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Economic Instruments and Environmental Policy

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I INTRODUCTION

Environmental resources are scarce and many are getting scarcer. Resource allocation problems abound and recent experience is disheartening. Despite the growing scientific consensus on global warming, action to reduce greenhouse gas emissions has been largely ineffectual. Progress with energy efficiency measures and on renewables has been slow. In the former case, the effect of rising incomes has stimulated demand offsetting on a global level the contribution from technology in widening the gap between economic growth and energy demand. With the prospect of a further 3 billion people this century, and the rapid development of China and India, demand effects will continue to put upward pressure on emissions. The International Energy Agency (IEA) estimate that world energy demand will rise by 1.7 per cent per annum between 2002 and 2030, and CO_2 emissions over the period by 60 per cent (IEA, 2004). In the case of renewables, limited progress in Europe will be offset by the decline of nuclear output. Biodiversity loss – the rate of habitat loss and associated extinctions – shows no sign of slowing down. In a period

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which matches the geological extinction episodes, efforts to protect the great repositories of biodiversity – like the rain forests – have had little aggregate effect. By the end of the century, much of the Amazon will be gone.

These problems have been largely caused by the industrial transformation of the twentieth century,[1] based upon the harnessing of fossil fuels, which helped to facilitate a five-fold increase in population. Correcting them will require a switch from fossil to non-fossil fuel energy sources and the protection of species and habitats. These changes will be costly, and a natural way to make the transition to a more sustainable economy is to use the price mechanism and markets. Economic instruments, correcting for the market failures, are an obvious route forward for environmental policy, harnessing the market to deliver the economic transformation required. Yet the paradox is that economic instruments remain the exception rather than the rule, and their design owes more to politics and vested interests than the guidance which economic theory provides. The toolbox of economics has been largely ignored.

The aim of this paper is to restate the arguments for economic instruments, and to explain why this paradox arises by considering the political economy of introducing economic instruments, in particular the role of interest groups, lobbying and capture. Whereas economists – and environmentalists – are interested in the substitution effect towards a more environmentally benign economy, political economy is focused on the economic rents from policy and in particular the income effect.

The structure of the paper is as follows. In Section II the case for economic instruments is briefly restated. Section III looks at the economic toolbox for guidance in the design of economic instruments. Section IV then considers the counter case and reviews the main political economy reasons for the opposition to the more widespread introduction of economic instruments. It identifies the rent-seeking incentives and how these interact with the political process. Section V then considers implementation issues in the light of this rent-seeking behaviour, and in particular for the setting of instruments, their credibility and the hypothecation of the revenues. The case for a careful re-evaluation of environmental institutions is made. Brief illustrations of these points in two examples – climate change and biodiversity – are made in Section VI, before the main conclusions are presented in Section VII.

[1] For a comprehensive survey of the environmental history of the twentieth century, see McNeill (2000).

II THE CASE FOR ECONOMIC INSTRUMENTS[2]

Why use economic instruments? In a world of perfect information and a benign government which pursued the public interest, there would be little role for economic instruments. Regulators could plan the allocation of resources, yielding the optimal level of pollution. The corollaries of these two assumptions – uncertainty and government failure – provide the core rationale for a preference for markets over planning.

The terms of the first of these arguments was defined in the 1930s. Hayek pointed out that under imperfect information the choice of economic organisation turned upon which system best economised on information.[3] He argued that whereas the planner would need to know all the utility and production functions, in a market system each individual need only know the prices. The second part of the case for markets was developed slowly and in a piecemeal fashion as economists began to study the behaviour of governments and regulators. Government failures were analysed through public choice and voting theory; through the principal-agent model; and through regulatory capture and incentives of regulated firms.

These arguments established a general theoretical preference for markets over planning, which received further reinforcement – in both economic and, most importantly, political terms – as the scale of the failures under planning in the former Soviet Union were revealed. These failures were not only in mainstream economic performance, but also in the environment. The scale of environmental degradation in the Soviet Union was large, and also under reported. Recent evidence from China is no more encouraging. The pursuit of rapid industrialisation, combined with the manufacture of statistics, the suppression of protest and the absence of democracy, has left a legacy of environmental damage stretching from the drying of the Aral Sea to the dumping of nuclear waste.

A general preference for using markets is augmented by some specific attractions of economic instruments for environmental policy. Economic instruments do not discriminate between the supply and demand side of markets, and they are dynamic in effect. Whereas the planner may need a demand side policy for energy efficiency, and supply side policies for managing renewables, nuclear and other non-carbon sources, putting a price on carbon signals to both sides of the market, and delegates the choices to individuals and firms, seeking out the lowest marginal costs. It signals too to investors in

[2] There are a number of good sources stating the general arguments. See, for example, HM Treasury (2002).
[3] See Hayek (1948) for the collected relevant papers.

new capital and in research and development. By contrast with planning, it does not "pick winners".

Economic instruments should in general be administratively and bureaucratically light, in that the burden falls on setting and revising the economic instrument, whereas command-and-control requires administrators for each aspect of the policy, with inspection, compliance and enforcement procedures, based upon information requirements. Planning and regulation employs many administrators. Finally, economic instruments have been argued to provide a *double dividend.* By raising environmental taxes, it is argued that revenue is raised by correcting market failures. This revenue can displace other more distorting taxes, like those on labour. Hence there is a double efficiency benefit.[4]

III THE CHOICE OF INSTRUMENT

Given this general case for using the market, what does economic theory tell us about the appropriate economic instruments? What does it tell us about the choice of instruments? In the literature, there are two classic approaches – that of Pigou and of Coase. Both have been subject to considerable criticisms and each has been developed, but they remain the cornerstones of environmental economics.[5] We begin by drawing out some of their principle features from a policy perspective, and then turn to the implications of uncertainty for instrument choice.

