Massachusetts Institute of Technology
Department of Economics

14.01 Principles of Microeconomics
Midterm #2 Solutions
Tuesday, November 4, 2003

Please print legibly.

Last Name: _____ First Name: _____

Student ID: _____

IMPORTANT: Please circle your section.

Sandra Chan				12 PM	1 PM	2 PM
Patricia Cortes			11 AM	12 PM		
Antara Dutta	9 AM	10 AM				
Alan Grant		10 AM				
Allison McKie		10 AM	11 AM		1 PM	

Instructions:

You have two hours to complete this exam. The test has a total of 100 points on 16 pages. You should try to complete each section in 30 minutes leaving 30 minutes at the end to check your answers. You may use a non-programmable calculator. We encourage you to write your answers in pen as it facilitates any regrading requests you may have.

Do not write anything in the area below.

Question 1:	/5	Question 7(a):	/6	Question 8(a):	/5
Question 2:	/5	Question 7(b):	/3	Question 8(b):	/5
Question 3:	/5	Question 7(c):	/3	Question 8(c):	/5
Question 4:	/5	Question 7(d):	/3	Question 8(d):	/5
Question 5:	/5	Question 7(e):	/4	Question 8(e):	/5
Question 6:	/5	Question 7(f):	/7	Question 8(f):	/5
Question 7:	/35	Question 7(g):	/7	Question 8(g):	/5
Question 8:	/35	Question 7(h):	/2		
TOTAL:	/100				

Section I: True/False/Uncertain

In this section, write whether each statement is true, false, or uncertain. Please fully explain your answer, using a diagram if appropriate. No credit will be given for an answer without an explanation.

1. (5 points) A firm with a production function $q = L^{\frac{1}{3}}K^{\frac{1}{6}}$ that participates in a perfectly competitive market will never shut down, even in the short run.

   True. In the short run K is fixed, say at level $\bar{K}$. The cost function is therefore

   $$C(q) = L(q)\cdot w + \bar{K}\cdot r = \frac{q^3}{\bar{K}^{\frac{1}{2}}}w + \bar{K}\cdot r \quad \text{but} \quad P = MC = \frac{3q^2}{\bar{K}^{\frac{1}{2}}} > \frac{q^2}{\bar{K}^{\frac{1}{2}}} = AVC.$$

   Given that price is always greater that average variable cost for any $q > 0$, the firm will never shut down.

2. (5 points) Larry was working 8 hours at a job that paid wage w_1 and then worked 4 hours at a second job that paid wage w_2 ($< w_1$) because he could not work more than 8 hours at the first job. Now, he can work as many hours as he wants at the first job. It is possible that he will work exactly 8 hours.

   False. Given that working 8 hours was part of Larry's possibility set before the change and he didn't choose it, he would not choose it when his possibility set has expanded.

3. (5 points) An increase in the per hour cost of childcare reduces the number of hours working mothers work.

   Uncertain. Working hours will increase if leisure is a normal good and the income effect is greater (in absolute value) than the substitution effect.

4. (5 points) A monopolist will earn zero profits if it produces at a quantity where marginal cost equals average cost.

   False. The optimal quantity may occur at a point where the marginal cost equals the average cost. Note that the marginal cost curve always intersects the average cost curve at the minimum of the average cost curve. At the monopolist's profit maximizing choice of quantity, Q^*, consumers are willing to pay a price $P^* > AC$. P^* is greater than the average cost of producing Q^* because the demand curve is above the marginal revenue curve.

5. (5 points) Assume that a manufacturer of televisions has two inputs, labor and capital. The manufacturer's technology has constant marginal product of labor of 20 and constant marginal product of capital of 10. Consequently, the manufacturer will never use equal amounts of labor and capital in production.

6. (5 points) Suppose Congress decides to decrease the length of new drug patents from 20 years to 15 years; that is, new drug patents would expire in 15 years rather than 20 years. This action would increase every consumer's surplus and decrease every producer's surplus.

   False. For consumers who buy the new patented drug, their surplus will increase because new patented goods will be sold at monopoly prices for 5 fewer years. However, consumer surplus will be negatively affected by fewer new products/inventions being created. The profits from developing a patented good are now less (due to the shorter patent life) so products that before the shortened patent life would have been profitable and thus developed will now never exist. The consumers who would have bought those products now have lower surpluses. Whether a consumer's total surplus increases depends on how big the two effects are.

   Producer surplus will go down for new patented products because they have fewer years to charge monopoly prices at. However, firms with products with existing patents will not be harmed by this patent change since their patents will still be in effect for 20 years.

