Tax and Permit Instruments of Emission Abatement Policy[1]

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International thinking on climate change has moved quickly in the first half of the 1990s. This has occurred on two fronts: scientific research, and policy design. The central hypotheses from world climate models are that if present trends continue, emissions of carbon dioxide, methane, and other greenhouse gases will raise mean global temperature by between 1 and 4 degrees Celsius by 2100, leading to a sea-level rise of between 25 and 90 cm, with the range of these estimates reflecting various assumptions specified in the Intergovernmental Panel on Climate Change 1992 set of scenarios for the world economy (Working Group II "Summary for Policymakers" in IPCC 1996). Large-scale scientific experiments to test these hypotheses are being designed and put in place, and results from those experiments should become available during the first two decades of next century. Comprehensive surveys of the present state of climate science are available in the recently approved Second Assessment Report from Working Group I of the Intergovernmental Panel on Climate Change (1996). This reflects a strengthening international consensus on the link between emissions and climate change.

Meanwhile, the economic literature on appropriate policy responses to climate change has focussed debate on two central issues:

- What criteria should be used by the world community's representatives in choosing the scale and timing of policy response to climate change?

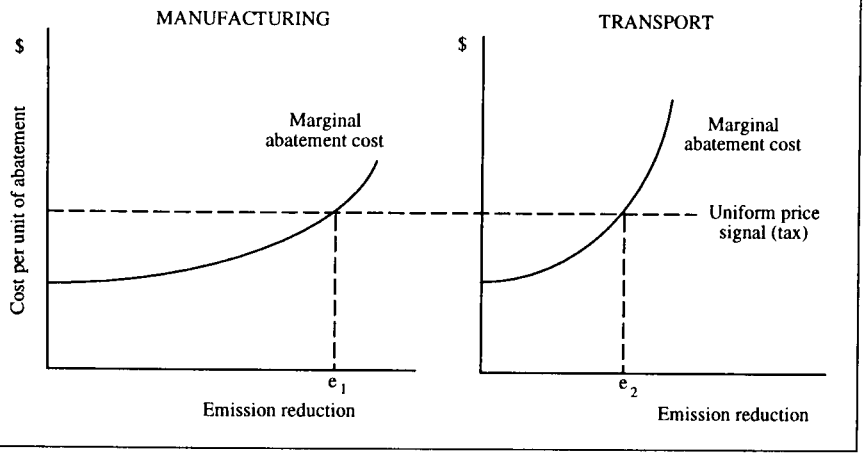
- Which policy instruments should be used nationally and internationally to achieve global abatement[2] of greenhouse gas emissions?

The second of these has proved easier to answer than the first[3], and is the subject of this paper. So-called "economic" instruments such as emission charges and tradeable permits are preferable to command-and-control techniques, because of the greater efficiency with which economic instruments can reveal and promote the least-cost abatement options. Under either of these two main economic instruments a uniform incentive for efficient abatement is provided by a price signal reflecting the shadow cost[4] of greenhouse gas emissions.

Figure 1 illustrates the operation of the price mechanism to achieve least-cost abatement across two sectors. The curves are drawn arbitrarily to show a hypothetical situation in which it is easier to achieve substantial emission reductions in "manufacturing" than in "transport". "Manufacturing" is assumed to have a relatively large set of low-cost abatement options; "transport" is assumed to have relatively fewer. The different marginal abatement costs faced by the two sectors are shown by the two curves. Total emission reduction is $(e_1 + e_2)$. In each sector, individual economic agents strike a balance between cutting emissions and paying the charge. Abatement options that cost less than paying the charge will be adopted; options that cost more than the charge will not. "Manufacturing", with its relatively flat cost curve, undertakes more abatement than transport and in the process avoids (legitimately) a substantial amount of emission charges which it would otherwise have to pay. "Transport", with its steeper abatement cost curve, generally opts to pay the charge rather than abate, but any abatement opportunities that do pay are undertaken. More important for the long term, the same incentives to reduce emissions apply across all sectors of the economy whatever their abatement cost situation.

