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# Personal Carbon Trading and fuel price increases in the transport sector: an exploratory study of public response in the UK

**Helen Harwatt [1], Miles Tight [2*], Abigail L. Bristow [3], Astrid Gühnemann [2]**

[1] *Sustainability Research Institute, University of Leeds, Leeds, LS2 9JT, UK*
[2] *Institute for Transport Studies, University of Leeds, Leeds, LS2 9JT, UK*
[3] *Transport Studies Group, Department of Civil and Building Engineering, Loughborough University, Leicestershire, LE11 3TU, UK*

**Abstract**

Large reductions of greenhouse gas emissions are required in order to avoid the worst impacts of climate change. Road transport is a significant contributor to UK $CO_2$ emissions, with the majority arising from personal road transport. This paper analyses Personal Carbon Trading (PCT) as a potentially powerful climate change policy tool and presents findings from an exploratory survey of public opinion. A working model of a PCT scheme with a fixed carbon cap was designed to achieve a 60% reduction of $CO_2$ emissions from personal road transport by 2050. A proportion of the annual carbon budget would be given to individuals as a free carbon permit allocation. There is an opportunity to sell unused permits. Fuel price increases (FPI) were recognised as having the potential to achieve an identical emissions target at a much lower cost.

A series of individual interviews were conducted to explore opinions related to the impacts, effectiveness, fairness and acceptability of both measures. Bespoke software was used to record behavioural response. The findings indicate that certain design aspects of the PCT scheme led to it being preferred to the FPI and suggest that the potential behavioural response to PCT may be greater than for a FPI. However, given that the sample was small and biased towards the highly educated and those with above average incomes, the findings should be considered as preliminary indications. Further detailed research is required.

*Keywords:* Climate change; Transport; Personal Carbon Trading; Fuel price increases; Public opinions.

* Corresponding author: Miles Tight (m.r.tight@its.leeds.ac.uk)

## 1. Introduction

Climate change is an urgent issue rapidly reaching the top of the political agenda. Based on the evidence available, the IPCC (2007) conclude with high confidence that the contribution of greenhouse gas (GHG) emissions to global warming over the last three decades has had a significant influence on many physical and biological systems. Due to existing atmospheric concentrations, lifetime and quantity of release, Carbon Dioxide ($CO_2$) is classified as the most significant GHG (IPCC, 2007). In the UK, road transport alone currently accounts for 22% of $CO_2$ emissions, the majority resulting from personal use (DfT, 2009).

As a policy response to the challenges of climate change, the UK government set out aims in its 2003 Energy White Paper (DTI, 2003) to achieve a 60% reduction of $CO_2$ emissions by 2050. This target was revised based on recommendations from the Committee on Climate Change (CCC, 2008) which set out a series of carbon budgets designed to achieve an 80% reduction in UK carbon emissions by 2050. The UK Climate Change Act 2008 contains a legally binding 80% carbon reduction target to be achieved by 2050 (OPSI, 2008). In order to achieve such cuts, new policy instruments should be considered – particularly those which achieve the carbon reduction targets in a cost effective and acceptable way. Personal Carbon Trading (PCT), in which a total amount of transferable permits are issued to individual end users for the right to emit $CO_2$, has raised interest in research and policy domains as an instrument with potential to reduce GHG emissions (DEFRA, 2006; Roberts and Thumin, 2006). PCT has the potential to deliver substantial carbon reductions with a high degree of confidence. However, an important question to answer is whether PCT can achieve sufficient social acceptance in order to be politically feasible. To this end, the research presented in this paper was a first step towards exploring the behavioural response and public attitudes towards a PCT scheme designed to significantly reduce carbon emissions from personal land-based transport. A further aim was to contribute to the growing debate regarding the application of pricing or trading measures to achieve emissions reductions (Keay-Bright and Fawcett, 2005; Raux and Marlot, 2005). As a comparable instrument, a system of fuel price increases designed to achieve the same emissions target was also explored. The focus of the research reported in this paper is on public opinion as it is possible that this could highlight some key aspects for further investigation given the lack of in-depth empirical evidence regarding PCT. This paper provides initial empirical evidence from an explorative survey focusing on the behavioral response, impacts, fairness, perceived effectiveness and acceptability of both measures yielding a range of insights.

After providing background information on the policies in the following section, the policies designed for use in the surveys are outlined in Section 3. Section 4 details the survey methodology with survey results presented in section 5 with discussion in section 6. Based on these findings, section 7 summarises the main issues that appear crucial in terms of influencing public perception and provides recommendations for future research.

## 2. Policy background

Tradable Permit (TP) schemes are regulatory measures designed to achieve environmental targets at the lowest possible social costs. They have the potential to achieve targets set under traditional 'command and control' measures but at much lower economic costs (Verhoef et al., 1997) as pollution credits can be transferred amongst those who are better equipped to make the desired changes (a reduction in emissions produced) and those for whom the market prices are more economically feasible than abatement technology at that time. TP schemes therefore provide flexibility in meeting emissions targets, as those who pollute over their assigned amount of permits are able to purchase additional permits from those who pollute below their threshold and subsequently have excess permits.

In a typical TP scheme, a target would be set (for example, an emissions reduction target), and the purpose of the scheme and the geographic area to be covered would be clearly defined. By distributing a certain amount of permits, the regulatory body is then able to control levels of pollution in line with the overall target, a process referred to as 'cap and trade' (Crals et al., 2003). Those affected by the system would then have to acquire tradable pollution permits equal to an amount of pollution which could then be emitted. The amount of permits available would then be gradually reduced until the target is reached.

To date, TP schemes have been applied to stationary emissions sources with the first scheme (the US Emissions Trading Programme) beginning in the US during the mid 1970's with the aim of adding flexibility to stationary sources in meeting the air quality standards required by the Clean Air Act 1975 (Tietenberg, 1985). More recently, phase I of the European Emissions Trading Scheme (EU ETS) was introduced across Europe in 2005, with phase II beginning in 2008, coinciding with the first Kyoto Protocol commitment period. The scheme was designed to "promote reductions of greenhouse gas emissions in a cost-effective and economically efficient manner" (DIRECTIVE 2003/87/EC) and to therefore contribute to achieving Europe's commitment to the Kyoto Protocol, a GHG emissions reduction of 8% below 1990 levels between 2008-12 (UNFCCC, 1992). The post-2012 agreement is at least a 20% reduction below 1990 levels by 2020. Currently the scheme includes high emitting industries, such as cement and steel, and power stations from the 15 countries that made up the EU before the expansion to 25 countries in 2004. The Commission states that limiting GHG emissions from aviation will form an essential contribution to the post-2012 commitment and in January 2009 published a directive to include air transport in the EU ETS (2008/101/EC). This will cover emissions from flights within the EU from all flights to and from EU airports from 2012. There is also a growing interest in the use of TP schemes to reduce emissions from land-based motor vehicles (Raux, 2002; 2004; 2005; SEPA, 2006; Grayling et al., 2006). The UK government have explored the prospect of including road transport in the EU ETS, concluding that the earliest possible date would be during phase III in 2013 (DfT, 2007). In addition, the Commission for Integrated Transport (CfIT) published a piece of research exploring the design of a TP scheme suitable for surface transport (Watters and Tight, 2007).

