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Use of Economic Instruments in Pollution Control : The Respective Merits of Taxes and Tradeable Permits

EXECUTIVE SUMMARY

Nature and advantages of taxes and permits

Economic instruments are designed to bring about cost effective pollution control. This involves sheeting home to the emitters of pollutants the costs they impose on others, and providing incentives for emitters to reduce those costs.

Pollution taxes and marketable pollution permits are two economic instruments designed to provide polluting firms and households with the necessary signals and incentives. Taxes set the **price** of pollutant emissions; the total amount of permits determine aggregate **quantities** of emissions, with individual permits being allocated initially on some basis such as current emission levels. Both taxes and permits signal the costs of pollution by putting a price on emissions. Taxes do so directly, by government decision, and permits indirectly, by forcing existing and would-be emitters to compete in the market for a limited supply of permits.

Economic instruments generate and harness the information about costs from a vast number of users and producers. They are, therefore, almost certain to bring about a more efficient outcome than if the control decisions were mandated by particular standards. This is due to market instruments making use of the same cost paring and profit searching incentives that have provided the higher living standards evident in market based economies.

The alternative of using command-and-control regulation is inferior to market solutions for two principle reasons. First, it requires that regulators have intimate knowledge of millions of productive processes and their alternatives so that an optimum regulatory structure can be set. Secondly, it relies on decisions not being clouded by political exigencies.

Taxes and permits compared

EFFECTIVENESS IN ACHIEVING A TARGET: A marketable permits approach has an apparent advantage in that the quantity target is built into the instrument being employed. To attain the target using taxes, the authority may have to alter the tax several times before emitters adjust to the target level of emissions. However, the advantage of permits is illusory in this respect, because in setting a quantity, the price at which permits trade must be allowed to feed back on their total authorised levels. Without this, a higher than expected permit price will mean that too few permits have been issued, and vice versa.

COSTS UNDER UNCERTAINTY: With uncertainty about the costs and benefits of lowering pollution, the abatement target is unlikely to be the most appropriate target. Errors are likely whether a tax or permits approach is used. Compared with permits, tax based systems bring reduced costs from errors where abatement

costs to emitters rise faster than damage costs to recipients. A tradeable rights system is preferable where abatement costs to emitters rise more slowly than damage costs to recipients.

DISTRIBUTIONAL ISSUES: Depending on how they are distributed, taxes and permits have different effects on the distribution of income and welfare between emitters and recipients of pollution. In the case of taxes, a charge is normally levied where none previously existed. The initial impact of the tax is on the users, but its final incidence will depend on whether they are able to pass it on. Different allocations of the right to pollute can be achieved by combining different emissions standards with a tax on emissions in excess of the standard and a subsidy on reductions below the standard. In the case of marketable permits, different allocations of rights can be achieved by combinations of free distribution and auctioning of permits.

EFFECTS OF ECONOMIC INSTRUMENTS ON INDUSTRY SIZE: In the longer term, both taxes and permits will increase costs in polluting industries. The result will be some firms leaving the industry and others finding ways of adjusting so that normal levels of profitability are restored for the production that remains.

RISKS OF POLITICAL INTERFERENCE: The main advantages of permits are that, as rights, they are less susceptible to governmental modification than taxes. Once vested, governments would be uneasy in seeking to raise further revenues from them, since to do so would be to impose a highly selective tax on a property right. If a tax is chosen, there is likely to be continuing conflict as to the appropriate rate. For example, an owner of a polluting factory might seek minimal taxes; those in its neighbourhood might seek punitive taxes; and the government, in pursuit of general revenue considerations, might seek to raise the maximum tax in order to lower other taxes or increase expenditures. Permits therefore have the advantage of providing a more secure basis for planning and investment by firms and households.

Use of Economic Instruments in Pollution Control : The Respective Merits of Taxes and Tradeable Permits

1. INTRODUCTION

1.1 Background

Pollution is an increasingly important issue for public policy. Greater attention is being focussed on the most efficient ways of ensuring it is factored into the decision-making processes. Inevitably this leads to making trade-offs between the costs of pollution and the benefits which are the indirect cause of it.

Market based economic instruments are widely regarded as being superior to traditional command-and-control because they encourage such trade-offs. Market instruments enlist individual self interest to allow the discovery and adoption of efficient abatement measures.