(i) Pigou and Coase

The classic solution to environmental externalities is provided by Pigou. The market failure arises because the supply curve does not include the social marginal costs. The Pigou framework involves internalising the externality, by imposing a tax equal to the marginal social cost. There then needs to be an income adjustment to take account of the income effect of the price change caused by the tax.[6]

Note several immediate implications of this simple framework. First, the changes involved are *marginal*, whereas some argue that climate change and biodiversity may be non-marginal. Second, the externality is assumed small enough so as not to distort the rest of the economy and hence it is a partial

[4] See Smith (1998).
[5] See for example, Baumol & Oates (1988).
[6] The income adjustment depends upon the concept of income used – in particular whether Hicks or Lindahl.

equilibrium approach, whereas climate change and biodiversity are considered large scale in effect, and a carbon tax which is capable of stabilising and then reducing emissions will have a significant role in the economy as a whole. Third, the framework does not indicate a superiority of taxes. Price *or* quantity can be fixed, and in the quantity case, this can be via command-and-control regulation or tradeable permits. Information is perfect, so it does not matter which way the problem is tackled. Imperfect information – to which we turn below – is what counts in adjudicating between the policy instruments.

The alternative classic approach was provided by Coase (1960). Being of a Chicago school persuasion, Coase was naturally hostile to the interventionist approach which Pigou's followers preferred. Rather than tinkering with the market, as a kind of social engineering, Coase took a more fundamentalist view of market behaviour, focusing on property rights. For him, externalities existed because of non-excludability, and excludability was a feature of ownership. If everything was owned, then the problem dissolves. But what might in retrospect be seen as a policy prescription to privatise, turned out in theory not to be necessary at all. For Coase, ownership existed by default: for example a river could be polluted if no one owned the right to prevent pollution. The trick was bargaining: polluter and pollutee would already have the incentive to arrive at the optimal solution *without intervention,* provided a number of demanding assumptions are met.

As with Pigou, there are very important implications. First, bargaining costs become crucial: whereas in bipartite pollution these are relatively straightforward, in diffuse pollution it is altogether more complex, and these transactions costs may be greater than the gains from bargaining. Second, the law and courts are relied upon for enforcement:[7] where there are disputes the courts would enforce property rights. But what is the value affected by pollution? And how might this be decided? The answer turns out to be informationally very similar to the task in the Pigou framework: judges and civil servants need similar information sets, notably the marginal cost of pollution, which in the Coase case is capitalised in the property right. Third, whilst property rights might deal with excludability, non-rivalry introduces the problem of the common. The tragedy of the common (Hardin, 1968) arises because individuals face a prisoners' dilemma, leading to over-exploitation of the resource. Here club theory[8] offered a Coasian solution – the public good or more relevantly, bad, might be internalised amongst its members who then fix the quantity at the optimal – internalised – cost. Treatises, protocols and international environmental agreements – like Kyoto – might be regarded as

[7] It is no accident that Coase's article was published in the *Journal of Law and Economics*.
[8] See Cornes and Sandler (1996) for a survey.

attempts to form such clubs.[9] However, the feature of such international clubs is the extenuation of the property rights – the absence of enforcement mechanisms and penalties for non-compliance. In other words, exclusion remains hard to achieve. Finally, Coase's approach does not discriminate between polluter and pollutee except in respect of property rights. Hence it gives no support for the polluter-pays-principle. Indeed, since many externalities arise because the polluted cannot enforce property rights, Coase tends in practice towards the pollutee paying. It excludes ethical criteria which rely on notions of equity, fairness and moral responsibility, being concerned with efficiency only, and in doing so, makes the success of international agreements less likely.[10]

Together, these two traditions have bequeathed much to the policy debate. The property rights approach is not in practice different in kind from the market failures approach. The internalisation of the externality in both cases creates a price for the use of resources – it is the way the price is arrived at which distinguishes them, and even here the practicality of courts assessing damages rather than civil servants is one of degree.

Assessing the damage requires cost benefit analysis (CBA), and there is now a voluminous and well-researched literature on the techniques and there are numerous case studies.[11] The essential idea is simple: pollution has benefits as well as costs, and the optimal level of pollution is where the marginal benefits equal the marginal costs. The practical problems are however immense. For large scale environmental problems like climate change and biodiversity loss, most of the people affected are not around to reveal their preferences. They are future people. The information on which existing people express their preferences is often weak. People know little about the science, the ecology or the causal links between these environmental problems and their own welfare. The time periods are large, and discounting in such circumstances is problematic.[12]

In policy terms, there are two possible reactions. The first is the one typically adopted, which is to rely on non-economic arguments – and therefore to set targets and instruments at sub-optimal levels. For example, the IPCC

[9] See Barrett (2003) for a general treatment of the design of international environmental agreements, and Barrett (2005) for a specific critique of Kyoto.

[10] Coase's approach is decidedly welfarist in Sen's terms: it is a narrow utility-base efficiency concept only, in an environmental context where ethical arguments are persuasive – not least in the concept of sustainable development. In the global problems of climate change and biodiversity loss, equity between north and south and between generations is at the core of the debates.

[11] See Helm and Pearce (1991).

[12] Whereas economic growth might be assumed in the short to medium term, and hence people become affluent, justifying discounting, it is not obvious that in a hundred or more years time the environment may not have deteriorated so much as to imply negative growth.

suggested that CO_2 concentrations should be limited to around 500–550 parts per million (ppm). This is a target embedded in UK domestic policy (DTI, 2003). Yet why 550ppm and not the pre-industrial 270ppm or some intermediary number is far from obvious. Presumably the scientists are taking a pragmatic view of what they *believe* might be politically stretching. But what determines the politically acceptable target? Is it not what politicians believe they can sell to their electorates? This in turn is based upon the preferences of current, not future voters, and based upon their information sets. Using the voting market rather than CBA creates subtle differences in outcomes – for example the avoidance of short-term costs, but the willingness to adopt aggressive longer term ambitions. But both the voting approach and CBA are designed to elicit preferences.

