EXPLORING TRAVELLERS' REACTIONS AND ATTITUDES TOWARDS A CARBON TAX OR FUEL QUOTAS: RESULTS OF AN INTERACTIVE SURVEY IN FRANCE

Patricia LEJOUX, Transport Economics Laboratory (CNRS, University of Lyon)

Charles RAUX, Transport Economics Laboratory (CNRS, University of Lyon)

ABSTRACT

This paper reports the findings of an Interactive Stated Response Survey, conducted on a small sample of households in France that examined carbon rationing scenarios for transport, involving either a carbon tax or tradable personal carbon allowances. Changes in travel behaviour that are envisaged preferentially by households are identified, with the resources and constraints at stake for these behaviour changes. Household attitudes towards the carbon tax and personal carbon allowances are analysed. Finally, a typology of the households is drawn up, based upon the strategies they employ in response to the scenarios.

INTRODUCTION

Transport generated approximately 25 per cent of emissions of CO2 – one of the main greenhouse gases (GHG) – in the world in 2003, and this share amounted to 30 per cent in OECD countries. Among these emissions from transport 18 per cent come from road transport; 3 per cent from air and 2 per cent from maritime transport (OECD 2007). Moreover, emissions from transport have increased sharply by 31 per cent in the world between 1990 and 2003. Following the sharp oil price increase which culminated in 2008 and the subsequent economic recession transport fuel consumption has shown a stabilisation and even a slight decrease. In response to the challenge of climate change and the objective of reduction by four of GHG emissions by 2050 in OECD countries, governments must implement policies to reduce these emissions. The transport sector would appear to be a priority sphere for action.

Some governments, notably the French one, are therefore considering the introduction of economic instruments that would encourage economic agents, i.e. households and firms, to reduce the amount of carbon they consume in motor vehicle fuel. Two types of measures may be considered: "price rationing", by means of a carbon tax, or "quantity rationing", by means of tradable personal carbon allowances – PCAs – (or tradable emissions quotas; see

Keay-Bright & Fawcett, 2005; Raux & Marlot, 2005; Raux, 2010). These measures set out to give a price signal that will modify the behaviour of households and firms by prompting them to trade-off between the cost of reducing the pollution they generate by one unit and the cost of paying the tax or purchasing an emissions quota for the same unit.

A carbon tax system has already been adopted in a number of countries (Finland, Sweden, Italy, Germany and Switzerland) and is currently being considered in France. The tradable quotas system has existed in the European Union since 2005 for firms with fixed facilities that generate the largest amounts of CO_2 (energy and steel production, etc.) in the form of the Emission Trading Scheme (ETS). This system has also been trialled recently for UK households in the framework of the "RSA Carbon Limited" programme (Prescott, 2008). Most of the research in this area has focused either on specifying the systems that could be put in place (Fleming, 2007; Raux, 2007; Watters & Tight, 2007), or on appraising the impact of the measures in question on the competitiveness of firms (Bureau & Mougeot, 2004; Raspiller & Riedinger, 2005). Research that sets out to evaluate the impact of such measures on households is scarcer and has mainly considered redistributive effects (Combet *et al.,* 2009; Wadud, 2007). Few studies have attempted to collect data on the attitudes of households on carbon tax (Comby *et al.,* 2009; Jagers & Hammar, 2009) and even fewer on PCAs and only in the UK (Harwatt, 2007; Owen *et al*., 2008).

How can the implementation of such systems affect individuals' travel behaviours and attitudes? The attempt to answer this question encounters one fundamental difficulty, namely that these households have not yet had the opportunity to try out either PCAs or a high carbon tax. It is therefore difficult to use past behaviours in order to imagine future behaviours. It is necessary to use a specific methodology, and the most suitable candidates seem to be Stated Response (SR) and stated preference methods. We have started with a SR survey in the context of our research (the CarbonAuto project).

This paper presents the results from an interactive Stated Response survey in which respondents from a sample of approximately twenty households were presented with a number of carbon tax and tradable emissions scenarios. The aim of the survey was to explore the choice set of the households and individuals and identify the variables that influence change in their travel behaviours and attitudes.

As we shall see below, by analyzing the data gathered in this survey we have identified the changes in travel behaviours that were envisaged preferentially by households, determined the explanatory variables for these behaviour changes, and identified household attitudes towards the carbon tax and PCAs. Finally, we have drawn up a typology of the strategies employed by households in response to the introduction of scenarios of this type.

The paper is structured as follows: section 1 details the survey methodology, section 2 describes the changes in travel behaviour envisaged by the households, section 3 examines their attitude towards the proposed systems, and finally section 4 presents a typology of the adaptation strategies employed by the households.