While traversing the arguments for economic instruments, this paper is largely concerned with an examination of the relative merits of the two principle bases of applying these - taxes and tradeable permits.

1.2 The nature of pollution

Pollution occurs when the waste products resulting from people's use of the natural environment impose costs on others. It is an inevitable by-product of living. Where it is of concern is where users of the natural environment fail to take those costs into account, due to the absence of a feedback mechanism to sheet home the full costs of their decisions. Thus the operator of a power station emitting sulphur dioxide may have no information about, or no incentive to take account of, the costs due to aggravation of respiratory diseases among the downwind population; the same may be true of a municipal sewerage authority whose discharges impose costs on swimmers near the outfall.

1.3 Pollution control

Permits, taxes *and* conventional command-and-control measures all involve the authorities determining the optimal trade-off between the costs of abating pollution and its costs to those adversely affected by it. In all three approaches, considerable knowledge is required not only of the preferences of those affected by pollution but also of polluters' abatement alternatives and their costs. Command-and-control usually specifies in some detail the abatement steps that emitters must follow. To do so efficiently requires considerable knowledge of a great variety of different production processes and their possible alternatives.

Where direct controls specify an aggregate level of emissions for a polluting facility, they leave incentives for the firm to find the lowest cost means of achieving this. This is likely to be more cost effective than if the regulator, who has highly imperfect knowledge of the options confronting the firm, were to specify the detail of the emission control procedures.

Taxes and marketable permits are economic instruments that take this efficiency generating approach further. They leave individual emitters free to decide their output and emissions levels, within a framework set for the community as a whole. They rest on market forces, which tend to produce better, more efficient outcomes than governmental direction in the production and distribution of goods and services. Economic instruments harness market forces to bring government specified demand for less pollution at a lower cost.

Pollution control through economic instruments involves the design of processes which signal to emitters the costs imposed on recipients, and which create incentives for emitters to take account of those costs in their use of natural resources. Control can be achieved using either positive or negative incentives, for example, subsidies to reduce emissions or taxes on emissions. The choice between "carrots" and "sticks" is mainly a matter of ethical and distributional judgement, rather than of efficiency in pollution control.

With direct controls, the regulatory authority needs to know the technological and other adjustment alternatives open to individual firms, in order to specify individual emission levels and technologies. This information is not required for the implementation of taxes or marketable permits, because individual emitters make their own decisions about output and emissions. The authority needs only to set either a tax or an aggregate quantity of emissions, and then monitor and enforce each firm's compliance with the tax or the permits that the firm has been allocated or has purchased.

1.4 Pollution taxes and marketable pollution permits (economic instruments)

Pollution taxes and marketable pollution permits are two policy instruments designed to provide the emitters of pollutants with the necessary signals and incentives. Both rely on monetary signals and financial incentives for emitters to reduce the costs they impose on others.

Pollution taxes involve setting a charge per unit of emissions. An optimal charge would be set equal to the anticipated value of the damage caused by last acceptable unit of emissions. That charge signals the damage costs to the emitter and imposes a financial incentive to reduce emissions. The firm will reduce its emissions up to the point where the profit loss due to a unit reduction in emissions is equal to the damage costs involved.

In a system of marketable pollution permits, the regulatory authority allocates on some basis permits equal to a determined aggregate quantity of emissions. The permits are tenable for a defined period (or perhaps indefinitely) and tradeable. Trading of permits among emitters will then establish a market-determined price of emissions. The market price of a permit signals damage costs, and, as in the case of a tax, emitters have financial incentives to respond by reducing emissions.

Taxes typically embody the "polluter-pays principle" - the "stick" approach. Emitters reduce emissions to avoid tax payments. Marketable permits incorporate both "carrots" and "sticks". If emitters can find a way to reduce emissions cheaply, they can gain from sales of excess permits.

