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Climate-change Policy: A Survey

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1. Introduction

Climate change presents a challenge to policy-makers of an altogether different kind to the day-to-day business of intervention in the economy to correct market failures. It is characterized by major and multi-dimensional uncertainties (in the science, the economics, and the politics), it is an externality created by almost all production and consumption, and it requires international cooperation on an unprecedented scale. Arguably, there is no other economic problem on this scale—save perhaps the related one of population growth. Furthermore, while economic analysis focuses on changes at the margin, many argue that the consequences of climate change may be anything but marginal. Climate change is likely to have a massive impact on biodiversity, it may alter oceanic currents, and it may displace whole populations and significantly reduce the economic prospects of our grandchildren.

Unsurprisingly then, the usual economists' toolbox looks puny against the scale of this challenge, and will require very considerable review and development. There will be no easy read across from existing economic theory and empirical evidence to policy. Just as the experience of the unemployment of the 1930s required a reinvention of much of macroeconomics, climate change will need new thinking, too. Environmental economics is in its infancy.

For many environmentalists, the conclusion that follows is that conventional economics has little to add; that the problem is largely a scientific, and a moral one. Scientists should, on this view, determine the 'correct' level of emissions, and then this level should be imposed

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through direct intervention. Where doubts may arise as to the wisdom of such an approach, moral philosophy, not economics, provides the necessary intellectual input: we have a duty to ensure that future generations are treated at least as well as our own on grounds of intergenerational equity. We should not discriminate between individuals according to the time period in which they happen to live. And, in recognizing uncertainty, we should be guided by the precautionary principle. Thus, it is argued, sustainable development—leaving future generations at least as well off as the present—mandates, first, the achievement of a stable level of greenhouse-gas emissions, and then a reduction.

This is the sort of reasoning that lay behind the Framework Convention on Climate Change in 1992, which set in motion a process which produced the Kyoto Protocol in 1997. Targets were fixed and allocated for the period 2008–12, as a first stage in what was envisaged to be a permanent process of negotiations, agreements, and enforcement (Grubb, 2003). An element of flexibility was built into the targets, to be further extended in subsequent negotiations.[1] Unsurprisingly, perhaps, there has been a strong and divergent reaction by politicians and economists. While some scientists thought the reductions agreed at Kyoto were too timid, the USA opted out (despite being a principal architect of the Kyoto Protocol), and a number of economists questioned the wisdom of having targets at all, and, if there were targets, at the level agreed. They also pointed to the exclusion of the developing countries.

Climate change is, thus, not only a problem on a wholly new scale, but one which must—of necessity—be an interdisciplinary one. Without the science, there can be no serious understanding of what the problem is; without the politics, there can be no strategy for reaching a global consensus to reduce emissions and, hence, defining international property rights; and without the economics, scarce resources are likely to be wasted on badly designed policy instruments. New science, advances in the understanding of international agreements and institutions, and new economic techniques are all required.

Though there are natural fluctuations in CO_2 levels and temperatures, the main cause of the rise in CO_2 emissions is economic activity and, in particular, the transformation of economies in the twentieth century. Since 1900, the global population has more than tripled and the consumption of energy (largely fossil fuels) has increased more than ten

[1] There are three flexibility mechanisms in the Kyoto Protocol—joint implementation, the Clean Development Mechanism, and a facility for emissions trading. The Kyoto targets are for greenhouse gases and not just CO_2. However, for simplicity, throughout the article we concentrate on CO_2.

fold.[2] Climate change has been caused by the way resources have been consumed, and climate-change policy necessitates a substantial change in the allocation of resources. Furthermore, while scientists may suggest the appropriate level of emissions to stabilize the climate, they have little to say about the optimal resource-allocation path to achieve such targets, given that it is impossible to move to a substantially non-carbon economy quickly.

This chapter focuses on the three core components of climate-change policy: the targets, the instruments, and the institutional structures. Respectively, the questions are: what is the optimal path for reducing CO_2 emissions? which policy instruments, or combination of instruments—taxes, permits, and command-and-control—are likely to be most efficient within the political constraints? and how might institutional arrangements and structures be designed to facilitate international agreements and credible global climate-change policies?

2. How Much Should We Reduce CO_2 Emissions?

In designing policy targets, there are two separate but related questions which arise: what is the optimal amount of CO_2 in the atmosphere? and how fast should we move from the current level to the optimal? They are separate in that it makes sense to identify what the ideal level would be, but related, since the optimal level is path-dependant.

