EXPLORING INNOVATIVE POLICY FRAMES FOR ACHIEVING BEHAVIOURAL CHANGE TO LOW CARBON TRANSPORT

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ABSTRACT

This paper considers innovative policies that could provide a policy framework to encourage the deep cuts in carbon emissions that will be required from the transport sector in the long run. The key measures considered are personal carbon trading and carbon taxes applied to personal travel and domestic energy consumption.

We bring together evidence from a small but growing number of studies of personal carbon trading in the UK and Sweden. Particular attention is given to an innovative research study undertaken by the authors in the UK in 2008 with 287 respondents in the South East of England and Cardiff, Wales. This study investigated both acceptability and behavioural change in response to a proposed personal carbon trading scheme or a carbon tax covering personal travel and domestic energy. Stated choice experiments were developed to explore preferences with respect to aspects of scheme design and their influence on acceptability. Whilst carbon footprint data was used as a basis from which to explore behavioural response to price and the different schemes with respect to both domestic energy consumption and transport.

Here we examine findings from this research and other studies that have explored acceptability and or behavioural change in response to personal carbon trading or carbon taxes. The paper aims to explore two issues: firstly, evidence on the factors that influence acceptability and secondly behavioural response.

To date the, albeit limited, evidence suggests that such policies could be designed to achieve public acceptability. Given the need to achieve very large reductions in carbon there is a

clear need to seriously consider such radical framing policies that provide a consistent message to individuals to achieve continued savings into the future.

Keywords: Personal carbon trading, carbon tax, acceptability, behavioural change.

INTRODUCTION

The evidence on the need to make very deep cuts in greenhouse gas emissions is now compelling (IPCC, 2007a; Stern 2009). The UK Government is committed to a cut in greenhouse gas emissions of 80% by 2050 as compared to 1990 levels under the 2008 Climate Change Act (UK Parliament). The Government has now committed to an interim target reduction of 34% by 2020 (Climate Change Act SI, 2009).

UK policy with respect to reducing emissions from transport, in common with that of other countries, is largely dependent on technological developments to both reduce the carbon intensity of transport fuels and improve the energy efficiency of vehicles. There is however, an increasing recognition both in the academic literature (for example, Hickman and Banister 2007; Bristow et al., 2008a; Stanley et al., 2009) and in recent policy documents (Climate Change Committee 2008 and 2009) of the need for additional behavioural change if stringent 80% reduction targets are to be approached.

There appears to be a disconnect, especially in the transport sector, between very ambitious policy targets for carbon reduction and policy reality. With target 80% reductions across the economy, transport cannot rely on other sectors to over-deliver. The current low carbon transport strategy (Department for Transport 2009a) should deliver a reduction of around 5% on 1990 levels by 2020 if all the elements are implemented and perform as anticipated. At present not all are firm and funded, and experience to date with, for example, moving to lower carbon cars suggests that progress is often slower than anticipated. Clearly the sector will significantly under-deliver relative to other sectors in the economy. This is partly because the transport sector is “difficult” and also because many measures, especially those relating to new technologies, are expensive and uncertain (Bristow et al., 2008a).

What could provide a consistent and sustained framework for carbon reduction into the future? There are a number of possibilities some limited to road transport including fuel duty and user charging schemes and others covering the whole transport sector or transport and domestic energy, including carbon taxes and personal carbon trading. Options are discussed briefly below – as are the policies in the major party 2010 election manifestos (given the recent general election in May in the UK).

Given variability in energy prices – especially oil – a carbon tax (or fuel tax) would not guarantee a consistent price signal. Unless the tax were automatically adjusted to iron out price fluctuations. Though clearly the price would still be higher than it would otherwise have been. The Conservative Party Manifesto (2010) stated that:

"We will consult on the introduction of a 'Fair Fuel Stabiliser'. This would cut fuel duty when oil prices rise, and vice versa. It would ensure families, businesses and the whole British economy are less exposed to volatile oil markets, and that there is a more stable environment for low carbon investment." Page 35 Conservative Party (2010)

This is a potentially interesting development – although it would only cover oil and not other energy sources.

A national road user charging system that is differentiated by location, time and vehicle type could provide part of an overall policy frame. The Liberal Democrat Manifesto (2010) favoured this type of strategy:

"Undertake preparations for the introduction of a system of road pricing in a second parliament. Any such system would be revenue neutral for motorists, with revenue from cars used to abolish Vehicle Excise Duty and reduce fuel duty, helping those in rural areas who have no alternatives to road travel" page 80 Liberal Democrat Party, 2010.

