Tradeable Emission Permits and the Control of Greenhouse Gases

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This article reiterates the case for tradeable permits as a global policy option for limiting greenhouse gas emissions, and considers the detailed design of a global tradeable-permit regime, emphasising the importance of the initial assignment of property rights, and arguing that the relevant property rights in this case are the rights of every member of the world community to share in a sustainable global atmosphere and climate. The allocation of permits should therefore be done on a per capita basis across the world community, with the result that rents generated by the process of reducing carbon emissions would accrue to non-polluters, most of whom live in the 'South'. The international transfers of income and wealth implied by the proposed scheme are large but feasible. There is therefore a real prospect that an international convention on carbon dioxide emissions could end the debt crisis and finance sustainable development in the South..

I. INTRODUCTION

The past two years have brought a flurry of scientific and diplomatic activity in the quest for an international convention to limit global emissions of the gases which are responsible for global warming. Attention has focused especially upon carbon dioxide as the most important of those gases. While there appears to be widespread agreement on the need for policy initiatives, no consensus has yet emerged regarding the best mechanism through which the international community could implement a programme of cutting back global emissions. The three leading contenders are direct quantitative emission restrictions, carbon taxes, and tradeable emission permits, with most attention in the economic debate having been given to carbon taxes.

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The Journal of Development Studies, Vol. 28, No. 3, April 1992, pp. 423–446
PUBLISHED BY FRANK CASS, LONDON

Bertram, Stephens and Wallace [*1989*] argued that a world-wide tradeable-permits system could be an effective way of advancing the interests of developing countries in harmony with the global community's interest in protecting the atmosphere, provided that permit entitlements were allocated in such a way that the resulting rents accrued mainly to poor countries. This theme was taken up by Grubb [*1989: Ch. 5*] and has been the subject of some discussion since [*e.g. Hoel, 1991*]. This article develops the suggestion with particular emphasis on the need for any international convention to be based upon an appropriate set of property rights giving priority to the world's non-polluting poor.

II. THE CONCEPT OF TRADEABLE PERMITS

The idea of using tradeable permits to control pollution emerged in the 1960s and 1970s from a long theoretical debate over the economics of externalities [*Dales, 1968; Baumol and Oates, 1988: Chs. 5 and 12; Pearce and Turner, 1990: Ch. 8*]. Externalities are benefits or costs, arising from economic activities, which are experienced by third parties without their having participated in any market transaction. Global atmospheric pollution is the classic example of an externality which has all the characteristics of a public good (or rather, bad). No human being can escape the effects, short of leaving the planet; the effects are shared by the entire global population, albeit in uneven ways; and there is, as yet, no market to which people can go to purchase an alternative state of the world's atmosphere and climate. (It is taken for granted here that the world does indeed face a real present choice amongst alternative future climatic states, as outlined in, for example, Rosenberg *et al.* [*1989*]; Leggett *et al.* [*1990*], despite the scientific uncertainty about what actual outcomes will flow from choices made now – see [Solow [*1990*]. It is assumed also that there exist technologically-feasible means of stabilising and eventually restoring the gaseous composition of the earth's atmosphere, especially by the adoption of energy-efficient techniques of the sort outlined in [Goldemberg *et al.* [*1988*].)

The idea that the problem may best be thought of in terms of a missing market harks back to two famous economics papers: Scott Gordon's [*1954*] study of the tragedy of the commons in the marine fishing industry, and Ronald Coase's [*1960*] paper on social cost. Both suggested that if an appropriate set of enforceable property rights could be established, together with a competitive low-cost market, it should be possible for individuals to trade their way out of problems such as overfishing and pollution. Government could thus address such problems without em-

barking on detailed direct intervention through devices such as taxes on polluters, or regulations to control the quantity and quality of emissions according to a uniform standard. Such tax and regulatory instruments, however, could still appropriately be used alongside a tradeable-permits regime if the benefits of doing so could be established. (The general rule recognised by Coase is that the cost-effectiveness of government intervention can be determined only by analysis, not as an a priori matter of principle.)

The advantages of allowing individual agents to move freely towards pollution abatement, in a framework which makes it worth their while to do so, are considerable. Those who face the highest costs of reducing their emissions will tend to be buyers of permits which enable them to continue existing operations. Those whose clean-up costs are less will be able to sell off permits and use part of the proceeds to pay for pollution reduction, while still being left with a profit. The result of such trading on a world scale would be to concentrate global cleanup investment in those locations and industries where cost effective abatement options are available, so that the pollution which remains is from 'hard-core' (high net abatement cost) sources.

An important advantage of concentrating abatement effort according to sensible economic criteria, rather than relying upon rigid country-by-country targets, is that industrialisation in the South need not be compromised, since countries with high marginal returns on carbon-emitting activities will be able to reap those returns, so long as permits are held and the technology used is energy-efficient and not unnecessarily pollution-intensive. The idea becomes more attractive the more efficiently the market mechanism works, relative to the efficiency of a governmental regulator. Two important issues here are the transactions costs involved in the working of the hypothetical market, and the possible possession of market power by some individual or group which might enable them to skew the outcome to their own advantage.

Consideration of the real world suggests that in practice, both of these problems are likely to be greatest in markets of medium size. In a very small market involving transactions between two individuals, with no other parties involved, face-to-face dealing minimises transactions cost, while market power reduces to the personal characteristics of the two parties. (This was the base case for Coase's [*1960*] analysis.) In very large (say, global) markets, economies of scale permit the profitable operation of institutions to facilitate individual trading – stock markets, publicly posted prices, networks of brokers – while the very large number of participants makes it difficult to establish uncontested market power. It is when we turn to markets in the middle – for example, small national

economies – that transaction costs and market power pose the greatest obstacles. For this reason, a tradeable-permit regime to combat atmospheric pollution is likely to work better at global than at national level, whereas direct regulations and carbon taxes are likely to succeed at national level if anywhere.