This can be seen in the literature on the social cost of carbon (SCC), and the often tortuous attempts to reconcile the political targets with CBA approaches. Pearce (2003) reviews this literature and arrives at low numbers. This result is reinforced in Mendelsohn (2005) and Tol (2005). Yet the 2050 target to reduce emissions by 60 per cent by 2050 would need a much higher number. Attempts to reconcile the two unsurprisingly either try to utilise assumptions at the high end, or appeal to those factors which bias the results. The bizarre feature of these reconciliation attempts is that the higher the SCC required, the higher the implied tax, and hence the greater the macroeconomic impacts of meeting the target. The risks of starting with the conclusion and working back to find a set of consistent assumptions which pervades much of the policy process are correspondingly high.

(ii) Taxes Versus Permits

In the Pigou framework, the choice between price and quantity mechanisms (and regulation) is not determined, because information is perfect. The location of the benefits and damages functions is known. But the science and the policy process is about uncertainty. In practice, policymakers have only the haziest idea about where the functions lie, have limited resources to estimate them, and know that they will be subject to wide ranges of outcomes for small changes in assumptions. And if taxes are used, we cannot be sure of the effect on quantities; and vice versa.

For many politicians and civil servants this uncertainty leads them to reach for the perceived certainty of regulation. Yet, Weitzman (1974) has provided a framework for addressing this problem. He considers two characteristics of uncertainty: uncertainty about the shape of the damage and cost functions, and uncertainty about their position. The results are unsurprising: if the cost function is expected to be flat relative to the damage function, then being a bit too tough on the quantity will not cost much – hence

quantities should be fixed and the price left to adjust. If, however, the cost function is expected to be steeper, then prices – taxes – are preferred.

Weitzman had in mind a local externality. Where the problem is a global public bad, the choice of instrument is complicated by the need for an agreement between countries in the global club. Whereas in the climate change example, there has been a suggestion that some form of global carbon tax might be optimal,[13] it is arguably much more plausible to fix quantities. These are measurable, and make monitoring and enforcement easier. Therefore, it is hardly surprising that international environmental agreements tend to be set in quantities – from fishing quotas, to Kyoto targets and species protection based on sustainable (in the biological sense) numbers.

(iii) Regulation for Taxes and Permits

The selection of taxes and quantities is typically presented in economics textbooks as the end of the matter: the problem is then "solved". Yet in policy terms, it is but an initial start. Taxes and permits require regulation. The former requires that the domain of the tax is defined, the formal incidence is set, collection is organised and inspection and compliance mechanisms are created. Pollutants are rarely easily mapped onto a tax base. In the carbon case, for example, proxies are typically used, ranging from broad measures of energy, some regulatory definition of carbon input content, to some output emissions measure. Whilst the latter is the pollution that the tax is required to address, it would require measurement devices across a whole range of activities, and whilst perhaps plausible for large industrial plants and power stations, is rather less cost-effective for small scale operations, households and appliances.[14]

The latter – permits – is typically much more demanding in regulatory terms, since it requires the creation and sustaining of *permit markets*, as well as the defining of the initial property rights, the rules for their allocation and enforcement procedures. Permits work if the market is competitive so the price can adjust to reveal the marginal costs. So the regulatory task lies not only with the permits and their allocation, but also with competition. Much evidence on the scale of these market creation and regulation problems have been gathered in the privatisation processes for the energy industries – which are also major pollution media. Competitive markets need to be kept open, and subject therefore for continuing regulatory oversight. Regulating for

[13] See for example, the proposal by McKibbin and Wilcoxen (2002).

[14] In the UK, the establishment of the Climate Change Levy (CCL) involved a complex administrative process. In even micro examples, like the Aggregates Levy and the Landfill Levy, there are regulatory administrative functions that have had to be created.

competition turns out to be far more complicated than regulation of monopoly.[15]

In summary, the lessons from the environmental economics literature are considerable, even if based on questionable marginal and partial equilibrium methods. These are:

- from Pigou, that correcting market failures is about adjusting the price or the quantity, and that substitution and income effects matter;
- from Coase, that internalisation of property rights – and hence the permits approach – is another way of achieving a similar result to taxes; and that this argument can be extended to global public bads through clubs;
- that CBA is a useful but limited input into instrument design;
- from Weitzman, that uncertainty drives instrument selection;
- that both taxes and permits require regulation.

But although these theoretical insights are both powerful and relatively simple, they do not get us very far. The design of policy begins with them, but most of the problems come afterwards.

IV THE POLITICAL ECONOMY OF ECONOMIC INSTRUMENTS AND THE REASONS WHY THEY ARE NOT UTILISED

So far, it has been argued that there is a good theoretical case for considering the use of economic instruments, and that theory provides some guidance as to how to design such instruments. But we also noted that the take-up has been slight: economic instruments remain the exception rather than the rule. Why?

The starting point in trying to understand this reluctance is the positive theory of government, regulation and bureaucracy. Rather than simply assume that public bodies pursue the public interest, these bodies are better understood as rent-seeking agents. The policy formulation process is about vote maximising, but in the context in which there are multiple pay-offs for individuals and public organisations. Policy design and the policy process are themselves instruments for public and private institutions.

[15] On regulating for competition in the design of energy markets, see Green (2005) and Helm (2004) Chapter 17.

(i) Multiple Objectives and Multiple Market Failures

In considering policy instruments, there are multiple objectives and multiple market failures to deal with. For example, a policy to reduce carbon emissions is typically contextualised with objectives on employment, competitiveness and fuel poverty. Tax revenue may also be important. Such multiple objectives have in environmental debates been integrated into the overarching objective of sustainable development, which explicitly includes economic growth, environment and social objectives *without* defining the trade-offs. The economic and social objectives have, for example, frequently biased climate change policies: in 1998, the British coal industry was protected and a moratorium on new gas fired stations announced to protect mining areas, and the Climate Change Levy was an energy rather than carbon tax to avoid damaging the coal interest.[16] Politicians are rarely interested in a single well-defined externality, and hence the efficiency of policy needs to take proper account of the objectives. In the policy process, these objectives can be played off against each other.