Whilst road user charging would largely target congestion it can also assist in carbon reduction. However, a revenue neutral system that also led to the abolition of VED and lower fuel duty would have negative carbon impacts. Fuel tax increases have been the most effective mechanism to date in the UK of reducing carbon in transport and the VED system now gives a very strong point of purchase signal. These measures would risk undermining some of the most effective measures in reducing carbon consumption in the transport sector.

A more radical approach was taken by the Green Party:

Reintroduce the fuel duty escalator, raising fuel duty by 8% per year. This will raise £2.2bn in 2010 rising to £10bn by 2013. In the longer run we would introduce a system of domestic carbon quotas. Page 16 Green Party 2010

The fuel duty escalator was demonstrably effective in reducing carbon emissions from transport in the UK from 1993 to 1999. The Green Party would also replace VED with a graduated purchase tax and introduce VAT and fuel duty in the aviation sector. The Green Party is the only party to place a form of personal carbon trading in their manifesto. All the major parties are committed to the 80% reduction in carbon emissions by 2050 (no relevant measures were identified in the Labour Party manifesto). The new coalition Government programme contains a reform of Air Passenger Duty and plans for HGV road user charging but doesn't explicitly address surface transport and carbon (HM, Government 2010).

A personal carbon trading scheme could provide a suitable framework. There has been considerable interest in the concept of Personal Carbon Trading (PCT) at Government level in the UK where the Department of the Environment, Food and Rural Affairs (defra) concluded in the light of pre-feasibility studies that the concept is "an idea currently ahead of its time in terms of its public acceptability and the technology to bring down the costs" and will not be developed further as potential policy at this stage (defra, 2008). However the

Environmental Audit Committee report on personal carbon trading, suggested that PCT could be "essential in helping to reduce our national carbon footprint" (House of Commons, 2008a) and recommended that research focuses on public and political acceptability.

Given the time frame over which adaptation is required it is certainly worth considering more innovative approaches such as personal carbon trading. This remains an under-researched area with respect to both the acceptability of such policy measures and behavioural response. The aim of this paper is to review the available evidence on the acceptability of PCT and Carbon Taxes (CT), and the likely behavioural response that could be generated by the application of these schemes. This review considers the limitations of the available studies and identifies the challenges for future research in this field.

The paper is structured as follows. The next section provides brief definitions of PCT and CT. This is followed by an examination of the available evidence on the acceptability of PCT and CT and what might influence the acceptability of such schemes. The evidence on potential behavioural change is then reviewed. The paper ends with conclusions on evidence to date and future research directions.

DEFINITIONS AND COST EFFECTIVENESS

Personal Carbon Trading (PCT) is a potentially powerful instrument with which to bring about reductions in carbon emissions in the areas of domestic energy consumption and personal transport. The key concept of a PCT is that it covers carbon emissions relating to personal transport and domestic energy consumption. Individuals receive an annual "carbon allowance" based on average emissions. The allowance reduces over time, in line with carbon reduction targets. Thus, those who have carbon emissions *above* the allowance would have to *buy* more permits and/or reduce their emissions and those with *below* allowance emissions would be able to *sell* their excess permits.

A Carbon Tax (CT), is a more familiar conceptual approach to achieving carbon reductions. A CT makes carbon intensive goods or services more expensive and therefore reduces the demand for them. In a basic form, all carbon consumption would be taxed (Crals and Vereek, 2005).

The theoretical case for permits over tax is summarised by Raux (2008). It depends on: the presence of a steep damage function, where the costs of error are high; relative sensitivity to price and quantity signals; heterogeneity amongst consumers; and the relative acceptability of different measures. It is therefore a highly suitable context in which to consider a trading system. Arguments in favour of CT focus on: the clarity of the price signal; the generation of revenue which may be recycled. Both PCT and CT allow individual choice as to where carbon reductions are made thus allowing people to choose their least cost path to carbon reduction.

A carbon tax would be relatively easy to administer within existing frameworks whereby domestic energy and transport fuels are taxed. The cost effectiveness of a PCT is more problematic and relies on uncertain cost estimates and uncertain estimates of the additional carbon savings that would result. Lockwood (2009) provides the most thorough analysis of these issues to date. He suggests that a scheme could become cost effective at a £60 value of carbon (which is the 2020 non-traded sector price for carbon, (DECC, 2009) if it produced additional savings of around 8% - that is savings over and above those that might be delivered by a tax. This is somewhat higher than the defra (2008) estimate that any additional savings might be in the range 0 to 5%.