Section II: Long Answer Question #1

This question is in parts and is cumulative. If you cannot solve part of the question and you need the results of that part in later parts, you should assume a generic functional form (*e.g.* $q_S(p) = S(p)$) or describe what you would do with the solution from the earlier part to receive partial credit.

7. Casinos are one of Atlantic City's main attractions and for purposes of this exercise constitute a competitive industry. Assume each casino in the city has the same *long-run* total cost function given by

$$C(q) = \begin{cases} (q-2)^2 + 5 & \text{if} \quad q > 0 \\ 0 & \text{if} \quad q = 0, \end{cases}$$

where q is the number of units of service the casino provides (think of a unit of service as one customer participating in one round of blackjack). Prices and costs are in dollars. Assume free entry and exit of firms and constant input prices.

(a) (6 points) Compute the long-run supply function of each firm in the industry.

Firm Supply Function in the Long-Run = Marginal Cost Function (MC) above the Minimum Average Cost (MAC).

$$MC(q) = C'(q) = 2q - 4$$

$$AC(q) = \frac{C(q)}{q} = q + \frac{9}{q} - 4$$

To find MAC, $AC'(q) = 1 - \frac{9}{q^2} = 0 \implies q = 3 \implies MAC = 2.$

So, $p = MC(q) = 2q - 4 \quad \text{if} \quad p \geq 2.$

Thus, firm long-run supply curve is

$$q_S = \begin{cases} \frac{p}{2} + 2 & \text{if} \quad p \geq 2 \\ 0 & \text{otherwise} \end{cases}$$

(b) (3 points) Derive the long-run market supply function.

Given our assumptions of a perfectly competitive market with identical firms, free entry and exit, and constant input prices, long-run market supply curve is $p = 2$.

Demand for casino services is given by the demand function:

$$Q_D = 500 - 100p.$$

(c) (3 points) Find the long-run equilibrium price and market quantity.

Equilibrium is $p^* = 2$ *and* $Q^* = 300$.

(d) (3 points) At the long-run equilibrium in part (c), calculate how many service units each casino will provide and how many casinos will participate in the market.

We know from part (a) that each firm is producing $q = 3$ at $p = 2$, therefore 100 firms should be producing.

Welfare analysis

(e) (4 points) Compute and show graphically the consumer surplus and producer surplus at the long-run equilibrium you found in part (c).

$$\textit{Consumer Surplus} \quad (CS) = \frac{3 \cdot 300}{2} = 450.$$

$$\textit{Producer Surplus} \quad (PS) = 0.$$

Now suppose that the Atlantic City council, as a result of continuous complaints by residents about the disturbing noise caused by the casinos, is studying proposals that reduce the trade of casino services.

(f) (7 points) One council member, who owns an existing casino, proposes to limit the number of casinos in the city and impose a limit of 50. Find the new equilibrium price, market quantity, and amount sold by each casino in the long-run with this limit in place. Compute and show graphically the consumer surplus, producer surplus, and total welfare in the casino market under this policy.

Have to find first the new Long Run Market supply curve. For quantities below 150 (50 firms $*$ 3) the function is a horizontal line at $p = 2$, but quantities above the supply curve is the sum of the supply curves of the 50 firms:

$$\textit{Long Run Market supply curve} = \begin{cases} Q_S = 0 & \textit{if} \quad p < 2 \\ p = 2 & \textit{if} \quad p = 2 \\ Q_S = 50\left(\frac{p}{2} + 2\right) = 25p + 100 & \textit{if} \quad p > 2 \end{cases}$$

New equilibrium is $p^* = 3.2$ *and* $Q^* = 180$. *Consumer surplus is* $CS = \frac{1.8 \cdot 180}{2} = 162$, *producer surplus is* $PS = 150 \cdot 1.2 + \frac{30 \cdot 1.2}{2} = 198$, *and total surplus* $TS = CS + PS = 162 + 198 = 360$.

(g) (7 points) Rather than limiting the number of casinos as in part (f), another member proposes to impose a per unit tax of \$1.2 on casino services (paid by producers) so that in addition to reducing the trade in the casino market the city council can collect some resources. Assume that the resources collected by the council will be distributed back to consumers and producers in the casino market so tax revenues are included in total welfare. Compute and show graphically the consumer surplus, producer surplus, tax revenues, and total welfare in the casino market under this policy.