Let us start with the optimal level, which is where most scientific discussion begins. A reasonable amount is known about long-term trends in CO_2 levels. We know that the pre-industrial levels were of the order of 270–80 parts per million by volume (ppmv), and that the number has substantially increased since the industrial revolution, and particularly in the twentieth century, and is now around 370 ppmv. On current emissions trends, this could exceed 500 ppmv in the current century and even, eventually, 750 ppmv (see IPCC, 2001*a*). We also know that over longer periods the levels have fluctuated. An obvious starting point might be to regard the pre-industrial level as 'normal' and to take this as 'optimal'. Indeed, some environmentalists make the further connection that we should therefore adopt production and consumption patterns consistent with such a pre-industrial society.[3] But such an approach is not politically or economically plausible, and an alternative is to take current emissions levels as the base line, and to

[2] See Cohen (1995). McNeill (2000) provides an accessible summary of aggregate data on the main environmental trends in the twentieth century.

[3] This preference for a pre-industrial society is often linked to a wider claim about the virtues of an Arcadian life style.

attempt in the first instance to hold that line. This is the Kyoto approach. Subsequent steps might involve reductions in emissions, and a number of suggestions have been made, notably the RCEP (2000) proposals—carried over into the 2003 Energy White Paper (DTI, 2003*a*)—that UK emissions should not exceed levels consistent with a concentration of 550 ppmv, which would entail a 60 per cent reduction in emissions by 2050.

These numbers are subject to uncertainty. The precise levels over the last few thousand years are estimates from ice cores and other sources. Atmospheric CO_2 is a stock with inflows and outflows. The increase in emissions arises from diverse and often diffuse sources, and trends in emissions are particularly uncertain because they depend upon future policies, technologies, and population trends. These have to be included within climate models, where the simultaneous dependencies and feedbacks are crucial. Radical discontinuities are, by their nature, harder to model: a suspension of the gulf stream, changes in storm and cloud patterns, and the impact of deforestation and melting of the polar caps are examples which some scientists think are plausible within the century time frame (see IPCC, 2001*a*, pp. 15–16, 570–6).

These uncertainties are about the numbers and trends. But there is the additional step from the numbers about CO_2 concentrations to climate, on the causal relationships inducing climate change and its effects. Higher levels of CO_2 do not translate in a simple way into higher global temperatures. For this, a model of the climate and the causal mechanisms is needed. Some commentators—and several lobby groups—have focused on the problems with the science of climate-change models and suggested that even the direction of the relationship between CO_2 and temperature is questionable. This extreme position has gradually given way, as the climate-change models have developed, to a recognition that the uncertainties now lie with the scale, not the direction of change. But the range of temperature changes predicted remains wide and subject to substantial revisions, and some sceptics suggest we should focus on research to reduce the uncertainty of the science first, before changing policies.

Economists naturally focus on uncertainty in policy design, and there has been a tendency to see economic arguments as challenging the scientific approach. There are two reasons for this: the first, to do with the scientific uncertainties; and the second to do with the introduction of costs and benefits. On the former, it is important to recognize that the uncertainty in economic models of climate change is probably at least as great as that of the science (De Canio, 2003). The economic uncertainties are enormous: attempts to create general equilibrium models which can simulate the effects of a change in climate on the world economy—

termed integrated assessment models (IAMs)—tend to involve heroic assumptions. Over a longer run, such models need to simulate the path of technology and of demand, and to include the feedbacks from policies, including taxes on carbon, depletion of resources, and population trends.

To some, such attempts are too demanding to yield meaningful results, and clothe an inherently unpredictable path in a cloak of scientific and technical sophistication. General equilibrium models addressing more immediate and smaller-scale changes, such as tax changes, have had limited success. Politicians and the wider public, having little understanding of the technicalities of such models, may place too much faith in their predictions.[4] While this danger is widely manifest, the problem with this response is that it leaves policy design to the whims of political selection, and it provides no guidance as to the optimal level of emissions and emissions control. A central insight which environmental economics brings is that the optimal level of pollution is not normally zero: it is where the marginal costs of abatement equal the marginal costs of the pollution. Given that the marginal costs of abatement are unlikely to be negligible—and, indeed, may be very large—and that the marginal costs of pollution are not infinite, it follows that the optimal level of CO_2 in the atmosphere is unlikely to be the pre-industrial 270 ppmv. It may be 500 ppmv or more or less. Thus, although the IAMs may be imperfect, they provide a starting point for trying to estimate the optimal point—if only to see the simultaneous consequences of a series of assumptions. They provide valuable inputs into the policy process, but should not be decisive.

Economic analyses also demonstrate that such calculations vary greatly between countries and regions. Some countries are likely to be net gainers from climate change as agricultural productivity increases (through increases in warmth and the benefits to plants of CO_2 itself), as heating requirements fall, and because the offsetting costs of emissions are relatively smaller in economies which are more industrialized. Others may be worse off, and some much worse off.