To regulate emissions from individuals, a TP scheme could either be implemented upstream i.e. amongst fuel producers, or downstream i.e. amongst individual consumers. In an upstream scheme, individuals receive the incentive to reduce consumption solely through a price signal. The final distributional impacts of an upstream TP would

ultimately be determined by the use of any surplus revenues. A downstream scheme offers individuals a free permit allocation, therefore for those consuming below the initial allocation there would be a financial benefit. Alternatively it allows an amount of fuel to be purchased without any additional cost (while using the free permit allocation). The downstream TP approach might therefore attain greater levels of public support compared to a TP system based upstream amongst fuel producers or a FPI. However, a downstream TP scheme is likely to have higher implementation costs, given the large number of potential traders and the level of monitoring required, although it is possible that such costs can be largely, if not fully, offset by selling a proportion of the annual carbon budget.

In terms of suggested mechanisms for PCT, there are two main approaches within the literature: Domestic Tradable Quotas (DTQs) and Personal Carbon Allowances (PCAs). DTQs were originally developed by David Fleming in 1996 based on the concept of contraction and convergence, proposed by the Global Commons Institute in 1990 (Meyer, 2000). They are designed to achieve a significant reduction in $CO_2$ emissions from domestic sources, including household energy and transportation (DTQs are also known as Tradable Energy Quotas (Fleming, 2007)). PCAs were proposed by Hillman and Fawcett (2004) and further developed by Fawcett (2005), also with the aim of significantly reducing carbon emissions in the UK. Also based on the principle of contraction and convergence, the PCA scheme uses a very similar structure to the DTQs scheme. A fundamental difference is the scope of the scheme as PCAs regulate emissions arising from personal energy use only, whereas DTQs cover all national emissions sources, thus organisations and individuals. Both schemes would be implemented at a national level with an annual limit placed upon the amount of carbon emitted from energy use. This 'carbon budget' could then be reduced each year in order to achieve the overall emissions target. All fuels would be assigned a carbon rating, corresponding to the quantity of carbon emitted on combustion per unit of fuel and by the generation of a unit of electricity. As, at the time, roughly 40% of energy consumption in the UK was for domestic purposes, it was concluded that for the DTQs scheme 40% of the annual carbon budget would be allocated free of charge to adults on an equal per capita basis, and the remainder auctioned to organisations. An equal per capita allocation of PCAs may be justified in terms of equity, where everyone is provided with equal rights to pollute. Dresner and Ekins (2004) note the potential of DTQs to be a more equitable measure compared to carbon taxes, due to the per capita permit allocation. Fawcett (2005) suggests that government subsidies for energy efficiency and/or renewable energy measures could be an appropriate way of addressing problems for groups adversely affected by a PCA scheme rather than allocating additional permits because the latter results in a reduced ration available for everyone else. The PCAs include a smaller allocation for children.

A computer data base would contain a carbon account for each individual and all transactions would be recorded. Each person would have an electronic swipe card which would have to be used, for example, when purchasing petrol. Research has revealed that such a database is feasible using existing technology and could be linked to all fuelling stations in real-time, therefore allowing instant trading of carbon units. The carbon unit account could form part of a national identity card scheme, should this be introduced (Starkey and Anderson, 2005). Both schemes would include personal land-based transport.

Within the literature there are several suggestions for TP schemes to reduce fuel used for personal transport amongst individual consumers. For example, Keppens and Vereeck (2003) outline a system of Tradable Fuel Permits (TFP), while Raux and Marlot (2005) describe how a system of decentralised transferable permits could be used to reduce fuel consumed for transport, using the case of France as an example for potential application and Wadud et al (2008) examined the implications of a tradable carbon permit scheme for personal road transport in the USA.

Public acceptance of policies such as PCT is a fundamental consideration when deciding whether a policy will become operational (Whittles, 2003; Schade and Schlag, 2003; Jones, 1995; 2003). Several key determinants of acceptability of road pricing measures (defined as any measure that could impose additional costs on motorists) identified from the literature include fairness, policy effectiveness (ability to achieve its aim) and benefits received as a result of implementation (Rietveld and Verhoef, 1998; Viegas, 2001; Jakobsson et al., 2000; Fujji et al., 2004; Erikson, 2006; Bonsall et al; 2007; Schade and Schlag, 2003; Rienstra et al., 1999; Jones, 2003; Whittles, 2003; Jaensirisak et al., 2003; Eriksson et al., 2006). Issues relating to infringement of freedom and exclusion from activities are common objections to pricing measures. It is possible that such issues will also be applicable to the acceptance of a PCT scheme for land-based personal transport.

Raux (2002) anticipates that rationing the right to freedom of movement would be one of the main public objections to the introduction of a PCT scheme in the transport sector. Inequities within society already exist due to an unequal distribution of resources, but it is possible that a PCT scheme could be designed in a way that avoids exacerbating these inequities and potentially reduces them on the basis that each person would receive an equal amount of permits free of charge and therefore avoid a price increase whilst consuming within this free allocation. A per-capita subsidy could be introduced in a pricing scheme, although this could potentially somewhat negate the simplicity advantages compared to a PCT scheme.

Fuel price increases (FPI) could potentially be an alternative approach to PCT. The fundamental differences between fuel price increases and PCT is that the former would not have a national limit on carbon consumption (physical cap). A FPI method would benefit from the relatively low implementation, monitoring and transaction costs, thus in theory achieving the emissions target at a much lower cost, and hence being more economically efficient. The ability to create large sums of public revenue could be a further benefit of fuel tax. Potential inequities resulting from tax increases (see e.g. Wadud et al., 2010) could be largely offset by revenue redistribution and the scheme could be made more attractive to the public by hypothecating revenue into supportive measures, such as public transport improvements. These would provide alternatives for those with the lowest willingness to pay for fuel. Given the potential merits of a FPI, it was included as a comparative measure.

## 3. Survey methodology: Policy design

In order to explore public response to a personal carbon trading scheme, it was first necessary to design a scheme in sufficient detail for such a purpose. This section outlines the Tradable Carbon Permit (TCP) scheme developed in this research. The fuel

price increase (FPI) is also described, however as fuel price increases are a far more familiar instrument, the focus here is on the design of the TCP scheme. Both policies were designed to be as realistic as possible and hence to serve as policy scenarios in order to measure public response, thus the policy outlines do not intend to fully explore all related technical and implementation issues. Here it is assumed that the transport sector takes an equal share of the reduction commitment, therefore both measures are designed to deliver a reduction in carbon emissions of 60% by 2050. A 2006 date for scheme implementation was used for consistency with the start date used in the surveys (see section 4) and to allow the use of actual data rather than a forecast starting point.