In confronting the problem of greenhouse gas emissions, a tradeable-permit regime has several major advantages over alternatives such as carbon taxes or country-by-country quotas. It provides the incentive for industry worldwide to cut back emissions, without placing on national governments the heavy burden of negotiating and enforcing specific country-by-country limits. Besides being an allocatively efficient means of addressing the problem of global pollution abatement, it should also be easier to negotiate than country-by-country quotas, while avoiding the severe moral-hazard problems of a global carbon tax (which would result in the administering agency gaining control over annual revenues of staggering magnitude). It avoids also the problems of harmonising a system of nationally-administered carbon taxes, and the enormous bureaucratic effort required to fix and enforce detailed case-by-case restrictions. All that a tradeable-permit scheme requires of national governments is their agreement to global emission limitation, and their adherence to the international legal convention required for enforcement. There need be no fiscal burden placed on national governments, and only limited surrender of sovereignty if international agencies and other non-nationals are given access to the courts of any country to pursue offenders.

III. SOME RECENT DEVELOPMENTS

The concept of tradeable permits was cautiously supported by Working Group III of the Intergovernmental Panel on Climate Change in October 1989:

> of all the instruments examined, the system of tradeable emission rights came in for the most attention and was considered to be most promising. It offers the advantages of flexibility, efficiency in pollution abatement, direct control of total emission levels, a mechanism for trading reduction in different gases, and incentives for research into pollution abatement technology (IPCC WG3-II/Doc. 3, cited in Grubb [*1990a: 3*]).

Unfortunately, the subsequent development of discussion in Working

Group III of the IPCC was increasingly dominated by diplomats from major industrial powers such as the USA and Japan, anxious to protect their national's vested interests as the world's major emitters of greenhouse gases. In its June 1990 report [*Intergovernmental Panel on Climate Change, 1990: 37*] the discussion of a possible tradeable-permit system was given a single half-hearted paragraph in the 46-page paper, with the sole sentence on permit allocation eliminating at a stroke any prospect of support from developing countries for this option. The sentence reads: 'Once an overall limit on emissions has been set, emissions entitlements amounting to that limit could be provided *to emitting sources* and free trading of such entitlements allowed' [*emphasis added*]. By this pre-emptively slipping in the US practice of 'grandfathering' permits (that is, giving them to established polluters) [*Baumol and Oates, 1988: 179*] as though it were the only allocation option available, the June 1990 document sought to remove the choice of property rights assignment from the negotiating agenda. But this is the central issue which could render a tradeable-permit system attractive to the world community at large. In effect, the IPCC committee proposed that the property right of all citizens of the world in a sustainable atmosphere and climate should give way to the right of existing polluters to have their activity legitimated and rewarded. On the face of it, this violates Coase's [*1960*] principle that initial property rights should be allocated on the basis of which party would suffer 'greater harm' from having to bear the cost of the transactions needed to secure the socially-optimal outcome. This theme is developed below.

IV. A SUGGESTED FRAMEWORK

The main advantage of tradeable-permit regimes is their ability to achieve environmental aims with a minimum of bureaucratic apparatus. The central problem with most such schemes to date has been that the 'licence to pollute' has been granted to firms which were already major polluters, with the result that the rents associated with a growing scarcity of pollution entitlements fell into the hands of those firms – a result with obvious equity problems, which provides the wrong incentives both to polluters and to others.

Bertram, Stephens and Wallace [*1989*] argued that that a global system to regulate greenhouse gas emissions over time spans of several decades should start from a strong presumption in favour of the long-run property right of the world's population to inhabit a sustainable global ecosystem. This means that any tradeable-permit system should be designed in such a way as to incorporate the principle that polluters should pay, through the

mechanism of being obliged to buy at least part of their right to pollute. A second basic principle was that the large flows of rents generated by those payments should be channelled directly from polluters to the owners of the property right, without passing through the hands of large international agencies on the way. This would mean an entirely new and massive channel of North–South transfer payments, mediated through a newly-created world market in pollution rights. The possibilities which this opens up both for development and for solving debt-servicing problems are obvious.

Suppose that an international consensus in favour of action on the greenhouse problem emerges. What institutions might then be established, and how would they work? The remainder of this section outlines the tradeable-permits system proposed in Bertram, Stephens and Wallace [*1989*]. Some alternative options are then reviewed, some lessons are drawn from recent real-world experience with tradeable permit systems, and the possible orders of magnitude of North–South redistribution are indicated.

First, a global emissions budget for each greenhouse gas would be formulated and announced by an international agency relying on the best obtainable scientific advice. This budget would be specified in terms of annual permitted emissions over a time period – say, the next ten years – but would be subject to annual revision as scientific information accumulated, and in the light of the development of carbon sequestration projects such as reafforestation. Operators of polluting activities in all countries would be required, under an international convention recognised by their national governments, to hold a portfolio of permits corresponding to the composition of their emission streams. The discussion which follows abstracts from this diversity of greenhouse gases and assumes, for simplicity, that we can treat carbon emissions as homogeneous. In practice the composition of emissions would of course have to be confronted in the design of the range of permits.

Around five billion 'shares' in this emission budget would be notionally issued on a one-share-per-head basis to the world population. In the first instance, national governments would be allocated shares corresponding to their populations, but there is no reason in principle why allocations could not be made, with the national government's agreement or by its own initiative, to sub-national groups - for example tribe of indigenous people, or local-government agencies, or even individuals or families. (Transactions costs should in theory be the main determinant of how widely entitlements can be distributed. In practice, few national governments are likely to surrender the opportunity to capture the rent revenues attached to share allocations.)

Each share would entitle the holder to emit a specified proportion of the global budget for each year of the permit's life. In the case of global carbon emissions, the numbers are convenient: the present level of gross emissions is six billion tonnes per year [*Grubb, 1989: 28 Table 3*] and the world's population is somewhat over five billion people. The human race is therefore emitting (that is, utilising the atmosphere and associated ecosystems as a dump for) roughly one tonne of carbon per year per person. In 1990, thus, each share would equate to roughly one tonne of carbon - that is, one-five-billionth of global emissions.

A typical scientists' target for the required reduction in emissions is 60 per cent globally in the next twenty years, which would imply a fall in per capita emissions to about one-third of a tonne by 2010, with nearly eight billion shares on issue and a global budget of 2.4 billion tonnes. (This assumes a 1.5 per cent p.a growth of eligible world population. A permit system relying on a per-head-of-population share issue would probably have to include some ceiling on growth of eligible population, in order not to be exposed to criticism for giving an incentive to some countries to promote accelerated population growth.)

