Economics 33530: Assignment 1 (due Friday, September 21)

Professor Jensen Fall 2007

Problem 1

The market demand for vaccinations is given by the MPB function

$$MPB = 40 - (1/8)Q,$$

where MPB is the price of (marginal willingness to pay for) a vaccination, and Q is the quantity demanded at that price.

The MSB function for vaccinations is given by

$$MSB = 50 - (1/8)Q,$$

where MSB is the marginal social value of a vaccination.

The marginal private cost MPC of producing and providing vaccinations is given by

$$MPC = 5 + (1/2)Q$$

where Q is the quantity supplied by the industry at that MPC.

1. What is the market outcome? Specifically, determine the quantity of vaccinations provided by the market Q_M, and the corresponding price P_M and net social benefit NSB_M.

$40 - (1/8)Q_M = 5 + (1/2)Q_M$ if $Q_M = 56$
$P_M = 40 - (1/8)(56) = 5 + (1/2)(56) = 33$
At $Q_M = 56$, $MSB=50–(1/8)(56)=50–7=43$ and $MPC=5+(1/2)(56)=5+28=33$, so
$NSB_M = (1/2)(56)(50 – 43) + (56)(43–33) + (1/2)(56)(33 – 5) = (28)(7+28)+560 = 1540$.

2. What is the socially optimal outcome? Specifically, determine the quantity of vaccinations provided by the market Q*, and the corresponding price P* and net social benefit NSB*.

$50 - (1/8)Q^* = 5 + (1/2)Q^*$ if $Q^* = 72$
$P^* = 50 - (1/8)(72) = 5 + (1/2)(72) = 41$
$NSB^* = (1/2)(72)(50–41)+(1/2)(72)(41–5) = (36)(9+36) = 1620$.

3. Suppose the government intervenes by offering consumers a subsidy of s per vaccination, so that now the marginal private benefit function becomes

$$MPB(s) = 40 + s - (1/8)Q.$$

What consumption subsidy s will alter the market outcome to the socially optimal quantity Q*?

$40 + s - (1/8)Q = 5 + (1/2)Q$ at $Q=72$ if $40 + s - (1/8)(72) = 5 + (1/2)(72)$, or
$s = 5 + (1/2)(72) - 40 + (1/8)(72) = 10$.

4.Suppose instead that the government intervenes by offering producers a subsidy of S per vaccination provided, so that now the marginal private cost function becomes

$$MPC(S) = 5 - S + (1/2)Q.$$

What production subsidy S will alter the market outcome to the socially optimal quantity Q*?

$40 - (1/8)Q = 5 - S + (1/2)Q$ at $Q=72$ if $40 - (1/8)(72) = 5 - S + (1/2)(72)$, or
$S = 5 + (1/2)(72) - 40 + (1/8)(72) = 10$.

5. Which of these two policy approaches would you recommend, and why?

This is really just a question of whom you prefer to subsidize (give the $10), consumers or producers. Your answer just needs to provide some (any) reasonable explanation for why you prefer to subsidize one group over the other.

Problem 2

Suppose there are two firms (labeled 1 and 2) producing electricity whose marginal abatement cost functions are

$$MAC_1 = 480 - 3E_1$$

and

$$MAC_2 = 400 - 2E_2$$

where E_1 and E_2 are the levels of emissions by these firms.

1. In the absence of government policy, what levels of emissions are chosen by each firm? Label these E_{1U} and E_{2U}.

$MAC_1 = 480 - 3E_{1U} = 0$ at $E_{1U} = 160$ and
$MAC_2 = 400 - 2E_{2U} = 0$ at $E_{2U} = 200$.

2. Suppose the government passes a law requiring that each firm reduce its emissions by 50%, so E_1 must be reduced to $(½)E_{1U}$ and E_2 must be reduced to $(½)E_{2U}$. Determine the total abatement cost of this reduction for both firms.

At $E_1=(½)E_{1U}=80$, $MAC_1 =480-3(80) =240$, so $TAC_1 =(½)(160-80)(240) = 9600$.
At $E_2=(½)E_{2U}=100$, $MAC_2 =400-2(100) =200$, so $TAC_2 =(½)(200-100)(200) = 10000$.

3. Determine the tax per unit of emissions that achieves the same level of total emissions as the requirement of a 50% reduction by each firm, $(½)(E_{1U}+E_{2U})$. If the government levies this tax, what are the resulting levels of emissions chosen by each firm. What is the total abatement cost of the resulting emissions reductions for both firms? Is this approach more or less efficient than requiring equal percentage reductions in emissions? Explain.

To achieve total emissions of 180 at a tax t such that $t = MAC_1 = MAC_2$ requires that $E_1 + E_2 = 180$ and $t = 480 - 3E_1 = 400 - 2E_2$, or $3E_1 - 2E_2 = 80$.
This occurs if $E_1 = 88$ and $E_2 = 92$.
At $E_1 = 88$, $MAC_1 = 480-3(88) = 216$, and $TAC_1 = (½)(160–88)(216) = 7776$.
At $E_2 = 92$, $MAC_2 = 400-2(92) = 216$, and $TAC_2 = (½)(200–92)(216) = 11664$.

The correct tax is $t = 216$, and $TAC_1+TAC_2 = 19440 < 19600$, so this approach is more efficient because it achieved the same reduction in pollution at a lower total cost.

4. Now suppose the government creates a "cap and trade" program with a total cap of $(½)(E_{1U}+E_{2U})$ pollution permits, and it divides these permits equally between the firms. If they are allowed to trade these permits, what is the resulting price of the permits, what are the resulting levels of emissions chosen by each firm? Is this price the same as the tax the government would have to choose to attain total emissions of $(½)(E_{1U}+E_{2U})$? Explain.

To achieve total emissions of 180 at a price P such that $P = MAC_1 = MAC_2$ requires that $E_1 + E_2 = 180$ and $P = 480 - 3E_1 = 400 - 2E_2$, or $3E_1 - 2E_2 = 80$.
This occurs, as above, if $E_1 = 88$ and $E_2 = 92$.
At $E_1 = 88$, $MAC_1 = 480-3(44) = 216$, and $TAC_1 = (½)(160–88)(216) = 7776$.
At $E_2 = 92$, $MAC_2 = 400-2(46) = 216$, and $TAC_2 = (½)(200–92)(216) = 11664$.
$P = 216$ is the same as the tax required to make $t = MAC_1 = MAC_2$ when $E_1 + E_2 = 180$.
The reason is just that the condition for choosing the tax is the same as the condition that the price must satisfy, $t = MAC_1 = MAC_2$ defines t and $P = MAC_1 = MAC_2$ defines P.