### *3.1 The TCP scheme*

The main features of the scheme including estimated financial costs and permit prices are outlined in the following sections.

#### *3.1.1 Achieving the emissions target*

The emissions target would be achieved by placing an absolute physical limit on the amount of carbon available for road transport (converted into the fuel equivalent) each year, thus creating a carbon budget which would be gradually reduced by 1.34% each year from 1997 levels, for example by 2.68% in 2007; and 4.02% in 2008, 5.36% in 2009 and so on until 2050. The gradual and known reduction in carbon availability allows society to steadily adjust. As the reductions become greater, dependency on carbon consuming modes could be reduced as alternatives, such as more fuel efficient or alternatively fuelled vehicles, became available. There might also be reductions in the need to travel by car if the provision of shops and services become more localised.

#### *3.1.2 Use and distribution of carbon permits*

Each year, half of the annual carbon budget would be allocated to individuals free of charge, with each UK citizen aged 17 and over receiving an equal allocation. The allocation method is likely to encourage individuals to reduce their carbon consumption in order to benefit from selling excess permits, thus providing monetary gains to those who change their behavior and to those who are already low carbon consumers. Permits would be traded in a central permit market, requiring a real time database with secure trading facilities. Access points could include fuel stations, post offices and the internet. Current information technology is considered adequately sophisticated to enable the administration of such a scheme (Grayling et al., 2006; Starkey and Anderson, 2005). In order to cover operating costs, replace lost fuel tax revenue, and provide investment for public transport improvements, the remaining 50% of the annual carbon budget would be sold through the central permit market by the government. Any surplus permit revenue would be invested into the provision of supportive measures, such as local amenities and services, telecommunication networks, cycle lanes and footpaths which would reduce the need to travel and would be particularly important in order to counter the potentially regressive impacts of the TCP scheme.

The TCP scheme would work on the basis that carbon permits are required in order to purchase fuel for land based personal transportation modes (e.g., car, motorcycle). Each person would have an individual carbon account with an electronic swipe card that must

be used when purchasing fuel, and selling or buying permits. In order to reduce the possibility of carbon shortages, the permits for sale would be released gradually throughout the year, for example an equal amount released at each 3-month interval. In addition, there would be a limit on the amount of permits each carbon account could contain at any one point in time. This would reduce the potential to stockpile and thus distort permit availability. Carbon permits would not be required for public transport journeys thus providing an incentive to use such modes. Public transport would be covered by a separate trading scheme applying to public transport operators which would commence 5 years after the introduction of the individual permit scheme in order to allow operators some adjustment time.

Each person would be able to access their account details in real time as all information would be stored on a national electronic database. Research suggests that a database could be based on current technology (Starkey and Anderson, 2005). Carbon accounts could be included in a national identity card scheme[1] , as this would greatly reduce the implementation costs, in addition to providing extra security and therefore reducing the potential of fraudulent permit cards, hence the following section assumes the carbon accounts would be contained within individual identity cards.

### *3.1.3 Estimated financial costs*

The TCP scheme has been designed to be self-funding with respect to operating costs and forgone revenues, see table 1.

Table 1: Estimated financial costs of TCP scheme: £m 2006 and 2007.

| | *2006* | *2007* |
|---|---|---|
| Lost fuel tax revenue | 231.2 | 462.5 |
| Operating costs | 175.1 | 175.1 |
| Scanning equipment | 40.5 | - |
| Information campaign | 8.3 | - |
| Public transport investment | 139.0 | 139.0 |
| Total costs | 594.1 | 776.5 |

As the carbon budget is reduced, the amount of lost fuel tax revenue would increase each year, necessitating an annual increase in permit price. The amount of permit revenue required each year was estimated using the fuel taxation revenue in 2003 (£17,259 million) and the annual reductions in carbon availability. For example, in 2006 fuel sales would be reduced by 1.34%, resulting in a loss of £231.2 million. This loss would increase each year in line with the annual carbon reductions.

The operating costs are based on those of the UK Driver and Vehicle Licensing Agency, which was considered to be the closest in terms of the similarities in administration requirements and the monitoring of a national database. The estimated cost of scanning equipment would provide a chip and pin machine in each fuel station and post office outlet in the UK. These costs could be reduced if existing machines were adjusted to read the carbon cards. The cost of an advertising campaign conducted by the UK government 'preparing for emergencies' was adopted as the requirements (e.g., TV

[1] The new Coalition Government has announced that the planned UK identity card scheme will be scrapped (HM Government, 2010).

and radio advertisement, leaflets, website and national coverage) were very similar. The annual investment in public transport was derived from the estimated displacement of car journeys onto public transport. The amount of local government expenditure per annum was then used as a guide to estimate the revenue required. For example, if a corresponding reduction of 1.34% is assumed for car passenger kilometres, the displaced kilometres can then be added to public transport kilometres (it is unknown exactly how many car journeys would be displaced) as such: 1.34% of 678 billion passenger kilometres (DfT, 2006a) = 9.0852, causing a 9.46% increase in public transport km (9.0852 = 9.46% of 96 billion public transport passenger km). At the time when the PCT scheme was designed, local government expenditure on public transport was £1462 million (DfT, 2006a), resulting in the addition of £139 million from permit revenue (9.46% of £1462m = £139m). This estimate does not consider the potential changes in operators costs and revenues.

### *3.1.4 Free allocation of carbon permits and estimated permit price*

Given that the fundamental requirement of the permit sales would be to cover the costs of the TCP scheme, the total annual cost of the TCP scheme (including the replacement of fuel tax revenue) was divided by the annual carbon budget, giving a price per kilogram of carbon. As the study focuses on personal land based transport, the carbon emissions from these modes have been used to calculate the initial carbon budget of 26,165 million kilograms carbon[2]. Thus, for example, in 2006 the total costs were £594.1 million and the annual carbon budget was 26,165 million kilograms, hence £594.1 million/26,165 million gives a permit price of £0.02 per kilogram carbon. It was assumed that half of the annual carbon budget would be allocated free of charge to individuals, the annual costs of the TCP scheme are therefore recouped from the sale of the remaining half of the carbon budget giving an initial price per kilogram of £0.04. For simplicity, a fixed permit price is assumed for each year based on the revenue requirements.