The idea that CO_2 emissions have costs and benefits naturally leads to the idea that CO_2 is a commodity, which can be valued and traded like any other. This means that it has a price, which is the outcome of its supply and demand, and is amenable to application of the traditional economics tools of valuation. The price is a *social* one, in that it needs to incorporate the social dimensions—the externalities and distributional effects across the current populations and over generations.

[4] See, on the institutional incentives and structures, Wildavsky (1979).

There have been a number of attempts in the literature to arrive at the social cost of carbon. David Pearce (chapter 5 in this volume) summarizes the evidence and suggests that the value lies within the range of £4 per tonne of carbon (tC) to £27 tC. The importance of this calculation is illustrated through his critique of the approach by Clarkson and Deyes (2002), who estimate £70 tC, an estimate which the Department for Environment, Food and Rural Affairs subsequently used (Defra, 2002*a*). His analysis provides not only a critique of the government number—suggesting that it should be much lower—but also an insight into the core issues raised by the cost–benefit exercise. The main issues are: the use of discount rates and the way in which future generations' interests are taken into account; equity weighting and the interests of developing countries; catastrophe and the possibility of non-marginal changes; innovation and technical progress; and assumptions about continuing economic growth.

It is important to recognize that these are all issues amenable to analysis and modelling, and not merely criticisms. There is, for example, a voluminous literature on the use of discount rates, and the social cost of carbon can be modelled against different assumptions. The climate-change debate has focused on the issue of whether to discount the future at all and, within discounting, on whether to use discount rates that decline over time.

On equity weighting, the consequences are highly significant to the valuation exercise. This conveys an important policy lesson: the extent to which carbon emissions are reduced is to a significant degree a question of the global redistribution of resources to poorer countries. Whether this is best achieved by developed countries reducing CO_2 emissions or by direct wealth transfers is far from clear. The catastrophe problem is less amenable to modelling precisely because it is non-marginal. However, there are many examples of small-probability, large-cost events that confront policy-makers, such as a nuclear accident, a collision with an asteroid, or a virulent virus. The 'catastrophe' in the climate-change case is not likely to be the end of all human life: it is more likely to be a sharp reduction in welfare over a short time frame. How much resource should be devoted to such low-probability, high-cost events is controversial, but it is not infinite. Faced, for example, with new evidence of a rapid slow-down of the gulf stream, it is unlikely that a zero-emissions policy would be adopted and successfully implemented immediately (see Ingham and Ulph, chapter 3 in this volume).

The treatment of innovation and the assumptions about economic growth are linked: economic growth over the long run has conventionally been linked to technical progress, and the pushing out of the production frontier. Innovation in the context of the social cost of carbon is particularly important, because the 'solution' to climate change is likely to lie in large part with supply-side substitution to non-carbon energy technologies (assuming that demand for energy continues to grow).[5] The costs of reducing emissions over time are, therefore, greatly affected by the technology assumptions, and the policy implication is that efforts should focus on inducing more rapid technical progress.[6]

These issues can all be incorporated and organized within IAMs. Different assumptions will produce different estimates of the social costs of carbon. There remain substantive objections in principle to the whole exercise. These focus mainly on the nature of the information used—whether based on willingness to pay or willingness to accept.[7] Cost–benefit analysis is a technique which attempts to elicit the preferences of current individuals. The choices they make depend upon the information available to them and the way it is presented (the framing effect). Some environmentalists argue that climate change is a problem which is both so complex and large-scale, and so serious in its consequences, that we cannot rely on the choices people make now. Preferences should either be reflected through the delegation of the political process—electing people to choose on our behalf—or directly by 'experts'. Choice, on this view, should be restricted to those with superior information. There are many problems which are addressed in these ways—notably military and medical ones—but in the case of climate change, since the economic effects of policies to mitigate global warming are likely to be large, electorates will need to be persuaded to absorb the costs, and a useful starting point remains the information about their preferences from cost–benefit analysis studies. If results turn out to be very sensitive to the framing effect, then this conveys useful information, too.[8]

These considerations affect the choice of the number and the reliance placed upon it. But whatever the number chosen, there is an important

[5] Technology is also important on the demand side, enabling more efficient energy utilization.

[6] An example of the impact of assumptions about technical progress is seen in the MARKAL model which informed the 2003 Energy White Paper (DTI, 2003*a*). On MARKAL, see DTI (2003*b*) and Helm (2004, ch. 22).

[7] Willingness to pay and willingness to accept differ in part because willingness to accept assumes an ascription of property rights. There may, however, also be important framing effects issues.

