(4)

The Internalization of Externality

1. Pigou versus Coase - The Red versus the Blue.

There are basically two traditions or general approaches to the internalization of externalities. The first known as the Pigou approach invokes an agency, usually a government, that coordinates activity by imposing a tax on the activity which is responsible for the externality. If the agency has the necessary information to measure the social benefits and social costs of the imposition of the regulating tax instrument it will set the optimal tax at the level where social marginal benefits are equal to social marginal costs.

The solution is quite transparent in the case of the pasture. If you recall the pasture has a capacity of 100 units of grass per season, and a steer with an opportunity cost $.5 will be worth $1 if it grazes when the size of the herd is less or equal to 100, e.g. $n = \leq 100$. When the herd is greater than 100, say 101 each cow gets only $\frac{100}{101}$ units of grass so that the value of the total product is $n\frac{100}{n} = \$100$ for all $n > 100$. But it still pays an individual acting in isolation to add cows for there will be a positive profit to be made up to the point where the size of the herd is equal to 200 (the opportunity cost of each additional cow is equal to $.50). So as additional cows are added total rents fall by an amount $.50. The tragedy of the commons, and the "source" of the externality is that each person enlarging his herd does not take into fact that by adding one steer the steers of all the other herders will get a little bit less grass.

The social optimum in this simple problem is a total herd size of 100 cows. Such an outcome can be supported in one of two ways.

A grazing tax equal to $0.5 can be imposed. This raises the opportunity cost per steer to $1.0 and the desired herd, equal top 100 should quickly be established. The individual herder makes zero profit, but the government now has a surplus equal to $50 which can be disposed in one of two ways.

(a) It can be distributed to the herder using the pasture.

(b) It can be distributed to society as a whole by a means of the reduction of other taxes. Remember there is an alternative sector in this economy as the opportunity cost of a steer is $0.5. The tax or entry fee is referred to as the price approach.

Alternatively, the planner (government) can set the quantity of steers which will be allowed to graze in pasture. This could be done by creating transferable grazing permits (TGP). These could be assigned, either by auction or they could be assigned by proportion to the original herd each owner had. Whatever the method of assignment, scarcity rents are created by the quantity restriction. After the assignment is made the TGP will be worth $.50. When the permits are auctioned the government collects the rents. When they are given away the "incumbent firms" (those who were there) will be enriched.

2. The Pigouvian solution to the environment problem.

Consider a situation where a large number of polluters (injurers) emit smoke into the atmosphere which damages the health and welfare of a large number of households (victims). The equilibrium level of pollution is a "public good". It is non-rival and non-excludable. The level of pollution is excess from a social standpoint as initially the use of the atmosphere as a resource to emit pollution is zero.

As there are a large number of polluters, a government or planner must create a scarcity value in pollution rights by restricting pollution to some level. As it will be very expensive to adopt the technology so as to get rid of every last bit of pollution there will be an optimal level of pollution. At this level the marginal social value of additional cleanup or abatement will equal the marginal social cost of abatement.

As the abatement is carried out by a large number of different firms or processes it is important that the allocation of abatement across firms is cost effective. A necessary condition for social optimality is that "production efficiency" apply. This condition will be satisfied if the marginal cost of abatement is equalized across polluters.

This principle is very important for if it is satisfied one of key requirements for economic efficiency will be satisfied. This is the condition of cost effectiveness or "production efficiency".

It is a statement about how to minimize the total social cost of achieving a given environmental standard. The equalization of the marginal cost of abatement across different firms that pollute insures that the allocation of the effort for clean up of the environment is cost effective. It is the same principle that tell us that it is in society's interest to have a given amount of wheat or bread at minimum total cost.

The use of pollution taxes or transferable emission permits (TEP) are mechanisms that will satisfy (under certain conditions) the condition of cost effectiveness. Under a tax (the price approach) each polluter face the same per unit cost of emitting pollution. So each firm following self interest will abate up to the point where the marginal cost of abatement for that firm is equal to the tax. The pollution tax should be set at the level appropriate to meet the environmental standard.

So, even if economists have nothing to contribute to the choice of an environmental standard (they are unable to measure or to estimate the social benefits of different levels of pollution abatement) they have something to contribute to the implementation of that standard. As they understood the virtues and shortcomings of markets they advocate a market-type approach for the implementation of the standard in the form of pollution taxes or emission permits (TEP) which both lead to an outcome where the marginal cost of abatement is equalized across firms and processes.

The great virtues of this approach is that it is cost effective and it allows for the decentralization of information when implementing a given environment standard. The regulator does not need to know anything about the capacity of each individual polluter to abate. Once the pollution tax is set firms will self-select. Those who have the technology to clean up will do so and those who do not have the technology will have to pay more tax. As the pollution tax creates a scarcity

value in the pollution of the atmosphere firms will have an incentive to develop or acquire abatement technology (induced innovation).

The case for pollution taxes or TEP is of considerable importance. The environmental laws passed in 1970 in the US to clean up air and water pollution were implemented by lawyers not economists. So instead of using pollution taxes or TEP the US Congress and the Environmental Protection Agency (EPA) used a variety of regulations commonly referred to as command and control (C and C). The regulations prescribed the type of technology different industries have to use. As the regulators we typically did not know cost differences across firms or industries or the relative cost of pollution abating associated with different processes within a particular firm, they will use rough rules of thumb such as the directive that all sources of pollution within a particular industry should be cut back 80%.

As the marginal cost of abatement varies across different sources of pollution varies by large amounts the cost effectiveness condition is not satisfied and numerous case studies of the costs of implementing a given environmental standard by the C and C approach were often several times greater than the cost of a market-based system such as tax.

