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synthesis article

The economics of personal carbon trading

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Proponents of personal carbon trading (PCT) make strong claims for the policy on the basis of environmental effectiveness, efficiency and equity, in comparison with alternative policies such as 'upstream' trading schemes. However, this review of the relevant theory and evidence suggests that these claims are not as strong as they may first appear. Effectiveness is qualified by the strong likelihood of a safety valve on grounds of political risk. The case for efficiency is challenged by the fact that the administrative costs of PCT will inevitably be higher than those of an upstream scheme. The additional effects of PCT would have to be significant in order to offset these costs sufficiently to make it the more efficient option. The case for equity is stronger. However, a PCT scheme in the UK would still create groups of net losers on low incomes who could not be compensated easily, and this would have some impact on its political acceptability.

Keywords: economic efficiency; environmental effectiveness; equity; personal carbon allowance; personal carbon trading

Les adhérents au principe d'échanges de carbone individuel (personal carbon trading « PCT ») revendiquent fortement cette politique en soulignant l'efficacité environnementale, l'efficacité et l'équité, par rapport à d'autres politiques telles que les systèmes d'échanges « en amont ». Cependant, selon cette revue théorique et les observations empiriques, ces revendications ne sont pas aussi solides qu'elles n'apparaîtraient à premier abord. L'efficacité environnementale se justifie par la forte probabilité d'une soupape de sûreté du fait du risque politique. En ce qui concerne l'efficacité l'argument est mis en doute par le fait que le coût administratif du PCT serait inévitablement plus élevé que dans un système en amont. Les effets supplémentaires du PCT devraient être assez importants pour compenser ces coûts de manière à en faire l'option la plus efficace. L'argument en faveur de l'équité est plus robuste. Cependant, un système de PCT au Royaume-Uni pourrait tout de même faire naître des groupes de perdants nets à faibles revenus pouvant être facilement compensés, et ceci aurait un impact sur son acceptabilité politique.

Mots clés: echanges de carbone individuel; efficacité économique; efficacité environnementale; équité; quota individuel de carbone

1. Introduction

From an economic point of view, there would be a strong case for introducing personal carbon trading (PCT) if it were environmentally effective (i.e. ensured carbon emissions reductions), were more cost-effective than alternative policies, and did not worsen equity. This article reviews some recent attempts to assess PCT by these criteria.

A number of different variants of PCT have been suggested (see Fawcett and Parag, this issue). The main differences between the approaches are the scope of the cap; who ultimately has responsibility for surrendering the units; and which sources of carbon emissions are covered by the scheme (Roberts and Thumim, 2006; Keay-Bright, 2008). However, most of the focus within

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the policy and research community[1] has been on two proposals which have some common elements – domestic tradable quotas (DTQs), now known as tradable energy quotas (TEQs) (Fleming (2005), and personal carbon allowances (PCAs) (Hillman, 2005; Hillman and Fawcett, 2004). Both schemes involve the free allocation of tradable permits to individuals, and include emissions from residential energy use, personal transport and aviation. The schemes differ in that TEQs have an economy-wide cap and involve the auctioning of remaining permits to businesses, whereas PCAs focus only on the personal sector.[2] Strictly speaking, this article focuses on personal carbon trading schemes of the PCA type, although in practice many of the issues concerning PCAs will also apply to TEQs, and in this article we refer to PCT in general.[3]

Proponents of PCT have argued that the idea meets all three of the criteria mentioned above. The application of a cap on total emissions, declining over time, is assumed to guarantee environmental effectiveness, especially relative to a tax on emissions. The equal allocation of permits is also seen as a guarantee of equity. On cost, proponents have simply tended to assert that an electronic trading system could be set up at relatively low cost, and point to platforms such as the Nectar card[4] system as low-cost analogues.

However, on closer examination, each of these positions is open to question. This article reviews the arguments and evidence (especially in the UK context) for each in turn.

Assessing PCT involves comparing it with alternative policies. There are many possibilities, including carbon taxes, upstream trading schemes, regulations, market transformation schemes, information and motivational campaigns etc. However, most of the literature focuses on the first two, and on the comparison with upstream cap-and-trade schemes in particular, partly because, as explained below, this is the current direction of travel in policy, at least in the UK and other parts of Europe.

2. Effectiveness

One of the central arguments made by proponents of PCT is that it is environmentally effective, especially in comparison with a tax on emissions. Hillman (2004: 133–34) argues that 'rationing has the advantage of certainty of result: it is clear exactly what carbon savings will be made', while Fleming asserts that: 'TEQs are effective. The [carbon] Budget is a virtual guarantee that targets for the reduced carbon emissions will actually be met' (Fleming, 2005: 15).

However, while this may be true in principle, when pollution trading schemes have been introduced in practice they have always included mechanisms that may limit their environmental effectiveness. The most common of these is a ceiling on the permit price – usually in the form of a penalty charge that is paid if the market actor does not have sufficient permits to cover their emissions – which acts a safety valve to avoid extreme price spikes. This is the case, for example, with the EU Emissions Trading Scheme (EU ETS), where the Phase II penalty is €100/tCO_2.