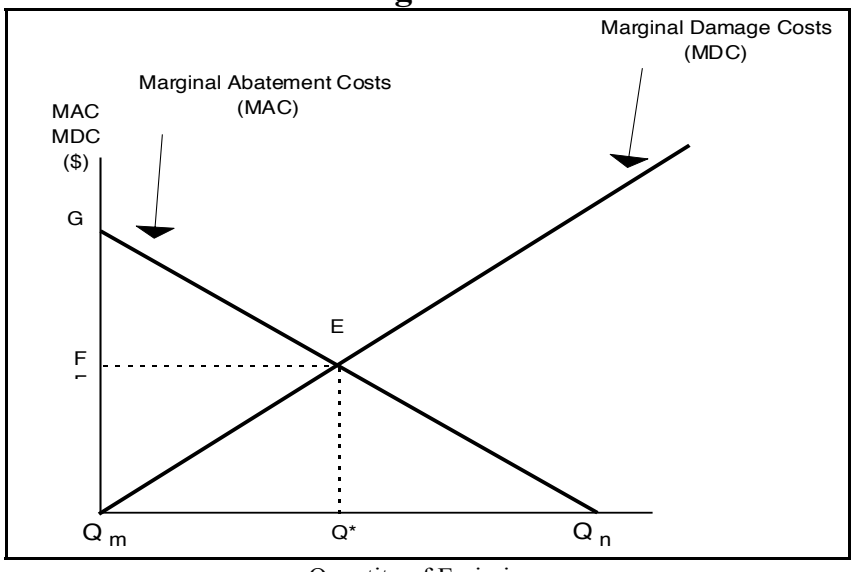
2. TRADEOFFS IN POLLUTION CONTROL

2.1 Identifying the efficient level of pollution

In determining a tax or total number of marketable permits, the regulatory authority must balance the costs the community bears due to pollution against the costs it bears when emitters are obliged to reduce the output of valued activities and/or increase production costs. Thus the authority requires information about how changes in aggregate emissions of the pollutant affect the value of pollution damages and the total benefits to emitters. As discussed at length in Section 3, public decision makers will in fact have great difficulty in obtaining accurate information about these matters. The complexity of the implementation decisions stemming from these difficulties is reduced when an economic instrument approach is used, because the authorities need not be aware of the detailed solutions available on a firm by firm basis.

From the point of view of an individual emitter firm or household, the costs of progressive reductions in emissions - usually termed marginal abatement costs (MAC) - are measured by the incremental reductions in the firms' profits, or the households' welfare, as emissions are reduced. Figure 1 depicts the MAC curve for a group of firms[1] producing the same pollutant, together with the marginal damage costs (MDC) curve for those affected by pollution. The vertical axis shows both the marginal abatement costs and marginal abatement benefits in dollar terms. The horizontal axis gives the quantity of emissions.

Figure 1



The MAC curve rises as emission levels fall, indicating that successive reductions involve increasingly large sacrifices of profits or welfare. In the absence of any pollution controls, emitter firms will maximise their profits by producing at the level where their costs of producing the last unit sold (not including pollution

[1] Household emissions of pollutants are ignored in this paper, in order to concentrate on the implications of taxes and marketable permits for industry.

costs) are equal to the addition to the firm's sales revenue. The level of output determined by emitters' own costs will generate a level of emissions, Q_n, which is excessive from the community's point of view.

Assuming that it is possible to identify the damage costs suffered by the recipients of pollution, the successive increases in damage costs as emission levels increase are depicted by the marginal damage costs (MDC) curve. The optimum level of emissions is at Q*, where the profits gained from the last unit increase in emissions are just offset by the additional damage costs.

2.2 Can markets automatically discover the correct abatement levels?

If the number of parties involved is small, it is possible that the optimum, Q*, will be arrived at through negotiations between emitters and recipients. Such negotiations will usually be costly. One reason is that pollutants can be expensive to measure; another is that it is often difficult to identify sources and recipients of particular emissions; a third is that it may be hard to get agreement on the values attached to emissions, given the lack of comparable market situations. So negotiations may be rejected or break down.

The most important reason for the absence of negotiations between emitters and recipients of pollution is that usually many people are harmed by the same emissions of a pollutant. As a result, action to reduce emissions of a pollutant commonly benefits many people - it is a collective or public good. Unlike with private goods, individuals cannot easily choose a different level of abatement, and a different level of compensation, from their neighbours. Partly because of this, individuals who will benefit from reductions in pollution may prefer to free-ride - to leave others to seek emissions reductions. The individual recipient reasons that her contribution to collective action will make little or no difference, and she will automatically reap the benefits of reduced emissions. Thus she may decide to make no contribution at all.

If most recipients prefer to leave it to others, there will be no private negotiation to reduce emissions. Thus, public agencies may be best placed to control emissions of pollutants which affect large numbers of people.

