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Commentary on Fullerton, Leicester, Smith, 'Environmental Taxes'

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The role of taxation in climate change policy

Paul Johnson and Nick Stern

Commentary on Fullerton, Leicester and Smith for Mirrlees Review of taxation

Fullerton, Leicester and Smith's paper (henceforth FLS) offers an excellent survey of the theory and practice of environmental taxation. Our purpose in this commentary is not to review either the paper as a whole or the subject matter as a whole. Rather it is to expand upon their treatment of climate change.

Responding appropriately to the challenge posed by climate change is among the greatest challenges facing policy makers in the UK and internationally. It is important that the responses are designed with a clear understanding of the economics. An effective response will require both extremely careful economic analysis and appropriate use of instruments, and very substantial use of such instruments on a global, or near global, scale.

We hope to add to the FLS analysis by taking a slightly different approach to the problem. We hope thereby to complement their analysis without repeating the main elements of it. Our strategy in outlining our view on the role of taxation in dealing with climate change is to start by very briefly reviewing the science, and then the basic economics, demonstrating the unprecedented nature of the climate change problem and the way in which the nature of that problem impacts on the solutions we should be looking at. In our view this provides a strong basis on which to conclude that significant action is required. It also provides some strong indication of the economic instruments that are most likely to be effective, in particular given the global and long term nature of the problem.

The issue of risk is at the centre of our discussion. The scale of the potential problems created by climate change is very large, and the risks associated with atmospheric concentrations of greenhouse gas rising above any specified levels are both hard to know and potentially very big indeed. Indeed, both recent developments in science and in economics suggest that the scale of these risks and their importance is even bigger than was appreciated at the time the Stern Review was written. This drives us towards conclusions which put mechanisms which limit quantities of emissions at the centre of a policy framework.

We go on to consider some of the options open to the UK and draw some conclusions about the role of pricing generally and of tax in particular. Pricing the externality imposed by emissions of greenhouse gases is going to a crucial part of the policy solution, but not the only one. Intelligent regulation and support for technology will also be vitally important. So far as pricing is concerned it is likely to be the case that UK participation in the EU Emissions Trading Scheme will be the most effective method for pricing carbon in the UK in the near future. Hence the role of tax in the UK response to climate change may be limited to those sectors excluded from the EU ETS. Road transport is the largest such sector and is already subject to very substantial tax levels. So overall an *additional* role for the tax system specifically may be quite limited. We stress that this is not necessarily a conclusion that will stand true in all countries where there are particular barriers to trading schemes, nor will it remain true in the UK if the EU ETS does not develop as we hope it will.

Climate change

Before starting on the economics and the policy implications of global warming, it is important to get some of the key scientific issues in perspective. The economics flows from the science. The four key points about climate change are that:

(1) It is global in its origins and effects;
(2) It is highly non-marginal (the potential impacts are very big indeed);
(3) Risk and uncertainty are pervasive;
(4) It is very long term and increases to the flow of greenhouse gases into the atmosphere (near enough) permanently increase the atmospheric stock;

First, and most obviously, this is a global problem. It is global because it matters not a whit where GHGs are emitted – the impact of a tonne of CO_2 emitted in London is the same as that of a tonne emitted in Beijing, Sydney or Buenos Aires. It is also global because the impacts of climate change will be felt across the globe – differentially to be sure, but globally nonetheless.

Second at plausible, indeed likely, levels of future GHG concentrations and temperature rises impacts on geography, environment and therefore economy and social structure of the world are potentially huge. The 2007 Intergovernmental Panel on Climate Change (IPCC) makes this very clear.

The actual scale of climate change, though, is uncertain. Table 1 (using fairly conservative estimates of probabilities from the Hadley Centre) illustrates this uncertainty showing the probabilities of particular temperature increases associated with different greenhouse gas concentrations. Temperature increases of 5C, which would be as likely as not with concentrations at 750 ppm CO_2e, would be world changing. As Stern (2008) puts it “the last time temperature was in the region of 5C above pre-industrial times was in the Eocene period around 35-55 million years ago. Swampy forests covered much of the world and there were alligators near the North Pole”. We are dealing with the possibility of change on a scale that economists rarely, if ever, have to consider.