The underlying driver of such safety valves is political risk. The supply of permits in any cap-and-trade market aimed at limiting pollution is not only completely inelastic but also declining. The price elasticity of the demand for permits will depend both on behavioural change and on the existence of low-carbon alternative services and products. It is not yet known how elastic such demand will be, but – as discussed in Section 3 – the short-term elasticities of demand for household energy and transport fuels are typically low. If carbon demand is similarly inelastic, the price for personal carbon allowances could be quite unstable.[5]

The possibility of price spikes creates a potential problem of political risk, arising from a number of sources.[6] One is the worsening of fuel poverty for some poorer households (those with above-average emissions that would have to buy additional permits) by an uncertain amount. This would, of course, apply to any form of carbon pricing, including a carbon tax. However, while a government can directly control the level (and design) of a tax, it cannot determine in advance the carbon price in a cap-and-trade scheme. Another political risk is general unpopularity if personal carbon scheme prices were to rise greatly in excess of carbon prices paid by businesses in the EU ETS (Defra, 2008a: 31).

It is hard to imagine that any government would be willing to expose itself readily to these kinds of open-ended risks. Indeed, the UK Government's 2008 assessment of PCT argued that any putative PCT scheme (or an alternative upstream trading scheme) would have to have a safety valve on precisely these grounds of political feasibility (Defra, 2008a).

In practice, a safety valve for a PCT scheme could work through the sale of additional permits into the market at the ceiling price, or possibly by allowing the buying in of permits from the EU ETS, as is the case for the Carbon Reduction Commitment scheme for the commercial sector.

Such a 'soft price cap' arrangement no longer guarantees that emissions will be under the original cap, although if there is a link to the EU ETS then the sum of emissions covered by the EU ETS and the PCT scheme together would be capped in total.[7] The likelihood of a soft price cap scheme in the event of real-world implementation raises a fundamental issue in assessing PCT as a policy option. On the one hand, a soft price cap is certainly not what the original proponents of PCT (and subsequent supporters) have in mind.[8]

But, at the same time, the political risks associated with a hard price cap scheme are real. This implies that PCT would be adopted in the form in which its proponents originally intended it (i.e. with a hard price cap) only under conditions where the risks of an uncontrollably high carbon price are outweighed by the political risk of not having a guarantee of effectiveness in the face of extreme climate change. This is not yet the situation in the UK, or arguably anywhere else in high-emitting countries. Ironically, due to the long lag between carbon emissions and their climatic impact, this situation may be reached only when it is too late to avert dangerous climate change (see, for example, Giddens, 2009).

A second question about the environmental effectiveness of PCT arises from its interaction with existing policies. To the extent that it would create a single price for carbon across a range of activities, it is not clear that PCT would initially create any further distortions in addition to the considerable number that already exist in the policy landscape (Sorrell and Sijm, 2005).[9] However, any new policy – whether PCT, an upstream trading scheme or indeed a carbon tax – will be effective only if it leads to abatement that would not have otherwise taken place through existing policies (or indeed other changes such as an economic recession).

Probably the clearest examples apply to carbon emissions from electricity use in homes and from personal aviation. Electricity generation is already covered by an existing cap-and-trade scheme (i.e. the EU ETS), and emissions from aviation will also be covered by it from 2011. If a UK-based PCT were to reduce emissions in these areas, this would put downward pressure on the EU ETS carbon price, encouraging higher emissions elsewhere in the EU ETS bubble, and would not effectively reduce emissions relative to the situation without a PCT scheme.

Thus the problem for PCT (and indeed a growing problem for any new climate policies) is that the field is already crowded; Defra (2008a) lists some 60 existing and planned policies aimed at reducing personal carbon emissions, across personal road transport, domestic heating and hot water, lighting and power, and aviation. This picture raises the real possibility that, far from being effective, PCT would be largely environmentally redundant.

Nevertheless, we should not immediately conclude that there is no potential 'policy space' for PCT, for three reasons.[10]

1. There are still likely to be feasible abatement opportunities in the UK at reasonable cost that have not yet been realized by any existing policy. An indication of these opportunities may be derived from the first report from the Committee on Climate Change, *Building a Low-Carbon Economy* (Committee on Climate Change, 2008), which includes two scenarios. The first offers projections of emissions 'that are broadly in line with policies to which government is committed in principle, but where precise definition and implementation of policy is still required' (Committee on Climate Change, 2008: 117). The second is a 'stretch ambition' scenario, which 'adds further feasible abatement opportunities for which at the moment no policy commitment is in place, including more radical new technology deployment and more significant lifestyle adjustments' (Committee on Climate Change, 2008: 117). An analysis of these two scenarios indicates that the total opportunity for abatement in home energy use and driving, additional to current policies, would be in the region of 8–9 $MtCO_2$ per year by 2020 (Lockwood, 2009).[11]
2. Another reason to be cautious about the view that PCT is likely to be redundant is that climate policy objectives and targets are not fixed but have evolved over time, especially in response to developments in climate science. For example, the UK's emissions target for 2050 has changed from a 60% reduction on 1990 levels to an 80% reduction in the 2009 Climate Change Act. Because of the inherent lag in the feeding of climate research into national and international policy-making processes, and the fact that the direction of travel appears to be towards impacts being greater than previously anticipated (e.g. Hansen, 2008), targets are more likely to increase than to decrease.
3. Finally, there is the poor record in predicting the impact of policies on actual emissions. There is an element of spurious precision in such predictions, and experience shows that early projections of the impacts of past carbon-reduction policies have sometimes been wrong, and can be overstated. For example, the expected impact on 2010 emissions from the 2000 Climate Change Programme was originally estimated to be a reduction of 76–86 $MtCO_2e$. By the time of the 2005 review of the Programme, which led to its revision and expansion, this projection had fallen to 63.4 $MtCO_2e$, implying an original overestimation of one-fifth or more (Environmental Audit Committee, 2007).