Given that supply is perfectly elastic, it should shift upwards to $p = 3.2$. *The new equilibrium point is* $p^* = 3.2$ *and* $Q^* = 180$. *Consumer surplus is* $CS = \frac{1.8 \cdot 180}{2} = 162$, *producer surplus is* $PS = 0$, *taxes are* $T = 180 \cdot 1.2 = 216$, *and total surplus is* $TS = CS + PS + T = 162 + 216 = 378$.

(h) (2 points) If the objective of the council is to maximize total welfare in the casino market, which of the two policies should the members choose?

They should choose to implement the taxing policy.

Section III: Long Answer Question #2

This question is in parts and is cumulative. If you cannot solve part of the question and you need the results of that part in later parts, you should assume a generic functional form (*e.g.* $q_S(p) = S(p)$) or describe what you would do with the solution from the earlier part to receive partial credit.

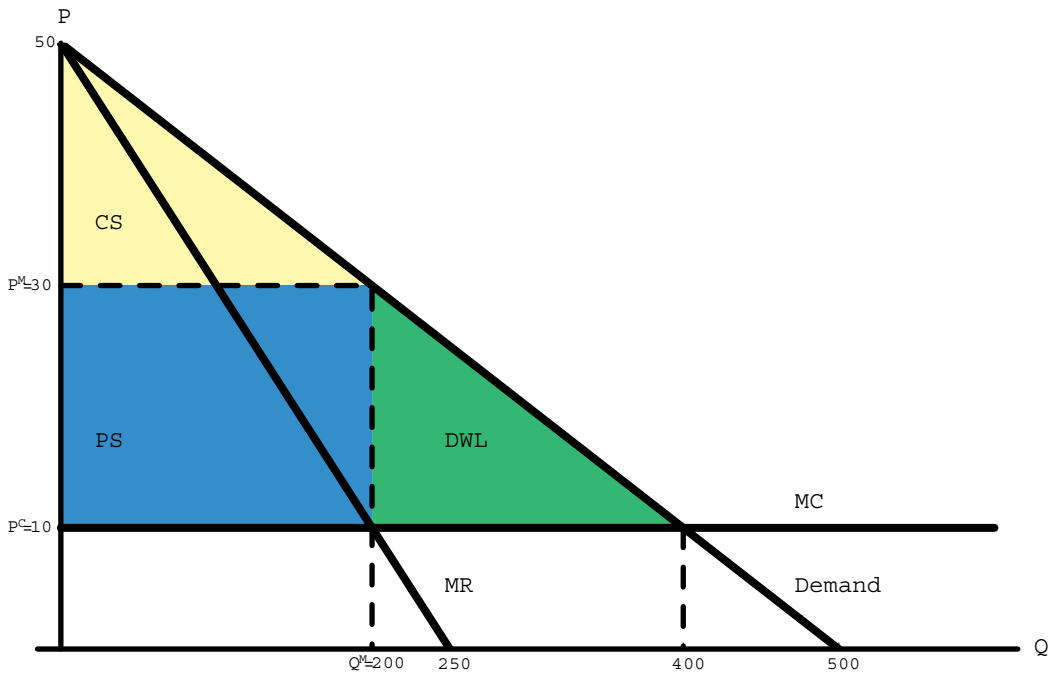
8. Ohana Airlines has a monopoly in supplying inter-island flights in Hawaii. It faces a market demand $Q = 500 - 10P$. Suppose that the cost of providing flights between islands is given by the cost function, $C(Q) = 10Q$, where Q is the number of inter-island tickets sold.

   (a) (5 points) Find the price Ohana Airlines will charge and the number of tickets it will sell.

   A monopoly maximizes its profits by finding Q such that $MR(Q) = MC(Q)$. Revenue$= PQ$ and using the demand equation, we can isolate P and find the inverse demand equation, $P = 50 - \frac{1}{10}Q$. Plugging this into the revenue, we get: Revenue $= \left(50 - \frac{1}{10}Q\right)Q$. Taking the derivative of the revenue equation with respect to Q, we get that $MR = 50 - \frac{1}{5}Q$. Taking the derivative of the cost function with respect to Q, we find that $MC = 10$ (always). Thus, $MR = 50 - \frac{1}{5}Q = 10 = MC \implies Q^M = 200$. We can now plug this back into the demand equation to find that $P^M = 30$.

(b) (5 points) Calculate the consumer surplus and producer surplus under the monopoly outcome you found in part (a). Also, calculate the deadweight loss associated with this outcome relative to the perfectly competitive outcome. Indicate on a diagram the consumer surplus, producer surplus, and deadweight loss of the monopoly outcome.