ACCEPTABILITY OF PERSONAL CARBON TRADING AND CARBON TAXES

Here we are exploring the acceptability of measures to the general public. Table 1 summarises the small, but growing body of evidence from the UK on the acceptability of both personal carbon trading and carbon taxes. Many studies of PCT propose a carbon tax as an alternative approach. The survey approaches vary through the highly qualitative, focus groups and in-depth interviews through CAPI and pen and paper surveys to postal and internet surveys. Likewise the sample sizes and their representativeness also vary. The 12 studies[1] provide a useful snapshot of evidence from the period 2006 to 2009. It is worth noting that much of the work on acceptability (and indeed behavioural response) thus far has been undertaken by students or for Government Departments or policy research organisations[2].

Levels of support for PCT and CT are perhaps higher than might have been expected. Two small sample highly qualitative pieces of work with non-representative samples report very high levels of support (77% and 74 to 91%) and these results are likely to reflect the very specific populations surveyed. The poll reporting 61% support is not specifically of a PCT scheme but for reward/penalty for energy use. Excluding these studies the average support is 34% and the range 16 to 47%. This is a reasonable starting point from which to develop an acceptable policy. There appears to be no systematic effect of survey method on the results.

Six of the studies ask respondents for support for more than one policy, in most cases PCT and a CT (though also fuel price increases and forms of upstream trading). In all six cases PCT gains greater support than the alternatives.

In three cases respondents were asked repeat questions on acceptability, near the beginning of a survey and towards the end. Bird et al (2009) found that support for PCT fell, whilst for

[1] We note that at least two other small scale masters level student projects have addressed this area, Lowe, 2005 and Coombs et al 2008 – both referenced in Von Knobelsdorf (2008). However, it has not proved possible to locate these.
[2] To date no empirical work has appeared in refereed academic journals, though this situation is changing (Harwatt et al, forthcoming; Bristow et al, forthcoming).

TABLE 1 Evidence on Acceptability of PCT and Similar Schemes

Author & date	Survey type & sample size	Definition used	PCT results	Alternative measure: CT unless otherwise stated
YouGov, 2006a	National Poll of 1619	Every individual should be given a "personal carbon allowance" which they could either spend on carbon fuels and such like or else sell in whole or part to other people	25% Good idea 23% Bad idea 52% Not know enough	n/a
YouGov 2006b	National Poll of 2645	Would you support or oppose an initiative to financially penalize those using more than the average amount of energy per person and financially reward those using less than the average?	61% Support 22% Oppose 17% Don't know	n/a
Energy Saving Trust, 2007 and Dungate, 2009	1192 in-home household interviews	Willing to commit to a "carbon credit card" scheme with a set number of emissions to stick to and that required trading with people who had more credit so as not to go into the red	5% Yes, definitely 24% Maybe 28% Probably not 42% Definitely not 1% Not stated	n/a
Harwatt, 2008	60 in-home interviews (recruited through employers), Leeds	Detailed description of a scheme affecting petrol and diesel purchases for personal transport: Do you personally consider the Tradable Carbon Permit Scheme to be:	77% Acceptable 4% Neutral 19% Unacceptable	Fuel price increase: 49% Acceptable 12% Neutral 39% Unacceptable
Bird et al., 2009	1081 online opinion poll	Personal Carbon Trading. Each year every person in the country could be given the same number of "carbon credits" which they would have to spend when they bought petrol, diesel, electricity, coal, gas, heating oil or a flight to go on holiday. People who used more than there allocation would have to buy extra credits. People who used less than their allocation could sell any spare credits. People could increase their spare credits by saving energy in their homes installing insulation, choosing energy saving appliances, choosing cars that do not use a lot of fuel and by driving and flying less	Initial response 31% support 28%Neither/not sure 40% Oppose	 19% support 23% neither/don't know 58% oppose Limits on fuel and energy suppliers 23% support 35% neither/don't know 41% oppose
		Final response	25% support 33% neither/not sure 42% oppose	20% support 27% neither/don't know 53% oppose Limits on fuel and energy suppliers 24% support