However, it is also the case that policy is constantly evolving. Mayer Hillman prefaced his original proposal for PCAs with a lengthy discussion of UK climate policy as it was in 2003–2004. As he notes, policy at that time contained many gaps and shortcomings, and it was clear, even then, that the 2010 target for reducing carbon emissions by 20% from 1990 levels would not be met.[12] Hillman concluded that 'radical changes in government priorities and policy are required to prevent serious climate change' (Hillman, 2004: 84). However, since that time, many policies have changed, and new ones have been introduced, partly in response to the fact that the existing policies were not working.[13] The failure of existing policies is not sufficient grounds for introducing PCT; instead it needs to be assessed relative to other new alternatives.

3. Efficiency

The clearest alternatives to PCT are an upstream trading scheme (with the cap applying to, and tradable permits auctioned to, original suppliers of fuels in the economy) or a carbon tax covering the activities that a PCT scheme would include. Both of these alternatives will create a price for carbon in the same way that PCT would and, under certain conditions, the price will be identical.

In discussing the choice between a carbon tax and cap-and-trade, the conventional approach is to cite a classic paper by Weitzman (1974), which establishes that, under uncertainty about the marginal costs of supplying a good (here carbon emissions reduction), using a price instrument (tax) is more efficient than a quantity instrument (cap) when the marginal benefit schedule is relatively flat compared with the marginal cost curve, and vice versa when the marginal benefit schedule is relatively steep.[14]

However, over time, it has become clear that aspects of the climate change problem make this framework less relevant than it may appear. The persistence of carbon dioxide in the atmosphere (and thus the time lag between emission and effect), together with the potentially catastrophic (i.e. non-marginal) impacts of high global temperatures (Weitzman, 2009), mean that it is effectively impossible to make judgements about the relative slopes of marginal cost and damage functions (Grubb, 2007).

In these circumstances, what is more important is the practical direction of policy. Here, while most countries have a mix of both carbon trading and tax, the general direction of travel is towards an expansion of trading.[15] The EU ETS is expanding its scope. In the UK, the instrument for reducing emissions in medium-sized organizations in both the public and private sectors is the Carbon Reduction Commitment (CRC). For these reasons, it makes most sense to compare PCT with an upstream trading scheme, and this comparison formed the basis of the Government's own recent assessment of PCT (Defra, 2008a, 2008b).

The potential additional benefit of an emissions trading scheme at the downstream, individual level, over that of an upstream trading scheme, depends on two factors. The first is how much additional emissions reduction a PCT scheme can deliver over an upstream scheme, within a specified time period and given a ceiling price in a soft price cap scheme (see discussion in the previous section). The second is the shadow price of carbon. Against the potential additional benefit must be placed the potential additional costs of running a PCT scheme, as compared with an upstream scheme.

In its 'pre-feasiblity' study, the Government produced an efficiency assessment using this approach, which was the first empirical attempt at estimating the potential benefits and costs of PCT, certainly in the UK (Defra, 2008b). The assumptions about prices, costs and quantities made in the Government study were subsequently reviewed by Lockwood (2009). The following sections draw on these studies.

3.1. The shadow price of carbon

In its assessment of PCT, the Government attributed a value to each tonne of avoided carbon emissions of £30, based on the shadow price of carbon (SPC) (Defra, 2008a). At the time of the study, the Government's approach to defining and setting the SPC was to equate it with the social cost of carbon – in other words, the damage caused to the global economy by emitting the marginal tonne of carbon. The actual value of the shadow cost of carbon was taken from the Stern Review (Stern, 2007), whose estimates were £29/tCO_2 in 2013, rising to £33/tCO_2 in 2020.

However, several academic peer reviewers of the Government's approach (Dietz, 2007; Ekins, 2007; Newbery, 2007) pointed to the large uncertainty surrounding estimates of the social cost of carbon, ranging from £0/tC to more than £1,000/tC (Downing et al., 2005) – an uncertainty of three orders of magnitude – and for this reason argued that a better basis for the SPC would be the marginal cost of abating carbon.

The Government accepted this critique (Price et al., 2008: 2), and in July 2009 the Department for Energy and Climate Change published a revised SPC, based on the marginal abatement cost approach (Department for Energy and Climate Change, 2009).