(ii) International Contexts

The multiple objectives also affect the way in which international agreements are formulated. Climate change and biodiversity require coalitions to be formed, negotiating protocols, treaties and conventions. These typically take the form of repeated Prisoners' dilemmas, but within the context of multiple objectives.[17] Although economic instruments play a part in meeting these objectives, the international negotiations are very much about verifiable quantities, and other command-and-control measures will be at least as important. The option of using a carbon tax – and hence focusing on cost certainty rather than quantity – does not fit well with such international negotiations.

Because there is a Prisoners' dilemma dimension, free-riding incentives encourage delay and weaker targets. In the Kyoto context, the US benefits from being outside the formal targets, and argues that this is in part because China and India are not included. Delay is part of the free-riding process, and it applies as much to business as to government. Delay can take many forms. There may be arguments about the advantage of further research, and these can be backed up by attempting to influence CBA studies.

[16] See DTI (1998), Helm (2004) and the Marshall Report (1998).

[17] Thus Russia's acceptance of Kyoto was widely assumed to be a *quid pro quo* for support in WTO negotiations.

(iii) Political Risk Aversion

In choosing between policy instruments, government's attitude to risk is important. There is typically an asymmetry between the response to greater efficiency through the use of economic instruments and the exposure should policy fail. The losses tend to have greater influence than the gains. This asymmetry is reflected in the way politicians respond to "events". When a negative case arises in the media, there is a demand to "do something", with command-and-control regulation the typical response to ensure "it never happens again". But when events are broadly positive, and a command-and-control regulation is not binding, there is little corresponding pressure to deregulate or move towards an economic instrument.

(iv) Industry Preferences and Capture

If government is reluctant to use economic instruments, why might industry take a similar line? Polluting industries are interested in maximising profits, by minimising costs (including environmental costs) and gaining strategic advantage. For major environmental problems, companies are in the main in oligopolies, which are typically multinational – for example, in the oil, electricity and gas industries and in chemicals. This industry structure means that carbon intensive firms will: (i) want to minimise the substitution effect; (ii) minimise the income effect; and (iii) raise rivals' costs.

We noted above in Section II that the great advantage economic instruments had over regulation was the economy of information. The informational demands of planning in the context of uncertainty open up considerable scope for capture, and it is the opportunity for capture which makes regulation more attractive to industry than economic instruments. Whilst the latter are general, and largely transparent, command-and-control regulation is typically plant-specific and thereby opens up scope for a case-by-case engagement in the policy process.

The principal-agent problem arises because there is asymmetric information and different objectives between regulator and regulatee. In environmental regulation, there are multiple such principal-agent problems – between voters and politicians, between politicians and officials, between officials and regulatory bodies, and finally between regulatory bodies and industry. Thus in the energy area, energy enters into the election process, officials have their own views, and officials lock horns with the agencies.

The process of capture is a subtle one, again with many dimensions. Industry plays off the various levels of the principal-agent hierarchy; it engages in "research" to influence the debate about costs and benefits, often hiring consultants to make "reports"; it briefs the media; lobbies MPs in specific constituencies where factories and jobs are located; and pollution

inspectors find employment in the regulatee. A career structure builds up in companies, around corporate affairs, public affairs and regulation.

The scope for capture depends upon the nature of regulation. In an administrative system, such as the UK, where public officials are delegated the public interest objectives largely free from judicial review, and where the "rules" are pragmatic and piecemeal, the scope is very considerable. Other, more judicial systems, like the US, and more rule-driven ones, like the EU, are arguably less amenable to capture.[18]

(v) The Income Effect

This process of regulatory capture has the effect of blunting the aggregate impact of substitution. Environmental constraints are consequently weakened. But as the problem of climate change has become more urgent, there has been a shift from the traditional advocation of regulation towards the income effect – from resisting the constraint to influencing its form. Thus, confronted with a choice between carbon taxes and tradeable permits, even though permits may lead to a tighter overall constraint on emissions, industry typically prefers the latter. The reason is that under permit schemes, there is typically an initial grandfathering. This neutralises the initial income effect, but it also serves the purpose of giving strategic advantage to the incumbents, and raising rivals' costs. The former is obvious; the latter more subtle. Most systems recognise the need for a new entrants' reserve, but this is only part of the entrants' problem. Emissions need to be traded in a liquid and transparent market: in oligopolies – like energy – incumbents have physical hedges, whereas entrants typically do not. The permits markets are not fully competitive, and they interact with wholesale commodity markets. The result is multiple advantages to incumbents – and a considerable and continuing problem in regulating for competition in the permits market.

V IMPLEMENTATION

It has been argued that economic instruments have inherent advantages over traditional regulation, and economic theory gives a guide as to how to design these instruments. But it has also been argued that governments have multiple objectives, are risk averse and that economic instruments do not necessarily fit into international negotiations. Polluting industries may prefer regulation which they can capture. Since the environmental policy that

[18] See on BATNEEC, Pearce (2000).

emerges will inevitably come out of a political process, in which the interests of polluting industries will play a significant part, the final question is whether economic instruments can be modified in such a way as to meet the political concerns, but nevertheless bear down on the current environmental problems. In this section, the setting of economic instruments, their credibility and the role of hypothecation are considered.

(i) Setting Tax and Permit Levels

The first and obvious task is to set the tax or the permit levels. It might be thought that the obvious way to begin this exercise is to examine the costs and benefits as indicated above. Remarkably, this is the exception rather than the rule. CBA is largely absent from the EU Directive setting process,[19] and has been absent from the process of establishing CO_2 and greenhouse gas targets and biodiversity treaties and agreements.