Concentrations in 2006 were around 430ppm and are rising at around 2.5 ppm p.a. Given the rapid growth of China among others that rate of growth will soon rise above 3ppm. So on business as usual we really could expect to be reaching 750ppm CO2e by the end of the current century.

Beyond the uncertainty over the impacts of GHG concentrations on temperature rises there is also uncertainty over the impact of temperature change on a whole range of physical phenomena on which we depend – from the frequency and violence of extreme weather events to the monsoon in Asia and the strength of the North Atlantic thermohaline circulation. And then the actual impact on both natural ecosystems and human society and economy, whilst increasingly well understood, is still subject to much uncertainty.

Table 1

Likelihood in percent of exceeding a temperature increase at equilibrium

Stabilisation Level (in ppm CO2e)	***2°C***	***3°C***	***4°C***	***5°C***	***6°C***	***7°C***
450	78	18	3	1	0	0
500	96	44	11	3	1	0
550	99	69	24	7	2	1
650	100	94	58	24	9	4
750	100	99	82	47	22	9

In addition, it is the stock of GHGs in the atmosphere that matters and once a certain stock level is reached it is, with current and prospective scientific knowledge at least, close to irreversible. In other words once we reach a certain level of GHG concentration in the atmosphere we will have to live with that level for some time.

From Science to economics

From this simple description of the science flows a great deal of economics. First there is the global nature of the problem. The UK emits only about 2% of global annual emissions of GHGs. Any policy action by the UK needs to be seen in a global context. Any analysis of the appropriate policy instruments needs to take account of this. An efficient policy response requires, as near as possible, a global carbon price. There is little point in any one country acting alone.

Importantly there are also major equity considerations. It is both the case that rich countries have created most of the stock of GHGs in the atmosphere, and that poor countries will be hit first and hardest by climate change because of their geography, their low incomes and their greater reliance on climate sensitive sectors like agriculture. As all international negotiations on these issues make clear, there will be no progress unless these, and other, equity considerations are given full weight. A response to climate change will need to be one in which, through one mechanism or another, developed countries find ways to provide financial support to developing countries.

The economics also needs to address the facts of the non-marginality of the impacts and the associated risks and uncertainties. It is here that the simple-minded approach to pricing for externalities fails us. With uncertainty a price-based policy might involve substantial risks of high emissions. The potential dangers from high emissions are on a scale that requires policies that focus on these risks and thus lead to quantity targets for emissions. We must, of course, check both on the overall costs of implementing such targets in relation to overall benefits in terms of damages avoided and on the marginal costs in relation to marginal benefits. There are, however great difficulties in calculating the marginal benefits, or social costs of carbon (see below).

This argument on major risks illustrates the importance of the non-marginality of this challenge. Many of the tools of economics, including those usually applied to cost-benefit analysis, have been developed to deal with informing choices over projects or programmes which, in the scheme of things, will have only marginal impacts on overall economic welfare. The choice over whether or not to deal with climate change will have huge effects on welfare of future generations.

Indeed one issue that FLS touch on (as have others) is the appropriate weight to attach to future generations. The fact that most of the costs of climate change will be felt by generations yet to come has led some commentators to suggest that action now is hard to justify. There are two possible reasons for believing this to be the case.

The first is just that these are future generations and that their welfare should be of relatively little concern to us. That is the implication of a high pure rate of time preference. If we don't care much about future generations then we won't be willing to do much to protect them from climate change or anything else. If we don't care about the future the problem just disappears. But this hardly seems a sensible basis on which to make policy. It is hard to understand the ethical judgment here – discriminating against someone on the basis of their date of birth does not look attractive.

The second is that since we are poorer than future generations are likely to be, it is inequitable for this generation to spend money on improving the welfare of future generations. This argument might have some force. The conclusions reached in the Stern review were based on the assumption that the elasticity of the marginal utility of consumption is one. That itself implies a significant ethical judgment in favour of equity – it would imply that we would be happy to transfer income from income from someone with income of 100 to someone with income of 20, even if 80% of the transfer were "lost" along the way. Atkinson and Brandolini (2007) point out most policy, particularly as it affects intra-temporal redistribution, appears to be made on significantly less egalitarian presumptions than that. The argument of Nordhaus (2007) for example that a much greater egalitarianism is appropriate seems to sit oddly with both observed policy and most intuition. In any case somewhat higher values do not change the conclusion that the discounted benefits of action greatly outweigh the costs. It is additionally important to note that severe climate change could in any case have such an impact that future generations will not be as much better off than us as might otherwise be supposed. We should, of course, note that there will always be pure time discount rates which result in dismissing any future set of damages as negligible.