The competitive equilibrium would be where $P = MC \Longrightarrow P^C = 10 \Longrightarrow Q^C = 500 - 10(10) = 400$. *Consumer surplus* $CS = \frac{1}{2}(50-30)(200) = 2000$, *producer surplus* $PS = (30-10)(200) = 4000$, *and deadweight loss* $DWL = \frac{1}{2}(400-200)(20) = 2000$.



(c) (5 points) How could the government of Hawaii regulate Ohana Airlines in order to eliminate the deadweight loss? Explain your answer. Are there any possible problems with the government's solution? Explain.

In order to get the perfectly competitive outcome, the government could set a price ceiling at $P = 10$. *So although the monopoly would like to charge* $P^M = 30$, *the highest price it can charge is the competitive price. At* $P = 10$, *we'll get* $Q = 400$ *and thus, the perfectly competitive outcome. This will eliminate the DWL.*

The question then becomes how does the government know the firm's cost function (or the demand curve) in order to set the price ceiling at the price where the marginal cost curve intersects the demand curve. If the government has the wrong information or guesses wrong then we won't end up at the perfectly competitive outcome. If the price ceiling is set too high, then Ohana Airlines will charge a price higher that MC and some DWL will still exist. Worse, if the price ceiling is set too low, then $P < MC$ *and since MC is constant, this means that* $P < AVC$ *(Average Variable Cost) and Ohana Airlines will no longer supply inter-island flights.*

(d) (5 points) Suppose the government decides to tax Ohana Airlines $20 per ticket. Find the price the airline will charge and the number of tickets it will sell. Compare this to the perfectly competitive outcome. Explain the intuition for your answer.

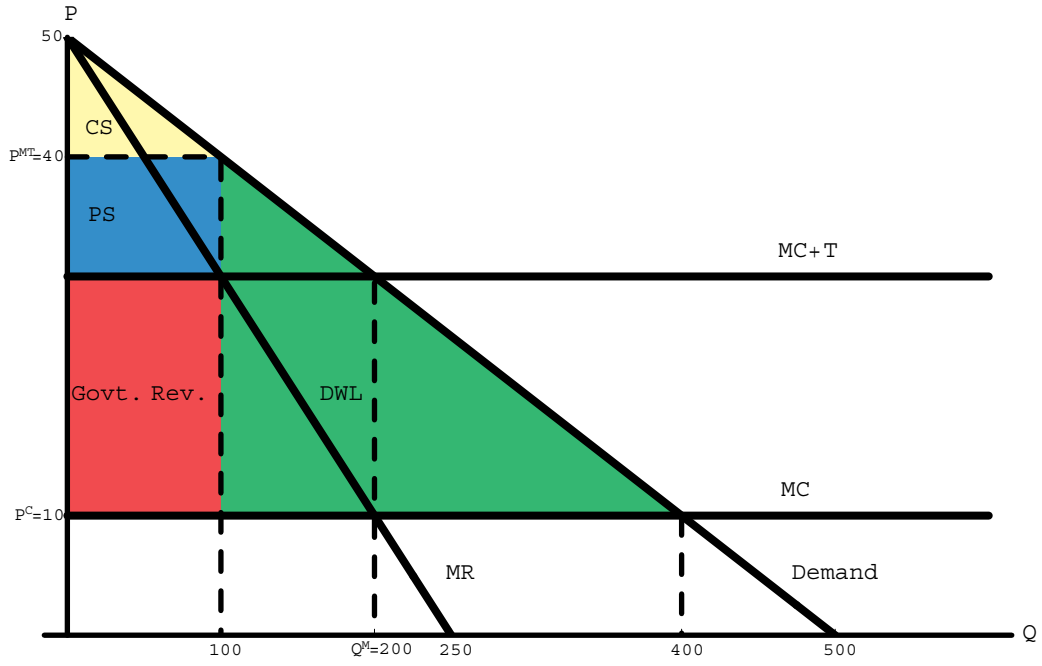
The $20 tax increases the cost of selling tickets. Instead of $C = 10Q$, *Ohana Airlines now has the cost function,* $C = (10+T)Q \implies C = (10+20)Q \implies C = (30)Q$.

Once again, the monopoly maximizes profits by setting $MR = MC$. $50 - \frac{1}{5}Q = 30 \implies \frac{1}{5}Q = 20 \implies Q^{MT} = 100 \implies P^{MT} = 50 - \frac{1}{10}(100) = 40$.

