EC 501: Problem Set 12, Solutions

1. (a) If Johnsville is not regulated, it will ignore the externality and simply maximize its profit, using the monopoly solution. Now demand can be written as

$$P = 22 - \frac{1}{120}Q,$$

$$then \quad MR = 22 - \frac{1}{60}Q.$$

Setting MR=MC to maximize profits gives us:

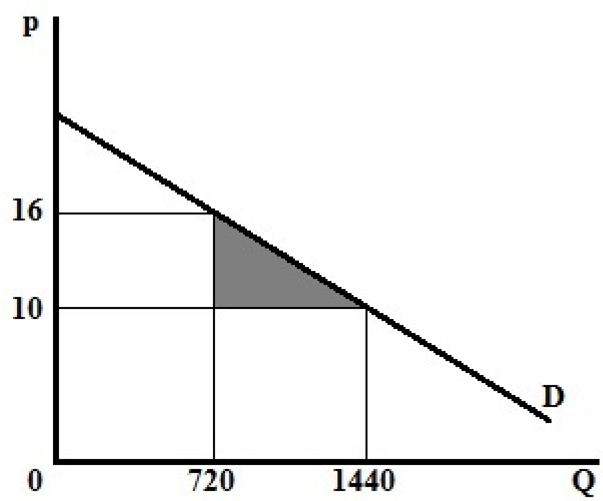
$$22 - \frac{1}{60}Q = 10 \qquad \rightarrow \qquad Q = 720.$$

Then

$$P = 16 \qquad and \qquad \pi = (16 - 10) \cdot 720 = 4320.$$

(b) Under competition, since MC=AC=10, we will have p=10 and so Q=1440.

(c) Since the damage caused by the asbestos is greater than the \$4 cost of abatement, the socially efficient solution would involve abatement of all of the asbestos. The SMC of insulation would then be \$14 per ton, and this should be the price. Using the demand curve, we find that then Q=960.



The figure shows the monopoly and competitive solutions, and the shaded area shows the normal deadweight loss due to monopoly when there is no externality. Against this we need to account for the fact that the extra 720 units of production under competition lead to *720x* in external damage costs. This net deadweight loss due to monopoly is therefore

$$DWL = \frac{1}{2} \cdot 6 \cdot 720 - 720x = 720(3 - x).$$

Since we are told that $x>4$, this DWL is negative; in other words, social welfare is higher under monopoly than under competition.

2. (a) $\triangle\pi(Q)$ is the rise in profits if Q tons of pollutants are cleaned up; it is therefore a measure of the total benefit from abatement. The marginal benefit (MB) of abatement then is

$$MB = \frac{d\triangle\pi}{dQ} = 10 - \frac{1}{5}Q.$$

The optimal level of abatement would be found where the MB and MC of abatement are equal, that is, where

$$10 - \frac{1}{5}Q = 2 \qquad \rightarrow \qquad Q = 40.$$

(b) Whether Filthy bought Trout or Trout bought Filthy, a jointly owned firm would attempt to maximize joint profits. In this case, they would want to maximize

$$\Pi = 10Q - \frac{1}{10}Q^2 - 2Q,$$

since $2Q$ is total clean-up cost. This is maximized where

$$\frac{d\Pi}{dQ} = 10 - \frac{1}{5}Q - 2 = 0 \qquad \rightarrow \qquad Q = 40.$$

(c) The Coase Theorem states that the problem of externality disappears if property rights are well-defined and transactions costs are zero, regardless of the allocation of property rights. The answer to (b) neither confirms nor denies the theorem, because here the problem of externality is being eliminated not by negotiation but by a process of *internalization* of the externality.

3. (a) The competitive equilibrium will have firms divided between the two fields in such a way that the average product (AP) is equalized across the fields. Now

$$AP_A = \frac{Q_A}{N_A} = 39 - \frac{1}{2}N_A \qquad and \qquad AP_B = 30 - N_B.$$

Further

$$N_A + N_B = 30.$$

Then

$$AP_A = AP_B \qquad \rightarrow \qquad 39 - \frac{1}{2}N_A = N_A \qquad \rightarrow \qquad N_A = 26.$$

And then $N_B = 4$. Since $AP_B = 30 - N_B$, $AP_b = 26$. And AP_A must also be 26 then, as AP is equal across the two fields. Therefore total output is

$$Q = 26 * 30 = 780.$$

(b) Using the fact that $N_B = 30 - N_A$, we can write total output as

$$Q = 39N_A - \frac{1}{2}N_A^2 + 30(30 - N_A) - (30 - N_A)^2.$$

Then output is maximized when

$$\frac{dQ}{dN_A} = 39 - N_A - 30 + 2(30 - N_A) = 0 \qquad \rightarrow \qquad N_A = 23.$$

Then $N_B = 7$. This allocation is the one where the MP has been equated across the two fields.

(c) Since the efficient solution involves fewer wells on field A, government needs to charge a fee to companies that want to drill on field A; the fee would need to be the difference in AP between the two fields at the optimum. Now, with $N_A = 23, N_B = 7$,

$$AP_A = 39 - \frac{1}{2}N_A = 27.5 \qquad \textit{and} \qquad AP_B = 30 - N_B = 23.$$

Thus the fee needs to be set at 4.5 so as to reduce the net AP_A to 23.

(d) When a resource is commonly owned, too much use of that resource takes place under free entry, since firms are guided by their *average* product rather than *marginal* product. In our example, the more productive field, field A, attracts too much entry. The marginal entrant does not take into account the negative externality he imposes on all other firms in the field.