2.3 Can government identify the efficient level?

Even though markets may fail to reach the appropriate level of abatement, there is no more likely that a government pollution control agency will identify correctly the optimum level of emissions at Q*. To get emission standards right, the agency has to know the marginal curves depicted in Figure 1. In other words, it has to know the incremental changes in firms' profits and the value of pollution damages as emission levels change. It has to get this information from the political process and direct from emitters and recipients. There is no reason to expect that any of these sources will be accurate, since in the political arena, unlike the marketplace, individuals rarely have to back up their stated preferences with their own money. Thus emitters have incentives to exaggerate abatement costs, to persuade the agency to set lenient standards, if they do not expect to be compensated for reducing emissions; conversely, recipients have incentives to exaggerate damage costs, if they do not have to pay for the resulting tight standards.

2.4 Implementing taxes and emission levels when the efficient level of pollution is known

If the two marginal curves in Figure 1 are known accurately, implementation of either taxes or marketable permits to achieve economic efficiency is in principle straightforward. The pollution tax per unit of emissions should be set at F, which is equal to the marginal damage cost at the optimum level of emissions, Q*. Firms will then find that it pays to eliminate all emissions for which the tax exceeds the profits previously earned (the profits due to successive units of emissions are represented by the MAC curve). As a result, the emitters as a group will cut total emissions to Q*.

For a marketable permits approach, the total quantity would be set equal to the optimum level of emissions, Q*. As a result of trading in the market, permits will eventually end up with the emitters who value them most - those whose incremental profits from units of emissions (measured by the MAC curve) are highest. Given a total of Q* permits, emitters whose profits from an extra permit exceed the incremental profit at Q* will be buyers of permits; emitters whose profits from an extra permit are less than the incremental profit at Q* will be sellers. The final price of permits will be equivalent to the required tax rate.

3. DISCOVERING THE NATURE OF THE MARGINAL CURVES

3.1 The marginal abatement cost curve

The major problem in designing pollution control instruments is the difficulty public decision makers have in identifying accurately how the total profits of emitters and value of pollution damages change as total emissions change. Without knowing the true marginal abatement cost and marginal damage cost curves, it is impossible to identify the optimum level of emissions.

Why are the two marginal curves so difficult to measure? Consider first firms' costs of reducing emissions. For a particular pollutant, the marginal abatement cost curve for a single emitter traces out the least costly combination of emission reduction options as the level of emissions changes. The emission reduction options available to the firm may include:

- reducing output or changing the output mix;
- changing production processes to reduce the ratio of emissions to product;
- adding emissions controls at the end of the production process;
- relocating production to an alternative site;
- varying the timing of emissions.

The true MAC curve for a single firm may incorporate any or all of these options. Thus, for example, a firm may begin reducing emissions by maintaining its

output, while changing its production set-up to reduce emissions (using extra labour to clean equipment, cleaner raw material inputs, scrubbers to eliminate smokestack emissions, etc.), thereby incurring progressively higher input costs (and thus lower profits) as it reduces emission levels. As a result, the MAC curve rises at a rate determined by the increasing costs of inputs. Once emissions have been reduced to a lower level, the firm may find it cheaper to cease changing its production set-up and to reduce emissions further by reducing output. In that case, the subsequent rises in the MAC curve will reflect the combined effects of reduced sales revenue and reduced input costs. Hence the marginal abatement costs for the firm are unlikely to follow a smooth path as emission levels change.

Since the true MAC curve for a single firm can be a hybrid incorporating a variety of emission reduction options, the true MAC curve for a group of emitter firms is likely to be very complex in construction, given the wide variety of options available within the group.

The complexity of the MAC curve highlights the formidable intricacies involved in a regulatory authority setting emission levels for individual firms or specifying technologies. Exacerbating these difficulties, production and abatement technologies and product and input prices are continually changing - the MAC curve is dynamic rather than static.

3.2 The marginal damage cost curve

Changes in the total value of pollution damages are still more difficult to measure. In principle, marginal damage costs might be revealed by the amounts that the recipients of pollution are willing to pay for successive reductions in emissions. However, as reductions in most important pollutants are collective or public goods, benefits from reductions in emissions cannot be assigned exclusively to individuals. And marginal damage costs are unlikely to be fully reflected in market values or in other private activity.