To derive the annual free allocation of carbon permits, the annual carbon budget related to personal transport use (i.e. subtracting the proportion relating to bus and rail) was divided by 2 (to represent the half that would be given free of charge), then divided by the number of adults in the UK aged 17 and over (46, 161, 981 – ONS, 2001). This provided a free carbon allocation per person for each year of the scheme. For example, 11,351 million kilograms/46, 161, 981 equates to 245 kilograms for each person aged 17 and over in 2005. No allowance was given to those aged below 17 years. To obtain the monetary value of the free weekly carbon allocation, the annual allocation was divided by 52 e.g., 245/52 = 4.7 kilograms/week. This was then multiplied by the value of the permits per kilogram, for example 4.7 x £0.04 = £0.18 per week in 2005.

### *3.2 The fuel price increase (FPI)*

The emissions target would be achieved by gradually increasing the price of fuel to the level required according to the fuel price elasticity used. Using current fuel prices, a short-range conventional elasticity of fuel demand of -0.25 (Glaister and Graham,

[2] 68% of 39,000 million Kg carbon = 26, 520 million Kg carbon. This amount would be reduced by 1.34% to provide the initial carbon budget: 26, 520 – 1.34% = 26, 165 million Kg carbon.

2000), was applied for the first five years, and then graduated up by -0.05 per year until -0.7 was reached. This elasticity was then applied thereafter up to 2050. It is recognised that this method has limitations as the long-term response is unlikely to remain the same each year over such a long time period.

The FPI would provide revenue for an annual investment in public transport, an information campaign and also cover annual monitoring costs (regular monitoring of fuel sales would be required, which could result in the adjustment of fuel prices if they were not having the desired effect on consumption and/or in response to oil price fluctuations). Surplus revenue would be invested into the provision of supportive measures, such as localisation of amenities and improved paths and cycle lanes. As for the TCP scheme, it is recognised that such investment would be particularly important where regressive impacts are most apparent, for example for car dependent households in rural areas.

## 4. Survey methodology: interview design and implementation

For the purpose of this research, face to face interviews with individuals were considered the most appropriate method given the public's (then) unfamiliarity with the concept of personal carbon trading. The survey was designed to be explorative, hence a range of open and closed questions were used following a formal structure which ensured that all respondents had considered each of the aspects included in the survey. At this stage of research on the issue of PCT it was decided that a qualitative approach would be most suitable in order to collect detailed information.

A total of 60 people were interviewed between February and May 2006 with each interview lasting around 1.5 hours. It was recognised that a small sample would not be representative of the UK population, therefore the employed population were selected as the focus for the study given that they tend to do the most travel (DfT, 2006b), and could therefore be affected by the policies to a larger extent. Staff members from two of the largest employers in Leeds - the University of Leeds and Leeds City Council, were recruited via an email that provided a brief explanation of the study, details of participation and offered a small monetary reward on completion of the survey. In order to avoid over representation of particular groups, such as car users, males/females, and urban dwellers, a screening questionnaire was completed by all interested parties. Respondents then completed and returned a 7-day travel diary, at which point an interview was arranged.

### *4.1 Interview procedure*

The interviews were designed to explore respondents' views and opinions without any discussion with the interviewer i.e. the interviews were not designed to be an interactive discussion/debate as it was considered desirable to obtain uninfluenced responses. The interview was arranged into three sections, each having a different topic and purpose. The first section was designed to provide a measure of environmental concern, problem perception, and knowledge of transport issues as these personal attitudes were considered to be an important factor in terms of acceptability ratings (Fujji et al., 2004). Section 2 began with an explanation of either the TCP scheme or FPI (the order of

presentation was alternated between respondents in order to reduce bias). The explanation consisted of the scheme aims, how it would work and what the revenues would be used for. The relative benefits of each scheme were not presented as the intention was to measure respondents' uninformed thoughts on such issues. Respondents were given an opportunity to seek clarification on any aspect of the scheme, followed by questions regarding the behavioural response. An existing computer based tool which calculated and displayed current weekly carbon consumption (calculated previously from the travel diary) and estimated weekly fuel expenditure (Tight et al., 2008) was adapted and used here. This provided two interfaces, one relating to the TCP scheme, the other relating to the FPI. The software calculated and displayed the free allocation of carbon permits at three points in time: 2010, 2020 and 2030. In 2010, the free permit allocation equated to 4.4 kilograms of carbon per person per week, decreasing to 3.8 kilograms of carbon per person per week in 2020 and 3.1 kilograms of carbon per person per week in 2030. Carbon consumption (defaulted to current consumption) was displayed alongside each permit allocation, together with the total estimated price of fuel and permits. The use of these screen displays helped to raise respondents' awareness in terms of the possible implications of the policies on their personal lifestyles. Table 2 shows the prices used in the software to calculate estimated spending in each time period. It should be noted that respondents were not shown the prices in this form – only in terms of their total estimated spending per week.

Table 2: Fuel price (pence) and % increase from base[3] in each time period for the TCP scheme and FPI.

| *Year* | *Fuel price/litre TCP scheme* | *Fuel price/litre FPI* | *% increase TCP scheme* | *% increase FPI* |
|---|---|---|---|---|
| *2010* | *88.2* | *90.7* | *3.8* | *6.7* |
| *2020* | *96.7* | *106.8* | *13.8* | *25.6* |
| *2030* | *115.2* | *137.4* | *35.5* | *61.6* |

For the TCP scheme the estimated costs included spending on permits above the free allocation (price per kilogram of carbon based on estimated annual financial costs of the scheme and the amount of carbon available to sell from the annual carbon budget – see section 3.1). For the FPI the estimated costs included the increase in fuel price necessary to achieve the desired reduction in fuel consumption (derived by applying conventional elasticities of fuel demand to current fuel prices – see section 3.2). Respondents were asked how they would respond if the TCP scheme was introduced, and whether they would try to consume within their free allocation or buy extra permits as required if they were available. It was explained to respondents that there would be a limited availability of permits at the national level and therefore no guarantee that permits could be bought in addition to the free permit allocation due to potential carbon shortages on the market. They were informed that the prices displayed were based on minimum fixed permit prices which could increase due to the impacts of demand and availability. There was then an opportunity to alter individual journeys according to what respondents considered to be feasible, for example cycling to work rather than using a car (responses

[3] Base fuel price = 85 pence per litre for both the TCP scheme and FPI.

were unprompted). The changes were made within the software and the carbon consumption was recalculated and displayed alongside the corresponding time period.

When discussing the FPI, respondents were asked if they would make any changes to their current travel behaviour as a result of the increased fuel costs and changes were made where they were considered to be feasible in each time period. For both policies, respondents were asked to assume that their current circumstances, for example in terms of age and income, would remain the same in each time period. They were told the prices derived by the software did not include inflation or fluctuating oil prices.