To get the full benefits of economic instruments, it is important not to grant exemptions, either to sectors or to individual firms. If Government wishes to sustain certain high-emissions activities that are unprofitable with an emission charge in place, it should do so explicitly. In practice, many governments pursuing a "mixed bag" approach have given exemptions to large industries which entered into voluntary emission-reduction programmes, but this reflects simply the politics of large vested interests rather than an efficient means of eliciting least-cost abatement.

Figure 1
IDENTIFICATION OF LEAST-COST ABATEMENT



Two Economic Instruments

The emissions charge approach requires some central authority to estimate the shadow price, fix the rate, and arrange for the revenues to be collected and allocated. Market forces then determine the volume of emissions. The tradeable-permits approach requires initial agreement on a time-path of allowable quantities of emissions (or a mechanism for setting the quota on an ongoing basis), followed by the creation and allocation across the community of entitlements to emit within the limit. Market forces then yield a permit price reflecting, over time, the implicit shadow price of emissions given the constraint imposed by the limit on total allowed emissions.

From the point of view of the abstract economic theory of emission abatement, emissions charges are exactly equivalent to tradeable permits in terms of their economic effects. In economy-wide models of the cost of abating greenhouse gases, therefore, it is common to use the emission-charge instrument to represent both, since their overall economic impacts ought to be identical apart from the effects of institutional factors and transaction costs.

There are, however, important differences between the two instruments in the real world, and it is these factors which enter into the choice of which to use in a particular case - for example, New Zealand in the late 1990s. The main differences are:

The effects of risk and uncertainty -
In the real world, it is not possible to forecast with certainty what the response of the economy will be to changes in the price of emission-intensive goods.

Consider first the emission-charge instrument. Elasticities of demand change over time, new technological discoveries shift the relevant supply curves, and

complex interactions take place amongst sectors within the economy. It is therefore not possible to predict for sure what effect on total emissions a charge of, say, $50 per tonne of carbon emitted will have. If a charge is chosen as the instrument, therefore, there will be uncertainty about the path that emissions will follow, and if the government's emission targets are not met the charge may have to be adjusted over time to "seek out" the economy's responses. There are two layers of uncertainty here: the Government's uncertainty over whether the chosen emissions charge will meet the quantity target for emissions, and the private sector's uncertainty over whether and when the Government will change the charge if its goals are not met.

The permit instrument causes the uncertainty to fall in a different pattern. Once Government has issued permits for some defined quantity of emissions, the private sector then determines the value of permits in the secondary market. Because, again, elasticities of demand and supply curves shift over time, the future price at which permits will trade (and hence the cost of acquiring them, from the point of view of individual polluters) is uncertain. In a permit system the Government gains greater certainty on its quantity targets but the private sector bears the uncertainty about the cost of achieving them.

In a nutshell, the private sector faces pretty much the same uncertainty about future prices whichever regime is chosen. Government may feel attracted to the permit instrument because once introduced and enforced, it appears to remove quantity uncertainty.

Overhanging both possible policy regimes, however, is the more general and pervasive uncertainty across the whole world economy over what global targets will have to be set as scientific data improves in quality. A steady tightening of global emission levels would translate in domestic terms to increased emission charges or reduced permit allocations, with flow-on effects to the economy.

Roundaboutness of the transmission mechanism -
Regardless of whether the policy instrument chosen is a charge or a permit system, most people will feel the impact through a price signal. Goods whose production requires large emissions will become more expensive relative to low-emission goods. The economic mechanism by which emissions are reduced is simply that consumers substitute low-emission (cheaper) goods for high-emission (more expensive) goods, while at the same time producers of goods and services substitute other inputs for those whose price has been driven up. Over time, in addition, the search for lower-cost alternatives to emission-intensive goods should lead to accelerated technical progress and innovation. All of these responses are triggered by the price mechanism.