There are several reasons why CBA is not the automatic tool for calculating the optimal value of the tax or the permit level. The first is the scepticism about the technique itself. As noted above, putting monetary values on non-market goods raises ethical hackles. The argument is that efficiency is not the only criteria: that saving lives, landscapes or species involves deep ethical judgements, and cannot be the subject of monetary valuation. The response to this objection is twofold: that decisions to protect the environment do nevertheless *in fact* involve resource costs, and hence the costs and benefits are relevant to the decision; and second, the use of CBA as an input to decision-making is quite different from CBA as a decision rule. Few economists would actually claim that efficiency is the *only* criteria. In other words, CBA is an input, not a determinant of the level of economic instruments.[20]

A second objection is based upon the information that goes into CBA studies. Because these are non-market issues, preferences have to be revealed through contingent valuation and related techniques. These techniques run into two main problems: that preferences are based upon the information available – and in particular the *framing* of the choices; and preferences may be revealed strategically – particularly where public goods and public expenditures may be involved. Judgements about environmental matters typically involve specialist knowledge – of geology, ecology and natural history – and, as in health, preferences may be about general issues like "a good environment" as with the desire "to be healthy", but expert judgement may be

[19] See Pearce (2004).

[20] Nevertheless the introduction of numbers into the policy process tends to give them greater weight.

required for the valuation of specific environmental outcomes, as with the selection of specific treatments and drugs. For example, whilst bright green fields and large conifer forests may *look* like they are good environmentally, in practice knowledge of the consequences for insect and bird life of the applications of nitrates in the first case, and the value of bog and upland moorland for vulnerable species in the second case, would change choices.

Strategic preference revelation is a well known and serious problem, to which there are clever theoretical "solutions", such as the Clark-Groves test. These attempt to confront individuals with the tax consequences of their spending choices. But in practice such strategic behaviour is pervasive. It is exacerbated when there is no compensation and the burdens have differing income effects on the people included.

A third objection is based upon who is included and excluded in CBA studies. Environmental problems have both horizontal and vertical dimensions to choice. For example, just whose preferences over the preservation of polar bears should be included is far from obvious. Should it just be local – Inuit – peoples? Should it be Canadians and Russians? Or should everyone who has seen a polar bear on television be included? And, vertically, should future generations be included? To see how difficult this problem is, suppose there are people who have never seen a swallow. Would they miss – and value – it?

A fourth objection is the costs. Full-blown CBA studies are typically very expensive. They take time, and if they are to avoid short cuts like benefit transfer, are interview intensive. The importance of this depends on the scale of the problem. Benefit transfer techniques provide one short cut, but are controversial.

A fifth objection is the capture question: sceptics argue that the CBA process is easy to capture by vested interests, and environmentalists are suspicious that CBA tends to systematically undervalue the environment, because economists tend to focus more on the costs (often easier to estimate) than the benefits, and that industry and polluting parties can then latch onto the costs in the broader political debates.

These considerations have two implications for instrument setting: that CBA represents an input into the decision making process; but because it is imperfect, it cannot give a precise estimate of the desired level of the instrument. It acts as a guide and a check, but not a determinant. Thus setting instruments requires the input of other information – including expert evidence – and whatever the answer, it is likely to be "wrong". And as with the choice of instruments, the Weitzman framework provides a guide too: the instrument should be set in the direction of risk indicated by the expected shapes of the cost and damages functions. Thus, if permits are used because

the damage function is expected to be steep, then the number of permits might also be set on the cautious side. But, perhaps more importantly, if the damage function is steep but taxes are used, then the Weitzman framework tells us to set them on the high side. The corollaries in each case should be borne in mind too.

A further sophistication on this approach concerns the likely availability of future information about the shapes of the functions. If new research will, for example, tell us whether abrupt climate change is likely, but that the marginal damage of an extra tonne of carbon is on current information low, we might set a low carbon tax now, but want the flexibility to set it higher later on. Setting the tax is informationally-revealing. There is "learning-by-taxing".

Flexibility is therefore at a premium in instrument setting in the context of imperfect information which is also changing through time. There are then two further aspects to the information problem: how much research to do; and how to time the flexibility given the nature of the capital stock. In principle, the optimal amount of research depends on the expected costs and benefits, and that in turn depends upon the starting point. But there are obvious problems here too: the marginal benefits of research are typically unknown – often that is the point of research – and the costs too depend upon the precise research trajectory chosen, which in practice is typically made up as researchers go along. The traditional model of loosely defined research budgets may in fact be optimal.

For major polluting activities, like electricity generation, the substitution effect depends upon how fast the capital stock turns over. Given that lead time may be long and vary between types of technologies and vintages, instruments need to be set not only to change short run demand side behaviour, but to signal longer term prices. The stickier the capital stock, the greater the attraction of setting low initial taxes or high permit levels, but signalling tighter levels later. As we shall see below, this intertemporal price setting relies on credibility.

There is an additional reason for starting with low levels – and that is political acceptability. This enables people to adjust to the income effect, since not only the capital stock may be sticky, but so too can household budgets. This is particularly important for lower income groups, with less access to credit and other mechanisms to absorb short run shocks. This can be interpreted in the Weitzman framework as a political damage function which is steeper than that for the externality itself, where the slope is determined by the degree of political risk aversion.

Finally, there is a wider learning effect: the economic instrument itself carries information. The process of introducing the instrument educates the affected parties. It attracts the affected parties' attention, and is often

accompanied by media information on ways of substituting to mitigate the impact.

In summary, the setting of instruments is an imperfect business. CBA provides a tool, but is incomplete, and expert and other inputs are required. The instrument is itself an information revelation tool, and there are good reasons to start with a low value, especially where there is fixed and lumpy capital (provided that the damage function is not thought to be very steep).

(ii) Credibility and Revision

Flexibility allows subsequent instrument levels to be adjusted, and opens up lobbying opportunities. These may most obviously be attractive to industry, but government too might exploit the flexibility. In many environmental policy problems, there are time-inconsistency features. For example, the government might promise *ex ante* to increase a carbon tax to that level necessary to achieve a given target, but mindful that voters prefer lower prices, might *ex post* renege.