The fact that the risks and uncertainties associated with different levels of GHG concentrations are substantial is also a reason for action rather than inaction. In the first place the consequences of higher temperature increases than the mean expectation are much more than proportional to the additional increase in temperature. Second, under these circumstances the incomes and welfare of future generations will be lower. In a series of recent papers (Weitzman 2007a, 2007b) Marty Weitzman has argued that there is a strong case for attaching a lot of weight to the possible extreme outcomes, underlining the centrality of risk in dealing with the economics of climate change.

Importantly there is also an asymmetry because of the effective irreversibility of greenhouse gas levels. If it turns out in the future that the consequences of higher GHG concentration levels is greater than we currently believe we are still stuck with whatever GHG concentration we have at that moment. And a sharp increase in abatement efforts later in response to new information will itself be expensive. On the other hand if it turns out that the consequences of climate change are less dramatic than we currently believe then it is easy to move on to a less ambitious abatement path. To stabilise at 450ppm now will be really quite expensive. If we do nothing for 20 years it will by then be very expensive to stabilise at 550ppm. The Stern review estimated that, starting now, it would be possible to stabilise below 550ppm at a cost of 1% of global GDP p.a.

We go through these issues, and we could have developed them further and addressed other issues, because it is important to understand that a reasonable interpretation of the evidence on likely climate change and its likely effects, alongside fairly conservative assumptions regarding how to take account of costs and intergenerational equity, lead to strong conclusions regarding the need to act. In our view it is not the case that the balance of evidence should lead one to take the view that the need for action is uncertain or should be delayed or can be started very gradually. There is a need for swift application of significant economic tools. The issue then becomes which tools, applied how and in what global context.

Choice of mechanism

This paper appears in a volume about tax, yet we have dwelt so far on some basic science and some basic economics regarding the need to respond to climate change. The reason for that is in part to be clear that this does lead to a strong and convincing case for action and in part because the choice of mechanism to deal with climate change depends to a large extent on the basic science and economics.

Price mechanisms – taxes and trading

The natural starting point is that we are dealing with an externality, and that we would like to internalise that externality by reflecting it in the prices that people and firms face. If we estimate a social cost or shadow price of carbon then we should ensure that that cost is faced by those who emit carbon. We come back to the issue of how to put a price on carbon below.

There are different mechanisms for ensuring this cost is internalised. The obvious alternatives are straight price mechanisms like taxes and quantity based mechanisms, including tradable permits. The standard analysis shows that prices are preferable where the benefits of reductions change less with the level of pollution than do the costs of delivering the reductions. Conversely quantity mechanisms are preferable where benefits of further reductions increase more with the level of pollution than do costs of delivering reductions; in other words there are large and sharply rising costs associated with a given level of pollution.

This might lead us to prefer taxes in the short run because short run costs of adjustment might be high and benefits of emission reduction relatively low. And it might point to quantity constrained trading schemes in the longer run as long run abatement costs are lower and the costs of inadequate total reductions are high.

For an individual country facing an externality this might be a good blueprint for policy. But as we have seen there are many issues specific to climate change, which make it rather different from most externalities. First, as we have discussed the risks associated with inadequate emission reductions, are very significant. Important also is the international nature of the problem and considerations of equity between developed and developing countries. In our view, these create a strong presumption in favour of carbon trading as a primary policy response at an international level.

Empirically it seems more likely that international agreements on trading can be reached than international agreement on taxes. There already exists the EU Emissions Trading Scheme, the biggest carbon trading market in the world at present, which has created an active international carbon market within the EU. Active trading schemes also exist or are being developed in California, North Eastern states of the USA and Australia.

