Taxes vs. Standards Under Uncertainty

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Firms emit Benzene as a by-product in the production of synthetic fibers, plastics, and resins. Knowing benzene is a harmful pollutant, a regulator decides to design an efficient policy to control benzene emissions produced at a chemical plant in Bakersfield. The regulator estimates the total firm benefit of using amount, Q, of benzene to be:

$$TB(Q) = 120Q - 0.25Q^2$$

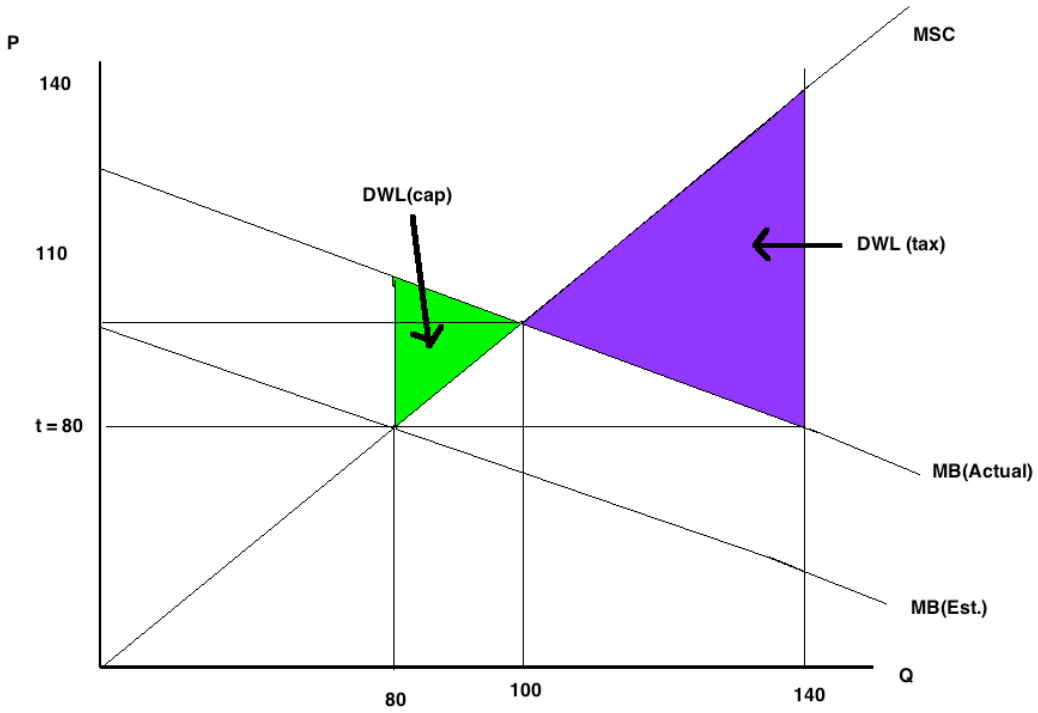
. The total social cost of emitting Q units of benzene is equal to:

$$TSC(Q) = 0.5Q^2$$

Q1. Using the estimated total benefits and total social cost, what pollution tax (t*) would the regulator set? What pollution cap (Q_E) would the regulator set? Show graphically.

Q2. Suppose it turns out that the regulator has under-estimated the firm's benefit of using benzene. The benefit of using benzene (Q) at the chemical plant is actually $TB_A(Q) = 150Q - 0.25Q^2$. What is the socially optimal amount of benzene. What is the actual outcome that will occur under the tax from part 1 (t=80).

Q3. Using the actual benefits and costs of benzene emissions, show the social optimum, and the outcome under a pollution standard graphically. Shade the areas on the graph that represent deadweight loss under a standard set at $Q_{Estimate}$ and deadweight loss under a tax set at t=80. Calculate deadweight loss in each case. Why is deadweight loss larger using one instrument than the other?



A1. The firm's expected marginal benefit of Benzene use is: MBE

$$MB(Q) = 120 - 0.5Q$$

Marginal social cost of Benzene use is:

$$MSC = Q.$$

Equating MSC and MB, the regulator would set a standard of:

$$120 - 0.5Q = Q$$

$$Q_E = 80.$$

The tax (or fee) that would achieve this expected outcome is t* = MEC (=MSC)

$$t^* = \$80$$

A2. The firm's actual marginal benefit of using Benzene is:

$$MB_A = 150 - 0.5Q$$

Marginal social cost of Benzene use is unchanged:

$$MSC = Q.$$

Equating the actual marginal benefit and social cost curves, gives the socially optimal level of Benzene use:

$$150 - 0.5Q = Q$$

$$Q^* = 100.$$

Under a tax of t = \$80/unit, the firm will continue to pollute as long as the marginal benefit of polluting an additional unit of Benzene is greater than the value of the tax:

$$150 - 0.5Q = 80$$

$$Q^{tax} = 140.$$

A3.

Standard:

Using the area formula A = ½(base)(height), we need to calculate the height of the DWL triangle by calculating MBA(80) = 150 – 0.5(80) = \$110.

Deadweight loss under the standard is:

$$DWL(standard) = ½ (100\text{-}80)(110\text{-}80) = \$300$$

Tax:

For the tax, we need to calculate the height of the DWL triangle by calculating MSC(140) = \$140.

Deadweight loss under the tax is:

$$DWL(tax) = ½ (140\text{-}100)(140\text{-}80) = \$1{,}200$$

Note: You can use calculus to calculate the deadweight loss by integrating the area between MBA and MSC in each case or by calculating the area of the triangles.

This is the Wietzman model: Under uncertainty on the actual MB of emissions facing firms, the standard performs better than the taxes in this case because the MB function is relatively flat.