This approach to the shadow price of carbon implies that a PCT scheme will be efficient if the carbon price in the scheme is no higher than the shadow price. There is one further complication, however, which is that the new guidance on pricing carbon gives two short-term carbon prices up to 2020: one for activities covered by the EU ETS (the 'traded sector') at £25/tCO_2e with a range of £14–31, and one for those not covered by the ETS (the 'non-traded' sector) at £60/tCO_2e with a range of £30–90. Effectively, two different marginal abatement cost schedules have been assumed.

Most proposals for PCT would cover emissions from some activities already in the traded sector, or planned to be so (electricity generation and aviation), but the majority would be in the non-traded sector. This makes ascribing a single SPC to an evaluation of PCT difficult, and reflects the policy interaction problem (see above). A SPC weighted by the proportion of aviation and electricity emissions in total personal emissions for the UK would be a little under £50/tCO_2e.[16]

3.2. Additional potential impact of PCT

Both a PCT scheme and an upstream trading scheme would produce a price for carbon permits. In the case of an upstream scheme, the price would immediately be borne by upstream fuel producers and importers. However, the expectation is that these firms, and subsequent firms down the supply chain, would pass through the price, so that ultimately the individual customer would pay the same amount as in a PCT scheme (Defra, 2008a). This has largely been the case for the opportunity costs of carbon permits in electricity generation (Sijm et al., 2006).

There are no estimates of the price elasticity of the demand for carbon, so it is hard to anticipate what the pure price effects are likely to be. However, estimates of the price elasticity of demand for energy, which are sometimes used as a rough guide, range from –0.1 to –0.25 in the short run, and from –0.3 to –0.7 in the long run (Lockwood, 2009: 17–19). These ranges are relatively low compared with other goods and services, and are especially low in areas where there are limited alternatives, such as domestic electricity and gas use. In a soft price cap scheme (see above), low elasticities mean that the impact of a carbon price will be fairly limited.[17]

However, in addition to a pure price effect, a PCT scheme might be expected to have other kinds of impacts on behaviour. The Government's study focuses exclusively on the potential effect that PCT would have on the visibility of personal carbon emissions (Defra, 2008a: 33–35). Note that it may also be possible to increase the visibility of the carbon price generated within an upstream trading scheme, by mandating that it appears on invoices, as is the case with VAT. A review of the behavioural economics and social psychology literature suggests that PCT may have a wider range of effects (Capstick and Lewis, 2008; Lockwood, 2009). These include visibility – not just of carbon emissions, but also, especially in relation to an upstream trading scheme, of the carbon price itself. Such visibility may drive people towards greater abatement than just with a pure price effect, through mental accounting effects, endowment effects and the disruption of habits. However, it is unlikely that this measure would produce as powerful a visibility effect as would arise from a PCT scheme.

A second set of effects may arise from how a PCT scheme may affect motivation, through changing preferences by spreading norms about appropriate behaviour and through effects associated with perceptions of fairness and cooperation.[18] Evidence suggests that there is a general social preference for fairness (e.g. Fehr and Schmidt, 1999; Camerer and Loewenstein, 2003), and a personal carbon allocation would provide everyone with a very accessible indicator of what a fair level of emissions is.

At the same time, an important concept in behavioural economics is 'conditional cooperation' (e.g. Biel et al., 1999). By introducing a common constraint, PCT may successfully induce cooperation, in the form of individuals being more willing to reduce emissions.[19] This effect may be even stronger in the context of international agreement to act on climate change.

Such non-price behavioural effects may be particularly important for the challenge of reducing emissions in household energy use and driving. For example, the first report by the Committee on Climate Change identifies the main reason for the poor take-up of the available cost-effective abatement opportunities as the effect of 'subtle but extremely important barriers relating to information availability, awareness of energy costs and climate change concerns' (Committee on Climate Change, 2008: 225–226).[20]

A pilot of PCT cannot easily replicate all the conditions of a real scheme (Fawcett et al., 2007), meaning that it is difficult to produce direct evidence about the behavioural effects of PCT, above and beyond a pure price effect. The Government's approach was to focus on the potential effects of PCT on the visibility of emissions, citing evidence from a review (Darby, 2006) that suggested indirect feedback on energy use has reduced total use by 0–10%. This range is halved on the assumption that a part of the potential will be taken up by other forms of feedback, such as smart meters, giving a central estimate of a 2.5% reduction in energy (and emissions) (Defra, 2008a: 66).

An alternative approach, taken in Lockwood (2009) and Bird and Lockwood (2009) is to determine the amount of additional abatement that PCT would have to deliver to make the scheme cost-effective, given an SPC and an estimate of costs of running a scheme. This is discussed further in Section 3.4.

3.3. Administrative costs of PCT

Most economists would rule out a downstream trading scheme such as PCT *a priori* on the grounds that transaction costs would be far too large (e.g. Hepburn, 2006; Sorrell, 2007), and the size of the organizations involved in the CRC was limited precisely on such grounds. Indeed, it is self-evident that a scheme covering some 50 million adults is always going to have higher costs than a scheme covering a few hundred firms upstream. The question is how much higher those costs are likely to be.