Additionally carbon trading allows significant flows of *private* resources from developed to developing countries. The most important such mechanism at present is the Clean Development Mechanism (CDM), a project based mechanism created by the Kyoto protocol which allows rich countries to use credits from investments in emissions reductions in poor countries to offset against their own emission reduction commitments. This mechanism as it currently stands not without significant problems, but it is clear to us that some such mechanism is highly likely to play a key role in global climate policy. It is most readily part of a trading system.

An additional issue that needs to be borne in mind in this context is the fact that CO_2 is produced by burning fossil fuels. Fossil fuels are finite resources and their owners have a choice over if and when to extract them. In the absence of a global cap on emissions, and an expectation that policy will lead to taxes rising over time, there is a risk that the resource owners will respond to a pricing policy designed to limit emissions by raising production and cutting prices in the short run, thereby increasing global emissions[1]. This underlines the need for *global* cap and trading systems to be introduced as soon as possible.

This is not to say that trading schemes are unproblematic either in principle or in practice. To be effective a trading scheme needs to be:

- Credible – if it is deemed likely that direction of policy will change firms will not invest in the necessary infrastructure;
- Flexible – if the science changes, there must be room to adjust the policy;
- Predictable – the policy framework must allow firms to understand quite clearly when and why policy might change.

[1] See Sinn (2007) for example.

If policy direction is unclear then firms may, rationally, decide on a "wait and see" approach and delay investment decisions. In the case of power generators, major players in production of CO_2, this can itself create serious security of supply issues. In addition to being credible, flexible and predictable, trading schemes also need to be deep, liquid and well designed. Deep in the sense of covering as great a portion of carbon emissions as possible; liquid in that a real shortage needs to be created in the market such that trading occurs at prices that are significantly positive and not overly volatile; and well designed in the sense of not creating perverse incentives or market distortions in the way permits are allocated.

Nobody would claim that the first phase of the EU Emissions Trading Scheme met these criteria. Real shortages were not created, allocations were not transparent in the sense that it was not immediately clear that there was no shortage in the market and hence prices were very volatile, settling at a very low level. Crucially, in its own terms, and also by comparison with a tax system, allocations were "grandfathered" rather than auctioned. In other words emitting firms were simply given permits on the basis of expected future emissions. As FLS demonstrate quite comprehensively, this is a highly sub-optimal allocation policy.

Since the permits had significant economic value grandfathering amounts to providing considerable subsidy to incumbents and, because the marginal cost of power generation was increased by the trading system, in many energy markets prices rose such as to earn "windfall" or super normal profits for electricity producers.

Giving away permits also creates a very clear disadvantage for a trading system by comparison to tax – no money is raised for the government.

The important point, however, is that none of these aspects of a trading system is inevitable. Indeed the EU has clearly learnt from the first phase, has tightened up allocations in the second phase and has recently indicated a desire to move to 100% auctioning of allowances in the third phase.

The price level

Whether using taxes or trading to set a price on emissions the question of course arises of what the appropriate price should be. The way to answer that derives from some of the economics set out earlier in this paper.

In many circumstances one would look at the marginal cost associated with an additional unit of emission and set the price that needs to be internalised accordingly. The marginal cost in this context is the Social Cost of Carbon (SCC). The SCC measures the full global cost today of an incremental unit of carbon (or other equivalent greenhouse gas) emitted now, summing the full global cost of the damage it imposes over the time it spends in the atmosphere. Obviously the calculation of the SCC will depend on expected damages, discount rates and so on discussed above.

Using the SCC as a guide to policy is very problematic. Its level depends on a huge array of assumptions concerning model structures over the indefinite future and the value judgements applied. In particular, the SCC itself depends on the future emissions path and long-run stabilisation level. Because an extra unit of carbon in the atmosphere does more damage the more GHGs there are in the long run, the SCC associated with a path towards an expected stabilisation of 450ppm CO2(e) is likely to be considerably less than that associated with a path towards a higher stabilisation target of, say, 550ppm., the SCC associated with a particular path towards stabilisation target does not necessarily tell us what price to use : not only do we have to take risk into account, including policy risk in the future, there are all the usual problems of income distribution, market imperfections,and the interactions with other policies.