This time-inconsistency problem is common across a number of policy areas, and amongst the solutions advocated, some form of delegation is typically required. In monetary policy, for example, governments have in the past promised *ex ante* to set interest rates at whatever level is necessary to control inflation and have repeatedly reneged *ex post* faced with elections. The solutions in this case have included: appointing conservative central bankers, and giving independence to central banks. In competition policy, again independence has been a preferred route to avoid the short-term impact of the political desire to protect jobs.

In the environmental case, less thought has been given to independence and the credibility problem. Helm, Hepburn and Mash (2004) set out a model in which an independent energy agency sets carbon taxes to achieve a CO_2 target. In principle, the same approach could be used at the EU level for revisions to the EU ETS. However, in practice this is left to the Commission and member states, with the result that predicting the future level of permits relies on the analysis of wider political objectives and the way in which lobbying will influence the outcomes. In general, the retention of flexibility at central government level increases uncertainty and is likely to result in the instrument being set at too low a level.

Individual instruments could be set by separate agencies, or brought together within a single body, such as a suitably designed environmental agency. There are economies of scale in the analysis, and a broader body might be less open to capture by sectoral interest groups, as its overall reputation will be at stake in each and every case.

(iii) Hypothecation and the Use of Revenues

It was noted above that the opposition to economic instruments is partially caused by the inelasticity of demand and the consequent relatively high income effect, compared with the substitution effect. In first-best welfare analyses, the economic instrument is set, and the revenues accrue to central government, which then optimises the use of the receipts from the taxes or the auction of permits. This theoretical result is reinforced by the reluctance to concede the principle of the disaggregation of revenues. For both reasons, hypothecation of revenues has typically been fiercely resisted by finance ministries.

Faced with high income effects, the targets of economic instruments have focused on ways of neutralising the income effect. The most obvious route is through grandfathered permits, and unsurprisingly where industry is credibly threatened with a tax or permit, the latter is typically preferred. The most obvious example is in carbon policy. In the UK, consideration of the choice of instruments, as set out in the Marshall Report (1998), reflected these interests, and in the end resulted in an energy tax *and* the UKETS system. In the latter, industry also achieved a subsidy to pay for emissions reductions which might in any event have occurred.[21]

Grandfathered permits have additional advantages to incumbents – on top of the neutralised income effect – in that they provide important strategic assets, which in oligopolies can act as entry deterrents, unlike the auctioned case.[22] This aspect creates complex regulatory problems, and the EU ETS, for example, requires a special "entrant reserve" of permits.

Tax hypothecation is not, however, typically proposed as the simple return of the income effect to those paying the tax. At the limit, this would render the instrument useless. Rather there is some domain within which the revenue is ring-fenced. For example, the domain may be total industry tax costs, with a carbon tax used to reduce labour taxes. This approach was used with both the UK and the German energy taxes in the late 1990s.[23] The advantage here is in the form of a double dividend – externalities (bads) are taxed, improving resource allocation; and distorting taxes are reduced, giving a further efficiency gain. The revenue use might be even more closely targeted on the externality – using the income effect revenues to improve the substitution

[21] The government case was that emissions trading was an infant industry and the subsidy represented an investment in gaining a competitive advantage for the City of London.

[22] Unsurprisingly, both BA and Virgin have argued for inclusion of the air sector within the EU ETS, giving both grandfathering and protection against entrants.

[23] In the UK case this was rather undermined by the fact that the national insurance reductions hypothecated on the CCL were subsequently reversed with the government raised national insurance.

effect. An example might be taxing pesticides and nitrates, using the revenues to subsidise the conversion of land to organic methods of farming. The income effect is kept within the sector, but there will be very important incidence effects, typically favouring small over large farmers.[24]

Once there are revenues to distribute, lobbying and capture become important factors. As with the setting of instruments, there is a credibility effect, and institutional design matters in reducing the distortions that result. The least attractive option – often followed – is to give the monies raised to the industry itself to administer.

VI THE PRESSING CASES

In this section we consider two cases: one where the use of economic instruments has been widely advocated (carbon policy); and the other where it has not (biodiversity). We start with climate change and carbon policy.

(i) Carbon Policy

The climate change problem is now reasonably well known. The science is nineteenth century in origin and the phenomenon reasonably well understood in theoretical terms.[25] The data is also rich, and getting richer. In the last 500,000 years there have been major fluctuations in climate, and from the ice cores and sea sediment cores, there are sets of data for carbon dioxide and other gases, and temperature. The ice ages are, in effect, a very large experiment in varying gas concentrations in the atmosphere.

Climate is not however uniquely determined by gas concentrations. The earth's orbit varies, and there are variances in volcanic behaviour, as well as very complex feedback mechanisms.[26] Unsurprisingly, therefore, there is a wide range of temperature forecasts for given CO_2 and other greenhouse gas concentrations.

Feeding this uncertainty into policy requires that several steps are taken. The first is to consider what targets for CO_2 reduction should be set. Given the sheer scale of the problem, it is unlikely that the costs of conducting appropriate CBA would matter much. On the costs side of the calculation, the uncertainty is over technical progress, and the timing of non-carbon technologies displacing conventional oil, gas and coal ones. Given the capital

[24] A further point here is that since large farmers tend to dominate trade bodies – like the NFU in the UK – such hypothecation is typically opposed.

[25] See Weart (2003) for an accessible survey of the development of the theory of climate change. See also King (2005).

[26] Obviously, previous ice ages could not have been caused by anthropomorphic emissions.

stock in the energy sector is fixed and lumpy, it is likely that the shorter term costs are high, but in the longer term uncertain, dependent on technologies. It is also likely that over time the degree of uncertainty might fall, but not necessarily.

On the damage/benefits side of the calculation, the degree of uncertainty is likely to be even higher. The impact of increased temperature varies by location as does the effect of rising sea levels. Damage to biodiversity is hard to calculate. Environmentalists assume the damage function to be steep, but this is not obvious. Furthermore, the short-run damages are likely to be small, relative to the long term.