Proponents of PCT typically give some attention to the practical feasibility of the approach but gloss over the issue of costs. Fleming states that 'TEQs are a hands-off scheme, with virtually all transactions being done electronically, using the technologies and systems already in place for direct debit systems and credit cards' (Fleming, 2005: 10). Hillman similarly argues that 'administration of carbon rationing should be simple' (Hillman, 2004: 128), assuming that existing banking transaction technologies can be used.

Starkey and Anderson (2005) look in more detail at the feasibility issues, coming to the conclusions that enrolment would be 'challenging but … feasible', and that the costs would be 'not insignificant' but less than those of other large government information technology projects (2005: 37).

The only detailed cost estimate to date is that carried out by Accenture and the Centre for Sustainable Energy as part of the Government's pre-feasibility study (Lane et al., 2008). This research finds that PCT is technically feasible, but suggests that the costs of setting up and running a PCT scheme are likely to be very high. The scale of the costs lies at the heart of the Government's view that PCT is not to be pursued further at this point. Lane et al. (2008: 31–33) conclude that set-up costs for a PCT scheme could range from £700 million to £2 billion, with annual running costs in the range of £1–2 billion. This compares with estimates of £50–100 million to set up an upstream trading scheme, and £50 million a year to run it.

As the study notes, 'the primary cost driver [of running costs] is the annual cost of operating an additional 50m current accounts for Carbon Credits' (Lane et al., 2008: 33), and this element represents 60–80% of the annual running costs, which in turn dominate the one-off set-up costs.

Thus it is *administration* that lies at the heart of the cost debate, rather than costs related to information and communications technology *per se*. The communications systems and most of the elements of the software that are likely to be needed for handling account set-up, transactions and trading are already in use in the banking system (see, for example, Roberts and Thumim, 2006).[21]

This makes the overall cost estimate quite sensitive to assumptions about the costs of administration of personal carbon accounts.[22] Lane et al. (2008) estimate the annual cost of maintaining a 'carbon credit account' (CCA) at £15–20 per annum, based on a figure for the costs of running a bank current account, adjusted for the fact that a CCA would not have an overdraft facility. Lockwood (2009), using a study of European current account fees (Oxera, 2006), argues that administrative costs could be somewhat lower, in the range of £10–15 per account per year.

A purely electronic platform for PCT, with no account administration, could bring the cost down significantly, although there would still be the need for the ongoing registration of new accounts and termination of old ones. But it is also clear that some support services would have to be offered if vulnerable individuals were to be protected. A proportion of the UK population still has limited financial literacy, and this would have an impact on PCT, implying the need for call centres and possibly even face-to-face support (Bird and Lockwood, 2009).

Lockwood (2009) also examines other assumptions made in Lane et al. (2008), such as the frequency of car refuelling and the level of security required in verifying individuals' identities as they enrol on the scheme (a major driver of the set-up costs), as well as the time costs of PCT to individuals assumed in Defra (2008a). Overall, in contrast with a central estimate of £2.6 billion per year from Lane et al. (2008), which amortizes set-up costs over 10 years, Lockwood (2009) produces a central estimate of £1.4 billion.

3.4. Assessments of efficiency

As noted above, the overall efficiency of PCT, relative to an alternative such as an upstream cap-and-trade scheme, depends on the value of emissions reduction, as given by the shadow price of carbon, the additional emissions reduction from PCT, and the additional administrative costs of running PCT.

This relationship can be shown graphically, as in Figure 1.[23] The vertical axis shows the SPC, and the horizontal axis shows the additional effects of a PCT scheme, expressed in percentage terms of expected emissions in 2013 (232.5 $MtCO_2$), but these effects can also be expressed as expected absolute abatement. Any point in the space defined by the two axes is the monetary value of a given amount of additional abatement at a given shadow price of carbon (SPC). Given that the SPC has now been defined in terms of the marginal abatement cost for a given abatement target rather than the social costs of carbon, this point can also be interpreted as the costs avoided through pursuing a PCT scheme, rather than an upstream scheme, that would otherwise be incurred through other policies. The additional administrative and time costs of running a PCT scheme, above and beyond the costs of running an upstream scheme, are shown in the curved lines on the graph, which denote the cost-effective boundary or break-even point for a scheme, for a given abatement cost and level of additional abatement.