				33% neither/don't know 44% oppose
Owen et al., 2008	92 in 12 focus groups, and post group questionnaire (Manchester, Birmingham, Nottingham, Surrey, N. London and Cheddar sample by environmental and socio-economic segment)	Questionnaire after a 2 hour focus group / workshop discussion. Basic description: Everyone is given an equal number of carbon credits from a national carbon budget which they would have to use to buy household energy (i.e. gas, oil or electricity), personal transport fuels like petrol or flights, to cover the amount of carbon that would be emitted. All adults would have to take part in the scheme. People would be able to buy or sell their credits through a carbon trading scheme. For example, those who used less carbon and so did not use up all their carbon credits would be able to sell them. Those who needed extra credits would be able to buy additional credits.	2% very positive 24% positive 18% neither 13% quite negative 41% very negative	1% very positive 12%positive 29% neither 24% quite negative 33% very negative Upstream trading 1% very positive 7% quite positive 24% neither 34% quite negative 34% very negative
Bristow et al., 2008b	79 Citizen Forum, Cardiff	10 minute explanation of PCT and a carbon tax on personal transport and domestic energy: would you vote for a PCT / CT	16% Yes 48% unsure/don't know 36% reject	8% Yes 28% unsure/don't know 64% no
		CT: If the money raised was spent in your preferred way would you vote for such a tax? PCT: if the Government introduced the version of PCT that you most liked would you vote for it?	31% yes 41% unsure/don't know 28% no	58% yes 16% unsure/don't know 26% no
Bristow et al., 2008b	208 CAPI survey, South East England	The purchase and use of energy that contributes to climate change, gas, electricity, petrol /diesel, coal / oil / wood would require you to provide carbon permits for that amount of energy. We are asking you to consider only your personal travel including commuting to a place of work but not business travel. Businesses would be subject to a similar scheme to encourage the reduction of emissions. All adults would be given an equal and free allowance of permits. Initially, in the first year this would be based on average carbon consumption. After that the allowance would gradually reduce to encourage reductions in carbon use.	43% accept 37% neutral 20% reject	22% accept 26% neutral 52% reject
		Repeat question at the end of the survey	43% accept 22% neutral 34% reject	35% accept 21% neutral 44% reject

		If the money raised was spent in your preferred way would the tax be acceptable to you?		55% yes 27% not sure 18% no
Von Knobelsdorff 2008	152 postal survey, Cambridge	Every individual receives the same share of emission rights for free. When they purchase fuel, oil or gas, they directly have to pay with some of these permits for the amount of emissions they cause. If someone uses less emissions rights, they can sell the surplus permits. For example this might be the case if they do not use the car every day. Someone who needs more emissions rights can buy them from the government or an agency. Would you support such a scheme?	8% yes very much 36% yes 43% mixed feelings 4% rather not 9% not at all	n/a
	165 on-line survey Cambridge, students		9% yes very much[3] 27% yes 47% mixed feelings 10% rather not 7% not at all	n/a
Howell 2008	35 focus groups (students, Oxford)	Pre- discussion (no detail of definitions)	31% Strongly like[4] 43% Like 0% Neutral 20% Dislike 6% Strongly dislike	0% Strongly like 51% Like 6% Neutral 34% Dislike 9% Strongly dislike
		Post discussion	37% Strongly like 54% Like 0% Neutral 3% Dislike 6% Strongly dislike	0% Strongly like 12% Like 14% Neutral 40% Dislike 34% Strongly dislike
Wallace 2009	317 (postal survey largely to existing respondents, Newark and Sherwood)	It has been suggested that everyone in the UK should be given an annual "carbon allowance" to allow them to buy units of household energy / power, vehicle fuel, and airline mileage. If a person does not use all their units, they could sell them to other people who need more units. What do you think of such proposals?	11% strong support 31% moderate support 21% no feelings 20% moderately opposed 17% strongly opposed	n/a
Capstick and	65 email survey	PCA domestic energy and transport: question after	41% support[5]	n/a

[3] Adapted from Figure 15, page 35 von Knobelsdorff.
[4] Adapted from Howell 2008

Lewis, 2009		completing behavioral response. The idea of a Personal Carbon Allowances scheme is that each year , every person in the country would be given the same number of "carbon credits" (their carbon allowance) which they would need to use whenever they bought petrol, diesel, electricity, gas coal, heating oil or a flight to go on holiday. (and brief explanation of buying and selling)	31% unsure 28% oppose	
Jagers et al., 2009	938 postal survey 2007. Sweden, national	PCA –(not specified in paper)	47% support	

[5] Capstick and Lewis use a 10 point scale from 1 strongly oppose to 10 strongly support. As there is no central point we have classified scores of 5 and 6 as uncertain or neutral.

CT there was a very small increase in support. Bristow et al (2008b) found no change in overall PCT support but an increase in support for CT. Howell (2008) identified an increase in support for PCT. Clearly, the "learning" process, the amount of information provided to respondents, and the nature of group discussion all appear to have an influence on the level of support for the different policies. However, again this influence is not systematic. Further investigation, is therefore needed to provide further evidence of the specific the features of a PCT that attract or repel support other things being equal (Bristow et al., forthcoming).