After respondents had considered their behavioural response, a series of questions regarding the impacts on lifestyle, costs and benefits, fairness, effectiveness and acceptability followed for example in the form of 'how acceptable do you personally consider the fuel price increase to be?'. In addition to providing a qualitative answer, respondents were also asked to quantify their response to most questions on a Likert 7-point scale. To obtain comparable responses, the final section of the interview repeated the previous section for the policy not yet discussed (i.e. either the TCP scheme or FPI). The policies were discussed separately and respondents were not asked to compare their responses given in sections 2 and 3 of the interview. It should also be noted that the software and related price impacts were also presented and discussed separately in relation to each policy. A time period of around 40 minutes elapsed before respondents were introduced to the software for the second policy in section 3 of the interview, it is therefore unlikely that the cost implications of the policy discussed in section 2 were memorised and used as a comparison. There was no evidence of price comparisons being made during the interviews. Socioeconomic data were collected at the end of the interview.

### *4.2 Response rate and sample characteristics*

The response rate of 5.9% was low in comparison with similar public surveys (e.g., Jakobsson et al., 2000). In consideration of the high level of commitment and input required from respondents, a low response rate was anticipated hence a large amount of emails were sent (>1000). In addition, it was expected that a proportion of the emails sent would not be viewed.

All respondents lived in either West, South or North Yorkshire in the UK and worked in the city of Leeds. Table 3 displays the sample characteristics.

Table 3: Sample characteristics.

| *Variable* | *Respondents* | *UK average* |
|---|---|---|
| **Female** | 63% | 51.2% |
| **Age** | | |
| 18 – 35 | 53% | 38.6 years |
| 36 - 53 | 37% | |
| >54 | 10% | |
| **Education** | | |
| Basic | 7% | 11% of population has higher education qualifications |
| Further | 18% | |
| Higher | 44% | |
| **Gross household Income/annum** | | |
| <£10, 000 - £20, 000 | 27% | £28, 000 |
| £21, 000 - £40, 000 | 23% | |
| >£41, 000 | 20% | |
| **Car availability** | | |
| 0 | 17% | 72% households have access to 1 or more cars |
| 1 | 53% | |
| 2+ | 30% | |
| **Annual car kilometres** | | |
| Below average (>0 – 8,000) | 39% | 8,796 km/person |
| Average (8,001-9,000) | 13.5% | |
| Above average (>9,001) | 47% | |
| Sample average: 12,064 km/person | | |
| **Average km travelled per mode**[4] | | |
| Car | 232 | 178 |
| Bus | 28.7 | 10.9 |
| Train | 80.2 | 14.2 |
| Motorcycle | 1.1 | 1.1 |
| Taxi | 1 | 1.8 |
| Cycle | 4 | 1.1 |
| Walk | 5.5 | 6.1 |

The sample over represented females and younger age groups, with the majority of the sample aged under 36 years old. People with higher education were also over represented as only 11% of the UK population has higher education qualifications (ONS, 2001), however, the small sample size should be considered in addition to the strategic targeting of the employed sub-population. The majority of the sample were earning above the UK average income (ONS, 2001), which again was anticipated given the method of recruitment. As intended the sample exhibits higher than average car use and car ownership, which was expected to be higher still given the above average income levels. In addition, in comparison to the national average, the sample travelled almost 6 times further by train, more than twice as far by bus, and almost 4 times as far by cycle, whilst walking and taxi use amongst the sample was below the national average. The higher than average use of public transport was not anticipated, although it is plausible given that a proportion of the sample worked very close to the city centre of

[4] From the travel week recorded in the 7-day diaries. The UK figures are derived from Transport Statistics (DfT, 2006a) provided in distance travelled per person per mode per year, which were thus divided by 52 to obtain a weekly figure and multiplied by 1.609 to convert from miles to kilometres. The data used in Transport Statistics is collected through the National Travel Survey, which is an annual survey using a 7-day travel diary to record personal travel.

Leeds and the availability of a relatively good public transport system. This is discussed in more detail in section 5.2 together with the results recorded by the software.

## 5. Survey results

Illustrative quotes from the interviews are used, however it should be noted that these do not imply a consensus view amongst all 60 respondents.

### *5.1 Concern for the environment, problem perception and knowledge*

Environmental concern was measured using 10 items on a 7-point scale, ranging from 'very strongly disagree' to 'very strongly agree'. In order to minimise the risk of response bias, the statements were randomly presented in negative and positive form. The average score of environmental concern was 5.7 (maximum score = 7), thus on average respondents were highly concerned about the environment. Cronbach's Alpha is 0.76, indicating an adequate degree of internal consistency that is comparable with other studies reporting environmental concern (Weigel and Weigel, 1978; Dunlap et al., 2000; Walton et al., 2004). The level of concern for the environment across the sample is consistent with other findings, despite the sample size and characteristics. For example, in a survey conducted amongst a nationally representative sample by the UK Department for Transport (DfT, 2006c), 84% of respondents were very or fairly concerned about environmental issues and 81% were very or fairly concerned about climate change. In addition, more recently in the UK Omnibus 2008 survey (Omnibus, 2009) 81% of adults said that they were very or fairly concerned about climate change, with a quarter being very concerned. A similar proportion, said that they were very or fairly concerned about environmental issues. In terms of variations according to education levels, 90% of respondents with degree level or above qualification were very or fairly concerned about climate change compared with 73% amongst those with no formal qualifications. Thus, whilst the results are potentially biased by a high level of environmental concern, given the high levels prevalent across society, it is unlikely to be a significant issue i.e. could also be apparent in a representative sample and is therefore not a characteristic unique to this sample of 60 individuals.

Problem perception was measured by asking if any problems were associated with current levels of road transport. On average, each respondent stated 2.6 problems, the main ones being congestion, air pollution and safety. These findings are consistent with those reported by CfIT (2002), where congestion was the most commonly mentioned transport issue with vehicle pollution affecting health and road safety rated as the next most important issues.

A list of 10 individual statements regarding the environmental and health impacts of transport were presented with the options 'true', 'false' and 'not sure'. Scores were then calculated for each respondent, with an average score of 3.8 (maximum score = 10), thus indicating a low level of knowledge amongst the sample.