[8] The literature on the application of cost–benefit analysis techniques to environmental problems is voluminous. See Bateman and Willis (1999) for a summary.

consequence of having a single number—and that is *consistency*. If the same number is applied across the range of policies—as it should be, since the social cost of a tonne of carbon is roughly the same wherever it is emitted—then the outcome should ensure that the substitution effects are efficient. The corollary of this point is that since existing policies implicitly assume a social cost of carbon, and since these assumptions vary enormously, current policies are likely to be very wasteful. We return to this point in section 5 below, in critiquing current policy.

A second policy implication is that the number is likely to vary over time. The marginal cost of emitting a tonne of carbon, given the current concentrations, is likely to be different (less) than if the pollution takes place in the future when concentrations have gone up. The social cost will rise through time (Mendelsohn, chapter 6 in this volume). Any carbon policy—whether permits, taxes, or command-and-control—should therefore be designed so that it can be ratcheted up through time, a point which turns out to have considerable implications for policy credibility and institutional structures.

A third policy implication of having a number is that this lends itself to economic instruments—arguably it is the optimal carbon tax. Or, put the other way around, an economic instrument requires a number—either a price or a quantity (which implies a price). If the social cost is, say, £4 tC (as per the lower bound of Pearce, chapter 5), then a price of carbon of that level would internalize the externality. If, however, Clarkson and Deyes (2002) are right, then a carbon tax of over £70 tC is indicated—or other forms of intervention which have equivalent effect. The effects would be very different, especially in the short run.

3. What Sort of Policy Instruments Should We Have?

A social cost of carbon may lend itself to a carbon tax, but it does not necessarily require one. The social cost can be integrated by a planner into command-and-control policies. These can take the form of designating technologies, or the less informationally demanding form of fixing the total quantity of emissions. The former is very informationally demanding; the latter assumes that the path to the optimal quantity is known, i.e. that the policy-maker knows the quantity of emissions which would come about as a result of the decisions of firms and individuals confronted with the price. If the quantity is translated into property rights, then a price of permits will emerge, though this will not necessarily be equivalent to the social cost of carbon.[9]

Almost all existing climate-change policies have command-and-control elements, involving choices of technologies and quantities, which is somewhat counter-intuitive in the context of the weight of the economic literature, which favours market-based instruments.[10] The fact that this is true in a wide variety of economies suggests that there is likely to be some rational (political) explanation. To see what this comprises, we need first to reiterate the standard case for economic instruments and then consider the particular features of the carbon case.

The starting point is to recognize uncertainty (in certainty, the planner can choose the optimal outcome, since all the demand and supply functions are known). Above, we noted a series of sources of uncertainty: about the optimum level of CO_2 in the atmosphere, about the transitionary path to reduce emissions, and about the costs and benefits of climate change. We noted, too, that the social cost of carbon was sensitive to the discount rate, equity weightings, innovation, and the economic growth path. The errors in climate models were compounded by the errors in economic models.

Faced with so much uncertainty, the planner's problems are immense. The market will have problems, too, but the great merit of the price mechanism in such circumstances is that it economizes on information, and it reveals information. It economizes since it decentralizes decision making to each firm and household, and each only needs to know the price, not everyone else's production and utility functions as does the planner. It reveals information, in that the policy-maker can see what happens when the price of carbon is imposed, so that the optimum can be better determined, and the instrument can be adjusted accordingly. The planner, by contrast, will observe queue shortages or surpluses. It is likely that there is learning-by-doing.

Economic instruments decentralize decisions about carbon abatement, with several important consequences. The market dictates which supply- and demand-side responses are cheapest, and which forms of pollution are marginal. It is neutral between adaptation and abatement. If the policy is credible (see below), then it encourages responses through time, benefiting non-carbon R&D. It is likely that, in the short run, adjustments will be on the demand side (since capital is fixed), but over time the supply side will respond as the capital stock is replaced.

9 The difference between the carbon tax and the permits prices depends on the income effect.

10 The forms of environmental regulation are discussed in Helm (1998), Heyes (1998), and Pearce (1998*b*). They are collected together in Helm (2000); see also HM Treasury (2002).

A credible economic instrument signals both. And, as noted above, if the marginal cost of carbon is expected to rise over time, then a low tax now can mitigate the costs in the short run when capital is fixed, while signalling a higher rate in the future.

In the literature, the choice of economic instrument is classically presented as one between adjusting prices or quantities for a particular commodity.[11] The policy-maker can fix the price and allow the quantity to adjust, or vice versa. Under uncertainty, the choice is an empirical one, dependent upon the expected shapes of the marginal damage function relative to the marginal costs of abatement, and the degree of relative uncertainty between marginal costs and marginal damages. If the damage function is expected to be steep (for example, the effects of a small dose of mercury in a water course can wipe out aquatic life), then a quantity restriction is preferable. If—as with climate change—the damage function is expected to be fairly flat (a small increase in CO_2 now arguably makes little difference to global temperatures), and if the costs of further abatement are, in the short run at least, very high at the margin, then a price mechanism is to be preferred.[12]

Ian Parry (chapter 10) provides an analysis of the carbon taxes versus permits debate, emphasizing the importance of the income effect. The revenues raised from carbon taxes can reduce distortions elsewhere—what has become widely known in the literature as the *double-dividend* effect—notably labour-market distortions resulting from income taxes. This holds for tradable permits, too, but crucially only if they are auctioned. In practice, it is highly unlikely that they will be, except at the margin.