Evidence on stakeholder views seems to follow a similar pattern. Siveter's (2006) survey of eight stakeholders found higher levels of support for PCT than tax. Whilst Bird et al., (2009) interviewed 17 stakeholders and found broad support for PCT in theory but doubts about practicality and acceptability. In both studies a considerable number of stakeholders were drawn from environmentally active organisations.

The Bristow et al., (2008b) result for the Cardiff sample shows a considerable increase in support when the design reflects respondents preferences, with respect to PCT design and the use of revenues for CT. This issue is explored further in the next section.

Table 2 shows findings from four studies where respondents were asked which of two or three schemes they preferred. Here the results are mixed to say the least, with one in favour of PCT, two in favour of CT and one where the two are tied.

TABLE 2 Preferences between policies

Author & date	Survey type & sample size	Definition used	Choice
Bird et al., 2009	1081 online opinion poll	You have seen three different types of action to reduce carbon dioxide emissions. If one was going to be introduced, which one would you prefer?	27% PCT 15% CT 15% limits on fuel and energy suppliers 43% none of the above
Owen et al., 2008	92 in 12 focus groups, and post group questionnaire	Personal carbon trading, upstream trading and carbon tax: rank in order of preference: first choice	34% PCT 34% CT 11% upstream trading 15% refused
Bristow et al., 2008b	79 Citizens' forum, Cardiff	If the Government decided to introduce one of the proposals… which personally would you prefer to see?	20% PCT 56% CT 24% unsure/don't know
Jagers et al., 2009	938 postal survey Sweden	Prefer current carbon tax or a PCA	66% CT

WHAT MAKES PCT OR CT MORE ACCEPTABLE?

We will first consider examples of polls that obtain responses to tax increases or similar measures relating to personal transport and domestic energy use without specifying any particular use for the funds raised.

A YouGov (2008a) poll asked whether the automatic increase in petrol and diesel should take place, 8% of respondents supported this proposition whilst 50% said it should be reduced. The Omnibus survey carried out for the Department for Transport (2010) obtained 10% support for increasing the tax on petrol in 2009 (up slightly from 8% in 2008, but down on the 14% of 2006). Fuel duty was viewed as a stealth tax by 48% of respondents to a YouGov (2008b) and is the most disliked form of "stealth" tax. In an earlier poll for the taxpayers alliance (YouGov 2007) fuel duty was seen as an unfair tax by 60% of respondents. Fuel Duty is particularly controversial in the UK for a range of reasons including its historic hypothecated link to road investment; and the very high levels of duty. Nevertheless, increased parking charges are even less popular obtaining just 6% support in the Omnibus survey (DfT, 2010). Higher taxes on less environmentally friendly cars gained greater support at 37%. The defra tracker survey (Thornton, 2009) found 24% support for the statement "for the sake of the environment car users should pay higher taxes" – as this could be any form of tax it is not surprising that support falls between that found for increasing fuel taxes and increasing tax on less environmentally friendly cars. Greater support for a vehicle related tax is understandable as this is avoidable, even by car users, in a way that fuel duties are not.

Air travel was addressed in the Omnibus survey (DfT, 2010) as an increase in the cost of flying which was supported by 21% of respondents. A statement in the Defra tracker survey "people who fly should bear the cost of the environmental damage air travel causes" was supported by 44%. However, this was more a statement of principle and did not mention any increase in cost.

A poll for Ernst and Young (YouGov 2008c) asked respondents to agree/disagree with the statement "My home energy bill needs to rise to help combat climate change" gaining 4% agreement. Defra (2002) report a survey in 2001 that asked about potential government policies including the introduction of an energy/carbon tax on electricity and other fuels that damage the environment which achieved 53% support.

Table 3 provides evidence from polls and research studies where a question on support for a a tax proposal without indication of the use of the collected funds is followed by proposals with various destinations of the funds. With hypothecation the increase in support can be in excess of 20 percentage points especially where the revenues are recycled into environmental expenditures or tax reductions that make the effect broadly neutral. Levels of support in excess of 70% are not uncommon. Table 3 contains hypothetical proposals. There is less evidence on the acceptability of measures expressed through revealed preference referenda. Thalmann (2004) suggests that even with recycling three green tax proposals in Switzerland failed to achieve majority support.