Each share would be valid for a specified time period, after which it would be replaced by a newly-issued share, again allocated on the per-capita rule. Once the system had reached a steady state, a good rule of thumb might be that all shares should be ten-year entitlements, with one-tenth of the total outstanding stock expiring in each year. Thus in each year a new issue of one-tenth of a share per capita would be made on the same basis as the original issue. This principle of continually turning-over the stock of permits has two rationales: first, to keep the market liquid so that barriers to entry cannot be erected by cartels of industrial interests; and second, to ensure the availability at any time of entitlements lasting ten years into the future, which would make it possible for a firm contemplating an investment in a carbon-emitting plant to secure at the outset a portfolio of ten-year entitlements for its expected emission stream. (Ten years is a rough estimate of the typical planning horizon for industrial investment decisions.)

In the first year of the system, only one-tenth of the issued permits would be for ten years; the remainder would be spread evenly down the spectrum from nine years to one year. By the end of the ninth year of operation of the system, these shorter-term permits would all have been retired and replaced by ten-year permits. The secondary market would thus from the start be setting spot prices for permits with different periods to expiry, and the outstanding stock of permits would be comprised, in approximately equal proportions, of ten different maturities.

Secondary trading in permits would be entirely unrestricted, and any

barriers to the emergence of a free world market would be removed. The emission permits would then be internationally-traded paper assets comparable to shares and bonds, and would probably be traded mainly through the world's sharemarkets, using existing networks of brokers and with no restrictions on the identity of market participants or the currency of trading. A central computerised register would be maintained in order to monitor the global distribution of permitted emissions, and this register would be open to public scrutiny to enable national governments, commercial competitors and NGOs to carry much of the monitoring workload.

Enforcement of the permits would be designed on a cost-effective basis. Ideally, each national government would sign a convention binding its citizens to acquire permits for all carbon-emitting activities, and opening channels through which legal action against offenders could be initiated by non-nationals, with uniform sanctions agreed under international law. It would then be straightforward both for the international budgeting agency to initiate cases against major offenders, and for governments, environmental organisations or individuals to mount test cases in any country whose nationals offended. Hopefully in addition, national governments would be willing to use their own policing mechanisms to ensure compliance.

If fines are to be levied on offenders, the issue of who captures the resulting revenues is a touchy one. Grubb [*1990a: 4*] proposes that fines should go into an international fund which could be used to buy-in permits on the open market, thus contributing to the downward pressure on global emissions through a mechanism closely akin to open-market operations by a central bank. This would be a superficially attractive idea for a tradeable-permit system based on specified *quantities* of permitted emissions per permit, because as outstanding permits were bought-in the budget would automatically be tightened. However, this would not work in the Bertram–Stephens–Wallace proposed system. There, the predetermined global pollution budget is proportionally split among outstanding permits, so that each permit would represent a fractional share of the total, not a right to a specific tonnage of pollution. Thus a programme of open-market buying, withdrawing permits from circulation, would simply raise the quantity of pollution allowed to each remaining permit, and so would give capital gains to the holders of the remaining permits without affecting total permitted global pollution. In this case it seems preferable that fines or other levies be devoted to the promotion of carbon sinks to directly improve the state of the atmosphere.

The key goal, however, is to enforce compliance rather than raise

revenue via fines. If in the process national governments fine their own locals, it is not essential that the resulting revenues go into an international fund. Indeed, this is one area where the incentives facing national government would be fully compatible with the operation of the Bertram–Stephens–Wallace regime. If budgetary goals lead national governments to fine offending polluters, or to levy domestic carbon taxes, such initiatives would serve not as alternatives to the global permit system, but as reinforcements to it.

The suggested procedure of leaving cases to be heard, and determined, by the existing judicial systems of specific nations within the framework of an international legal convention, involves inevitable compromises of national sovereignty. It would be feasible only if the tradeable-permit regime offered strong incentives favouring participation by otherwise-recalcitrant national governments. The proposed allocation system, with its deliberate bias towards the poor countries which contain a majority of the world's population, should provide such an incentive for many governments in the South. Governments in the North, whose powerful industrial interests will be faced with the bill for buying-in permits from offshore, are more likely to be a problem. The USA, in particular, might well seek to reverse the property-rights basis of the permit allocation, claiming privilege for its industries' right to pollute over the world population's right to a sustainable atmosphere. The assumption behind this paper is that the rich-country governments have a sufficient stake in the international rule of law, and a sufficiently informed and vocal environmental constituency at home, to persuade them to withstand pressure from industrial interests and thus commit themselves to a policy package which solves the pressing economic development problems of the South in tandem with the global problem of ecological sustainability.

The technology for monitoring emissions is here assumed to be either available or likely to be profitably developed once the permit system became operational. Poor-country governments, once in control of substantial portfolios of marketable permits with an annual top-up through reissues, would have a clear and direct incentive to ensure that the system was enforced, and it could be anticipated that a profitable industry providing the technology and services required would quickly emerge.

V. OTHER OPTIONS

Tradeable permits are only one of four broad classes of policy instruments which can be used to reduce a pollution externality. The four are direct regulation, taxation, provision of a framework for private litigation, and the creation of new markets in which rights to pollute can be

traded. These options are not necessarily mutually exclusive, but each has a distinctive strategic character.

Direct regulation has traditionally been the main policy instrument used by national governments to deal with pollution inside their own territories. Its advantages lie in its transparency and certainty. Transparency occurs because the authorities can explicitly set out in written form the limits within which private economic agents must constrain their behaviour, and individual offenders can be prosecuted on the basis of concrete evidence regarding that behaviour. Certainty is gained, to the extent that the authorities put resources into policing the regulations, because enforcement is direct, in contrast to the indirect reliance on impersonal market mechanisms which occurs in some of the alternative systems. There are, however, three important drawbacks to direct regulation as the basis for an international policy regime.

The first problem lies in the cost of administering the regulations, including the task of designing and enforcing the small print. Even at national level, detailed environmental regulations absorb large amounts of time, create large bureaucracies, and tie up resources in hearings, enquiries, investigations and the like. At international level this problem is compounded.