It is, therefore, somewhat surprising that, despite these reservations, permit schemes have dominated climate-change policy developments. There are two reasons, both with important political elements. The first is that international agreements tend to be set in quantities rather than prices. The second is that carbon taxes are explicit and involve substantial income effects, which are disguised in the grandfathering of permits schemes. That a carbon tax might overcome these obstacles, and that it might, as noted above, also be more efficient, does not necessarily mean that it will be adopted. It needs to overcome the political and institutional obstacles, too.

The international dimension of the climate-change problem lends itself to quantity solutions for good economic reasons. The essential problem is that of an oligopoly, with poorly defined property rights.

[11] The classic articles are Weitzman (1974) and Roberts and Spence (1976).

[12] These assumptions may change over time: in the future the costs of non-carbon technologies may fall, while, as noted above, the marginal cost of carbon may rise.

The objective is to reduce output of CO_2. Countries, however, have different initial endowments, different capital structures, and face different marginal cost and benefit functions. Everyone (or almost everyone) has an incentive to cheat—to get others to reduce emissions while maintaining their own levels. The solution mimics an oligopolistic collusion or cartel: there must be accurate monitoring of emissions, cheating must be detectable, and punishment must be enforceable. In such circumstances, political negotiations will inevitably start with measurable quantities and look for a direct linkage between the overall objective (which is a quantity reduction) and the policy instrument. Using prices rather than quantities adds a further element for cheating, especially if there is a lack of credibility in the *ex-post* adjustments in taxes to meet the target (see below).

In an international agreement,[13] elements of equity as well as political power come into play. The burden of emissions reductions needs to be shared. From the economic theory perspective, the cheapest solution is independent of who has the initial rights. Trade will ensure that the marginal costs are minimized. But from a political perspective, the initial rights are crucial—politics is conducted as much in terms of the income effect as the substitution effect. Each country considers how much it will gain or lose by cooperation and, indeed, Russia's recent ratification of the Kyoto Protocol has been explicitly tied to the pay-offs. Climate-change agreements are, ultimately, the assignment of property rights—the starting point of emissions-trading schemes.

With the focus on the different costs and benefits between countries, the problems of enforcement, and equity considerations, it is not difficult to see why Kyoto has been so hard to negotiate. Following the Framework Convention in 1992, the developing countries effectively opted out of the first phase of Kyoto for 2008–12, as eventually did the USA. China's programme of economic expansion, largely based upon coal-fired electricity generation, left it outside, too,[14] while Russian involvement has had to be negotiated on the basis of the 'hot air' credits for the rapid falls in emissions associated with the collapse of the communist system at the end of the 1980s. Interestingly, those countries most in favour of Kyoto are either those with few immediate costs, or those with arguably a greater equity weighting on the welfare of developing countries.

The income effect explains why large corporations have typically favoured permits over carbon taxes. There are two factors at play here.

[13] Barrett (2003*a*) provides a comprehensive analysis of environmental agreements, protocols, and treaties. See also Barrett's chapter 13 in this volume.

[14] On China's energy programme, see IEA/OECD (2000) and Kroeze *et al*. (2004).

First, a carbon tax reduces profits by increasing costs, unless demand is inelastic. Thus, while electricity generators and oil companies may be able to pass through the tax, companies facing international competition—predominantly large energy-users in chemicals and manufacturing—may not be able to do so. Where this competition comes from developing countries outside the Kyoto framework, the effect may be considerable. There are companies where the share of energy in total costs is large, and where there is little prospect of non-carbon fuel sources replacing their fossil-fuel sources in the short to medium term. Permits, by contrast, are grandfathered, reducing the initial impact of the policy and perhaps even providing a windfall in the event of plant closure for other reasons.[15]

Grandfathered rights have the further benefit to incumbents of being particularly powerful barriers to entry, benefiting in this case the electricity generation and oil companies, where entry comes significantly from within the Kyoto boundaries. Permits raise entrants' costs, a well-known entry-deterring strategy in oligopoly theory.