*5.2 Behavioral response*

The majority of respondents (37) would not make any changes in response to either scheme in any time period, although 26 of these people were consuming within their free permit allocation during one or more time periods and hence did not need to change in response to the TCP scheme. This group would mainly opt to either keep their excess permits for leisure trips, give them away to friends and/or relatives, or sell them to the national permit market if the price was high enough. Others that were willing to sell their permits to the national market were likely to wait until the market price increased to provide a substantial profit. The responses demonstrate that the concept of permit trading within the TCP scheme was understood and considered during the decision making process. Several respondents who did not travel by car stated they would keep their free permits unused to avoid them being used by car users, for example:

*"I think I'd keep my permits, I wouldn't want someone who drives 50 miles to work and back every day to buy them and it would save even more carbon if I didn't sell them".*

*"I'd only sell them to someone who I knew genuinely needed to use their car, I wouldn't sell them to someone so they could drive their kids to school".*

Hence there could be unused permits each year which would have an impact on supply, particularly prior to significant carbon reduction adjustments i.e. in the short term. It is likely that those consuming within their free carbon permit allocation did not respond to the FPI either because their consumption was low, hence the price increases could be absorbed. In addition, many respondents felt that their car use was already minimal and could therefore not be reduced. The respondents that were consuming over their free permit allocation but did not respond to either policy (11 in total) largely felt that their car use was essential and could not be reduced, the journeys they made could not be made by other modes, using public transport would be inconvenient, expensive, increase journey times and reduce their choice of journey origin, destination and travel times. These respondents felt that the car provided them with options and convenience that they were unwilling to substitute and instead would prefer to pay the additional costs. Over half (7) of these respondents were above UK average carbon consumers. For example:

*"I'd just pay that, I wouldn't really notice to be honest and I'd just cut down spending on other things if the prices went up anymore".*

*"I wouldn't care about the cost, I'd pay it if it meant I didn't have to change" and "I wouldn't like it but yeh I'd just pay it".*

*"I don't want to hear about climate change, I just want to get on with my life to be honest".*

In total, 12 respondents stated they would make changes to their travel behaviour only in response to the TCP scheme, 3 respondents stated they would make changes to their travel behaviour only in response to the FPI and 8 respondents stated they would make

changes to their travel behaviour in response to both policies. The types of changes stated by respondents were in response to an open question, hence suggestions were not provided by the interviewer. The main responses given in relation to the TCP scheme were the use of train to commute to work between 1 and 3 days per week, the use of bus to commute to work for 3 days per week, and walking for short leisure trips. For the FPI, the main response was to use the train to commute to work for 2 days per week. Other responses include using the bus to commute to work between 1 and 5 days per week; car sharing; telecommuting; changing vehicle; cycling to work and working locally (closer to home). Table 4 shows the impact of the changes on total kilometres travelled by the whole sample for each policy and time period.

Table 4: Total distance (kilometres) traveled for the whole sample per mode[5] per week (base) with % change in 2010, 2020 and 2030 for the TCP scheme and FPI.

| *Mode* | *Base* | *2010* | | *2020* | | *2030* | |
|---|---|---|---|---|---|---|---|
| | | TCP | FPI | TCP | FPI | TCP | FPI |
| Car | 13921 | -9.5 | -0.6 | -17.4 | -4.4 | -29.0 | -11.0 |
| Bus | 1719 | 0.0 | 0.0 | +13.5 | +5.0 | +13.5 | +12.0 |
| Train | 4814 | +17.4 | 0.0 | +33.1 | +8.2 | +38.0 | +23.5 |
| Cycle | 241 | +28.6 | +20.3 | +33.6 | +20.3 | +51.0 | +20.3 |
| Walk | 332 | +8.5 | +1.6 | +11.2 | +2.2 | +16.0 | +4.0 |
| Total | 21780 | -1.8 | -0.1 | -2.4 | -0.3 | -8.4 | -0.4 |

A paired t-test revealed significant differences between base kilometres and kilometres travelled in 2030 for both the TCP scheme ($p<.02$) and the FPI ($p<.025$). By 2030, in relation to the TCP scheme, car kilometres were below the UK national average (per person) with walking increased to above the national average. Conversely, for the FPI car kilometres remained above UK average and walking kilometres remained below the UK average. The ratio of car kilometres to cycle kilometres declined as a result of the TCP scheme, going from 57 car kilometres per cycle kilometre in the base to 27 car kilometres per cycle kilometre in 2030.

Table 5 shows the change in carbon consumption across the whole sample for each policy and time period.

Table 5: Total carbon consumption from the whole sample (kilograms) per mode[6] per week (base) with % change in 2010, 2020 and 2030 for the TCP scheme and FPI.

| *Mode* | *Base* | *2010* | | *2020* | | *2030* | |
|---|---|---|---|---|---|---|---|
| | | TCP | FPI | TCP | FPI | TCP | FPI |
| Car | 512 | -11.3 | -0.4 | -35.4 | -5.9 | -38.0 | -21.3 |
| Bus | 33 | 0.0 | 0.0 | +32.0 | +12.1 | +33.0 | +24.2 |
| Train | 82 | +10.0 | 0.0 | +22.0 | +4.9 | +23.0 | +20.7 |
| Total | 647 | -7.7 | -0.3 | -23.8 | -3.4 | -25.7 | -13.1 |

[5] Taxi and motorcycle did not change from the base level of 59 and 694 kilometres respectively.
[6] Taxi and motorcycle did not change from the base level of 3 and 17 kilograms respectively.

The total carbon consumed per person during the base and 2030 was significantly different for both the TCP scheme ($p<.02$) and FPI ($p<.025$). The total change in carbon consumption from all modes shows that the increase in public transport offset some of the reductions from car use. For example, in 2030, the TCP achieved a 38% reduction in car carbon but the overall reduction from all modes was 25.7%.

The percentage reduction in carbon consumed by car use is greater than the corresponding reduction in kilometres traveled by car (see table 4). This reflects the switch by one respondent to a smaller car that consumed less fuel, and by another to a zero carbon emissions car in 2030 for the TCP scheme. Hence, carbon consumption and demand for permits and fuel were reduced without having to reduce vehicle kilometres travelled. For the FPI, the largest reduction in car carbon from base consumption and the greatest increase in carbon consumed by public transport were achieved in the long term (2030), which reflects the higher long run elasticity applied (Glaister and Graham, 2000). It is possible that greater reductions could be achieved before 2030 if supportive measures were made available, such as increased public transport quality and availability, cycle facilities and local shops. In response to the TCP scheme, the greatest reductions in carbon occurred in 2020, with a further change in 2030 but at a much smaller level. Thus, the capacity and/or willingness to change was almost exhausted after two rounds. However, long term supportive measures, such as clean-fuel vehicles at reduced costs and improved public transport, should have been implemented by this point therefore providing additional opportunities to reduce carbon consumption. Also, if sold on an open market, the increasing permit price could provide an additional signal in the long term. This was lacking from the survey due to the use of fixed permit prices (see section 3.1.4).

### *5.3 Policy effectiveness*

The data in table 5 was used to assess the effectiveness of each policy in terms of achieving intermediate carbon reduction targets, shown in table 6.

