Economics 230a, Fall 2018
Lecture Note 2: Policies for Dealing with Externalities

We already know that a first-best response to externalities can in principle be achieved via Pigouvian taxes, which induce those causing the externality to internalize the external social costs (or benefits) of their actions. There are, of course, problems in implementing Pigouvian taxes; we may not know exactly what the marginal damage (or benefit) of an activity will be at a first-best equilibrium, since we are starting from a different equilibrium, and we don't have direct market valuations of the damage (or benefit). There may also be political reasons for tax-based solutions to be eschewed in favor of alternative approaches, if for example hidden taxes are more acceptable than explicit ones. There also may be administrative problems with taxing or otherwise controlling externalities directly, if it is hard to observe or measure their levels. For example, automobiles may cause negative externalities that are proportional to their tailpipe emissions of greenhouse gases, but the emissions from any particular automobile may be difficult for government to measure.

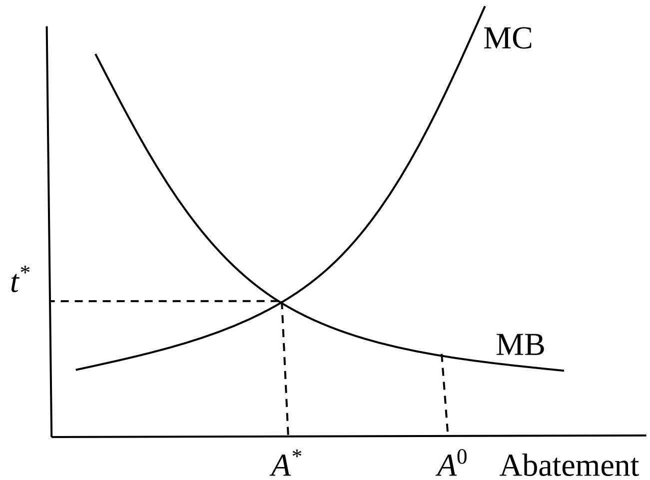
Alternatives to Corrective Taxes

Bovenberg and Goulder discuss alternatives to corrective taxation. The closest is probably *subsidies for pollution abatement.* If government pays polluters a subsidy for each unit that pollution falls below some benchmark level, then this is equivalent to providing them with a lump-sum transfer combined with a Pigouvian tax. That is, if the pollution benchmark is B units of emissions and the subsidy rate is s, the polluter receives a total subsidy $s(B - X)$ from the government, where X is the amount of pollution it emits. This is equivalent to getting a lump-sum transfer of sB and facing a tax at rate s per unit of pollution. In a world where the government can adjust lump-sum taxes and transfers, the subsidy-based policy and the tax-based policy are essentially identical. But, if the government must raise other, distortionary taxes to fund the lump-sum transfer implicit in the abatement subsidy, this policy may be less attractive, leaving aside the potentially adverse distributional consequences associated with transfers to polluters.

Quotas

Another common alternative to corrective taxation is *quotas* – using controls on quantities rather than prices to modify behavior. In the absence of uncertainty, quotas can be used to achieve the same outcome as corrective taxes.

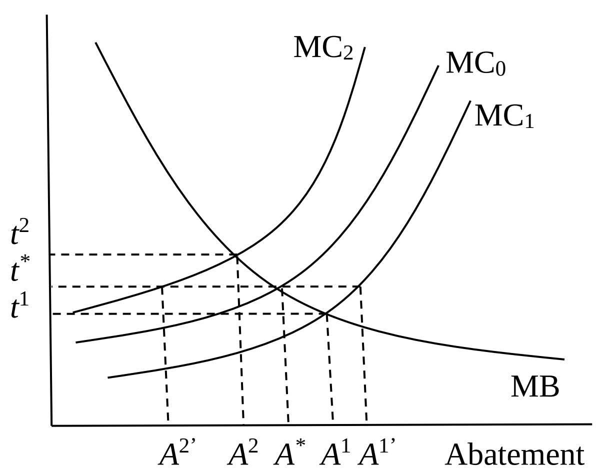
Consider the case where we know the marginal private costs of abatement and the marginal benefits of abatement. (Abatement can come from reducing output of a product that involves pollution, or from a switch in inputs – from coal to natural gas, for example; each method is costly to the producer, and we assume that producers efficiently choose among alternatives optimally, i.e., in a manner that minimizes their marginal abatement costs.) Representing costs, benefits and units of abatement in the following graph, we see that t^* would be the optimal Pigouvian tax. If A^0 represents complete abatement, then producers would abate up to A^* and choose to pay the tax at that point on remaining emissions, as further abatement would cost them more than the tax. How could we replicate this outcome using quotas?