For these reasons, emissions-trading schemes have had a good press, encouraged by intense lobbying. The UK experimented with its own scheme, providing a subsidy to large users to take additional reductions in emissions beyond those in the command-and-control plant-level emissions controls provided through the integrated pollution-control system. It excluded electricity generators and renewables, to avoid damage to the coal industry and to protect the high cost of renewables, and had very limited effect.

A better-designed system is the European one (see CEC, 2003*a*). This is more comprehensive in two senses: it includes the electricity sector, and it includes all the EU members. As such, it has a number of the desirable general features discussed by Tom Tietenberg (chapter 8). It will, however, still face the core challenges of such schemes. Rights have to be allocated, trades have to be regulated, revisions will be needed, and adjustments to take account of other policies incorporated in the scheme's design. The adjustment problem will be especially difficult in the UK, from the existing partial scheme to the comprehensive one, since the primary impact in the UK will be on coal power stations, which are likely to be crucial in maintaining security of supply in the second half of the first decade of the twenty-first century.[16]

In practice, though a permits scheme will play a central role in climate-change policy within the EU, and more generally in respect of

[15] This has been the experience of the UK Emissions Trading Scheme—see section 5 below.

[16] See Helm (2004, chs 16 and 23) and also DTI (2003*c*).

the future development of the Kyoto framework, it will be hedged around with other policy instruments. Steven Sorrell and Jos Sijm, in chapter 9, consider how these plural instruments will mesh together. The starting point is to recognize that the policy process does not typically conform to the economist's rational framework, where objectives and instruments are consistently matched. On the contrary, policy is almost always a piecemeal process—problems arise, and when politically acute, beget 'solutions'.

Thus, in the UK, there is an Energy Saving Trust (EST) with associated energy-efficiency policies; there is a Carbon Trust to spend monies on low-carbon technologies; there is a Renewables Obligation to support, predominately, wind power. In addition, there has been *both* a UK Emission Trading Scheme (ETS) *and* an energy tax, the Climate Change Levy. As noted above, the inconsistency of policy—and its inefficiency—can be seen by comparing the very different implied social costs of the policy measures against each other, and against the estimates for the level of the social cost of carbon. (We return to the point in section 5.)

A further characteristic of policy is that reform does not tend to happen wholesale. It is unlikely that at the international level Kyoto will be completely abandoned; and it is improbable that energy efficiency and renewables policies will be abandoned in favour of the European Emissions Trading Directive as the *sole* instrument of policy. Politics creates interests which support each policy; in economic terms, policies have rents. As a result, in the policy process, reform tends to be incremental.

These considerations have important consequences for policy analysis. Some inconsistencies are more inefficient than others and these costs can be estimated and ranked, so that priority can be given to the most significant distortions. Some policy rents are so large that they create insurmountable obstacles to change. And some overlap may be desirable, once the multiple market failures are identified. For example, there is considerable evidence of 'barriers' to take up for energy-efficiency measures, ranging from the landlord–tenant incentive problem, to capital market failures, and lack of information (see, for a summary, EST, 2001*a*). But, in such circumstances, the correct approach is to deal with each of the main market failures, and then tackle the carbon problem through the main policy instrument. It suits the vested interests to confuse climate change with other market failures, but they are analytically distinct and should be addressed separately.

4. What is the Appropriate Institutional Structure?

So far, we have argued that, although a permits scheme may be economically inferior to a carbon tax, its political advantages are considerable, including the fact that it is in sympathy with quantity-based international agreements. Signatories to agreements such as Kyoto could achieve their allocation in a number of ways, but there are considerable practical difficulties with all of them. Using any instruments requires that governments have credibility, both to firms and individuals within the country, and internationally to other parties to such agreements. International agreements typically lack the facilities to enforce quotas, and given that the free-rider problem is pervasive, some other mechanism will be required to induce confidence among the other parties.

Though not sufficient, it is necessary that the parties have confidence that instruments will be set and adjusted to meet the nationally allocated targets.[17] Dieter Helm, Cameron Hepburn, and Richard Mash (chapter 14) provide one such mechanism. They consider the credibility problem in terms of multiple objectives and time inconsistency and, with the analogy of monetary policy in mind, suggest that some form of delegation to an agency may be required credibly to commit to carbon targets. Such an agency might be given a single target for carbon emissions (as, in monetary policy, central banks are given inflation targets), and the setting of the appropriate instrument, such as a carbon tax, might be delegated too (analogous to the interest rate in the monetary policy example). Transparency of reporting would aid credibility further.

Such institutional reform would contribute to international credibility, too, and help to overcome the obstacles to a global climate-change agreement. But, as noted, it would not be sufficient: the process of negotiating the original 1997 Kyoto Protocol, and the subsequent attempts to gain ratification, have demonstrated how hard it is to achieve the necessary political buy-in. Many economists have suggested that the Kyoto Protocol is so flawed that it should be heavily circumscribed or abandoned in favour of other options. Among the critics, McKibbin and Wilcoxen (2002), Nordhaus and Boyer (2000), Victor (2001), and Barrett (2003*a*,*b*; and chapter 13 in this volume) have analysed the economic inefficiencies embedded within Kyoto and suggested alternative approaches.

