Economics 100A
Fall 2001
Prof. Daniel McFadden

Quiz #3 Solutions

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(by: Peter Adams)

Name:

SID #:

Section: **115** **116**

Instructions

You have 55 minutes to complete the exam.
Mark only on the exam.
Do not separate the pages.
Show all work.
Partial credit will be awarded where applicable.

1 True/False (5 points)

Indicate which of the following statements are TRUE and which of the following statements are FALSE.

1. Suppose $|TRS| = \frac{MP_L}{MP_K} = \frac{1}{3}$. If we reduce K by 6 units and want to keep output constant, we must increase L by 2 units. **FALSE**

   The definition of $|TRS| = \frac{MP_L}{MP_K}$ *implies that* $|TRS| = \left|\frac{\Delta K}{\Delta L}\right|$. *This represents the amount of capital needed, given a unit reduction in labor, in order to keep output constant. Alternatively, if we reduce capital by a unit, we must increase labor by 3 units in order to keep output constant (that is the reciprocal of the equation above). So* $\left|\frac{\Delta K}{\Delta L}\right| = \frac{1}{3} \Longrightarrow 3 * \Delta K = \Delta L$. *So if we reduce capital by 6 units, then we must increase labor by 18 units, NOT 2 units.*

2. If $p * MP_L > w$, then the firm should INCREASE the amount of labor (L) employed in order to maximize profits. **TRUE**

   This is true because the marginal revenue product from an additional unit of labor is greater than the cost to the firm of hiring that additional unit of labor. So, the firm can increase profits by hiring more labor.

3. If $LRAC > SRAC$, then the firm should INCREASE capital (K). **FALSE**

   Long-run average costs are NEVER greater than short-run average costs, because the firm is able to adjust all factors of production in the long run in order to minimize costs, whereas some factors (e.g. capital) are fixed in the short run.

4. If $MC = 0$ for all levels of output, then $AC = 0$ for all levels of output. **FALSE**

   This answer is false because there may be fixed costs. If the firm faces fixed costs even when $MC = 0$, *then* $AC \neq 0$.

5. A perfectly competitive industry IN the LR equilibrium exhibits $p = \min AC$. **TRUE**

   This is the implication of free entry and exit in a competitive market. In the long run, the firms that are producing in a perfectly competitive market will face a $p = minAC$. *In theory, all firms will use the same production technology and the "bid" down the market price to the minimum of average cost.*

2 Multiple Choice (5 points)

Circle the ONE correct response for each question.

1. Decreasing returns to scale (DRS) implies

   (a) that the TRS is constant.

   (b) isoquants are negatively sloped.

   (c) $f(tK, tL) > t * f(K, L)$.

   (d) $\boxed{AC \text{ increases with output, } y.}$

   If a firm has decreasing returns to scale, then doubling inputs for example, gives less than double the output. So in order to double output, we need more than double the input. That implies more than double the cost, so AC increases with output. The reverse is true for increase returns to scale, which result in AC decreases with output.

2. A firm is maximizing profit where

   (a) $TRS = p$.

   (b) the isocost curve intersects the isoprofit line.

   (c) $\boxed{\text{the isoprofit line is tangent to the production function.}}$

   (d) $MP_K = MP_L$.

   This is the definition of profit maximization. The firm achieves the highest possible profit to produce a particular level of output.

3. If a firm, wanting to maintain the same level of output and reduce costs, is producing where $\frac{MP_L}{w} < \frac{MP_K}{r}$, then it should

   (a) increase labor ($\uparrow L$) and keep capital constant $\left(K = \bar{K}\right)$

   (b) $\boxed{\text{decrease labor } (\downarrow L) \text{ and increase capital } (\uparrow K).}$

   (c) keep labor constant $\left(L = \bar{L}\right)$ and decrease capital ($\downarrow K$)

   (d) increase labor ($\uparrow L$) and decrease capital ($\downarrow K$)

   Here the marginal product (additional output) per dollar from labor is less than the marginal product per dollar from capital. So, if the firm wants to produce the same level of output at a lower cost is should trade off some labor in favor of more capital. In fact, it should continue to do that until $\frac{MP_L}{w} = \frac{MP_K}{r}$. *Rearranging this equality* $\Rightarrow \frac{MP_L}{MP_K} = \frac{w}{r}$, *which is one TRS condition for cost minimization.*

4. If $MC = 5$ and is constant and $|\epsilon| = 2$ and is constant, the profit maximizing monopolist will charge the following price:

   (a) $\boxed{p = 10}$

   (b) $p = 2$

   (c) $p = 5$

   (d) cannot be determined with the available information.