In reacting to pollution, the recipient also has several options, some analogous to those available to the emitter. The recipient can:

- bear the costs
- alter consumption and production activities to reduce damage
- adopt measures to insulate activities from damage
- relocate

The true MDC curve will incorporate the least costly combinations of these options for each recipient at each level of emissions. Thus the true curve would be very difficult to identify. And like the MAC curve for a group of emitters, the MDC curve for recipients as a group will be dynamic, varying with changes in prices, the technologies of consumption and production used by recipients, and with recipients' attitudes to pollution.

4. COMPARING TAXES AND MARKETABLE PERMITS

4.1 Information and efficiency

The essence of a government intervention to correct a spillover like pollution is uncertainty about the costs involved to all parties. The government is attempting to create a synthetic market, because the conditions are not present to allow the natural emergence of a normal market. Reproducing the information generating characteristics of normal markets is a vital role of the intervention.

The information-generating properties of pollution taxes and marketable pollution permits are very similar. Each relies on the profit-maximising behaviour of emitters to achieve the target level of emissions at least cost. In attempting to maximise profits net of the tax, or net of the cost of purchasing permits, emitters as a group will adjust along the MAC curve. Whether taxes or tradeable rights are used, the regulatory authority will achieve emission reductions at least cost, despite being ignorant of the production alternatives and abatement costs of individual firms and of the emitters as a group.

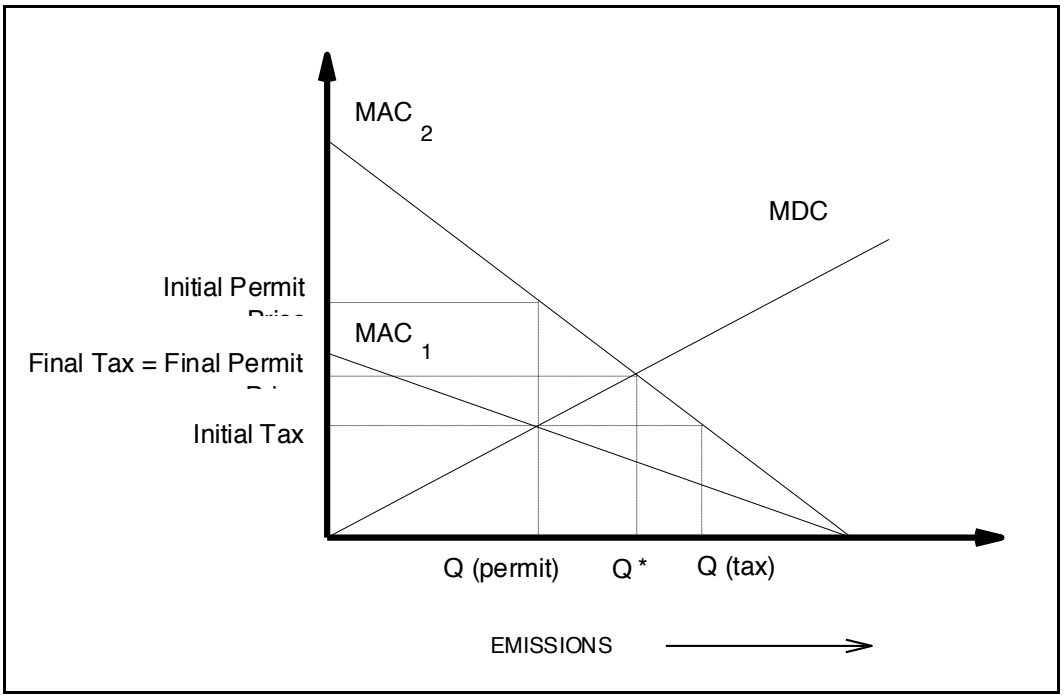
A possible advantage of marketable permits is that their prices, and therefore the costs to emitter firms, change automatically in response to inflation, which erodes the real value of a pollution tax.

Marketable permits are often thought of as having a related, more substantial advantage involving minimal intervention subsequent to the initial distribution of permits. It is argued that once the quantity has been set there is no further need for intervention. But, as with taxation, there must be a feedback if the initial allocation is set incorrectly. In the case of taxes, the correctness of the rate can be determined by examining the response to the tax rate as initially set; for tradeable rights, this evaluation is determined from the observation of prices at which the rights trade.