Over time the lawyers running EPA became aware of the limitations of the C and C approach and gradually the regulations were made more flexible and TEP's were introduced on a selective basis. The 1992 amendments to the Clean Air Act that further restricted the SO_2 emissions by coal-burning utilities in the mid-west and elsewhere have been implemented by a system of TEP. The restricted number of permits were given to the utilities in proportion to their original levels of pollution.

When is no uncertainty about either the marginal social benefit curve or the marginal social cost curve. We have the following propositions:

(1) From an allocative standpoint pollution taxes (prices) are equivalent to TEP (quantities) in the sense that the residual quantity of pollution will be the same and the "price" of a unit of pollution will be the same under both systems.

(2) When the TEP are auctioned off or sold at a fixed price the revenues collected by the government under a system of TEP will be the same as under a system of taxes — e.g. controlling by means of prices is equivalent to controlling pollution by means of quantities.

(3) When the TEP are given away or are assigned to the incumbent firms the incumbent firms will collect the revenues in the form of higher prices that would have been collected by the government if the TEP had been auctioned. This assertion follows from Proposition 1 that prices and quantities will be the same under the two types of pollution control. Some writers may reach the incorrect conclusion that if the TEP are given away by the regulator the total costs of the regulated firm will be lower and the price of the product will be lower. While this might occur in the short run for a competitive industry or in the long-run for a regulated industry whose price is regulated. But for a competitive industry where firms are free to enter and to leave the industry and prices are competitively determined the price of the product will reflect the scarcity value of TEP. The TEP's are valuable because the regulation now restricts the total amount of pollution which allow. The right to pollute is no longer free. The incumbent firms who might

have received their TEP "free" know that the permit are valuable and will raise the prices of the goods accordingly. The TEP have an opportunity cost they can be sold. The basic argument here is similar to the situation where the government "give away" apartment building it owns. The people who receive the "gift" would not be maximizing revenue if they rented the dwelling units at below market rents.

So, by introducing restrictions on the total quantity of pollution and by giving the TEP the government is enriching the incumbent firms at the expense of consumers and the general tax paying public. The taxpayers are involved for if the government sold the TEP it would obtain revenues or rents that they could use to reduce other taxes.

Uncertainty about abatement costs

We now weaken the assumption about the costs of abatement being certain or known to the administrator.

In an uncertain environment we consider two extreme care.

First, the marginal social cost of abatement is constant over a wide range of abatement. This means that the incremental damage to health and property is constant more or less over a wide range of pollution level. For this special case we know precisely what the marginal social level of abatement should be. But since we don't costs we will not know what the optimal quantity of pollution should be. But since by assumption we know the optimal price we (the regulator) will simply set a tax on pollution equal to the optimal price and let the quantity be determined by the "market". So, for this special case where the marginal social benefit of abatement is constant the optimal policy instrument are taxes or prices. It should be emphasized that when regulators set the price they can be certain about the marginal cost. But by knowing marginal benefit the regulator can came close the set marginal benefit equal to marginal cost when benefits are constant.

Second, consider a second extreme possibility where beyond some threshold level of pollution the social cost of additional pollution rising very rapidly. Think of an extreme example of where beyond some small amount the existence of a particular gas in the atmosphere will kill a large number of persons.

If we cannot exclude the possibility that the system will find itself operating at or close to the threshold level we cannot run a significant risk that we will exceed the threshold quantity for if we do we will pay a huge price in death and suffering. For this case, the social cost of making a mistake about abatement costs is much larger under the price method of regulation relative to the quantity approach. For if you set quantity below the threshold level you know it will not be exceeded.

For these two general proposition derived for two special cases we obtain the more general conclusion that when costs are unknown but we know that the marginal social benefit curve is relatively flat — and we are likely to find ourselves in the flat portion of this curve we shall minimize the social cost associated with the uncertain costs of abatement by using taxes (prices) and when the social marginal benefit curve is relatively steep (there is a high likely of a threshold effect).

Uncertainty over the benefits curve.

So far we have considered only the uncertainty over the cost curve. If we introduce uncertainty over the benefits curve we will in general not be able to achieve the best policy. An error in estimating the benefit curve necessarily has undesirable consequences, but if easy to show that those consequences and their undesirability will be exactly the same whether effluent charges or marketable permits are the regulator's chosen control instrument. It follows that uncertainly about the position of the benefits curve by itself offers no guidance on the choice between the two types of measures.

Proposition 1

The prices and quantities depend exclusively on the cost function and are entirely independent of the shape or the shape of the benefit function. This result follow because the source of pollution respond to the policy choice along the cost curve.

Proposition Two

When the position of the marginal cost curve is lower than expected, the emission reduction will generally be inadequate under a system of permits and excessive under a tax or effluent fee.

Proposition Three

All other things being equal the steeper the slope of the marginal benefits function the smaller will be the distortion $(q_p - q_o)$ resulting from regulating error about the system of marketable permits when q_p = quantity of abatement under permits

q_o= optimal abatement

q_t= quantity of abatement under tax

and the greater will be the distortion yielded by an effluent tax.

Proposition Four

All other things being equal the steeper the curve of the marginal cost curve the greater will be the distortion $(q_p - q_o)$ produced by a system of marketable permits and the smaller will be the distortion produced by the effluent fee.

Proposition Five

When the marginal benefits and marginal cost curves are linear, marketable permits and effluent fees produce this same absolute distortion when the regulator miscalculates the marginal costs if the absolute values of the slopes of the two curves are equal. If a threshold effect we should use quantities or permits as the instrument of central. For when we use prices, when abatement cost are uncertain we run the risk of exceeding the critical threshold level a paying a huge price from the excessive environmental degradation.