   Use the marginal cost mark-up condition for a monopolist to solve for the equilibrium price. It is derived by setting $MR = MC$ and the formula is: $p = \dfrac{MC}{1 - \dfrac{1}{|\epsilon|}}$, where ϵ is the price elasticity of demand.

5. Consider a competitive, profit maximizing firm with $\pi = 10$, $MC = 2y$, and $y^* = 5$; . where y^* is the profit maximizing level of output. Which of the following is FALSE:

   (a) $AFC = 3$

   (b) $\boxed{PS = 15}$

   (c) $AVC = 5$

   (d) $p = 10$

   This problem requires a few calculations and asks you to find the FALSE response. First, if $y^* = 5 \Rightarrow MC = 10$. A competitive, profit maximizing firm produces where $p = MC = 10$. This rules out answer (d), because it is true We can calculate variable cost as the area under the MC curve up to $y^* = 5$. This is the area of a triangle, so,

$$VC = \frac{1}{2}(10 * 5) = 25 \Rightarrow AVC = \frac{25}{5} = 5$$

   This rules out answer (c). Using the definition of profit, we can solve for fixed costs.

$$\begin{aligned} \pi &= TR - TC \\ 10 &= p * y - VC - FC \\ 10 &= 10 * 5 - 25 - FC \\ 10 &= 25 - FC \\ FC &= 15 \Rightarrow AFC = \frac{15}{5} = 3 \end{aligned}$$

   This rules out answer (a), leaving answer (b) as the only incorrect response.

3 Short Answer (10 points)

Be as specific as possible. Draw a detailed picture(s) to help clarify your response.

1. Describe the deadweight loss (DWL) from monopoly? Try to address the following questions in your response: **For a detailed picture, see Figure 24.5 on page 423 of Varian.**

   (a) What is "lost" or why do we consider it "loss" and who loses?

   What is lost is efficiency or welfare. Monopoly, relative to the competitive equilibrium (which you know is Pareto efficient), reduces output and increase price in order to maximize profit. It is considered loss because there are consumers willing to pay more for the good than it costs to produce, but those "gains" from trade are lost. Society loses because the industry is producing at an inefficient level, and in particular, consumers lose relative to the competitive equilibrium because the monopolist captures some consumer surplus.

   (b) How does the monopoly equilibrium compare to the competitive equilibrium?

   The monopoly equilibrium relative to the competitive equilibrium is characterized by a higher price and less output.

   $$p^M > p^C \text{ and } q^M < q^C$$

   (c) Is there always deadweight loss from monopoly? If no, under what circumstances?

   NO. If a monopolist can perfectly price discriminate, then he captures all of the consumer surplus. This is a Pareto efficient outcome, but one in which all surplus is producer surplus. In addition, if demand is perfectly elastic, then the monopolist produces a $p = MC$ and there is no DWL from monopoly. In effect, the monopolist must behave as a competitive firm when demand is perfectly elastic.

Be as specific as possible. Draw a detailed picture(s) to help clarify your response.

2. Describe the firm's shutdown decision (equation). Try to address the following questions in your response: **For detailed pictures, see Figures 22.3 and 22.9 of Varian.**

   (a) What is the shutdown decision in the short run (SR) and why?

   The shutdown decision for the firm is characterized by the equation $p < AVC$. Technically speaking, price must be lower than the minimum of average variable, but that is generally understood from the equation. In the short run, the firm is willing to produce output when $p < AC$ so long as $p > AVC$, because the firm is minimizing its losses from FC despite making negative profits. In other words, the firm will produce positive output so long as it is covering, at least, some of its fixed costs.

   (b) What is the shutdown decision long run (LR) and why?

   The shutdown decision for the firm in the long run is essentially the same as that in the short run. The firm will not produce output if $p < \min AVC$. Note, however, that in the long run, $AVC = AC$ because all factors are variable (there are no fixed costs in the long run). So, the long run shutdown decision is characterized as $p < \min AC$. The firm has no reason to produce output if it is making negative profits in the long run.

   (c) What is the firm's supply curve in each case?

   The firm's supply curve in the short run is the MC curve $ABOVE$ AVC, and the supply curve in the long run is the MC curve $ABOVE$ AC.

4 Analytic Problem (10 points): Bundling

Problem 1 *Aaron Fields works at Subway. He sells sandwiches for \$3.00 and cookies for \$2.00. Aaron notices there are 3 types of Subway customers. For every 10 people that enter Subway, 2 people purchase BOTH, 4 people purchase the SANDWICH ONLY and are willing to spend \$1.00 for the cookie, and 4 people buy the COOKIE ONLY and willing to spend \$1.50 for the sandwich. Assume the following:*

- *Marginal cost of producing sandwiches and/or cookies is ZERO* $(MC = 0)$.
- *Creating bundles has a ZERO marginal cost.*
- *New Subway customers have the same characteristics as the 10 people described above*
- *If a consumer is buying the sandwich, for example, at the individual price of \$3.00, then that is his willingness to pay for a sandwich. The same is true for a cookie.*

1. What is the maximum price the "SANDWICH ONLY" people would be willing to pay for the sandwich/cookie bundle? **\$4.00**

   The maximum price that the "SANDWICH ONLY" people are willing to pay for the bundles is the sum of their willingness to pay for each good $(\$3.00 + \$1.00)$.