The charge instrument creates the price effect directly, by raising the price at which carbon enters the economy. The permit instrument works in a more roundabout way. First permits must be allocated (see below); then the participants in the permit market must discover by experience what the market-clearing value of permits is; producers of emission-intensive products must enter the market to buy permits matching their planned output; then the cost of holding the required permits at this price must be factored into the costs of production of emission-intensive products; and finally these cost increases must be passed through to prices. Only then does the price-induced set of economic responses by consumers and other producers begin. Given that the point of the exercise is to give appropriate price signals to agents across the economy, the emission-charge instrument is the quick route to follow, and one would need to have good reasons for installing all the additional institutional machinery required to operate a permit system. (Making the Government's life easier at the expense of the private sector is not necessarily such a reason.)

There is therefore a strong practical case for starting off with a low-level economic instrument, applied to gross emissions and chosen for cost-effectiveness

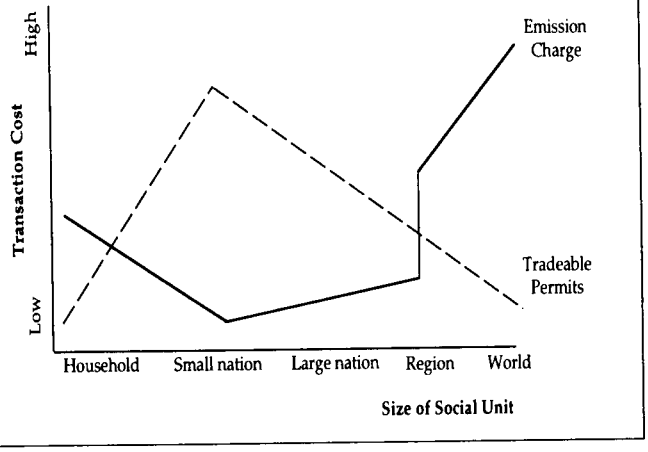
Transaction costs -
The costs of operating an economic instrument will vary with the circumstances. Emission charges, for example, are easiest to apply within a single political and currency unit (a nation state), and far more difficult when they apply across more than one such unit because of the need to cope with exchange rate changes, different tax laws

and practices across different jurisdictions, and difficult issues of how the revenue collected is to be allocated. Resolution of such difficulties involves transaction costs.

Tradeable permits work best (have lowest transaction costs) where all participants in the affected system have access to full information, and/or where markets are very "thick" (a thick market is one in which a very large number of transactions are occurring and there are a large number of participants involved). Thick markets simultaneously spread fixed transaction costs across large volumes (so reducing their distorting effect) and create high-quality price information. Thin markets lead to high transaction-cost burdens and poor-quality price information, while increasing the potential gains from strategic behaviour such as hoarding, insider trading, and misinformation.

These points immediately suggest that the transaction costs of emission-charge and permit instruments are likely to vary with the size of the affected community, in such a manner that a different choice of instrument will be appropriate at different size levels. Figure 2 sketches a suggested pattern. In very small communities such as the individual household, information tends to be readily available and the low number of participants in economic decision-making means that quantity instruments work effectively, often with no need to go through any price-setting procedure. Using a tax instrument in this setting adds unnecessary transactions to the process of adjusting resource allocation, and so the tax/charge instrument would not be preferred.

Figure 2
EMISSION CHARGE VERSUS PERMITS: TRANSACTION COSTS AND SIZE OF TARGET COMMUNITY



As the size of unit increases, the feasibility and effectiveness of informal quantity-trading falls away and the permit instrument takes on a formal, structured character with legal property rights being created and market institutions established for trading, in a setting where the market is still relatively thin and hence not fully efficient. Transaction costs correspondingly rise steeply. In contrast, tax instruments such as emission charges come into their own in this setting, where a single legal jurisdiction and currency coexist with established institutions for collecting and allocating tax revenues, so that the incremental transaction costs of a new tax are low.

As the size of unit increases from the small to the large nation, the larger number of players and larger number of transactions brings down the cost of the permit instrument, while increasing administrative complexity and scale of revenue-collection may well drive up the cost of the emission charge instrument. For large nations such as the USA, thus, the choice between the two instruments on the transaction-cost criterion is less clear than for small countries such as New Zealand.