Below the lines, the product of the SPC and the additional abatement from PCT, or avoided costs, is less than the estimated additional administrative costs. Above the lines, avoided costs are

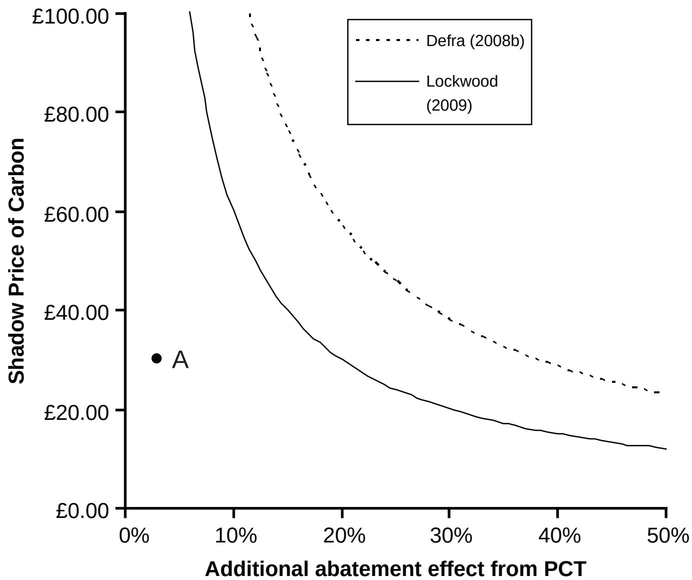

FIGURE 1 Cost effectiveness space for personal carbon trading.

greater than estimated administrative costs. Since the maintenance of a personal carbon account is the largest part of the administrative cost of the scheme, the administrative cost estimate has to be defined on a given number of accounts, which here we take to be 50 million, for illustration.

As described above, the Government's 2008 pre-feasibility study was based on a SPC of £30/tCO_2, while the central estimate of the additional effect of PCT by 2020, additional to a pure price effect, was 2.5% of projected 2013 carbon emissions, or around 6 $MtCO_2$. This implies a total additional benefit from PCT of around £180 million a year by 2020. This combination is represented by point A in Figure 1, which clearly lies well below the dotted line representing the Government's central estimate of the additional costs of running a PCT scheme, compared with running an upstream scheme. At £2.6 billion a year, this is almost 15 times the benefits (Defra, 2008a), and the effective cost of abatement would be in the region of £500/tCO_2. Thus at the heart of the Government's position is the view that PCT would be a very expensive way of inducing a relatively small amount of additional emissions reduction (Defra, 2008b).

Lockwood (2009), based on an alternative set of assumptions, comes to a somewhat (although not wholly) different view. The SPC, based on the marginal abatement cost is taken as £50–60/tCO_2e, and the central estimate of total administrative and time costs are in the region of £1.5 billion per year. As can be seen in Figure 1, this implies that for PCT to be cost-effective, the avoided costs from the additional abatement it induces, relative to the pure price effect of an upstream trading scheme, would have to be in the region of 10–12% of 2013 emissions, or around 25 $MtCO_2$ per year. If administrative costs are at the lower level of Lockwood's (2009) estimated range, additional PCT abatement would only have to be around 8% of 2013 emissions, whereas if costs are at the upper end of the range, abatement would have to be nearer 15% of 2013 emissions.

This gives an indication of the challenge facing the proponents of PCT. While the policy cannot easily be tested, to be reasonably cost-effective on even this amended set of estimates, its additional behavioural effects would have to be significant. This represents a considerable risk for any government considering the policy. The main way in which the risk could be reduced would be to cut scheme costs but, as argued above, there may be a limit to this if vulnerable participants are to receive appropriate support.

4. Equity

The argument that PCT is fair is a strong part of its appeal. While there is more than one interpretation of what is 'fair', the allocation of a right to pollute on an equal per capita basis seems to be a strong philosophical principle (Starkey and Anderson, 2005). In theory, other policies could have identical distributional effects: for example, if a carbon tax were applied at the same level as the equilibrium price in a PCT scheme, and the revenue from the tax were then redistributed on an equal per capita basis (Ekins and Dresner, 2004; Dresner, 2005). Redistributing auction revenue from an upstream scheme on a similar basis would also give the same outcome, if cost pass-through were 100%.

However, not only is PCT a more elegant and compelling approach from a distributional point of view, but the likelihood that taxes or auction revenues would in practice be redistributed in this way in the UK is very low.[24]

On the other hand, the basis for PCT's equity claim has been questioned, on two fronts. Firstly, Starkey (2008) has challenged the philosophical basis of the claim that equal per capita allocation is the fairest approach. Where an individual's initial situation means that they emit more carbon because of what Starkey calls 'brute luck' factors (such as living in a colder part of the country), fairness actually demands that person should receive an above average allocation. Amending allocations in a PCT scheme to reflect 'brute luck' factors might appear to undermine such a scheme, which is after all intended to influence decisions made by individuals. For instance, if carbon emissions became extremely expensive, people might decide to live in warmer parts of the country. Extra allocations for living in colder areas would provide a perverse incentive in this situation. While this may be true, there is still a good case for exploring *initial* allocations that reflect some factors that can be reasonably be construed as 'brute luck', since the decisions that people have taken about living in a particular part of the country are often long-term and irreversible, and so have the characteristics of 'brute luck' in the short term. This approach may also be needed to make PCT more politically attractive. It is striking that in deliberative workshops in which PCT is discussed by members of the public, the 'brute luck' principle is arrived at quite quickly, and it is also reflected in polling (Bird et al., 2008).