[17] In the EU ETS these are set in National Allocations. See DTI (2003*c*) for details of the initial UK proposals.

The 'flaws' are not hard to identify. As noted above, in addition to the exclusion of the developing countries, notably China and India, the USA has decided not to ratify, and Russia has sought to maximize its economic leverage. Even after the post-1997 renegotiations, with the elements of flexibility (notably emissions trading, joint implementation, and the Clean Development Mechanism) further developed, it remains the case that the USA, as the source of around 25 per cent of global emissions, and China, which in 2003 alone plans to add around 50 GW of coal power stations to its electricity system (about the same as the total capacity on the British system), will continue outside Kyoto, while many of their industrial competitors, notably the EU, will be constrained by the targets. And even among those inside, it is unlikely that the net effect will be even stabilization at the 1990 levels. Add to the partial coverage, the absence of any serious enforcement mechanism for those countries that do sign up, and a notable absence of credible policy commitments to deliver the targets, and it is easy to see the critics' point of view.

But whereas the economic inefficiencies of Kyoto are easy to identify, the alternatives are not much more convincing. McKibbin and Wilcoxen (2002) advocate unilateral hybrid policies for emissions permits; Nordhaus and Boyer (2000) develop the idea of a harmonized carbon tax; Victor (2001) advocates emissions trading with a safety valve; and Barrett (2003*b*) advocates R&D and standards protocols with an adaptation fund. However, the problems that confront Kyoto are common to most, if not all, of the solutions on offer. Most countries are better off if others reduce emissions and they themselves do not, at least in the short run. For most governments, elections are a far more immediate concern. Time horizons are short—typically less than 5 years; voters are ill informed; and politicians have little incentive to impose on voters the costs—and hence reduced living standards—that climate-change policies might entail. Elections are conducted largely in terms of short-term economic growth, not long-term environmental concerns, and take little account of the interests of future generations. Politicians are also exposed to the power of corporate lobbying and, in the carbon field, there are obvious large-scale businesses with an interest in undermining and delaying the implementation of policies to reduce emissions. The economic case for doing less now (reflected in the low cost of carbon) fits neatly with the political interest in avoiding confronting the polluters—the voters—with the consequences of their behaviour. The economic approach effectively boils down to doing little now, waiting for the social cost of carbon to rise, and then assuming action will be taken. At 370 ppmv the costs are assumed low, but perhaps not at 500 ppmv. But at 500 ppmv, the political incentives will be largely the same, and hence there can be no easy assumption that the necessary actions will then be taken.

Christoph Böhringer and Michael Finus (in chapter 12) provide a defence of the Kyoto agreement as a pragmatic move in the right direction. They point to what has been achieved, and consider Kyoto to be a first step towards a more comprehensive agreement: it allows iterative adjustments towards an evolving goal. In a sense, this is not entirely distinct from Victor's argument. While Victor emphasizes the gains in monitoring emissions, he does indicate that the Clean Development Mechanism can be built upon the framework already in place. What both have in common is a recognition that building up international agreements is a gradual process, which requires investment in credibility. The Framework Convention on Climate Change in 1992 was ambitious in attempting to set the course for dealing with climate change. What the Kyoto process has revealed is that trying to be too ambitious too early has left the main players—the USA, China, and Russia—on the sidelines. Bringing them back into the process requires either a watering down of the overall target, or large-scale pay-offs and concessions. Watering down means that the emissions will continue to grow at a faster rate for a longer period; concessions will either have the same effect or mean that some countries will have to bear more of the costs.

It is, however, not unreasonable for a political process to start off with the status quo. In political terms, given the long-run aim of stabilizing atmospheric concentrations, the Framework Convention started with trying to limit emissions at the 1990 level. It then moved on, at Kyoto, to try to negotiate reductions among developed countries to offset rises in developing countries for the period 2008–12, with the intention of thereafter making significant reductions. Gaining political consensus and going through the ratification process would be necessary steps (see Grubb, 2003).

In economic theory, solutions to free-riding problems typically involve compensation. The problem with climate change is that it is all about shuffling around the losses in economic output and growth. Without some element of international altruism, and with the major emitting countries better off if they do not curb their emissions, there is little chance of much progress. Indeed, it might be argued that it is surprising that Kyoto has come as far as it has, and that should sufficient countries ratify it so that it comes into effect, it provides perhaps the only credible means of exerting moral pressure on the USA. And if the USA were to participate, it is perhaps the only country powerful enough to exert pressure on China.