More commonly, the value pollutees attach to lower levels of pollution, will increase with the degree of pollution. If the true costs of abatement are higher than first thought, the tax rate will fail to bring about the amount of abatement that was anticipated. It must, therefore be adjusted upwards to bring about an increased amount of abatement. Similarly, if the total quantity of tradeable rights issued results in their trading at a price (equivalent to the tax rate) higher than anticipated, more rights should be issued. In both cases, the tax/quantity would also be modified by the degree of aversion pollutees feel to increasing levels of pollution.

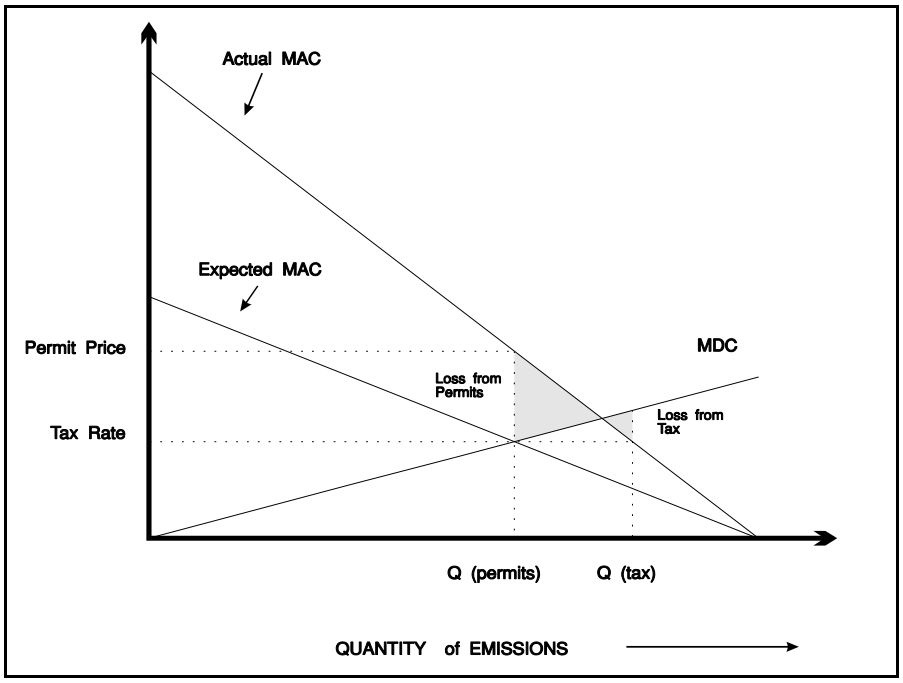
In the diagram below, the estimated marginal abatement cost, MAC_1, set at the Initial Tax brings more emissions than anticipated because the costs of abatement are at MAC_2 - that is they exceed the original estimated costs. This brings a quantity of emissions at Q(tax) rather than the estimated Q(permit). In the case of a permit system, the initial level, Q(permit) results in the permits trading at a price well in excess of that sought. It should be noted that the correct position - Final Tax=Final Permit and Q* - would be arrived at by raising the tax rate or increasing the number of quotas in a way that also takes into account the fact that damage costs increase with the quantity of emissions.