When we move to multi-nation units, there is a sharp discontinuity. Permits, trading in an international market, gain from market thickness and encounter no problems of conflicting jurisdictions so long as they are established and enforced under an international treaty. Emission charges, in contrast, run into high transaction costs associated with multiple currencies and tax jurisdictions.

Figure 2 is constructed on an intuitive basis; there does not yet exist any substantial body of empirical research on relative transaction costs along the lines hypothesized in the diagram. My aim in drawing the figure has been to show how it is possible to advocate tradeable permits as the preferred instrument for implementing international greenhouse-gas agreements, while at the same time rejecting the permit approach in favour of emission charges in the context of a small economy such as New Zealand.

Property rights -
An emission charge neither creates nor destroys any

well-defined property rights in the economy. Charges and tax breaks certainly have effects on the relative wealth of individuals across the community, but they do not confer legally-enforceable property rights.

Tradeable permits, however, are financial assets over which their owners have clear and enforceable rights. In issuing a permit to emit carbon to the atmosphere, Government is legitimating the ability of the permit holder to emit, while removing from non-permit-holders any right to emit. Creation of assets of this sort raises a host of difficult questions, including:

• Who should get the permits as they are issued? Existing emitters will want them grandparented[5] for no charge. Treasury will want to auction them to the highest bidder. Forestry companies will want to be given them as a reward for planting and growing trees. Energy-efficiency promoters will want them to be issued against measured savings from energy conservation. Participants in "voluntary schemes" under the 1994 policy will want their share. And so on. The politics of allocating the permits, with their promise of capital gains and possibly of seigniorage as well, would tend to be bitterly divisive, and would expose politicians and officials to intense pressures from vested interests.

• Are permit rights exposed to Maori challenge under the Treaty of Waitangi? Since legal interpretation of the Treaty is still evolving, this would inevitably be the subject of some litigation, with associated uncertainty and delays.

• What safeguards are needed, in a small community, to prevent strategic behaviour by parties seeking permits or holding permits, to gain at the expense of others? In large, thick markets competitive disciplines work strongly and monopolistic abuses are curbed by them. In small, thin markets, monopolistic influences can exert a large and perhaps dominant influence. This is not only through the exercise of market power, but also through the undue political influence that may be wielded by key sectors or industries to influence the allocation of permits in their favour.

Net Versus Gross Targets

The New Zealand Government has to date adopted a net-emissions approach to greenhouse gas issues, and if this policy position is sustained then the instruments used to promote abatement will need to be designed to fit this approach. In essence, the net approach means that a tonne of carbon absorption[6] is treated as identical to a tone less of carbon emitted, and should therefore face the same economic incentives. If the charge on a tonne of carbon emitted to the atmosphere is, say, $50 per tonne, then the rewards for absorbing a tonne of carbon out of the atmosphere ought to be $50 per tonne also.

In principle there is no difficulty achieving this situation with either of the two economic instruments on offer. Under an emission charge regime, tax offsets would be granted, probably in the form of tax credit certificates, to all recognised absorbers. Under a tradeable permit regime, carbon absorbers would be given permits to emit. In either case there are then two uses to which absorbers can put their tax credits or emission permits:

• If the absorber is also operating other processes which emit carbon, then the emission and absorption activities can be offset directly against one another. Under the tax-credit option, carbon absorption credits are subtracted from emission charges payable. Under the permit system, permits received for absorption activities are surrendered against emissions.

• If the absorber has no emission-creating activities, or its emissions are less than its absorption, then surplus tax credits or permits will be held which can be sold, for cash, to emitters elsewhere in the economy. Regardless of the precise form of the asset involved (tax credit certificate or emission permit) the same general secondary market mechanisms would apply to set a price per tonne of carbon and to transfer the tax credits/emission permits into the hands of carbon net emitters at that price. The financial return to absorbers on their carbon absorption should therefore be the same whichever instrument is used, apart from any deadweight losses such as transaction costs involved in operating the system.