TABLE 3: Green taxes and hypothecation

Source	Measure	Support	Oppose
Green Fiscal Commission, 2007, 1010 face to face interviews, national	Green taxes	51%	32%
	Revenues used on projects to reduce carbon dioxide emissions	73%	17%
	If other taxes were reduced at the same time	77%	9%
	Green tax on petrol revenues used to cut other taxes	48%	35%
	Green tax on flying, revenues used to cut other taxes	60%	20%
	Green tax on domestic energy	48%	35%
BBC World Service poll, 2007, 22,182 respondents in 21 countries	Support for higher taxes on the most harmful types of energy so that individuals/industry use less	50%	
	If tax revenue dedicated to clean/efficient energy	77%	
	If other taxes reduced so total tax bill stayed the same	75%	
BBC World Service poll, results for UK only	Support for higher taxes on the most harmful types of energy so that individuals/industry use less	54%	42%
	If tax revenue dedicated to clean/efficient energy	76%	
	If other taxes reduced so total tax bill stayed the same	77%	
Ipsos Mori 2006, 2050 in-home interviews, national	Doubling air passenger duty to reflect the environmental damage done by aircraft	50-52%	24-25%
	Tax on air travel (adds £20 to a return flight to Paris, £200 to Australia): revenues used to:		
	1. improve the environment	73%	9%
	2. education and health	58%	20%
	3. high speed rail	38%	31%
	4. cutting income tax	38%	32%

Bristow et al., (forthcoming) use stated choice experiments to systematically assess preferences for a range of design features for PCT including permit allocation, market arrangements for trading, permit life, purchase limits, the scope of the scheme, the transactions process, management of carbon accounts and permit price setting and for CT the use the revenue is put to. The findings suggest that design has a very large influence on acceptability of PCT. A key factor is the initial allocation of permits where the preference is for equal allocations but with extra permits for those with the greatest needs. The most attractive design combinations achieve acceptability approaching 80%. Whilst for CT support

rises to above 50% when the revenue is hypothecated in some way – with an exemption threshold the most popular preference.

EVIDENCE ON BEHAVIOURAL RESPONSE

Another important dimension of personal carbon trading schemes concerns their impact, at the individual level, on energy consumption, both for transport and domestic use.

In terms of their capacity to induce behavioural change, the arguments identified by the advocates of personal trading schemes consider economic and pollution-reduction efficiency as well as the psychology of individuals and their approach to environmental issues. The arguments generally firstly refer to the dichotomy upstream/downstream and, secondly, are developed to compare personal carbon trading schemes with more traditional carbon (or environmental) taxes, like the fuel taxes. The economic and pollution-reduction arguments help in assessing the effectiveness of downstream schemes over upstream ones and consider that at the individual level energy consumption reduction appears to be achievable more efficiently than at upstream level as the market mechanisms allow for the equalisation of the marginal abatement costs for the participants, as well as for a high degree of flexibility in the switch towards less polluting behaviour (Connor et al., 2008; Joskow et al., 1998).

Psychological arguments also support this view as individual-based downstream schemes are thought to be capable of increasing individual 'engagement' with emission reduction as they are seen to be as 'immediate' and a way to 'exercise responsibility' (Capstick and Lewis, 2008; Fleming, 1997; Starkey and Anderson, 2005), and transform carbon (and its corresponding monetary value) to a more visible resource that can be conserved, budgeted and managed (Capstick and Lewis, 2008). In terms of the dichotomy between PCT schemes and more traditional tax schemes, the former are perceived as more capable of generating higher emission reductions as they not only affect the price signals but also give individuals more choices as permits can be traded, destroyed (to stop others using them) or retained for future use (Wadud et al., 2008). Importantly, PCT schemes are also recognised to be a vehicle of 'feedback' and 'goal setting' to individuals. These processes are identified as having considerable potential to affect consumption in both domestic energy and transport (Abrahamse et al., 2007; Staats et al., 2004; Stepp et al., 2009). However, taxes may also be designed to involve targets and rewards. This might involve a target consumption level below which fuel and energy are not taxed as well as systems of rebates or rewards (this was the case, for example, of the electricity rationing system implemented in Brasil in 2001 discussed by Rocha Souza and Jorge Soares, 2007).

The arguments above, in particular those stemming from the environmental psychology literature could therefore provide support to the assertion the PCT schemes should be capable of generating greater reductions in CO_2 emissions at the individual level than a corresponding downstream taxation scheme levied on individual consumption. However, empirical evidence is so far limited. To our knowledge, only five studies have explored the behavioural impact of personal carbon trading schemes (or similar types of schemes). The first considered the impact of a trading scheme on transport emissions in comparison with an

equivalent increase in fuel price (Harwatt, 2008). Our study was the first to explore the potential behavioural impact, in terms of both personal transport and domestic energy usage, of personal carbon trading and carbon tax schemes (Bristow et al., 2008c; Zanni and Bristow, 2009). The impact in terms of transport and energy usage of trading scheme was subsequently analysed by Wallace (2009), while Capstick and Lewis (2009) and Parag et al (2009) compared the impact of carbon taxes, energy taxes and PCT. Finally, Howell (2009) discusses the behavioural effects of Carbon Rationing Action Groups (CRAGS), which are schemes very similar to PCT although they only consider voluntary participation (by individuals committed to carbon saving behaviour). Table 4 presents a comparative summary of these studies.