The second problem lies in the difficulty of designing effective regulations which can apply across all countries, given the very diverse characteristics of different societies, economies and legal systems. In practice, it is not really conceivable that an international organisation could undertake detailed regulation of individual polluters in all countries. Consequently the sort of regulations most likely to emerge in practice would be ones which placed more-or-less binding obligations on governments to regulate their own nationals. Examples of such obligations are the Montreal protocol on restricting emissions of CFCs, and the recent proposal for 20 per cent target reductions in carbon dioxide emissions by each country over the next 15 years or so. Such country-by-country quantitative targets are grossly inefficient, unfair and unsustainable. They serve only two clear purposes: first to enable politicians and diplomats to indulge in the pretence that they are responding to the greenhouse problem; and second to reinforce the dominance of the industrial great powers in the world political and economic order.

The third problem is the difficulty of enforcement, given that a world government does not yet exist, and is not likely to be allowed to develop much beyond the present embryonic institutions of the United Nations. International enforcement of global regulations would probably take the form of the imposition of sanctions (economic, diplomatic or military) on

offending countries, in effect holding national governments accountable for the behaviour of their polluters. It is not difficult to envisage the successful imposition of such sanctions on a small country by an international coalition led by large powers. It is less easy to see how such enforcement mechanisms would be brought to bear on the USA, the USSR, Japan, or other major economic and military powers. Because enforcement would be so crucially subject to the asymmetry of the global distribution of power and wealth, the moral legitimacy of the regulations would tend to be undermined in the long run, and there would be an incentive for 'underdog' countries to defect as a coalition.

Carbon taxes provide the second broad option for policy. Such taxes are the familiar textbook response to pollution, learned by every first-year economics student. The advantages of the tax approach, again, are familiar. First, it allows some scope for economic agents (both producers and consumers) to make optimising adjustments in their behaviour. Second, governments are experienced in implementing such taxes. Third, taxes raise revenue, which puts resources in the hands of the authorities, enabling them to finance both the administration of the tax itself, and further measures to reduce pollution or to promote research into pollution-related problems.

The carbon tax is the focus of most of the recent economics literature on the greenhouse problem [*e.g. Whalley, 1990; Schelling, 1990; Nordhaus, 1990a; 1990b; 1990c; Common, 1990; Hoel, 1991; Pearce, 1991*] and its relevance as an instrument which national governments might use to control domestic polluters is not in doubt. At the international level, however, it is an unattractive option. In the first place, there would be the problem of the currency in which the tax would be paid; exchange-rate issues would render it extremely difficult to achieve a uniform tax incidence across polluters in different countries, and would open up opportunities for manipulation. Second, and more important, any carbon tax on the scale required to make major inroads into world fossil fuel consumption would generate revenues on an unprecedented scale (several percent of world GDP) which would have to be collected and administered by someone. It is simply not conceivable that the world community would tolerate the emergence of an international agency with revenue-raising powers on this scale – nor should they, given the large element of moral hazard involved.

It is sometimes argued that carbon taxes have superior targeting properties to tradeable permits in cases where the marginal cost curve for pollution abatement is not known with certainty but is more steeply-sloping than the marginal benefit curve (for a summary of the static

theory see Baumol and Oates [*1988: 68–9*]. Intuitively, one expects the greenhouse problem to be characterised by a marginal cost curve which is convex downward and a marginal benefit curve which is concave, which makes it extremely difficult to apply this principle in practice. Interestingly, however, a recent guess at the total greenhouse abatement cost curve by Nordhaus [*1990a: 20*] appears to imply a roughly linear marginal cost curve up to 90 per cent abatement, by which stage the marginal-benefit curve could be argued to have steepened significantly. Nordhaus' data thus appear to be consistent with advocacy of a permit system in preference to a carbon tax. As Baumol and Oates note [*1988: 74*], 'where the marginal benefits function is quite steep, close control over quantity becomes important'.

Recent work by Hoel [*1991*] and Pearce [*1991*] has suggested that by imposing a uniform carbon tax and then distributing targeted reimbursements, an international government could mimic the effects of the tradeable-permits option outlined earlier. Quite apart from the underlying assumption that an international agency exists which could be relied upon to do this efficiently, the suggestion seems unnecessarily cumbersome and difficult to negotiate. If the aim is simply to imitate the operation of a tradeable-permit system whose allocative design targets the financial benefits to the poor, then it is probably better simply to implement the tradeable-permits system itself. This argument is reinforced when it is recalled that a key reason for allocating a large share of the benefits to developing countries is to provide 'side-payments' sufficient to persuade the South to join the system. The permits arrangement locks-in the side-payments up front, before polluting activity takes place and associated payments are made. The alternative of charging a carbon tax first, and making side-payments later, is obviously open to greater credibility problems, and would be less attractive to the South for any given level of side-payments.

Private litigation is the third option. If this approach were taken, an international convention would specify the standards within which all polluting activities would be legally obliged to operate, and would establish the right of any member of the world community to sue offending polluters before some appropriate court or tribunal. The simplest way to do this would be for each national government to write appropriate emission standards into its domestic law, together with a provision granting non-nationals the legal standing to sue in the courts of that country, possibly with a right of appeal to a world court. The great advantage would be the low administrative cost, compared to the regulatory approach. The work of identifying and investigating individual

offenders would be left to third parties with an interest in doing it – for example, environmental organisations such as Greenpeace and Friends of the Earth; international agencies such as UNEP; commercial competitors anxious not to be undercut by pollution-intensive countries; and ordinary citizens affected or offended by some polluter's activity. Precedents are provided by the international law relating to oil spills at sea, and by transboundary pollution treaties in Europe. The obvious disadvantages would lie first in the ability of large wealthy polluters to stall legal proceedings, possibly indefinitely; second in the question of what sanctions the courts could impose and how these would be enforced; and third in the natural reluctance of national authorities to see their courts invaded by litigants from outside their sovereign jurisdiction.

Tradeable permits are the fourth strategic approach. They should provide incentives for optimising adjustment by all economic agents to bring their collective emissions within a clearly-defined global pollution budget; and to these strong efficiency properties could be added the very desirable equity effect of transferring income and wealth from North to South, without any need for large flows of funds to pass through the hands of an international bureaucracy, provided that the initial allocation is along the lines suggested in this paper. If implemented together with the private litigation option outlined above, the scheme could be largely self-policing at very low fiscal cost to the world's governments; and it should be politically sustainable in the long run because of the strong incentives for a majority of countries to participate. Most important of all, it would spread the burden of adjustment across the world economy in such a way as to minimise the cost of abatement, which means that the poor countries would not see their economic growth blocked by the imposition of rigid and irrational country-by-country emission-reduction targets.