Table 6: Carbon emissions reduction targets (percentage change from current) and actual reduction for the TCP scheme and FPI in 2010, 2020 and 2030.

| *Year* | *TCP scheme carbon reduction %* | | *FPI carbon reduction %* | |
|---|---|---|---|---|
| | Aim | Actual | Aim | Actual |
| 2010 | 8.0 | 11.3 | 1.7 | 0.4 |
| 2020 | 21.4 | 35.4 | 10.6 | 5.9 |
| 2030 | 34.8 | 38.3 | 25.3 | 21.3 |

The emissions targets to 2030 were a 34.8% reduction for the TCP scheme, reflecting the linear reduction in carbon each year, and for the FPI 25.3% reflecting the assumed lower price elasticity in the early years. Table 6 shows that, up to 2030, the TCP scheme overachieved each intermediate target whereas the FPI failed to achieve any intermediate target despite having higher fuel prices than the TCP scheme (shown in table 2). This implies that the willingness to pay for fuel was higher than expected and that a quantity approach (limiting carbon availability) was a more effective method of achieving change amongst a group of above average carbon consumers.

In relation to the TCP scheme, the uncertainty of permit availability appeared to be the main driver for behavioural change, for example:

*"I'd want to make sure that I had enough permits for my leisure trips, there're some places where you can't use public transport, or it just takes too long. I'd cut back on the work trips and save the extra ones".*

*"It's the not knowing whether you'd be able to buy what you wanted, and the price of them, so I might not even be able to afford it anyway. I'd have to stick to my free allocation and get what my parents don't use, I wouldn't like to risk having to buy more in case there wasn't any there".*

It is possible that people are risk averse and would prefer an option with a known price to an option with an uncertain price (Bonsall et al., 2007). Hence, the TCP scheme could actually benefit, in terms of effectiveness, from risk aversion, i.e., people try to minimise the risk of permit shortages by reducing their permit use.

### *5.4 Impacts, fairness, perceived effectiveness and acceptability*

After considering how the policies might affect their travel behavior, respondents were asked a range of questions regarding perceived impacts on their lifestyles (including costs and benefits), policy effectiveness, fairness and acceptability. In most cases respondents were also asked how they thought society as a whole would rate each policy, for example in terms of acceptability. Table 7 shows the average scores for each attitude measure.

Table 7: Sample average attitude scores for the TCP scheme and FPI (standard deviation in brackets).

| *Variable* | *TCP scheme* | *FPI* | *P value** | *Scale* |
|---|---|---|---|---|
| Level of impacts on lifestyle | 2.5 (1.6) | 2.3 (1.6) | p>.010 | 0 to 6 |
| Strength of impacts on lifestyle | 0.4 (1.6) | -0.2 (1.5) | P<.005 | -3 to +3 |
| Personal cost/benefit | 0.3 (1.5) | -0.4 (1.5) | P<.005 | -3 to +3 |
| Social cost/benefit | 1.3 (1.6) | 0.2 (1.8) | P<.005 | -3 to +3 |
| Personal fairness | 1.3 (1.4) | 0.5 (1.9) | P<.005 | -3 to +3 |
| Social fairness | -0.6 (1.7) | -1.4 (1.5) | P<.005 | -3 to +3 |
| Perceived effectiveness | 3.9 (1.4) | 2.2 (1.4) | P<.005 | 0 to 6 |
| Personal acceptability | 1.1 (1.6) | 0.3 (1.8) | P<.010 | -3 to +3 |
| Social acceptability | -0.3 (1.5) | -1.2 (1.6) | P<.005 | -3 to +3 |

Note: *A Wilcoxon signed ranks test (equivalent to a paired sample t-test for categorical data) was used to measure any significant differences between the ratings for the TCP scheme and the FPI.

The extent of the perceived impacts on lifestyle were similar for both policies, however, the impacts resulting from the TCP scheme were perceived to be positive, whereas negative impacts were perceived to result from the FPI. In general, respondents felt that the TCP scheme would encourage them to think about the necessity of car use and find alternative modes, resulting in health and fitness benefits, whereas the fuel tax increases would result in increased costs without stimulating the same positive thought process and actions as the TCP scheme, for example:

*"I think because you've got to use the carbon permits all the time it'd really make you think about what you were doing and the impact on the environment, whereas with the fuel prices you'd be told what the purpose was at the beginning but it'd be less obvious in an everyday way and people might easily forget and just get mad about paying more for their fuel".*

On average, respondents thought the TCP scheme would provide personal benefits, whereas the fuel tax increases would result in costs. However, the FPI would provide social benefits, but to a lesser extent than those provided by the TCP scheme. The responses given to an open question regarding the ratings are closely related to those given in relation to the impacts ratings, with the TCP scheme having a greater impact on car use resulting in reduced levels of local air and noise pollution, and improved levels of personal health and fitness. In contrast, the increased price of fuel was by far the main response given in relation to perceived costs resulting from the FPI with reduced levels of air pollution being the most noted benefit. For example:

*"People only lose out from the fuel price increase but people actually benefit from the permit scheme".*

*"Not enough people will stop using their cars so there'd be little benefit from the fuel price, people would rather starve than stop using their cars".*

The social benefits were rated to be greater than the personal benefits for both policies, as a result of environmental improvements being considered more as a wider social benefit rather than a personal benefit.

The TCP scheme was considered more personally fair, and less unfair from a societal perspective than the FPI. In relation to the TCP scheme, the most commonly stated reason for considering the policy to be fair was the allocation of carbon permits on an equal per capita basis, with those using more than their free allocation having to buy additional permits and therefore incurring extra costs:

*"If it's been divided up equally then I think that's fair, I'd accept that that was my allocation and be happy to know that everyone else had the same amount".*

*"It's like the polluter pays because if you use more than your free allowance you've got to start paying".*

In contrast, most respondents thought society would generally consider the TCP scheme to be unfair, mainly due to a perceived restriction on personal freedom and car use, given the high level of importance placed on car use:

*"People see their car and freedom as a right. There'd be a lot of resistance and upset, the car gives people flexibility, freedom and safety. People need to be encouraged that it's a good idea rather than being told".*

However, many respondents thought that fairness ratings would increase over time as society became accustomed to the scheme and the benefits became visible. The FPI was considered to be less fair, mainly due to the perceived uneven impacts across society:

*"There'd definitely be an uneven distribution of benefits depending on income. People living in rural areas would be hit badly by this".*

*"We'd have a situation where only rich people can afford to drive, it'd become really elitist, more than it is now".*

Respondents thought that the price increases would be considered unfair by society, being largely viewed as an additional tax rather than a measure to reduce carbon emissions:

*"People aren't concerned about the environment so they'd see this policy as an unfair tax increase".*

*"People don't think they should pay more to use their cars because they can't see why it's wrong".*

The TCP scheme was considered effective at achieving the emissions target with the most commonly stated reason being the national limit on carbon availability:

*"If you can't go over the limit then it has to be successful".*

*"It'd make people think about what they were doing because you've got your own allowance with a figure on it".*