Table 4. Behavioural impact – existing evidence

Author & date	Survey type & sample size	Allocation type and scope	PCT results – average carbon footprint reduction	Alternative measure: CT unless otherwise stated
Harwatt, 2008.	60, in-home interviews	Free and equal allocation to all individuals - transport	Transport 7% - (2010) 23% - (2020) 25% - (2030)	Increase in fuel price 0.3% - (2010) 3% - (2020) 13% - (2030)
Zanni and Bristow, 2009.	198, hall interviews	Free and equal allocation to all individuals – transport and energy	Total - 16% Transport – 16% Energy – 16%	Total – 12% Transport – 11% Energy – 13%
Capstick and Lewis, 2009.	65, email survey	All individuals given an allocation of 80% of their current footprint – transport and energy	Total 18.8% (year 1) 22.1% (year 2)	[1]
Wallace, 2009.	334 postal survey and 21 personal interviews		[1]	[1]
Parag et al., 2009.	1,096 – n/a	n/a – transport and energy	[1]	[1]

[1] Only saving figures per single carbon saving actions are reported.

The considerable differences in terms of initial allocation (for example Capstick and Lewis set the initial allocation differently for each respondent at a level 20% lower than their initial carbon footprint), initial carbon footprint calculation (from the defra Act on CO_2 calculator to ad hoc software created by the authors), considered carbon saving actions and price levels make comparison across the different studies difficult. Generally, because of the novelty of the schemes, the existing studies are highly exploratory. Some, like Capstick and Lewis,

(2009) and Parag et al., (2009) are at the pilot-stage. The results discussed in this section should be therefore treated with caution.

Carbon saving actions across the existing studies differ not only in number (for example, Zanni and Bristow consider 19 carbon saving actions, while Parag et al (2009) consider only seven actions) but also in nature (Harwatt only considers personal transport choices while Wallace considers residential location choices like living closer to the workplace, and Parag et al 2009 discuss buying locally grown fruit and vegetables). Sample sizes also considerably vary, from 60 in the case of Harwatt (2008) to more than 1,000 (as for Parag et al, 2009) as well as the nature of the analysis performed on the collected data.

These differences make a comparison in terms of absolute savings (with respect to initial carbon footprint) very complex[6]. However, it can be observed that PCT scheme (or other similar scheme considering allocation and trading of carbon permits like CRAGs) seem to have a potential of generating saving of about 20% in carbon consumption. This is similar to findings in other hypothetical contexts. For example, Tight et al (2007) interviewed 35 households in-depth and asked them to work towards a 60% carbon reduction target in their transport activities in an environment supportive of behavioural change. Households were able to achieve an average saving of 21%, a similar finding to Lee-Gosselin (1989) in the transport context some 20 years earlier.

Some actual evidence on actual achievable carbon savings can be drawn from other studies. On domestic energy, for example, a recent experiment by British Gas and IPPR (Wainwright, 2008) suggests that with intensive support and free energy saving devices, families in eight streets in the UK achieved domestic energy savings of 8.56 to 29.32%, again suggesting a limit to short term behavioural savings even in presence of intensive support. In the case of CRAGS, whose mechanisms are very similar to those of a PCT, savings of about 30% were achieved by the volunteers across a number of cities in the UK (Howell, 2009 and www.carbonrationing.org.uk, accessed 25 May 2010). However this figure was calculated comparing initial and final carbon footprint figures of two slightly different samples. Nevertheless this evidence suggests perhaps a limit to what people feel able to achieve in transport in particular. This appears to be the case even for motivated volunteers in the CRAGs scheme for example. This has implications for policies intended to encourage behavioural shift.

Table 5 reports the results drawn by Zanni and Bristow 2009. First of all, the majority of respondents (80% in the case of Tax and 75% in the case of PCT) stated an intention to reduce their carbon footprint in response to the policy. Table 5 shows average savings of those who said they would change their behaviour of 16% for CT and 25% for PCT. If these figures are considered across the total sample we obtain savings of 12% and 16% for the two schemes, with end of experiment carbon footprint figures of 4.97 and 4.81 tonnes of CO_2 for the cases of CT and PCT, respectively. Savings for respondents who received PCT were higher for both transport and domestic energy usage cases. Overall, for the entire sample

[6] In addition not all of the studies report initial carbon footprint and carbon consumption figure after the application of the scheme

and irrespective of the schemes, home domestic energy saving were slightly higher than in personal transport (14.2% against 12.2%, however these two figures were not statistically different).