While in principle the move from gross to net targeting is simple, in practice it is far from easy. The central difficulty is to decide what qualifies as an absorption activity, and how absorption is to be measured on a basis that is consistent with emission. Much work is being done internationally on this problem, and in due course a set

of protocols will no doubt be adopted which provides rules of thumb. There will, however, always be areas where discretion and judgement are required, besides a great deal of detailed record-keeping (especially the maintenance of inventories of the volumes of stored carbon in the vegetation on each piece of land in the economy, not to mention the changing carbon content of the soil itself!)

Phasing-In

The net approach has some superficial intellectual attraction, but its adoption is likely to incur high administrative costs, regardless of whether the actual policy instrument used is a charge, a permit system, or direct regulation. There is therefore a strong practical case for starting off with a low-level economic instrument, applied to gross emissions and chosen for cost-effectiveness. As I see it, this means an emissions charge for New Zealand. The level of this charge would then be progressively raised (preferably on a pre-announced path to minimise uncertainty) to the point at which tax credits could be implemented cost-effectively, at which point the instrument could switch from a gross to a net basis, and some trading in tax credit certificates would begin. Subsequently as the emissions charge continued to rise (assuming that the emissions target becomes tougher over time) the secondary market in tax credit certificates would become thicker and more competitive, and per-unit transaction costs would fall, increasing the efficiency of the instrument overall. Eventually, if the world community moves to adoption of a tradeable-permit system (as Figure 2 predicts), the New Zealand emissions charge regime could be harmonised with the international system in one of two possible ways. Either the New Zealand Government would hold the national economy's emission permits and target the emission charge/tax credit system to achieve a matching net emission volume; or the New Zealand emissions charge would be phased out and replaced by a requirement for all carbon emitters (or introducers) to purchase and hold the internationally-issued permits. At this stage it is far too early to speculate on how those later stages of policy evolution might look in detail.

The medium-term transition path would thus be one from a low-level charge on gross emissions, to a somewhat higher charge on net emissions, and thereafter a charge calibrated to achieve whatever emission targets New Zealand accepts as its share of the world effort to stabilise atmospheric concentrations of greenhouse gases.

Because of the flexible design possibilities with either of the two economic instruments, I see nothing to be gained from trying to combine them into a policy package. If an emissions charge is adopted, then nothing identifiable can be gained by adding on a permit system, while substantial additional costs would be imposed on the economy by the additional institutional and transaction costs. If a permit system is adopted, then a separate charge would be redundant and wasteful of resources. The proposals for a charge-capped tradeable permit system in the recent report of a New Zealand Government working party would simply blunt the effectiveness of economic instruments while creating needless complexity and duplication.

My pick is that the emissions charge is the way to go domestically, while a tradeable permit system is probably best internationally. That judgement rests on my reading of the relative cost effectiveness of the two instruments in the two different settings. **VEC**

ENDNOTES

[1] This is an edited version of a paper presented to the AIC Greenhouse Gases Conference, Wellington, 21 March 1996. Geoff Bertram is a Senior Lecturer in Economics at Victoria University and a regular contributor to *Victoria Economic Commentaries.*

[2] Abatement is the term generally used in the climate-change literature for all actions that reduce the amounts of greenhouse gases emitted at any given level of world output.

[3] The use of cost-benefit methodology to identify optimal abatement effort, pioneered by Nordhaus in a series of papers, has been bogged down by the very high degree of uncertainty about future trends and by fundamental disagreements over the valuation of damage from climate change. By focussing purely on abatement costs, the present paper avoids any need to estimate a damage function. Uncertainty is coped with, as usual, by using a scenarios approach.

[4] Shadow cost is a term from social cost-benefit analysis. It refers to the true social cost of an activity such as pollution, as distinct

from the private costs faced directly in the marketplace by those undertaking (and benefiting from) the activity.

[5] Grandparenting is the regulatory practice, common in the USA, of handing out emission rights to those who already have an established track record as emitters. This obviously involves some discrimination in favour of existing emitters relative to new entrants. It is usually justified by appeal to implicit property rights in the status quo.

[6] Absorption (often also referred to as sequestration) involves the removal of greenhouse gases from the atmosphere by any processes over which human control is exercised. The main example is forestry planting, since trees grow by extracting carbon from the air.

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