If we are working in a world with a stabilisation target, the appropriate information to use in determining what the appropriate price of carbon should be is the abatement cost associated with the marginal policy required to achieve that change. Enqvist et al estimate that “it would be technically possible to capture 26.7 gigatons of abatement by addressing only measures costing no more than 40 euros a ton”. Stern estimates that by 2030 cuts would need to be in the order of 20 Gt CO_2e for stabilisation at 550ppm, suggesting a CO_2 price of around 30 euros a tonne of CO_2 (or around £80 per tonne of carbon).

This is within the range of the SCC calculated for a 550 ppm stabilisation target and seems to us to give a reasonable sense of the appropriate value to use for policy and as such a reasonable price to aim for in a tax or trading system, particularly for tax and trading systems focused on the production side.. The approach we are suggesting here has the following logical structure (1) examine target emission reductions in relation to risk, with an eye on costs of achieving them (2) infer the related marginal abatement costs (MAC) (3) check these against a relevant range of SCC calculations (4) check total costs against total benefits (5) iterate as necessary. This is likely to be a much more transparent and robust process than starting with an SCC with all its attendant problems of calculation. The approach suggested is founded clearly both in the basic scientific and risk structure of the process the relevant economics of risk and of public policy.

Mechanisms other than prices

We have focussed so far on the central role of the price mechanism - whether through taxes or trading – as a response to climate change. In the face of an externality this is, for very good reasons, the economist's first port of call. It is, however, worth stressing that we do not believe that the price mechanism is the only available tool, nor indeed is it the only tool that should be used.

A carbon price will, for example, incentivise energy producers to swap from more to less carbon intensive forms of electricity generation if the price is high enough to make the less carbon intensive generation worthwhile. However, it is highly unlikely that a carbon price at a plausible level will be enough to accelerate technological change at a rate which will generate sufficient reduction in emissions. There are in any case significant market failures in the innovation process partly as a result of the public good nature of the benefits and partly because high costs of development with uncertain pay-offs a long time in the future might make the private sector unwilling to take the risk. In addition in this case there are long term social returns from innovation which private firms will not take into account in making decisions. There are particular issues in the power generation sector – length of learning process, infrastructure inflexibility, existing market distortions and low levels of competition – which seem to make returns to, and levels of, R&D low.

Without significant changes in the way that electricity is generated (and in the longer run, in how cars are powered) CO_2 emissions will not fall at anything like the rate required to avoid dangerous climate change. Not least this reflects the availability of large quantities of coal which will be burnt in the developing world if not in the developed world. So some from of public support for, for example, both research and demonstration of carbon capture and storage technology will be vital.

In different ways non price instruments are likely to be needed to affect the behaviour of individuals. Energy conservation is an excellent example of an area in which individuals appear to be markedly reluctant to take advantage of clear incentives to reduce energy consumption, and thus expenditure, through straightforward measures like insulation, use of low energy light bulbs and purchase of energy efficient goods. This reflects a number of problems including inadequate information, difficulty of monitoring energy consumption, transaction or “hassle” costs of taking action, possibly lack of access to capital and, for tenants, the lack of incentives for landlords to invest in ways which reduce their tenants’ energy bills.

In respect of this set of issues again the price mechanism is unlikely to be the most effective tool. Governments have experimented with a range of measures including building and product regulations, introduction of “smart meters”, direct subsidisation of insulation for poorer individuals and provision of information. Many such regulatory and other mechanisms will in fact be economically optimal responses. Indeed, in those cases like improving energy efficiency, where there appear to be direct benefits to the consumer from acting given current prices, it is immediately clear that responses other than changing the price are likely to be optimal.

The important point about both the need for support for technology and the case for direct regulation or other measures aimed at individuals, is that we should not be seduced into believing that either tax or trading mechanisms will be anywhere close to adequate responses by themselves. There is a strong *economic* case for using a variety of instruments including direct regulation. Obviously we are not suggesting carte blanche for policy makers to impose such regulations willy-nilly; there needs to be careful analysis of the costs and benefits of different policies and the market failures they are designed to address, alongside a clear understanding of how they might fit with the central tax or trading mechanism. But the price mechanism must be seen alongside other aspects of the response to global warming, not as the only response.