Figure 2

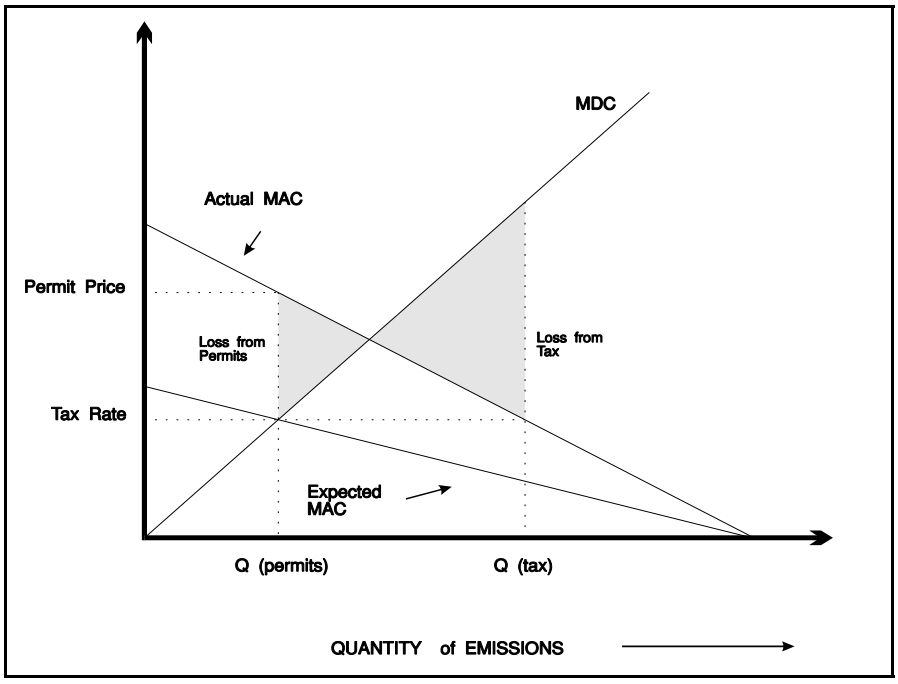


These considerations allow certain rules of thumb to be developed to cope with conditions of uncertainty and potential error. In general, if the costs of abatement increase at a greater rate than the costs of damage, a tax based approach will result in a smaller loss from an erroneous rate being specified than would a permit system that specified an erroneous quantity of emissions. If the damage from emissions is likely to increase at a faster rate than the costs of abatement, a permit system is preferable. The following diagrams might be helpful in illustrating this.

Figure 3 Comparison of Taxes and Permits with Uncertain Abatement Costs



Panel One -- Damage Cost Increase *Slower* than Abatement Costs



Panel Two: Damage Costs Increase *Faster* than Abatement Costs

These matters aside, because of their relatively fixed nature, permits provide a more favourable environment for long term planning and investment in both emitter industries and for the recipients of pollution. A likelihood of continual adjustments in tax rates authority makes industries more dependent on government decisions, thereby discouraging investments that involve long lead times and payback periods. This is further addressed in Section 4.7.

4.2 Distributional effects

The disposition of property rights to release pollutants into the environment affects the distribution of income and welfare between emitters and recipients of pollution. Both pollution taxes and marketable permits can, in principle, be structured to achieve a variety of distributional impacts. In the case of taxes, different allocations of rights to pollute can be achieved by combining different emissions standards with a tax on emissions in excess of the standard and a subsidy on reductions below the standard. In the case of marketable permits, different allocations of rights can be achieved by combinations of free distribution and auctioning of permits.

Taxes or auctioning of quotas accords with notions of fairness in making the polluter pay for a "good", the environment, that is usually considered to be owned by the whole community. However, such payment is not necessarily the appropriate approach. Rights may more appropriately be assigned to those who have first claimed them - especially when, at the time of appropriation, the rights were not considered to be particularly valuable.

This is best illustrated by the case of a polluting facility being located in a remote area where its emissions imposed no harm on anyone; over time new arrivals to the area - perhaps attracted by opportunities that the facility offers - may seek reduced levels of emissions. But, it is arguable that they should be obliged to offer compensation. Vesting rights to the present polluters and allowing these to be traded may therefore be a *de jure* recognition of a *de facto* situation. Of course, it may be argued that the *de facto* recognition did not extend to the transferability of the rights and some community compensation is warranted on these grounds.

4.3 Impacts on industry size

Pollution taxes and marketable permits each charge emitters for using the scarce absorptive capacity of the environment, the charge being based on the value others attach to that absorptive capacity. In the short term, both a tax and permits raise emitters' costs, and reduce the profits, output and emissions of all firms in a polluting industry. In the longer term, some firms will leave the industry, and normal levels of profitability will be restored for those firms that remain.

Whether marketable permits are auctioned or free has no effect on industry output and emissions in the long term, provided that the initial distribution of permits is not conditional on the firm continuing in the polluting industry. If the permits are free, the owners will seek to maximise their profits on them by either using them in their present businesses or on-selling them to someone offering a better price. If the permits are auctioned, the original users will only obtain them if they are willing to pay a higher price than rival users.

4.4 Geographic variations in the costs of pollution

To provide an accurate measure of costs to recipients and emitters, taxes and permit allocations should comprise values which differ geographically; however taxes have to be imposed on, and permits allocated to, sources. To arrange for taxes or permits to meet diverse environmental quality standards would compound the informational and monitoring tasks of the regulatory authority.