A second issue is that, while initial equal per capita allocations, pre-abatement, would be broadly progressive, the range of energy use (especially residential energy use), and hence emissions, within income deciles is larger than that within averages between deciles, at least in the UK (Ekins and Dresner, 2004). The implications for a PCT scheme were explored by an analysis by the Centre for Sustainable Energy as part of the Government's pre-feasibility study, using Expenditure and Food Survey (EFS) data (Centre for Sustainable Energy, 2008).

With an equal per capita allocation, 59% of all households and 71% of those in the lowest-three income deciles would have a surplus of allowances, without abatement. However, a significant proportion of low-income households would end up worse off – particularly those with particular characteristics that do not allow for immediate or easy emissions abatement, such as those with children, those not connected to the gas network, or those with no access to public transport in rural areas.

Thus both philosophical and empirical arguments against equal per capita allocation imply that a modified allocation arrangement might be both more progressive and be seen as 'fairer'.

In a recent study, again based on an EFS dataset, Thumim and White (2009) explored what the distributional impacts of a modified allocation of permits would be, and also how far any remaining adverse impact on poor households could be mitigated through the benefits system. Simple modified allocation rules were modelled, with a larger than average number of credits for households living in detached houses, those living in rural areas, households with children, households heated by oil, and pensioner households. In the scenario where these modifications are applied across all households, between 60% and 80% of households receive extra allowances, leaving a minority with lower allowances (by an average of 13%) than would be the case under an equal per capita allowance arrangement.

Not surprisingly, the resulting spread of allocations is 'fairer' in the sense that the impact of circumstances on a household's allocation is markedly lower. This is true not simply for the characteristics on which the modified rules are based, but also for other factors, such as the number of adults in the household and the type of tenure (owner occupier, tenant and so on).

However, these modifications do not make a lot of difference to how low-income households are affected in aggregate. Under an equal per capita allocation of allowances, 29% of households in the bottom-three income deciles are worse off. Under the modified rules, this rises to 30%. What the modified rules do is to create groups of winners and losers *within* low-income households.[25]

So, even with a modified allocation system that takes account of 'brute luck', a PCT system in the UK would create losers in low-income groups. A key question is therefore how far these households could be compensated. In practical terms, the benefits system would be the only feasible low-cost route of compensation.[26]

Broadly speaking, there is a trade-off between targeting and reach (and therefore the cost of compensation), according to whether the criteria for compensation is based on eligibility for means-tested benefits only, or whether eligibility for state pension is added (Thumim and White, 2009: 28–30). The former approach would target compensation better on low-income households, but leaves more low-income net losers uncompensated overall, around 1.1 million households. The latter approach leaves only about a quarter of a million net losers unreachable, but is less well-targeted and so is also more expensive. If the eligibility for compensation includes all households in receipt of means-tested benefits and/or state pension, then at carbon prices of £40/tCO_2 and £50/tCO_2, the cost of full compensation would be between £900 million and £1.12 billion a year, respectively (Thumim and White, 2009: 34).

A PCT scheme with modified allocation rules would probably be more feasible politically than a scheme with a simple equal per capita allocation rule, but would still present problems in practice. It would also be considerably more expensive to administer – especially in the set-up phase – as more verified information would be required to register people correctly, and allocations would have to be changed as circumstances changed. In this sense there is a clear trade-off between fairness and administrative cost.

5. Conclusions

As a pure principle, PCT does have many attractions, and its economic logic appears simple but strong. However, some of these positive attributes fall away when subjected to deeper analysis or considerations of practical application.

As with any other cap-and-trade scheme, its theoretical environmental effectiveness is, in practice, undermined by political risk and the virtual certainty of a soft price cap. As with any proposed new climate policy in the UK, it enters a crowded and fast-moving policy arena. In this sense, there may be more scope for PCT in other countries, which still have more policy space.

Probably the biggest challenge for PCT in practice is its transaction costs, which are likely to be large because of an irreducible core of administrative needs. These are also likely to be larger for a scheme which moves away from equal per capita allocations to some modifications based on individual circumstances – a policy design that is more likely to be seen as 'fairer'. The scale of possible costs involved, combined with the lack of any direct evidence on the likely non-price behavioural impact of PCT, makes it a risky policy for governments to adopt, above and beyond any reaction to a rationing concept, or to considerations of fairness.

These factors suggest that alternative policies for emissions produced by residential energy use and personal travel, such as carbon taxes, upstream trading schemes or indeed – in some cases – simple regulation, are far more likely to be adopted.