Given these stylised facts, the scope for using economic instruments would appear to be quite large. The damage function is not so steep as to mandate direct regulation, and carbon is a measurable emission over which the domain of an instrument can be set. In selecting instruments, the Weitzman framework suggests a tax is preferable to permits, and given the short run rigidities, it should be set low initially and adjusted *ex post* to achieve the target. Some independent body would be desirable to carry through this revision process, so that there is a credible signal to firms replacing their capital stocks and to those engaged in R&D.

Now compare this policy framework suggested by economic theory with that which might be suggested by a political economy analysis of the interests of the parties. Industry is likely to prefer permits (or, better, regulation), since the income effect can be neutralised and entrants disadvantaged. An independent instrument-setter or administrator of the revenues would be less attractive than government as administrator, since the latter is easier to influence and capture. And, in terms of the overall effect, delay is to be preferred to action. It is likely that industry would want the results of CBA studies to play up the costs and discount the damage.

Policy so far is clearly closer to the political economy predictions than the economic efficiency ones. Climate change policy is a rent-seeking opportunity for the players involved. These rents have economic costs too: the resulting policies on climate change have unsurprisingly had little impact on the overall problem, the Kyoto targets are not being met, and in particular countries domestic targets are being missed too.[27] The costs associated with the savings that are made are correspondingly higher.

Consider the main policies adopted in Europe. These are largely based around renewables and energy efficiency – now supported by the grandfathered EU ETS. In renewables, a set of vested interests have tried to

[27] Note that the UK's 2010 20 per cent from the 1990 target is unlikely to be met. Currently UK CO_2 emissions are *rising* at between 1-2 per cent per annum.

present their costs as low and appealed to technical progress to demonstrate that costs are falling. In the case of wind (currently the main renewable source), the incumbents have argued for regulatory and quantity-based policies, with reserved markets and cost-pass-through. Rather than a price on carbon, wind has been given a sector of the market within which the players can acquire tradeable ROC permits, which in turn must be compulsorily purchased by suppliers.[28]

Is this set of policies likely to be the most efficient solution – compared with the theoretically preferred carbon tax? Although a major reason for using an economic instrument is that the most efficient solution is not known *ex ante*, but rather left for the market to identify, the inefficiency of the renewables reserved market approach is that it eliminates two sorts of options: other non-carbon sources; and any carbon sources. On other non-carbon options, the obvious example is nuclear power which, whilst controversial and open to debate about its costs, is unlikely to be more expensive than wind. Recent estimates have suggested the subsidy for wind is likely to be three times higher than that needed for nuclear.[29] But the real weakness is in distinguishing between different kinds of carbon-based energy, for example between coal and gas. It may turn out that replacing coal with gas power generation is the marginally most efficient way of reducing total emissions in the short run. A carbon tax would entertain nuclear and types of carbon-based sources, ranking them according to the marginal cost of carbon reduction. The existing renewables policy rules out these options. In effect it truncates the supply function.

Similarly on energy efficiency, although it is likely that it will have an important part to play in the short run, it is not obvious that current policies are optimal. The advantage of a carbon tax is that it is neutral between the supply and demand sides.

(ii) Biodiversity

Biodiversity is widely considered to be much harder to address through economic instruments. It is far from clear what precisely biodiversity is, and most measurements go beyond the value of individual species. Unlike carbon, it is hard to imagine what a market in biodiversity might look like, and it is unlikely that individual species would represent a good proxy. Setting prices would be difficult, and the associated regulatory framework for a market would be hard to design.

[28] See Helm (2005b).
[29] See OXERA *Agenda*, April 2005.

These considerations usually result in the ruling out of economic considerations and economic instruments for most environmentalists. This would however be premature. First, there is a valuation question. What is biodiversity worth, and how much are we willing to pay for its preservation? In some – trophy – species cases, the answer is very considerable. The 1973 Endangered Species Act in the US, for example, has entailed the preservations of large tracks of forest to protect the spotted owl. Major projects may be held up to preserve a single endangered species. Yet, on the other hand, the destruction of probably the largest reservoir of biodiversity – the Amazon – proceeds apace as if the value is zero.

Opening the economic toolbox, the first question is whether CBA can contribute to identifying the optimal level of biodiversity. This can be approached in a number of ways – from doing contingent valuations, to looking at how much people actually do pay. These estimates demonstrate a very wide gap between what environmentalists recommend and the estimates of willingness to pay. The reasons may be several, but the informational and framing effects are likely to be substantial. Hence, it is better to look at the utility from disaggregated biodiversity services than to approach valuation through directly revealed preferences.

But once these are established, the next step is to consider how if at all economic instruments might play a role. Though it may be possible to attach a price to species, it is much more likely that controls could be exercised through quotas, which might be tradeable. For example, fish stocks' critical minimum thresholds have been used to establish fish quotas. Whale catches have been defined. In all of these cases, the problems have arisen in the political and regulatory processes – in lobbying, capture and in the weaknesses of enforcement. And in all these cases, the decisions have been made by politicians, rather than through independent regulatory bodies. Even the IWC has been the subject of national voting – and indeed the purchase of votes through aid and other mechanisms.

An alternative is to value the habitat rather than the species, and to preserve rainforests and other reservoirs through nature reserves. These might be whole areas, like the Amazon, marine parks where certain activities are prohibited, or local nature reserves. Though here again economic instruments are limited, there is a role for a form of Coase bargaining, whereby rich countries might pay poorer countries to preserve habitats. They might even buy them. A particular variant of these measures is debt-for-nature swaps, whereby debt is written off against commitments to preserve aspects of the environment. Thus even in the much more difficult area of biodiversity, economic instruments may have some limited role to play.

VII CONCLUSIONS

Economic instruments have a considerable contribution to make to environmental policy design, faced with the challenges of climate change and biodiversity loss. Yet their role has been limited, and politicians and their officials show a marked reluctance to move away from traditional command-and-control regimes.