The FPI was considered less effective with the majority of respondents feeling that the additional fuel costs would be absorbed by the majority, with costs needing to be much higher to incur change:

*"Putting the price up doesn't work. People don't stop smoking because the price goes up, they stop smoking for other reasons".*

*"It'd just be easier for most people to pay the extra cost and carry on rather than moving house or changing job".*

In terms of personal acceptability, 78% of respondents considered the TCP scheme to be acceptable whereas 50% rated the FPI as acceptable. In terms of the FPI, this is greater than the average level of support (37%) expected for road pricing in the UK (Jaensirisak et al., 2005). The TCP scheme is less comparable with road pricing than the FPI and is instead more comparable with findings from the RSA (2006) who found that 53% of respondents would accept limits imposed on their energy use if they helped to solve the problem of climate change. In addition, 61% supported penalties and rewards for above and below energy consumption. The findings were based on a nationally representative sample of 2465 individuals and opinions were consistent across gender, age, social group and region of residence. Bristow et al. (2010) review the limited available evidence and conclude that support for PCT from existing surveys (excluding small sample surveys) lies in the range 25 to 47%. Thus, in consideration of other

findings from more representative surveys, the acceptability of both the TCP scheme and FPI could be lower amongst a more representative sample.

In relation to the TCP scheme, the most commonly stated reasons regarding acceptability were the benefits received:

*"It's a fair way to reduce emissions, it improves public transport and encourages people to use it. I think the scheme would work well and has a target and aim to achieve and it's a big scheme for people to take on which would help to make people realise the scale of the problem and what needs to be done".*

The most commonly stated reason for accepting the FPI was the necessity to reduce carbon emissions:

*"We don't have a choice, we'd have to accept it because it'd be law and it's necessary".*

In terms of social acceptability, the majority of respondents thought society would consider the TCP scheme to be unacceptable, the FPI even more so. The most common jointly stated reasons were related to monetary cost and unfairness:

*"People don't want to pay more for fuel, they don't want to pay more tax for the NHS and schools so they won't want to pay more for fuel".*

Before the interview ended respondents were asked which policy they considered to be more acceptable. The majority of respondents (40) considered the TCP scheme to be more acceptable than the FPI, whilst 18 respondents considered the FPI to be more acceptable than the TCP scheme. The main reason for considering the TCP scheme to be more acceptable than the FPI was the ability to achieve the carbon reduction targets:

*"The trading scheme has a bigger impact even though it's more difficult than the fuel price increase. The trading scheme is the way we should go".*

The most commonly stated reason for preference of the FPI over the TCP scheme was the ability to continue current behaviour, albeit at increased monetary costs. This was considered to provide an element of personal choice:

*"There's no limit on consumption so there're more options. I can still do the journeys I want and can afford to pay the extra. It's more fair than the trading scheme".*

## 6. Discussion of results

The survey findings clearly indicate that certain policy design features influenced responses towards the TCP scheme and FPI. The perceived likelihood of achieving the carbon reduction target largely underpinned the difference in terms of behavioural response and attitudes towards the TCP scheme and FPI. The TCP scheme was viewed as largely unavoidable due to the imposed carbon budgets i.e. there would be little

opportunity for individuals to buy their way out. Respondents were thus convinced that substantial carbon reductions would be delivered. Whereas in relation to the FPI, given that price is the only limiting factor many respondents were unconvinced that it would deliver substantial carbon reductions based on the belief that the majority of individuals would continue their current car use and therefore not have to make any changes (other than increase their spending on fuel). The TCP scheme therefore offered people a level of reassurance that their efforts to reduce carbon emissions would not be in vain - the FPI did not have this effect. Hence, the perceived response of others appeared to be important in influencing the decision to change behaviour and particularly whether attitudes towards the policy would be positive or negative.

Uncertainty of carbon permit availability was crucial in prompting the behavioural response to the TCP scheme. Hence, the TCP scheme could benefit from risk averse behaviour in that people reduce their consumption in an attempt to avoid a situation where they are unable to obtain permits. It is recognised that the response could be different if respondents were to consider a PCT scheme with links to other permit markets rather than being constrained to a national carbon budget and thus potential shortages of availability as explored in this research. Uncertainty regarding permit price was also an important factor in terms of response to the TCP scheme, but to a lesser extent. In this survey design, the mechanism for stimulating behavioural change for the FPI is very different in that it relies solely on willingness to pay and therefore does not benefit to the same extent as the TCP scheme in terms of stimulating risk averse behaviour.

Interestingly, and perhaps, surprisingly respondents seemed to prefer a scheme with a hard cap and the possibility of permits not being available partly because it was perceived to improve policy effectiveness and partly because it was considered a fair mechanism due to the free equal per capita permit allocations and the limited opportunity for individuals to continue their current travel behaviour i.e. almost everyone would have to make changes. The benefits perceived as a result of the policies being introduced were a key factor in terms of acceptability – in this survey the TCP scheme was favoured mainly due to the belief that it could deliver significant reductions and co-benefits such as reduced levels of air pollution.

During the survey a number of respondents felt that the limit on carbon availability and use of carbon permits would constantly remind them of the purpose of the scheme and suggested that the TCP scheme could make people aware of their environmental impacts resulting from all aspects of their lifestyle and ways to reduce them, therefore further increasing policy effectiveness and subsidiary benefits through the uptake of environmentally astute behaviour (also noted by Starkey and Anderson, 2005). This impact was not suggested for the FPI, which could possibly be a result of negative preconceptions of fuel tax as a means to raise revenue rather than to improve the environment. Hence it is possible that perceptions of the FPI could be changed by introducing it as a carbon tax, to help remind people of the policy aim and also stimulate environmentally astute behaviour. However, DEFRA (2008) found a largely negative response to the concept of a carbon tax and respondents remained sceptical about the ability to stimulate the carbon reductions required.

## 7. Conclusions and future directions

This research has provided an initial insight into public attitudes and potential behavioural response to a PCT scheme and FPI both designed to achieve significant reductions in carbon emissions from the transport sector. Overall, there was a clear difference in attitudes towards the policies – respondents were much more positive about the TCP scheme in every aspect compared to the FPI. However, given that the sample was small and biased towards those with high education levels, high concern for the environment and above average incomes, it is not possible to draw firm conclusions.

The investigation into the role of PCT remains an emerging area with many avenues to explore. One important issue to explore in terms of the impact on acceptability and behavioural response is the different types of cap or limit on permit availability. The findings also suggest that it would be valuable for future research to include: larger scale and more representative attitudinal surveys; an exploration of the influence of personal and social norms on behaviour; the application of deliberative techniques for further exploration of specific issues; the impact of varying permit allocations to account for actual barriers to change; and efforts to explore behavioural change in a more realistic setting perhaps using longitudinal studies and/or carbon trading games.

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