Suppose that polluters are required to obtain a permit for each unit of pollution, and that government auctions a total number of permits equal to (A^0-A^*). It follows that total pollution cannot exceed (A^0-A^*). Also, the market-clearing price of permits will be t^*, since at the equilibrium abatement level, A^*, the cost to producers of not buying a permit will be the marginal cost of further abatement. Hence, the level of abatement and payments by producers will be the same as under the tax regime.

Note that this equivalence requires that permits (1) are auctioned by the government; and (2) can be freely purchased by any agent in the market. A violation of (1), for example by giving away the permits, would leave marginal incentives unchanged but would reduce government revenue, just as in the above comparison of an abatement subsidy and a corrective tax. Even if the permits are given away, permit trading would still ensure that the same equilibrium prevailed. However, if condition (2) is violated, for example if permits are given away and must be used by the producers who receive them, then the equilibrium will be different, because the marginal abatement costs of each producer will not be equalized, and hence the overall costs of abatement will increase. Thus, *nontradeable* permits/quotas are inefficient and dominated by a policy that allows trading. It is worth noting that, in a setting in which trading is not allowed, the optimal level of abatement would be lower, since the marginal costs of abatement are higher.

Another difference between price and quantity approaches arises with uncertain abatement costs. Following Weitzman (*REStud* 1974), which approach is more effective depends on the relative slopes of the MB and MC curves in the above figure. Suppose the expected MC curve is MC_0, but that costs might be higher or lower. If costs are lower, we would then wish to have a lower tax or fewer permits (more abatement); if costs are higher, we would want the opposite.



If we must fix either the abatement level A^* or the tax rate t^*, then either policy will induce deadweight loss. Under the tax policy, abatement will shift too much (to $A^{2'}$ or $A^{1'}$); under the abatement policy, it will not shift enough (or at all). Which distortion is greater depends on the relative slopes of the MB and MC curves. For example, if the MB curve is vertical, optimal abatement doesn't change and so the permit policy is best. If the MB curve is flat, then the optimal cost of abatement doesn't change, and so tax policy is best.

In reality, systems may resemble a mix of the two approaches; for example allowing more permits to be issued if the price of permits exceeds the expected price by more than a certain amount, or reducing the number of permits if the price is lower than expected, is a mixture of price and quantity schemes, effectively imposing a maximum and minimum permit price.

Performance Standards

A common approach to controlling externalities is a performance standard. An important example in the United States is the CAFE (Corporate Average Fuel Economy) standard requiring individual automobile producers to satisfy a certain miles-per-gallon rating for their annual sales. CAFE standards have been modified over the years, but all versions have some obvious flaws, including: (1) they cannot be traded among manufacturers; (2) they are unrelated to the number of miles actually driven and the amount of gasoline actually used; and (3) they do not apply equally to all categories of vehicles. While some or all of these important flaws need not apply to other performance standards, a fundamental problem with this class of regulations is that they implicitly combine a tax on externalities with a *subsidy* to production of the associated good.

Consider a firm that uses a two inputs in producing output, labor (L) and energy (E), the first of which is "clean" (i.e., no externalities) and the second of which is "dirty" (negative externalities). We impose a performance standard that the ratio of energy to output cannot exceed a certain ratio, r. As a result, the firm's optimization problem involves maximizing the Lagrangian, $pf(L,E) - wL - qE + \mu\left(r - \frac{E}{f(L,E)}\right)$, where output is $x=f(L,E)$, p is the price of output, w and q are input prices, and μ is the Lagrange multiplier of the regulation constraint. First-order conditions for L and E may be written:

$$pf_L - w + \mu\frac{E}{x^2}f_L = 0 \Rightarrow \left(p + \mu\frac{E}{x^2}\right)f_L = w\text{; and}$$
$$pf_E - q + \mu\frac{E}{x^2}f_E - \mu\frac{1}{x} = 0 \Rightarrow \left(p + \mu\frac{E}{x^2}\right)f_E = q + \mu\frac{1}{x}$$