2. What is the maximum price the "COOKIE ONLY" people would be willing to pay for the sandwich/cookie bundle? **\$3.50**

   The maximum price that the "COOKIE ONLY" people are willing to pay for the bundles is the sum of their willingness to pay for each good $(\$1.50 + \$2.00)$.

3. What are Subway's profits on a group of 10 consumers if the bundle is priced at the "SANDWICH ONLY" people's maximum price from (1)? **\$32**

   If Subway uses the "SANDWICH ONLY" bundle price of \$4.00, *then profit will be,*

   $$\pi = (2 * \$4) + (4 * \$4) + (4 * \$2) = \$32$$

   The "BOTH" people are certainly willing to buy the bundle at \$4.00 since they are willing to pay \$5.00 for both goods. The "SANDWICH ONLY" people are willing to buy the bundle because it is priced at their exact willingness to pay for both goods. However, the "COOKIE ONLY" people are not willing to buy the bundle because their willingness to pay for both goods (\$3.50) *is less than \$4.00. So, they will continue to buy the COOKIE ONLY at a price of \$2.00.*

4. What are Subway's profits on a group of 10 consumers if the bundle is priced at "COOKIE ONLY" people's maximum price from (2)? **$35**

   If Subway uses the "COOKIE ONLY" bundle price of $3.50, *then everyone is willing to buy the bundle and profit will be,*

$$\pi = 10 * \$3.50 = \$35$$

5. Which price should Subway set for the bundle? **$3.50**

   Subway should set the "COOKIE ONLY" price of $3.50 because profit is larger under that bundle price ($35 > $32).

6. What are Subway's profits on a group of 10 consumers WITHOUT offering the bundle? **$30**

   If Subway does not sell the bundle, then each consumer will buy according to their type.

$$\pi = (2 * \$5) + (4 * \$3) + (4 * \$2) = \$30$$

7. Is it more profitable to bundle or not to bundle? **Bundle** ($35 > $30)

8. If t people buy BOTH products separately, $\left(\frac{10-t}{2}\right)$ people buy the SANDWICH ONLY, and $\left(\frac{10-t}{2}\right)$ buy only the COOKIE ONLY, what is Subway's profit, WITHOUT bundling, as a function of t?

   Now, instead of know that 2 people buy BOTH, 4 people buy SANDWICH ONLY, and 4 people buy COOKIE ONLY, we have to express each as the functions of t given above.

$$\begin{aligned}
\pi\left[t \mid no_bundle\right] &= (t * \$5) + \left[\left(\frac{10-t}{2}\right) * \$3\right] + \left[\left(\frac{10-t}{2}\right) * \$2\right] \\
&= 5t + \left(\frac{30}{2} - \frac{3}{2}t\right) + \left(\frac{20}{2} - \frac{2}{2}t\right) \\
&= 5t + 15 - \frac{3}{2}t + 10 - -\frac{2}{2}t \\
&= \frac{5}{2}t + 25
\end{aligned}$$

9. At what values of t is it unprofitable to bundle? (Hint: Set profit function from (8) greater than or equal to the maximum profit under bundling, $\pi\left[t \mid no\_bundle\right] \geq \pi\left[bundle\right]$ and solve for t).

$$\begin{aligned}
\pi\left[t \mid no_bundle\right] &\geq \pi\left[bundle\right] \\
\frac{5}{2}t + 25 &\geq 35 \\
\frac{5}{2}t &\geq 10 \\
t &\geq 4
\end{aligned}$$

10. Give an economic interpretation of t.

    *Recall from the definition that t is the number of people who are willing to buy BOTH goods separately. The result from part (9) suggests that if more than 4 people out of 10 rather than 2 people out of 10 (as the problem originally states) are willing to buy BOTH goods separately, then the firm would be better off not offering the bundle and continuing to sell the goods separately. Note, if exactly 4 people are willing to buy BOTH (leaving 6 people, 3 "SANDWICH ONLY" people and 3 "COOKIE ONLY" people) then the firm is indifferent between not offering the bundle and earning profit of \$35 $(4 * \$5 + 3 * \$3 + 3 * \$2)$ and offering the bundle at \$3.50 and earning \$35 in profit.*