The fact that multiple tools should be used, though, does create one additional and very important issue for policy makers – how should these additional tools be used and designed in such a way as to fit in with the primary cap and trade policy. This is an issue of immediate and direct relevance in the context of what policies to put alongside the EU ETS in the UK and in Europe. At the most straightforward level, because the ETS creates a cap in affected sectors for a period, additional policies covering that sector will not reduce emissions in that period, though they may still be worthwhile in minimising costs in a dynamic sense. More complex are large scale policies like the EU renewables target which sits alongside the trading system and is intended to create an obligation across the EU to produce at least 20% of energy from renewable sources. If implemented there is at least a risk that this will undermine the trading system and result in emissions being cut in a way that is more expensive than would have been the case had the trading system been relied upon by itself.

UK context

We do not propose to go into much further detail regarding what all this means for the UK. But three points are worth developing somewhat. First, what might this mean for revenues available to the UK government. Second, we mention the role of carbon budgets. Third, we cannot avoid saying a little more about road transport since it both lies outside the current trading scheme and is the source of very substantial tax revenue.

Revenues

To put the discussion of tax into broad perspective at the UK level one can ask - what level of tax would be raised by applying a carbon tax at a particular level to UK emissions. We broadly agree with the sort of estimates made by FLS. Taking the £80 per tonne of carbon price discussed earlier, and applying a tax at that rate to the 150 million tonnes or so of annual carbon emissions in the UK would raise around £12 billion. This is not a number additional to current receipts. Indeed it is a lot less than the £25 billion expected to be raised from taxes on hydrocarbon fuels in 2007/08 (reflecting of course the fact that the vast majority of the external costs associated with road transport are congestion costs, not costs associated with carbon emissions). A more useful calculation perhaps is to say that if permits were auctioned at this price for the roughly half of emissions that are covered by the EU ETS some £6 billion might be raised. Applied to the full 75% or so of emissions that do not emanate from road transport raises that figure to £9 billion.

It is important to add that this ought to be thought of as being additional to extra revenue that would be raised from charging VAT at the full rate on domestic energy consumption. Relative to a neutral system in which all consumption is subject to a value added tax, the reduced rate of VAT on gas and electricity consumption is, in effect, a subsidy on their consumption. It is one of the odder elements of the tax system that it should subsidise this consumption whilst trying elsewhere to reduce energy consumption. As is discussed elsewhere in this volume other, for example distributional, objectives which government might have in mind, are best achieved through other elements of the welfare system.

Carbon budgets

There are numerous other instruments currently in use, including taxes like the Climate Change Levy (and associated climate change agreements) and in addition there are proposals for a new trading system for non energy intensive companies – the carbon reduction commitment. We do not propose here to look at them or other elements of the UK context in greater detail. However, there is one innovation which we cannot avoid mentioning. At the time of writing the UK is embarking on a novel and ambitious experiment in policy making with regard to climate change through the introduction of five year "carbon budgets" on the way to targeted reductions in emissions in 2020 and 2050. Government will be advised by an independent "Climate Change Committee" on both the eventual targets and on the path towards the target, defined by the total amount of CO_2 which can be emitted in each five year period. Following the committee's advice the government will commit itself to particular budgets and targets that will be, in some sense, legally binding. As such the government will be creating an entirely new constraint for the economy – it will be aiming for growth, redistribution and so on subject to the binding constraint that carbon emissions should be falling along a specified path.

As a way of creating certainty and credibility this type of commitment has some attractions – though the real certainty and credibility needed by investors in particular is around the carbon price and policy in specific sectors. A key question in this context is whether the existence of carbon budgets will alter the attractiveness of tax and trading relative to other instruments or affect the optimality of policy in other ways.

In principle setting targets or budgets should not alter the optimal policy mix. We would draw attention, however, to one potential danger with a system which sets a great deal of political credibility against meeting quite specific budgets over relatively constrained five year periods. The short run impacts of taxes might be rather less than their long run impacts – the short run price elasticity of demand for petrol, for example, is generally estimated at around -0.25 while the long run elasticity is about -

0.6[2]. This reflects the fact that consumers and manufacturers can take some time to respond to price (tax) changes through manufacture and purchase of more fuel efficient vehicles, for example. By contrast the immediate effects of some other policies, for example some forms of direct regulation of behaviour or products, might be rather greater. The existence of short run budgets at least has the potential to distort policy choices.