Now, suppose instead that we impose a subsidy at rate s on output and a tax at rate t on the use of energy, also requiring a balanced budget, e.g., $sx = tE$. The firm now seeks to maximize $(p+s)f(L,E) - wL - (q+t)E$, leading to first-order conditions:

$$(p+s)f_L = w \Rightarrow \left(p + \frac{tE}{x}\right)f_L = w$$
$$(p+s)f_E = q + t \Rightarrow \left(p + \frac{tE}{x}\right)f_E = q + t$$

Comparing the two sets of first-order conditions, we see that they are identical if we set $\mu = tx$. The intuition is that the firm relaxes the performance standard by producing more output, as doing so then allows the use of more energy. Indeed, given the conflicting incentives regarding usage of the dirty input (reducing its factor intensity but increasing its use through output expansion), it is possible that a performance standard may have the perverse effect of increasing overall use (see., e.g. Holland et al., *AEJ: Policy*, 2009). One could, of course, combine a performance standard with an output tax to mimic a corrective tax, as noted by Bovenberg and Goulder. In this simple example such a two-part policy would seem gratuitously complex, but in realistic circumstances the two-part policy might be easier to implement, for example if input use or emissions were unobservable but output and the technology used could be verified.

Another possible rationale for performance standards might be inattention or imperfect information on the part of consumers. Consider, for example, the lightbulb market. In 2007, President Bush signed into law a gradually implemented ban on the use of incandescent lightbulbs, which are cheaper but use more energy than alternative lightbulbs. Why implement a policy like this, rather than imposing an energy tax and letting individuals decide what type of lightbulbs to purchase? If individuals are myopic and do not account for operating costs as much as they should, a ban could be superior to a tax on energy, from a welfare perspective. (Of course, one could also impose a tax on incandescent lightbulbs.) Allcott and Taubinsky consider these alternatives and find, based on experimental data, that consumer bias is not large enough for an outright ban to be welfare-improving.

Dealing with Global Externalities

An important current policy issue is how to deal with externalities that cross national borders. For local externalities – those that do not directly affect the residents of other countries – a decentralized approach is generally called for: even if country B does not adopt an appropriate policy to deal with its local externalities, there is no cause for country A to act, except perhaps out of altruistic concern for the residents of country B. However, when externalities are global, with one country's actions causing an externality in others, the situation is different. Consider, for example, greenhouse gas emissions that contribute to global warming. Returning to the simpler case in which lump-sum taxes are assumed to be available, what should each country do?

The answer to this question depends on other elements of the policy environment, as discussed in the paper by Sandmo. In particular, if we imagine a process of worldwide social welfare maximization, then the standard single-country results carry over: we should have Pigouvian taxes that offset the worldwide externality each action causes. However, such worldwide global welfare maximization implicitly would also call for cross-country transfers, from rich countries to poor ones. What if such transfers are excluded from consideration? Then it is no longer optimal for each country to exactly offset the externalities it causes. Instead, greater offsets should occur in richer countries and smaller offsets in poorer countries. This will result in global production inefficiency, because the marginal costs of abatement will be higher in rich countries than in poor ones, but this is offset at the constrained optimum by the shift in abatement costs from poor countries to rich ones. That is, it would be more efficient for rich countries to transfer resources to poor countries and then to have the poor countries participate fully in abatement activities, but if such transfers are not feasible then a second-best strategy must be followed.

Another issue that comes up in the case of global externalities is whether countries should use taxes on imports, sometimes referred to in this context as <u>border adjustments</u>, to deal with inefficient behavior elsewhere. In particular, suppose that country B does not offset global externalities caused by its own production activities. Should country A impose a tax on its imports from country B, to simulate the Pigouvian tax that country B should have imposed directly? The answer to this question is complicated, because it depends in part on distributional considerations like that just considered. However, in general border adjustments will be an imperfect substitute for Pigouvian taxes, because they apply only to country A's imports from country B, not to all of country B's production.