Table 5. Average savings and composition – N=198

`	Scheme	
	CT	PCT
Initial average carbon footprint	5.59	5.58
Reductions for respondents who saved		
In Transport use	0.59 (17.6)	0.91 (40.0)
In Energy in the home	0.61 (21.0)	0.71 (25.1)
Overall	0.84	1.26
Reduction for all sample		
In Transport use	0.26 (11.5)	0.36 (15.6)
In Energy in the home	0.38 (13.0)	0.44 (15.6)
Overall	0.62	0.80
Average new carbon footprint (all respondents)	4.97	4.81
Average % saving (those who made changes)	16.25	25.42
Average % saving for all respondents	12.03	16.02

Saving differentials between trading and taxation schemes are difficult to unveil. Our findings above shows that saving under a PCT scheme should be higher in magnitude than under a taxation scheme, similarly to Harwatt (2008), although she compared a transport only trading scheme with a generic increase in fuel price. However, Parag et al (2009) found no significant differences between the two schemes. Specifically, Harwatt (2008) reports sample reductions in CO_2 emissions of 11.4% under a tradable carbon permit scheme and 0.4% under fuel taxes This result is perhaps surprising as although the price incentive in both cases was small, it was higher under the fuel tax than for the tradable carbon permit. When asked about reductions in the future, out to 2030 with greater price incentives higher reductions were achieved, but these were still higher with the tradable permit than for the tax.

In terms of specific carbon saving actions most likely to be adopted, our study (Zanni and Bristow, 2009) showed that about two thirds of car users said they would reduce their mileage and adopt a more fuel efficient driving style. In the case of Harwatt (2008) transport emissions were reduced by up to 38%. Conversely, our study showed there was a resistance to reducing the number of flights (the same was observed by Wallace, 2009), especially long haul international ones. In terms of domestic energy usage, setting the thermostat at a lower temperature in winter was the most popular action, similarly to Parag et al (2009), while generally making the home more efficient was the most popular action found by Wallace (2009). In common with other examples in the literature not considering trading or tax schemes (Poortinga et al., 2003; Scarpa and Willis, 2010) a certain scepticism was observed for unfamiliar domestic energy saving technologies (in particular electricity generating devices like micro-wind turbine, solar panels, and ground source heat-pumps) requiring a considerable initial investment and uncertain pay-off period. Improved home insulation

appeared however to be more acceptable, in line with the findings of other recent studies (Banfi et al., 2008).

CONCLUSIONS

Overarching policies to create a framework within which adaptation may take place are likely to be required as we look to consistent reductions over time beyond this point. Facilitating measures will be required too that support innovation rather than replication of current travel patterns at lower carbon cost. The low carbon future has to be attractive.

There is increasing evidence that innovative approaches such as PCT or a CT with revenue recycling or rebates may be close to achieving acceptability and that good design that reflects peoples concerns and desires with respect to fairness in particular, could help to achieve majority acceptance. The same is true of carbon tax with some form of recycling. It is critical to remember that with a free allocation and a limit in the initial years that will be close to the current average – many people will gain financially from PCT.

There is very little evidence on the potential behavioural response to PCT and the critical question of whether this would be significantly greater than to an equivalent price signal alone. Simulating the functioning of such schemes for an adequate simulation of their effects is indeed complex, and existing studies are normally based on relatively small samples and highly exploratory. This has to be taken into consideration when discussing their results. Nevertheless it can be observed that PCT schemes seem to be capable of generating carbon emissions reduction figures of about 20%. There is as yet no clear evidence as to whether PCT could deliver higher reductions in emissions than other measures which gave a similar price signal. The amount of literature concentrating on this aspect is however increasing and it is likely that more empirical evidence will be available in the near future.

Empirical research in on both acceptability and behavioural response is still very limited. Key priorities for research into public acceptability include: further systematic exploration of preferences for PCT design with larger samples; examination of the role of framing and discussion in influencing acceptability and comparison with other policies. The challenge of future analysis of behavioural impact is likely to be the capability of considering a wide range of economic, environmental and psychological factors in the analysis of the relative performance of these schemes in the context of climate change. In particular, further work should be able to consider a dynamic rather than static setting and simulate trading between agents over a larger sample of individuals in order to further explore respondents understanding of the schemes and attitudes to policies and the environment and precisely test the functioning of personal carbon trading schemes and their impact on energy consumption.

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