The new monopoly price ends up being even higher than the non-taxed monopoly price and thus even further from the perfectly competitive price. By taxing the monopoly, the government succeeded in increasing the price charged to consumers instead decreasing the price. The logic here is that although, we want Ohana Airlines to charge a price of $10, taxing away $20 will not get us to the competitive outcome. Effectively, the tax on the airline increased the marginal cost of selling tickets. The monopoly will share this additional cost (the tax) with the consumers and thus increasing its price. The new number of tickets sold will also be less since the new price is higher.

(e) (5 points) Calculate the consumer surplus, producer surplus, and government revenue associated with the tax in part (d). Also calculate the deadweight loss associated with this new outcome compared to the perfectly competitive case. Indicate on a diagram the consumer surplus, producer surplus, deadweight loss, and government revenue associated with the tax.

Consumer surplus is $CS = \frac{1}{2}(50-40)(100) = 500$, *producer surplus is* $PS = (40-30)(100) = 1000$, *government revenue is* $G = T \cdot Q^{MT} = (20)(100) = 2000$, *and the deadweight loss is* $DWL = \frac{1}{2}(400-100)(40-10) = 4500$.



(f) (5 points) Now suppose Ohana Airlines has a new cost function, $C(Q) = 2000 + 20Q$, where \$2000 represents a payment to Hawaii airports for the right to use those airports. Could the government of Hawaii implement the same strategy you suggested in part (c) to get the perfectly competitive outcome? Explain your answer. If not, give an alternative strategy and its outcome (price and quantity).

Ohana's new MC is now 20. If the government of Hawaii was to set $P = MC$, then there would be no DWL as long as Ohana Airlines chose to continue to be in business. However, this price doesn't allow Ohana Airlines to make up its fixed costs. If it continued to operate with $P = MC = 20$, then it would lose \$4000 every period. Consequently, if the government created a price ceiling of $P = 20$, then Ohana Airlines would stop offering inter-island flights. The solution that would have worked in part (c) does not work here.

So in order to keep Ohana Airlines operating, the government can do two things. First, it could set the price ceiling at $P = AC =$ average cost. This will be enough for Ohana Airlines to breakeven. To find what P is, the government needs to know where the AC curve intersects the demand curve. $AC = \frac{2000}{Q} + 20 = P$. Plugging this into the demand function we get: $Q = 500 - 10\left(\frac{2000}{Q} + 20\right) \Longrightarrow$ $Q^2 - 300Q + 20000 = 0$. Using the quadratic formula or by factoring, we find that $Q = 100$ or 200. To minimize the DWL, the government would choose the higher quantity, $Q = 200 \Longrightarrow P = 30$. Of course, this still doesn't get us the case where $P = MC$ (by construction).

The government could instead set the price ceiling at $P = 20 = MC$ and pay Ohana Airlines its fixed cost (\$2000). This will maximize the number of tickets sold, but will come at a cost to the government.

Since in either scenario, Ohana airlines makes no profits (breaks even) the comparison of the two possibilities comes down to the difference in consumer surplus and government expenditures. If $P = AC = 30$ with $Q = 200 \Longrightarrow CS = \frac{1}{2}(50-30)(200) = 2000$ and if $P = MC = 20$ with $Q = 300 \Longrightarrow CS = \frac{1}{2}(50-20)(300) = 3000$. CS is 1000 higher in the $P = MC$ scenario. However, it costs the government \$2000 to get this outcome. The government pays \$2000 to get consumers \$1000 of extra surplus. Unless, there is an equity argument here, it makes no sense for the government to subsidize $P = MC$.

(g) (5 points) Assume Ohana Airlines had been given the right to be the exclusive supplier of inter-island flights in Hawaii. If the government decided to allow other airlines to enter the inter-island market would that increase the consumer surplus relative to the scenario in part (f)? Explain your answer. Assume that all airlines have the same cost function as part (f).

Let's look at Ohana Airlines profits as a monopoly. Setting $MR(Q) = MC(Q) \Longrightarrow Q^M = 150, P^M = 35$ *so revenue is* $P^M Q^M = 35 \cdot 150 = 5250$*, cost* $C = 2000 + 20 \cdot 150 = 5000$*, and profit is* $\pi = 5250 - 5000 = 250$.

Given a monopoly is only able to make $250 profits after paying all of its costs, another firm could not enter and breakeven. Two firms would have two times the fixed costs as one firm. If one firm is unable to make enough profits to pay for $4000 of fixed costs, then two firms can't. Two firms will not be able to do better than one firm in generating profits. This is a case of a natural monopoly—one firm can produce the total output of the market at a lower cost than multiple firms could.