Notes

1. For example, Starkey and Anderson (2005), Dresner (2005), Seyfang et al. (2007), Starkey (2008).
2. Another important difference is that the PCA proposal is principally concerned with reducing carbon emissions, whereas TEQs have been promoted on the grounds that they fulfil a dual purpose, not only reducing emissions but also managing a decline in the availability of fossil fuels (especially oil and gas) (Lean Economy Connection, 2008).
3. A TEQ scheme would create a national market in tradable permits, and the marginal cost of abatement in the non-personal sector would effectively place a ceiling on the price of carbon in the personal sector. As described below, a real-world PCA scheme would almost certainly have a ceiling price imposed for political reasons: Defra (2008a) suggests a one-way valve to the EU ETS, for example. In this sense, the behaviour of the personal segment of the carbon market may be quite similar in both schemes.
4. Nectar is a voluntary reward scheme for consumers created on behalf of a consortium of UK retailers.
5. In the case of the EU ETS, with probably greater short-term demand-side elasticity, it was ultimately the fixed supply of permits that led to such an abrupt price collapse in 2006.
6. It should also be noted that these risks – and the presence of a safety valve – apply equally to an upstream trading scheme, although it is likely that the demand for carbon in such a scheme would be more elastic.
7. However, note that the EU ETS also allows some use of credits generated under the Clean Development Mechanism (CDM). There is considerable evidence that many of these credits do not represent additional reductions in emissions, above and beyond what would have happened without the CDM.
8. For example, the organization set up by David Fleming argues that the soft price cap approach is 'fundamentally in conflict with a core purpose of the [PCT] system' (Lean Economy Connection 2008: 12).
9. For example, while PCT would lead to the double carbon pricing of electricity, the current policy landscape applies a carbon price to electricity but not to domestic gas or petrol and diesel use. Seen in this context, a single PCT carbon price would initially raise the overall level of the price of carbon across electricity and other fuels, but would not change the underlying differentials between fuels. The eventual effect on relative carbon pricing would depend on differential responses to carbon pricing across electricity and other fuels. Note that if a PCT scheme did lead to a reduction in electricity use, this would put downward pressure on the EU ETS price.
10. It might be argued that there is a fourth reason, which is that once PCT is introduced, other policies could be removed. However, it is rare for climate policies (or indeed many other Government policies) to be removed, which is indeed the main reason why the policy landscape is so crowded.
11. If we adopt higher figures for the potential of behavioural change in residential energy use (see, e.g., Enviros, 2008), then this might increase to 15–20 $MtCO_2$ per year.
12. It is likely that the economic recession that started in 2008 will sharply reduce emissions. However, Hillman's point was that the target would not be met because of climate policies.

13. New and amended policies since 2004 include: a mandatory agreement to bring down average carbon emissions from new cars; an ambitious new renewable energy strategy that includes reforms to the Renewables Obligation and the introduction of a feed-in tariff and renewable heat incentive; a mandatory EU ETS, with declining caps now set out to 2020; hugely scaled-up energy-efficiency programmes for existing homes; and a proposed policy to refuse consent to new coal-fired power stations without carbon capture and storage. All these steps take up policy space that could potentially have been occupied by PCT.
14. See Hepburn (2006) for a recent discussion.
15. One practical factor pushing policy in the direction of trading is the difficulty of tax harmonization across countries (see Hepburn 2006 for a discussion), as the experience of Scandinavia in the 1990s showed.
16. Based on a proportion of 0.35 of personal carbon emissions from electricity and personal aviation (see Bird and Lockwood, 2009: 11)
17. For example, even a carbon price as high as £40/tCO_2 would mean an increase in domestic energy prices of around 20%, but an expected reduction in energy use and emissions of only around 7%, even in the long run. The expected impact on petrol and diesel use would be even less.
18. It should be noted that, strictly speaking, such a change in underlying preferences would make a comparative cost-benefit analysis between PCT and another scheme impossible (Nick Eyre, personal communication).
19. However, the literature seems to show that while voluntary kindness in games is rewarded, forced cooperation is not. This research is also mainly about games involving small numbers of people, rather than government-imposed rules. There is also a danger that imposing an incentive-based system – in this case, a carbon price that rewards abatement – 'crowds out' intrinsic motivations.
20. See also the reviews in Stern (2007), Retallack et al. (2007) and NERA Economic Consulting (2007).
21. Indeed, an experiment set up by the Royal Society for the encouragement of Arts, Manufactures and Commerce in 2007/2008, in which volunteers set up carbon accounts and had units deducted when buying road fuel from BP petrol stations, provided a real-life test of the relative ease and low cost of system and software costs for transactions. This project used the Nectar Card system (Michael King, Atos Origin, personal communication).
22. In the UK, it is in fact difficult – if not impossible – to identify the cost to a bank of running a current account in a straightforward way, because the costs of running the bank's infrastructure, including branches, call centres and IT system, are spread across the range of products and services it offers, including savings accounts, mortgages and insurances (see Competition Commission, 2007; Office of Fair Trading, 2008).
23. This representation, adopted by Defra (2008a), was first suggested by Josh Thumim of the Centre for Sustainable Energy.
24. Although it should be noted that in other countries with different fiscal traditions, such as France, Switzerland and the USA, where treasuries are not so implacably opposed to hypothecation, such 'cap and dividend' or 'carbon tax and dividend' approaches are being pursued.
25. Not surprisingly, the winners include low-income households with oil central heating, which in the EFS dataset includes all low-income households in Northern Ireland, and low-income single pensioners living in rural detached houses. However, younger, childless, urban, low-income households are less well off. Note that gas supply to households in Northern Ireland continues to expand, which would alter this picture in the future.
26. Resources for compensation would have to come from somewhere. One possible source could be revenue from the auctioning of non-personal permits to companies in an economy-wide scheme.

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