The reasons for this reluctance are to be found in the political economy of the policy process: policy is itself an instrument to achieve the goals of the participants in the process – politicians, officials, regulators and companies. Whereas economists have focused on optimal efficiency, and therefore on the substitution effect, the policy process starts where the economics leaves off – and places its emphasis on the income effect. The ways in which rent-seeking behaviour is reflected in the policy process depend upon the differing incentives and imperfect information. The latter opens the way to capture.

Economists have typically engaged in the environmental debate by stopping short of integrating the analyses of the policy process into the design of instruments. This has had the unfortunate effect of limiting the role of economic instruments. Rather, this paper has suggested that the political economy of environmental policy should be taken into account in instrument design, and stressed three specific aspects – in the setting of initial levels (usually low); in delegating the revision of instruments to institutions designed to minimise capture; and in hypothecating the revenue in such a way as to improve the substitution effect.

REFERENCES

BARRETT, S., 2003. *Environment and Statecraft: The Strategy of Environmental Treaty Making*, Oxford: Oxford University Press.

BARRETT, S., 2005. "Kyoto Plus" in D.R. Helm (ed.), *Climate-change Policy*, Oxford: Oxford University Press.

BAUMOL, W. J. and W. E. OATES, 1988. *The Theory of Environmental Policy*, 2nd edn, Cambridge: Cambridge University Press.

COASE, R., 1960. "The Problem of Social Cost", *Journal of Law and Economics*.

CORNES, R. and T. SANDLER, 1996. *The Theory of Externalities, Public Goods and Club Goods*, 2nd edn, Cambridge: Cambridge University Press.

DTI, 1998. *Conclusions on the Review of Energy Sources*, Cm 4071, London: Stationery Office.

DTI, 2003. *Our Energy Future – Creating a Low Carbon Economy*, Cm 5761, London: Stationery Office.

GREEN, R., 2005. "Electricity and Markets", *Oxford Review of Economic Policy*, Vol. 21, No. 1, pp. 67-87.

HARDIN, G., 1968. "The Tragedy of the Commons", *Science*, Vol. 162, pp. 1243-1248.
HAYEK, F., 1948. *Individualism and Economic Order*, Chicago: Chicago University Press.
HELM, D. R. (ed.), 2000. *Environmental Policy: Objectives, Instruments and Implementation*, Oxford: Oxford University Press.
HELM, D. R., 2004. *Energy, the State and the Market: British Energy Policy since 1979*, revised edn, Oxford, Oxford University Press.
HELM, D. R. (ed.), 2005*a*. *Climate-change Policy*, Oxford: Oxford University Press.
HELM, D. R., 2005*b*. "The Assessment: The New Energy Paradigm", *Oxford Review of Economic Policy*, Vol. 21, No. 1, pp. 1-18.
HELM, D. R., C. HEPBURN and R. MASH, 2003. "Credible Carbon Policy", *Oxford Review of Economic Policy*, Vol. 19, No. 3, pp. 438-450, reprinted in Helm (2005*a*).
HELM, D. R. and D. PEARCE, 1991. "Economic Policy towards the Environment: An Overview" in D. R. Helm (ed.), *Economic Policy towards the Environment*, Oxford: Blackwell.
HM TREASURY, 2002. *Tax and the Environment: Using Economic Instruments*, London: HM Treasury, November.
INTERNATIONAL ENERGY AGENCY, 2004. *World Energy Outlook 2004*, Paris: Organization for Economic Cooperation and Development/ International Energy Agency.
IPPC, 2001. *Climate Change*, Cambridge: Cambridge University Press.
KING, D., 2005. "Science Informing Policy on Climate Change", in D. R. Helm (ed.), *Climate-change Policy*, Oxford: Oxford University Press.
MCKIBBIN, W. J. and P. J. WILCOXEN, 2002. "The Role of Economics in Climate Change Policy", *Journal of Economic Perspectives*, Vol. 16, No. 2, pp. 107-129.
MCNEILL, J. R., 2000. *Something New under the Sun: An Environmental History of the Twentieth Century*, New York: Norton.
MARSHALL REPORT, 1998. *Economic Instruments and the Business Use of Energy: Conclusions*, London: HM Treasury, November.
MENDLESOHN, R., 2005. "The Social Costs of Greenhouse Gases: Their Values and Policy Implications", in D. R. Helm (ed.), *Climate-change Policy*, Oxford: Oxford University Press.
OXERA, 2005. *Agenda*, April [on-line publication, found at www.oxera.co.uk].
PEARCE, D., 2000. "The Economics of Technology-based Environmental Standards", in D. R. Helm (ed), *Environmental Policy: Objectives, Instruments and Implementation*, Oxford: Oxford University Press.
PEARCE, D., 2003. "The Social Cost of Carbon", *Oxford Review of Economic Policy*, Vol. 19, No. 3, pp. 362-384, reprinted in Helm (2005).
PEARCE, D., 2004. *European Environmental Policy*, World Economy.
SMITH, S., 1998. "Environmental and Public Finance Aspects of the Taxation of Energy", *Oxford Review of Economic Policy*, Vol. 14, No. 4, pp. 64-83.
TOL, R. S. J., 2005. "The Marginal Damage Costs of Carbon-dioxide Emissions", in D. R. Helm (ed), *Climate-change Policy*, Oxford, Oxford University Press.
TIETENBERG, T., 1991. "Economic Instruments for Environmental Regulation", in D. R. Helm (ed.), *Economic Policy towards the Environment*, Oxford: Blackwell.
TIETENBERG, T., 2005. "The Tradeable-permits Approach to Protecting the Commons: Lessons for Climate Change, in D. R. Helm (ed.), *Climate-change Policy*, Oxford: Oxford University Press.

WEART, S. R., 2003. *The Discovery of Global Warming*, Cambridge, MA: Harvard University Press.
WEITZMAN, M., 1974. "Prices vs Quantities", *Review of Economic Studies*, Vol. 41, pp. 477-491.