Where all sources contribute equally to emissions received at all receptor points, as is true with global CO_2, the costs of emissions are identical for all sources. Hence, in the case of CO_2 emissions, the same tax rate applies worldwide, and a whole-world permit market is appropriate.

Where emission costs and benefits vary for each emitter for each receptor point, it is in principle necessary to set different tax rates for each emitter-receptor pairing, or to create a separate permit market for each receptor point. This may result in prohibitively high administrative costs for either taxes or permits. A compromise solution to the problem of geographic variations in pollution costs is to define zones within which a single tax rate, or a single permit market, applies. All emissions within a zone are then assumed to impose approximately the same costs at all receptor points.

4.5 Transactions costs

With taxes, there are no transactions costs other than administrative costs which are likely to be similar for both a taxes and tradeable rights regime; each emitter simply responds directly to the incentive provided by the tax. In contrast, trades of permits involve the costs of identifying potential buyers and sellers and haggling over prices. If these costs are seen as large relative to the gains from trade, there will be little or no trade, and permits will not end up with those who value them most.

4.6 Monopolisation of thin markets

Hahn[2], reviewing emissions trading activity in the United States, found limited trading between firms in the case of air and water pollution permits, and extensive trading of permits for the use of lead in petrol.

Hahn's findings are partially explained by regulatory restrictions on permissible trades; another explanation is the small numbers of potential traders in many permit markets, often leading to strategic behaviour towards firms who are major competitors in the final product market. For example, the most important potential traders of marketable permits for biological oxygen demand along the Fox River in Wisconsin are pulp and paper mills. There was only one trade in this market in its first six years of operation. The potential for a small number of firms to act in a predatory manner with available permits would add support to a tax based approach in such situations[3].

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[2] Hahn, R.W., "Economic Prescriptions for Environmental Problems: how the patient followed the doctor's orders", Journal of Economic Perspectives, 1989:96-114

[3] There are other monopoly matters not covered in this paper. Many polluting firms may have some power to vary their product prices; in seeking maximum profits, such firms will set product prices above their costs of producing extra units, recognising that additional sales lower the price received for all units sold. Thus, from the community's point of view, a polluting monopolist produces and sells too little product, at a price which is too high.

Because a monopolist finds it profitable to restrict output below the level that maximises benefits to consumers, it also produces fewer emissions than a competitive industry with the same costs of production and pollutant abatement. As a polluting monopolist is already restricting its output and emissions, any additional contraction in output induced by a pollution tax or marketable permit system may, on balance, be detrimental to the community; the gains from reductions in

4.7 Flexibility of environmental standards and sovereign risk

The costs of abatement and pollution damages will vary over time, due to changes in product prices, input costs, production and abatement technology, industry and population location, and so on. Efficient use of resources over time involves a tradeoff between:

(i) variability in taxes or the aggregate quantity of permits, to reflect these economic changes; and

(ii) security of property rights and other "rules of the environmental game", so that firms' and households' planning and investment will not be inhibited, to the detriment of economic growth and people's welfare.

Pollution taxes remain under direct government control, may be readily changed in response to new scientific, technical or political information. Marketable permits are likely to be increasingly regarded as valuable private property, a basis for longer-term decision-making, and correspondingly difficult to change.

As knowledge of the environment, production technology and desired emission standards change, those with a benign view of government will see taxes as facilitating flexibility in environmental policy. On the other hand, once we admit the possibility of government error or objectives other than economic efficiency, marketable permits are more attractive because of the constraints that they are likely to impose on precipitate or ballot-box motivated government actions.

The great advantage of property rights is the incentive they give their owners to constantly search out the most efficient means of deploying them. While taxes might provide a more convenient means for government to search for the best solution, aside from the risk that political considerations will be prominent, the iterations involved in this process are likely to impact adversely on firms' abilities to plan with confidence. Being more difficult to change than taxes, tradeable rights provide a more secure basis for investment by firms and households. Permits also have the advantage that they involve only modest alterations to existing pollution control arrangements.

pollution due to the tax or permit costs may be less than the losses suffered by consumers due to further reductions in industry output. In these circumstances, the preferred course of action is to eliminate emitters' monopoly power, prior to the implementation of pollution taxes or marketable permits.