greater than the combined loss is consumer and producer surplus.
(b) Less than the combined loss in consumer and producer surplus.

(c) Greater than the dead weightloss.
(d) Less than the deadweight loss.

(b) The tax revenue generated will always be less than the combined loss in producer and consumer surplus by the amount of the deadweight loss. Deadweight loss can be greater or smaller than tax revenue depending on the slopes of the supply and demand curves and the size of the tax.

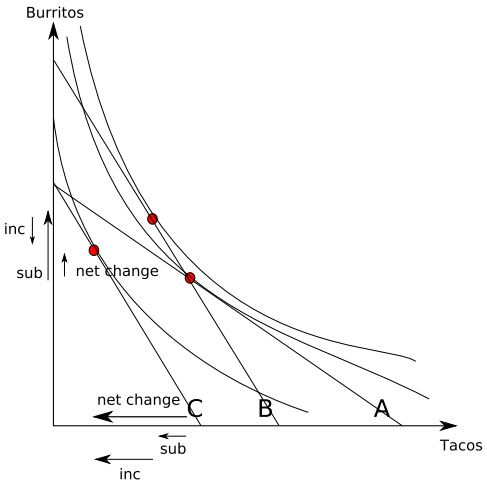
SECTION II: SHORT ANSWER (40 points)

For this section, be certain to show your work and clearly label any graphs you draw. Give complete answers but keep them concise. Please place a box around final answers where appropriate.

1. Suppose that burritos and tacos are substitutes. Use a graph to clearly show the income and substitution effects (including the sign and the relative magnitude of the effects) for both tacos and burritos when the price of tacos increases. Tacos should be on the horizontal axis and burritos should be on the vertical axis. You can assume that burritos and tacos are normal, ordinary goods and that indifference curves are convex. Be certain include all relevant labels on the graph. (10 points total)

   Because burritos and tacos are substitutes, we know that when the price of tacos increases, the number of tacos consumed should go down and the number of burritos consumed should go up. We also know that the substitution effect should be positive for the good that got relatively cheaper (burritos) and negative for the good that got relatively more expensive (tacos). The choice of where to put the consumption bundles should lead to a graph that matches up with these features.

   In the graph, the price change in tacos rotates the budget line from A to C. B is an intermediate budget line using the new prices and an income that is just enough to afford the old bundle under the new prices. The consumption bundles on these three lines should be positioned such that the overall change in tacos is negative and the overall change in burritos is positive, the income effect is negative for both burritos and tacos, and the substitution effect is positive for burritos and negative for tacos.



2. Suppose that demand for pizza slices for Alex is given by $D_A = 20 - 2P$ and for Billy is given by $D_B = 10 - 3P$ where P is the price of a slice of pizza. The market supply of pizza slices is given by $S(P) = -1 + 2P$. (8 points total)

   (a) Derive an expression for the market demand for pizza slices, assuming that Alex and Billy are the only consumers of pizza. (5 points)

Note that Alex's demand drops to zero when the price reaches \$10 and Billy's demand drops to zero when the price equals \$3.33. So the market demand curve will be zero for prices above \$10 and will have a kink at a price of \$3.33. The two segments of the market demand curve are as follows:
For $3.33 < P \leq 10$:

$$D(P) = D_A = 20 - 2P$$

For $0 \leq P \leq 3.33$:

$$D(P) = D_A + D_B = 20 - 2P + 10 - 3P = 30 - 5P$$

(b) Given your market demand from part (a), what is the price elasticity demand for pizza when pizza costs \$5 a slice? (3 points)

A price of \$5 puts us on the first segment of the demand curve where $D(P) = 20 - 2P$. We can use this demand function to find the elasticity as follows:

$$\epsilon = \frac{P}{Q}\frac{dQ}{dP}$$

$$\epsilon = \frac{P}{20 - 2P}(-2)$$

$$\epsilon = \frac{5}{20 - 2 \cdot 5}(-2)$$

$$\epsilon = -1$$

3. A firm uses capital and labor to produce tshirts. The firm's production technology is given by $f(K, L) = K^{\frac{1}{3}}L^{\frac{1}{3}}$. (22 points total)

(a) In the short run capital is fixed at 8 units. The price of output is \$2, the rental rate of capital is \$2 and the wage \$3. Find the profit-maximizing level of labor and the level of profits in the short run. (6 points)

In the short run, the firm will maximize profits by finding the point of tangency between the production function and the isoprofit line. This tangency condition is:

$$\frac{w}{p} = MP_L$$

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

$$\frac{3}{2} = \frac{1}{3}8^{\frac{1}{3}}L^{-\frac{2}{3}}$$

$$\frac{9}{4} = L^{-\frac{2}{3}}$$

$$L = \frac{8}{27}$$

Now that we know the level of labor and capital, we can calculate the profits:

$$\pi = p \cdot f(K, L) - rK - wL$$

$$\pi = 2 \cdot 8^{\frac{1}{3}} \left(\frac{8}{27}\right)^{\frac{1}{3}} - 2 \cdot 8 - 3 \cdot \frac{8}{27}$$
$$\pi = \frac{8}{3} - 16 - \frac{8}{9} = -\frac{128}{9}$$

Notice that even though the profits are negative, the firm would be worse off if they shut down. Their revenues are $\frac{8}{3}$ when operating and their variable costs are only $\frac{8}{9}$, so that have increased profits by operating rather than shutting down.

(b) Derive an expression for costs as a function of the number of tshirts produced in the long run. Your expression should not contain any variables other than the number of tshirts. (12 points)

To derive the costs as a function of ouput, we first need to get expressions for K and L as functions of output. To do this, we use find the level of capital and labor that produces the desired level of output and is located at a tangency between the isoquant and isocost curves. Starting with the tangency condition:

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

Now we can plug this into the production function to find L as a function of y:

$$y = K^{\frac{1}{3}}L^{\frac{1}{3}} = \left(\frac{w}{r}L\right)^{\frac{1}{3}} L^{\frac{1}{3}}$$
$$y = \left(\frac{w}{r}\right)^{\frac{1}{3}} L^{\frac{2}{3}}$$
$$L = \left(\frac{r}{w}\right)^{\frac{1}{2}} y^{\frac{3}{2}}$$

Plugging this into the equation we found for K as a function of L gives us:

$$K = \left(\frac{w}{r}\right)^{\frac{1}{2}} y^{\frac{3}{2}}$$

Now we can plug these expressions into the cost function to get costs as a function of output:

$$C(y) = w \cdot L(y) + r \cdot K(y)$$
$$C(y) = w\left(\frac{r}{w}\right)^{\frac{1}{2}} y^{\frac{3}{2}} + r\left(\frac{w}{r}\right)^{\frac{1}{2}} y^{\frac{3}{2}}$$
$$C(y) = 2\left(wr\right)^{\frac{1}{2}} y^{\frac{3}{2}}$$

(c) Does the production function exhibit increasing, decreasing or constant returns to scale? Be certain to justify your answer by showing appropriate work. (4 points)

To check returns to scale, we can multiply the inputs by some factor t and see what happens to output:

$$f(tK, tL) = (tK)^{\frac{1}{3}} (tL)^{\frac{1}{3}}$$

$$f(tK, tL) = t^{\frac{1}{3}} K^{\frac{1}{3}} t^{\frac{1}{3}} L^{\frac{1}{3}}$$

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

$$f(tK, tL) = t^{\frac{2}{3}} f(K, L)$$

So when the level of inputs is increased by a factor of t, the level of outputs is increased by a factor of $t^{\frac{2}{3}}$ which is less than t. So the production function exhibits decreasing returns to scale.