There is one obvious political problem. The large industrial countries would have to shoulder an adjustment burden proportional to the scale of their existing polluting activity, since the scheme would oblige the polluters to pay the rest of the world community for their right to pollute. The leading polluters would naturally be reluctant, and whether the opposition of the United States, Japan and some key European countries could be overcome by persuasion or pressure cannot be forecast with any certainty. However, the peoples of the rich countries have a large stake in protecting the global environment, which might well outweigh political pressures from powerful industry lobby groups.

One big problem is the possibility that an otherwise desirable tradeable-permits programme might be 'captured' by the large industrial powers as a means of advancing their own interests against the rest of the

world community, Whether tradeable permits at the global level are a workable idea or not hinges critically upon the property-right assumptions which underly any programme. The choice of property-rights assumption should be guided by the principle of seeking the highest possible degree of incentive compatibility to induce national governments to co-operate. One key requirement for a workable international scheme would be that permits *not* be allocated preferentially to existing polluters.

VI. WHOSE PROPERTY RIGHTS? THREE LESSONS FROM THE UNITED STATES

Coase [*1960*] offered the theoretical conjecture that, provided transaction costs and wealth effects were zero, establishment of a property right was the sufficient condition for emergence of an allocatively efficient outcome, and that it made no difference which property right was chosen. If individuals were free to trade, he suggested, the same result should be reached regardless of whether polluters had to compensate the victims of pollution for damage suffered, or the victims had to bribe the polluters to stop. Coase offered this conjecture in the context of an attack on the tax-based policy prescription of Pigou [*1938*], and many readers have misinterpreted him as arguing that the 'polluter-pays principle' was wrong – that is, that there is some presumption that the victims, rather than the polluters, should pay. What Coase actually argued was that pure (neo-classical) economic theory should leave one indifferent between the two options in the zero-cost, full-information, no-wealth-effects case, so that the choice would rest upon other criteria – including a consideration of real-world transaction costs, wealth effects, and legal precedents. As many subsequent commentators have pointed out, 'when wealth effects are admitted it is easy to see that the initial assignment of rights is everything ... To assign or allocate rights is also to assign or allocate power and the control over future benefit streams. A property right is, above all, the ability to hold something off the market until a possible buyer meets the price that the owner is free to set' [*Bromley, 1988: 54*].

In conservative hands, the Coase proposition had major policy ramifications in the 1980s. In particular, it provided vested interests in large industry with an apparent argument against the polluter-pays-principle. Rather than polluters having to pay for the damage they caused, so the argument ran, why should the victims not pay for the cleanup by bribing the polluters? This implied that the property right to be legitimated should be the polluter's right to pollute, rather than the victim's right to enjoy a pollution-free environment. Applied to a tradeable-permit sys-

tem, this meant that the permits were allocated to the existing polluters on a pro-rata basis – that is, the biggest polluters received the largest share of the right to pollute. This approach was applied by the Environmental Protection Agency (EPA) during the Reagan era in the United States to a number of experiments with tradeable permits as a means of regulating air pollution within 'hotspots' such as major urban centres.

As Cook [*1986: 221*] has pointed out, the EPA programme has been open to valid criticism on the grounds that it legitimates and rewards the activities of large corporate polluters: 'Beyond the concerns for cost-effectiveness, does society really want to grant full property rights in air resources to large corporations? What would the economic and political (both present and future) impact be if one, or even a few, large pollution sources got control of the available air resources in a region?' The US experience draws attention to three lessons for the design of tradeable emission permits. First, there are important distributional implications flowing from the property-rights decision, and these in turn have incentive effects from which Coase simply abstracted in his original article. Second, the choice of a property-rights framework that legitimates the position of existing polluters enables those polluters to erect barriers to entry which serve to obstruct the desired process of abatement [*Misiolek and Elder, 1989*]. Third, the Coase conjecture is vitiated if the allocation of property rights reinforces, rather than countervails, any asymmetry in budget-constraint regimes between polluters as a group and victims as a group.

To illuminate these three issues, consider the contrast amongst three possible ways of establishing a tradeable-permit regime to limit air pollution.

(1) In one approach, the starting point is the assumption that existing polluters have acquired, by their actions, a presumptive property right to emit pollution, and that other parties who have not caused pollution in the past do not have any share in that property right. Permits adding-up to the total pollution budget for the period are then allocated in accordance with this rule. Assuming that the pollution budget is tight enough to impose a binding constraint on emissions, there will be scarcity rents attached to the possession of a permit, until sufficient technological progress has been achieved to enable industry to work within the budget. These rents accrue to the holders of permits, either as excess profits on their pollution-causing activities, or as revenue from the sale of some or all of their permits to third parties wishing to enter the polluting activity.

The rents in effect constitute a reward to polluters for their past behaviour, while at the same time providing the means and the incentive

to adopt pollution-abating techniques in future. The obvious advantage of this property-rights allocation is that it avoids what would otherwise be a bruising political confrontation between the regulator and industrial vested interests. The equally obvious disadvantage is that the costs of the policy fall upon the rest of the population, who find themselves paying for high profits in the polluting industries, while at the same time they continue to experience the detrimental effects of pollution during the transitional period until abatement takes effect. Under these circumstances the political legitimacy of the policy regime is difficult to sustain, if governments are to any extent accountable to the wider public rather than merely to industrial vested interests (the latter, of course, including workers as well as capitalists in the industries concerned).

(2) A second approach would be for a governmental agency to print a fixed number of permits and put them up for open auction. The property-rights assumption here would be that while the commons are the property of the community at large, the government acts as agent for the community in regulating access. The revenues from the auction would then be captured by the government, providing resources which could be directed to other budgetary needs (presumed to be ultimately of benefit to the community whose property had been auctioned by the government agency). Would-be polluters would then have to pay for permits, either by acquiring them at the initial auction, or by secondary trading. At the initial auction, bidders would offer prices reflecting their estimate of the value to them of permits to emit pollutants, subject to their budget constraints. Given that budget constraints are the key to bidding strength, access to finance would be a powerful factor in determining the identities of successful bidders, and those bidders who could anticipate early cash returns from their possession of permits would obviously be in a preferred position relative to those not intending to make quick commercial use of permits. A bidding ring or rings with financial advantage could potentially sew up a large share of the initially-auctioned allocation, and by subsequently restricting the supply of permits to the secondary market, could drive up the price for speculative advantage, while at the same time erecting a significant barrier to the entry of new competitors (who, having to pay a premium to acquire the necessary permits, would begin at a competitive disadvantage).