Cap and trade schemes like the EU ETS might also look more attractive than tax in the context of budgets. By setting tight caps the government can guarantee meeting targets. In principle it should use the ETS sector up to the point at which the marginal abatement costs in that sector, are equal to costs elsewhere.

Road transport

As we have already suggested, and as FLS show, road transport is already very heavily taxed relative to the associated climate change externalities, though most of that tax can be justified by the scale of the congestion externality imposed by drivers. In this sector it is likely that a combination of technology support, possible regulation and other policies aimed at changing behaviour will be more effective than further tax increases. The effectiveness of other tax changes, like increased differentiation in favour of biofuels, will depend more on the characteristics of biofuels than what we know to be the effectiveness of tax policy in supporting such behaviour change.

That said we agree strongly with FLS that there is much to be said for congestion charging in the road transport sector. Optimal pricing of congested roads will lead to significant economic efficiencies and reduced demand for road space. We would go further to say that the appropriate pricing of infrastructure in this way should have significant advantages from the point of view of the transparency of a tax system aiming to deal with multiple externalities. It is not helpful to the public debate that there is no sense of the relative importance of congestion, carbon and other externalities in road fuel duty and certainly it is the implication of many government statements that it is the carbon/pollution externality that is the main determinant of duty levels.

If we are to aspire to a world in which carbon is consistently priced then leaving road transport out of the main pricing mechanism indefinitely is probably not the best long

[2] Goodwin et al 2003

run solution. It will only be possible to include it if the carbon component is separately identified and dealt with. This is an additional benefit that congestion pricing would facilitate.

Conclusions

We can draw some strong conclusions from this approach. Most importantly, as many economists and policy makers are coming to understand, the cost of action to deal with climate change is less than cost of inaction. This view is in contrast to the conclusions drawn in many earlier studies which understated the costs of climate change partly because the science was less well developed, partly because they didn't take full account of the risks and partly because they did not take account of the range of non-market costs which will clearly be crucial as the physical world changes in the face of climate change. Recent developments in economics and science, even since the publication of the Stern review, push us further in this direction. In addition an appropriate weighting of future generations generates larger costs associated with inaction.

The second conclusion we draw from the way in which we apply economics to the problem is that there are very powerful reasons for relying on quantity rather than pure price mechanisms.

In the first place the risks associated with greenhouse gas concentrations rising too quickly are very great. We cannot be sure about the effects of a pricing policy (a tax). This is particularly true in a situation where energy markets are oligopolistic and in the face of the fact that we are dealing with extraction of raw materials – without a cap, expectation of rising taxes may incentivise coal and oil producers to produce and sell *more* in the short run, at a lower price. Cap and trade systems allow *quantities* to be constrained in a way which nevertheless allows decisions over how and where to cut emissions to be decentralised through the market system.

Additionally the international nature of the problem points to cap and trade. Simple experience suggests that such schemes will be easier to introduce on a wide scale than would a large scale international tax. And trading systems can, if appropriately designed, allow significant flows of funds towards low income countries – flows which will be crucial to get their buy in to, and participation in, a global system.

These conclusions are relevant to the global issue of how to deal with climate change. For the UK participation in international trading schemes must be at the heart of policy. And swift movement towards auctioning of allowances must be central to that. But that does not answer all the questions about designing the response within the UK. Well designed regulation can and should bring down costs and provide certainty. But it is crucial to do this in a way which does not undermine the main cap and trade policy and big policy innovations which will interact with the trading system, as the EU renewables targets certainly will, need to be designed with great care to avoid unintended consequences. Technology support, especially for carbon capture and storage must be part of the appropriate policy response. And even for a sector as large and important for this issue as road transport it is not obvious to us that moving it into a cap a trade system is a priority. Taxation of petrol at the point of purchase is straightforward and well established. The greater economic gains may well be accessed by moving first to a system of congestion charging which targets better the major externality associated with road travel – congestion – and associating taxation of petrol more directly with the pollution externalities.

Finally, we concur with FLS. Climate change is a big problem which requires large scale action and the application of economic tools including taxes and auctioned allowances. But reasonable use of economic tools will not fundamentally alter the balance of taxation in the UK. There is probably not scope for raising even an additional one per cent of GDP in additional taxes or auctioned allowances.

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