Lecture Notes 2 supplement
Economics of the Environment and Natural Resources/Economics of Sustainability
K Foster, CCNY, Spring 2011

Pigouvian Fees: tax just equal to external marginal damages
so sometimes tax can be imposed without creating DWL
or government can provide a subsidy for not polluting

Tax or subsidy – what is difference?

- in SR
  - tax raises MC & VC and doesn't change FC
  - subsidy to not produce raises MC just like tax but lowers AVC [quasi-fixed cost]
- in LR
  - tax raises LR supply
  - subsidy to not produce lowers LR supply

This is in perfect competition; what about imperfect competition?
if company is a monopolist in producing output
if company is monopolist in producing emission (monopsony analysis)

In SR, assume C(y,e) = VC(y,e) + FC; if e=f(y) then C(y) = VC(y) + FC and $MC = \frac{dC}{dy} = \frac{dVC(y,e)}{dy}$.
A tax per emission would change costs to C(y,e) = VC(y,e) + te + FC = VC(y) + tf(y) + FC
Now marginal cost in the presence of a tax, MC_t, would be $MC_t = \frac{dC}{dy} = \frac{dVC(y,e)}{dy} + t\frac{de}{dy}$. We can assume that when output rises emissions also rise so that $\frac{de}{dy} > 0$; thus $MC_t > MC$.
A subsidy would pay the firm to reduce emissions below some target level, $\bar{e}$, so the subsidy is $s(\bar{e} - e)$. Put this into the firm's costs so $C(y,e) = VC(y,e) + FC - s(\bar{e} - e) = VC(y,e) + se + (FC - s\bar{e})$. So setting s=t produces the exact same effect on MC as the tax – paying the firm not to pollute is equivalent to taxing them if they pollute – in either case there is an opportunity cost to one more unit of pollution, on the margin. But there is a difference in the fixed costs, too, so the effects are not necessarily the same for the total market. Lowering the net fixed costs with a subsidy means that, in the short run, some firms will continue to operate, in order to receive the subsidy. Since the "short run" is amorphously defined as the period of time in which there are some fixed inputs, this could be a very long time for industries with long-lived capital such as electric power generation (where many plants are decades old and still going).

In the LR, a tax raises the average total cost of firms; a subsidy reduces the average total cost of the firms. We know from micro theory that in the long run firms will produce at their

minimum average total cost, so in the long-run a subsidy will mean more of the good being made (and therefore higher pollution) than with a tax.

Pigouvian Tax and Subsidy Example

Suppose production of some good, y, creates a level of pollution, p. For simplicity assume that each unit of y creates one unit of p.

The marginal cost of y is given as MC = 3 + y. Each unit of pollution has additional social marginal cost of 3, so the SMC(y) = 3 + (3 + y) = 6 + y.

The marginal benefit is the demand curve, which we assume is given by MB = 24 – 0.5y.

In private-competition equilibrium, y'=14 so p'=14 at price (=MC=MB) of 17.

The social optimum is instead where y*=12 so p*=12, at price (=MSC=MB) of 18.

So a tax of $t per unit of output, if levied on consumers, would shift demand down to 24 - t - .5y, so 24 – t - .5y = 3 + y and 21 – t = 1.5y; yt = 14 – (2/3)t. If t=3 then this would get us to the socially optimal level of output.

If the tax of $T per unit of output were levied on producers then their MC = 3 + T + y, so private equilibrium would get 24 - .5y = 3 + T + y and yt = 14 – (2/3)T – just as above.

Equivalently, the government could issue 12 permits for pollution. Firms would be willing to pay the marginal profits (of selling the good that would be produced) which are (MB – MC) = 24 – .5y – 3 – y = 21 – 1.5y = 21 – 1.5p. Set p=12 so its price is 3 – which is exactly the marginal social cost of the pollution.

Could also calculate cost of pollution. The marginal cost of pollution is 3; the marginal profits to companies from this pollution is (MB – MC) = 24 – .5y – 3 – y = 21 – 1.5y = 21 – 1.5p. Set MC(p) = MProfit(p) and solve for p*=12.

Or could subsidize firms to clean up from p_{max} = 14, so the cleanup, c = 14 – p. If cleanup is subsidized at s, then MC = 3 + y + s (since each unit of output created means one less unit of cleanup means one less unit of subsidy); again s=3 clearly delivers the same output (although, as noted, less efficient firms).

You can find the DWL for each case as functions of t or c or number of permits.