(3) A third possibility is that the property right of all community members in the commons could be recognised by the issuing of a large number of individual shares in the resource or in some aspect of it. The precise

institutional detail would be a matter for negotiation and debate, since individual shareholders would obviously have the right to nominate agents to receive and manage the shares on their behalf. (The view in (2) above that government acts as the agent of citizens at large is merely an extreme version of such delegation.) Would-be polluters would now have to enter the open secondary market to acquire permits from the initial recipients. Assuming that the spot price quickly adjusted to reflect the rental value of permits, then the rents associated with permitted pollution would come into the hands of the initial holders of share-permits as they opted to sell. The more open and efficient the market, the less would be the possibility of speculative or 'hold-out' behaviour by any group of initial permit recipients. The distinctive feature of this decentralised regime is that it removes from the hands of central government the control of the permit market, and with it the ability to realise the seigniourage rents which would otherwise come into the hands of the permit-issuing agency.

In the case of a global tradeable-permit regime, this property-rights issue is a far more serious problem than is the case with national or local programmes to check air pollution. This is because the political legitimacy of any international convention will rest heavily upon unanimous agreement amongst governments. If the US model of handing out permits to existing polluters were to be adopted for a global system, this would correctly be seen as a device to reinforce the existing global distribution of power and wealth, leaving poor countries to bear the main burden of financing the rich countries' clean-up operations, while having to pay twice-over to secure development opportunities for themselves. Rich-country governments would have a strong constituency of winners from the regime. Poor-country governments would have to represent, however imperfectly, large constituencies which would clearly stand to lose. The payoff matrix thus would look very unfavourable for the achievement of international agreement; and even if achieved, an agreement would probably not be politically sustainable, since the benefits to individual poor countries from free-riding on the world programme would be too great to ignore.

The world community has a strong interest in promoting greater equality of economic welfare by means of the economic development of poor countries. Such development will imply rising pressure on energy supplies, and poses the prospect of rising greenhouse gas emissions from at least some countries. If industrialisation is to proceed in the South in tandem with a global transition to a sustainable world, then that industrialisation must utilise state-of-the-art (and better) energy-saving

technologies [*Goldemberg et al., 1988*]. One way to make this feasible is to enable the economies of the South to capture the rents from a tradeable-permit regime, while providing them with the incentive to plow those rents into energy-efficient development. (Equally, it will be essential that established industries in the North face as much pressure to abate their emissions as do new industries in the South.)

If the opportunity is lost to tackle development and sustainability as simultaneous parts of a joint problem, then the global outlook darkens seriously. Either the greenhouse effect could be held at bay by condemning the poor countries to long-term underdevelopment; or the South might grow for a generation or two without regard to the environmental consequences, exposing the entire global community to the risk of catastrophic climate change.

The fact that a joint solution implies large transfers of wealth (side-payments) from North to South means that the proposals outlined here must be expected to encounter some degree of self-interested obstruction from the rich, particularly the United States and Japan, but it would be wrong to fudge the issue simply on that account. The world community faces an historic chance actually to achieve the development goals to which so much lip service is paid on the diplomatic circuit, as a by-product of that community's willingness jointly to confront the greenhouse issue. The developing countries deserve no less than full partnership in this process. If full partnership is denied them, they have the ability credibly to threaten ecological disaster. Prudence, as well as benevolence, should prompt the rich to tolerate economic redistribution on a very considerable scale.

VII. NEW ZEALAND FISHERY REGULATION: THREE LESSONS

In his discussion of the fishery case, Gordon [*1954*] identified the absence of a full set of markets, which resulted in unregulated private exploitation leading to overfishing. Over the following 30 years the world has moved to 200-mile exclusive economic zones, within which a number of governments have experimented with quasi-market mechanisms. New Zealand, for example, now operates a system of Individual Transferable Quotas – entitlements to a certain volume of fish catch of named species, which can be bought and sold by private individuals without government involvement. The New Zealand experience highlights three key problems to be overcome if a tradeable-permit system is to deliver the required environmental payoffs.

First, the decision to use the initial quota auction as a revenue-raising device exposed the scheme to severe moral hazard from the outset. The

New Zealand government declared itself to be in effect the monopoly possessor of fishing rights, and invited would-be fishery operators to bid for them. There was no reason why the short run revenue-maximising supply of quotas to this auction market should coincide with the sustainable yield of the fishery. (In theory, with full information, perfect foresight, and perfect competition, the two might coincide. In the real world, with very incomplete information, great uncertainty about the ecology of the fishery and the likely future trend of policy, and strong incentives for strategic behaviour by private-sector participants, matters were otherwise.) In the event, the urgent desire for revenue to help balance the budget in the short term led the government to oversell the fisheries, with the result that the quota system's implementation led to serious depletion of several fish species around the New Zealand coastline. The government then had to tighten the catch limits. The lesson is that the agency which fixes the volume of quotas to be issued should not itself stand to profit from an increase in their number. This principal-agent problem is the dominant reason why a tradeable-permit system should not be introduced by means of a revenue-raising auction. (As already noted, the risk of placing enormous revenue-raising power in the hands of any agency constitutes, equally, a strong reason for arguing that a carbon tax should not be contemplated on a global scale.)

The second problem with the New Zealand fisheries experiment was the mismatch between the species mix encountered in actual fishing, and the species mix in any given firm's quota porfolio. The result was that 'unwanted' species (those not included in the firm's quotas), when caught, are often dumped at sea – a wasteful practice that accelerates the damage to fish stocks and is impossible for government to monitor. The lesson is that economists' tendency to assume that resources are 'homogeneous' needs to be tempered by strong input from the scientific community about the structure of the real world.