If the free-rider problem is overcome, then the next step is to enhance the credibility of Kyoto. In addition to the role that emissions trading might play, there is also the question of its institutional structure. This might fall within the ambit of existing international institutions such as the World Trade Organization or even the United Nations, or new environmental international bodies may be needed. The arguments for delegation of carbon objectives to avoid conflicting objectives and to overcome the time-inconsistency problem discussed above apply not just to the national level but internationally, too. An international carbon-trading regime will need institutional support to establish, monitor, arbitrate, and revise carbon property rights.[18]

5. Policy Implications

We have established that the optimal level of carbon emissions is uncertain, and depends upon the costs and benefits of emissions reductions. The social cost of carbon is disputed, too. We have established that consistency is likely to improve economic efficiency, and that, although carbon taxes are economically superior to emissions permits, there are good political reasons why permits are likely to dominate. International agreements are plagued with problems, notably free riding, credibility, and enforcement, and are likely to take much longer to bring into effect than the architects of the 1992 Framework Convention imagined. In the light of these conclusions, what should policy-makers do now?

The obvious starting point is to consider whether existing policies are well designed, and whether the current emissions reductions could be achieved at lower costs—or whether, for the current expenditure of resources, the level of emissions reductions could be higher.

In most European countries, mixtures of policy initiatives have been introduced. These comprise energy taxes, emissions trading, support for renewables and energy efficiency, low-carbon technology support, international environmental aid, and numerous command-and-control rules. These policies have typically been developed in an *ad hoc* fashion, have been subject to vigorous lobbying by vested interests, and have been supported by overlapping and multiple agencies of government and voluntary bodies.

In the UK, by way of example, domestic targets have been set for CO_2 reduction (20 per cent by 2010; 60 per cent by 2050), independent of the

[18] The EU ETS is one example of the kind of super-national structure required, based upon a legally enforceable directive.

Kyoto targets for greenhouse gases. None of these has been subjected to serious cost–benefit analysis, and the overlaps have not been explicitly considered. In terms of policies, there is an energy tax (called the Climate Change Levy, CCL) which excludes coal; negotiated agreements with large industrial customers to reduce the effect of the CCL by up to 80 per cent; a renewables obligation on energy suppliers to take 10 per cent of their electricity from renewable sources, subject to a buy-out price; several schemes to support energy-efficiency measures; and there has been a UK ETS which subsidizes large industrial companies to adopt more stringent pollution limits (thereby reversing the polluter-pays principle) and which excludes electricity generators (and hence coal). Responsible departments, agencies, and other public bodies include: the DTI, Defra, and the Treasury (responsible, respectively, for energy policy, energy efficiency, and fiscal mechanisms); the EST (which promotes energy efficiency and administers the various energy saving schemes) and the Carbon Trust (which spends monies from the CCL on non-carbon technologies); the Environment Agency (responsible for pollution control and licensing); and Ofgem (responsible for regulating the energy industries).

The gap between economically efficient and existing policies is undoubtedly very large within the UK and in Europe. Existing carbon reductions could be achieved at (probably) significantly lower cost. The gap between the various implied costs in the different schemes and their variance, compared with the social cost of carbon from recent studies, is very large.

For some economists, the conclusion that follows is that little should be done now—that there is time to figure out appropriate policies.[19] The failures of Kyoto should not, therefore, be an immediate concern and a number of existing policies should probably be abandoned, or at best not expanded. If, and when, the social cost of carbon rises over time, then—and only then—should substantive action be taken.

For scientists, environmentalists, and even some politicians, this conclusion is anathema. Some argue that the damage now and in the future is much larger than IAMs have assumed—notably in terms of loss of biodiversity and the possibility of catastrophe. Intangible non-market values should also be included. Others challenge cost–benefit analysis directly: the framing effect is argued to be very large, other moral values beyond utility need to be taken into account, and the preferences of future generations may be very different from current ones.

[19] The main studies referred to in section 4 (Victor, 2001; McKibbin and Wilcoxen, 2002; Nordhaus and Boyer, 2002) all stress that there is time to develop new policy regimes—while the marginal cost of carbon is low.

There are two ways to approach a resolution of the sharp divergence in the climate-change debate. The first is to engage directly with the IAM approach and address the criticisms, while also taking a precautionary approach. Recognizing that the economic toolbox to tackle global warming is very crude, recognizing that a lot is left out (including, notably, adaptation) and revising the estimates of variables already included, provides the basis for an interdisciplinary approach. The second is to reject economic approaches and, instead, to focus on the political process to deliver non-economic objectives and to use policies on the basis of 'the more the merrier'. This chapter has argued that the former is the better way forward.