The third problem with the New Zealand fishery quotas was the tendency for quotas to be aggregated into the hands of a few powerful companies, leading to a situation where government regulators faced a concentrated and influential lobby group. The lesson for a global tradeable-permit system is that there must be built-in safeguards to keep the market liquid and competitive.

VIII. NORTH-SOUTH REDISTRIBUTIVE IMPLICATIONS AND INCENTIVE EFFECTS

Having outlined a pollution-abatement regime which provides the vehicle for very large North-South transfers, we may close with some

remarks on the orders of magnitude involved. There are some economists who feel that the whole exercise is out of the question. Mishan [*1990: 42n*], for instance, remarks:

> The notion, occasionally broached by Western politicians, of annual tribute to poorer countries in order to encourage them to finance ambitious programmes of reafforestation, and of changeover to less toxic technologies, cannot be taken seriously. The astronomical cost of attempting so grandiose a global economy strategy takes it out of the range of the politically feasible.

Read [*1990b*] has estimated (probably rather optimistically) that a programme to grow enough trees to sequester six billion tonnes of carbon annually would cost $400 billion per year. Nordhaus [*1990a: 20*] estimates that a 60 per cent cut in carbon emissions would cost the world over $300 billion per year. As Leggett [*1990: 3*] remarks 'The implications of concerted action to cut global emissions of greenhouse gases are not for the politically faint-of-heart.'

Before reaching the view that such numbers are too big to contemplate seriously, one should place them into perspective. The outstanding debt of developing countries as a whole in 1990 was US $1,265.2 billion, with annual debt-service payments of $162.7 billion [*IMF, 1990: 184 Table A45*]. Grubb [*1989: 2.8 Table 3*] estimates that a one per cent ad valorem tax on world carbon consumption would net $0.4 per tonne, or a total revenue of $2.4 billion annually; so a tax (or comparable permit system) which doubled world energy prices would thus raise $240 billion at current energy consumption rates. Official development assistance flows from OECD and OPEC countries are between $40 billion and $50 billion per year [*World Bank, 1990: Table 19*]. Total Gross Domestic Product of developing countries in 1988 was $3,061 billion, and that of the industrial market economies was $13,868 billion [*World Bank, 1990: Table 3*]. Annual arms spending by the OECD countries is of the order of $500 billion, and world arms spending over $800 billion [*Deger, 1990*].

Table 1 below shows the orders of magnitude involved in the tradeable-permit scheme outlined above. The estimates are based on a world population of 4.9 billion with one ton per head of carbon entitlements, in a world with the 4.9 billion tons of annual emissions identified by Bolin [*1989*]. (The population figure and the carbon emissions figure are low relative to 1990 estimates; both represent the situation in the mid-late 1980s.) With permits allocated on the basis of one ton per person, with no age or gender restriction, the mismatch between initial permit entitlement and actual emission performance is as shown in Column 4, if we leave out the effects of rainforest burning. (Inclusion of deforestation-related

TABLE 1
HYPOTHETICAL PERMIT-TRADING OUTCOME FOR MID-LATE 1980S DATA

Country	*(1) Per capita carbon emission (tons)*	*(2) Population millions*	*(3) Total carbon emissions excluding rainforest burning million tons*	*(4) Net buy-in required million tons (3) minus (2)*
USA	4.9	241.6	1183.8	942.2
Democratic Republic of Germany	4.9	16.6	81.3	64.7
Canada	4.4	25.6	112.6	87.0
Czechoslovakia	4.1	15.5	63.6	48.1
Australia	3.9	16.0	62.4	46.4
USSR	3.3	281.1	927.6	646.5
Poland	3.0	37.5	112.5	75.0
West Germany	2.9	60.9	176.6	115.7
UK	2.5	56.7	141.8	85.1
Netherlands	2.5	14.6	36.5	21.9
Netherlands	2.5	8.4	18.5	10.1
France	2.0	55.4	110.8	55.4
Japan	1.9	121.5	230.9	109.4
Italy	1.5	57.2	85.8	28.6
Spain	1.4	38.7	54.2	15.5
People's Republic of China	0.5	1054.0	527.0	–527.0
Brazil	0.3	138.4	41.5	–96.9
India	0.1	781.4	78.1	–703.3
Other	0.5	1868.3	843.9	–1024.4
World Total	1.0	4889.4	4889.4	0.0
Total net purchases by deficit countries				2351.6
Total net sales by holders of surplus permits				2351.6

Figures from Bertram, Stephens and Wallace [*1989: Appendix 3*], based on Bolin [*1989: Table 4*] estimates of actual carbon emissions and World Bank [1988: Table 1] estimates of population.

emissions could eliminate much of Brazil's gain from the system – a powerful potential incentive to secure Brazilian efforts to halt forest destruction.) The resulting estimate is that at least half the stock of permits would have to be traded internationally in order to legitimate the prevailing distribution of emission sources; in practice the figure would be somewhat higher because of the diversity of the countries included in the 'other' category, which includes New Zealand and several small European industrial economies as well as a mass of poor countries.

The implied gross transfer of purchasing power in the first round of trading would then be determined by the dollar value of permits per ton of permit entitlement. Each dollar on the carbon permit value, in the Table 1 example, would add over $2.4 billion to the North–South transfer. A $20 per ton permit valuation would thus transfer roughly $50 billion per year, assuming no abatement in rich-country pollution and no rise in poor-country utilisation of permits. This would be equivalent to a doubling of current development assistance, to a level which would still be below 1 per cent of the GDP of rich countries. A $40 per ton valuation would transfer $100 billion. Numbers of this order of magnitude lie well within the world community's grasp.

final version received November 1991

REFERENCES

Baumol, W. and Oates, W., 1988, *The Theory of Environmental Policy*, 2nd edition, Cambridge: Cambridge University Press.

Bertram, I.G., Stephens, R.J. and C.C. Wallace, 1989, Economic Instruments and the Greenhouse Effect, paper prepared for New Zealand Ministry for the Environment, Wellington, September. Reprinted as Working Paper 3/90, Graduate School of Business and Government Management, Victoria University of Wellington.

Bolin, D., 1989, 'Preventive Measures to Slow Down Man-Induced Climate Change', mimeo, University of Stockholm.

Bromley, D.W., 1988, *Property Rights and the Environment: Natural Resource Policy in Transition*, Wellington, Ministry for the Environment.

Coase, R.J., 1960, 'The Problem of Social Cost', *Journal of Law and Economics*, Oct.

Common, M.S., 1990, 'Policy Instrument Choice', paper presented to Workshop on Moving Toward Global Sustainability – Options and Implications for Australia, ANU, Canberra, 9–10 Aug.

Cook, B.J., 'Review of T.H. Tietenberg, 1986, *Emissions Trading: An Exercise in Reforming Pollution Policy*', *The Journal of Politics*, Vol.48, pp.220–22.

Dales, J.H., 1968, *Pollution, Property and Prices*, Toronto: University of Toronto Press.

Deger S., 1990, 'World Military Expenditure,' Ch. 5 in Stockholm International Peace Research Institute, *SIPRI Yearbook 1990: World Armaments and Disarmament*, Oxford: Oxford University Press.

Goldemberg, J., Johansson, T.B., Reddy, A.K.N. and R.H., Williams, 1988, *Energy for a Sustainable World*, New York: Wiley & Sons.

Gordon, H.S., 1954, 'The Economic Theory of a Common-Property Resource: The Fishery', *Journal of Political Economy*, Vol.62, April, pp.124–42.

Grubb, M.J, 1989, *The Greenhouse Effect: Negotiating Targets*, London: Royal Institute of International Affairs.

Grubb, M.J., 1990a, 'International Marketable Emission Permits: Key Issues', paper prepared for IPCC/OECD workshop on Financial and Economic Measures as a Response to Climate Change, Paris, April.

Grubb, M.J., 1990b, 'Issues and Options in Implementing Greenhouse Gas Control Agreements', paper for IPCC Energy and Industries Subgroup meeting on greenhouse gas emissions, London, June.

Hoel, M., 1991, 'Efficient International Agreements for Reducing Emissions of CO2', *The Energy Journal*, Vol.12,No.2,pp.93–107.

Intergovernmental Panel on Climate Change, 1990, *Policymakers Summary of the Formulation of Response Strategies: Report prepared for IPCC by Working Group III*, WMO/UNEP, June.

International Monetary Fund (IMF), 1990, *World Economic Outlook*, Washington, DC, May.

Leggett, J. (ed.), 1990, *Global Warming: The Greenpeace Report*, Oxford: Oxford University Press.

McKinsey and Company, 1989a, 'Protecting the Global Atmostphere: Funding Mechanisms' interim report to Steering Committee for Ministerial Conference on Atmospheric Pollution and Climatic Change, Netherlands, June.

McKinsey and Company, 1989b, 'Background Paper on Funding Mechanisms for the Ministerial Conference on Atmospheric Pollution and Climatic Change, with Particular Attention to Global Warming, 6th and 7th November 1989', Oct.

Marks, R.E., 1990, 'Reducing Carbon Dioxide Emissions from Australian Energy Use', Working Paper 90–027, Australian Graduate School of Management, University of New South Wales, July.

Mishan, E.J., 1990, 'Economic and Political Obstacles to Environmental Sanity', *National Westminster Bank Quarterly Review*, May, pp.25–42.

Misiolek, W.S. and H.W. Elder, 1989, 'Exclusionary Manipulation of Markets for Pollution Rights', *Journal of Environmental Economics and Management* 16, pp.156–66.

Nicolaisen, J. and P. Hoeller, 1990, 'Economics and the Environment: A Survey of Issues and Policy Options', OECD Department of Economics and Statistics Working Paper No. 82, Paris, July.

Nordhaus, W.D., 1990a, 'Greenhouse Economics: Count Before You Leap', *The Economist*, 7 July, pp.19–22.

Nordhaus, W.D., 1990b, 'A Survey of the Costs of Reduction of Greenhouse Gases', *The Energy Journal*, Fall.

Nordhaus, W.D., 1990c, 'Economic Approaches to Greenhouse Warming', paper presented to Conference on Economic Responses to Global Warming, Istituto San Paolo di Torino, Rome, 5–6 Oct.

Nordhaus, W.D., 1991, 'To Slow or Not to Slow: The Economics of the Greenhouse Effect', *Economic Journal*, Vol. 101, July, pp. 920–37.

Pearce, D., 1991, 'The Role of a Carbon Tax in Adjusting to Global Warming', *Economic Journal*, Vol. 101, July, pp. 938–48.

Pearce, D.W. and R.K. Turner, 1990, *Economics of Natural Resources and the Environment*, Hemel Hempstead: Harvester Press.

Pigou A.C., 1938, *Economics of Welfare*, 4th ed., London: Macmillan.

Read, P., 1990a, 'Global Warming: Why Mrs Thatcher Should Be More Ambitious', *National Westminster Bank Quarterly Review*, Nov.

Read, P., 1990b, 'Tradeable Obligations on Energy Firms and Global Redevelopment with Energy Environment Sustainability (GREENS): A Policy Response to Global Warming', Massey University, New Zealand, unpublished.

Rosenberg, N.J., Easterling, W.E. Jr, Crosson, P.R. and J. Darmstadter, (eds), 1989, *Greenhouse Warming: Abatement and Adaptation*, Washington, DC: Resources for the Future.

Schelling, T.C., 1990, 'International Burden Sharing and Coordination: Prospects for Cooperative Approaches to Global Warming', paper presented to Conference on Economic Responses to Global Warming, Istituto San Paolo di Torino, Rome, 5–6 Oct.

Solow, A.R., 1990, 'Is There a Global Warming Problem?', paper presented to Conference on Economic Responses to Global Warming, Istituto San Paolo di Torino, Rome, 5–6 Oct.

Tietenberg, T.H., 1985, *Emissions Trading: An Exercise in Reforming Pollution Policy*, Washington, DC: Resources for the Future.

Whalley, J., 1990, 'The International Incidence of Carbon Taxes', paper presented to

Conference on Economic Responses to Global Warming, Istituto San Paolo di Torino, Rome, 5–6 Oct.

Whalley, J. and Wigle, R., 1989, 'Cutting CO2 Emissions: The Effects of Alternative Policy Approaches', paper presented to NBER Conference on Applied General Equilibrium Modelling, San Diego, Sept.

World Bank, 1990, *World Development Indicators 1990*, Washington, DC.