1 METHODOLOGY

It is necessary to undertake qualitative interviews in order to understand changes in individuals' travel behaviours and attitudes in response to the carbon tax and PCAs. But in this context, a method based on semi-directive interviews would appear to be of limited use. How much faith should we place in the behaviour changes reported by households with regard to systems that they have never experienced? It is possible to get round this problem by using the Interactive Stated Response Survey methodology. We shall begin by describing the basic aspects of this method, and then go on to detail the protocol that we used for this research.

1.1 Basic aspects of the interactive Stated Response survey method

This method was developed at the end of the nineteen eighties by Martin Lee-Gosselin (Lee-Gosselin, 1988, 1996) in order to observe the reactions of Canadian households to a fuel shortage scenario. It has also already been applied to other topics, such as the use of electric cars in the United States (Kurani *et al*., 1994) and France (Faivre d'Arcier *et al.*, 1996), or urban tolls (Raux *et al*., 1995) or the factors involved in route choice (Andan & Faivre d'Arcier, 2001). This methodology has been discussed in Faivre d'Arcier *et al*. (1998).

The method consists firstly in setting the "fact base" which includes travel currently undertaken by the respondents (here the household members). Then the respondents are presented with a series of scenarios which modify their travel conditions (e.g. congestion, regulation, taxation or pricing) in order to see how they adapt to this new context. As the game progresses this context becomes gradually more constraining.

The method has three advantages. First, as what is considered are trips the respondents actually made – the fact base –, they are better able to assess the constraints that would result from a (stated) change in their behaviour. Second, this fact base serves as a reference during the gaming simulation in order to check the plausibility of stated responses. Third, the fact that the constraints are increased as the game progresses compels more or less the respondents to change their behaviour, thereby revealing their adaptation strategies. By provoking (stated) changes, this method produces a rich material on adaptation processes and their underlying characteristics.

Of course, this method does not assume that the behaviour changes stated by respondents will actually be adopted. Its aim is not to forecast changes in future behaviour with precision, but to approximate reality by reproducing the constraint the tested policies would place on the travel conditions of the respondents. Moreover this kind of study does not pretend to identify the behaviours and attitudes that are representative of the entire population but rather to gain an in-depth understanding of these behaviours and attitudes. Due to the duration of the interviews and the complexity of their analysis, this kind of survey applies generally to small samples (e.g. twenty to thirty or so respondents).

1.2 The survey protocol

In order to study how individuals' behaviours change in response to the introduction of a carbon tax or PCAs, a specific Interactive Stated Response Survey Protocol was drawn up.

Twenty households were included in the survey1, i.e. thirty-eight individuals living in a variety of locations in the Rhône-Alpes region with varied income levels and family compositions. They were also selected along various residential locations with reference to three categories: "centre" referring to centre of large cities with high density and good transit supply, "inner suburbs" referring to suburbs with average density and low transit supply, "outer suburbs" referring to periphery of cities or rural areas with low density and poor transit supply. Table 1 shows the breakdown of the sample according to income level and residential location categories.

Table 1: The survey sample (number of households)

	Centre	**Inner suburbs**	**Outer suburbs**	**Total**
High income		2	4	6
Average income	4	4	2	10
Low income		1	3	4
Total	**4**	**7**	**9**	**20**

An interesting aspect of this research is that it was conducted at household rather than individual level. This is important because the decision about a change in travel behaviour rarely depends on a single individual, as several members of the same household may make the same trip or may interact about car use or equipment decisions. This survey therefore takes account of the negotiations and trade-offs that take place between parents or between parents and children. Moreover, the participation of all the members of the household improves the reliability of changes in behaviour reported by one of them, since the others can interact and exert a kind of plausibility checking. For instance the presence of adolescents and children proved to be particularly instructive as regards the behaviour changes envisaged by their parents.

The households were recruited indirectly and contacted by telephone in order to elicit some sociodemographic data. They were then sent a questionnaire regarding the "fact base" which included a description of all the trips made by the household in the previous year, by all modes (walking, bicycle, public transport, car, train, plane, etc.) and for all purposes (work, shopping, drop-off, leisure, week-ends, holidays, etc.)2. Usually, SR survey "fact bases"

1 The sample originally consisted of twenty-five households, but five withdrew in the course of the survey.

2 At one time we thought of extending the survey to the housing sector in order to take account of fossil fuel consumption for heating purposes. This would have allowed us to study how households manage their total carbon budget and revealed the trade-offs they make

cover the trips made during one day or at most one week. However, for this research project it was important to deal with the travel practices of households in a comprehensive manner. This meant inclusion of long distance trips which frequently involve modes with particularly high emissions (car, plane, etc.) and observe trade-offs between short distance and long distance travel. While this has the disadvantage of increasing the complexity of the household questionnaire, it has the benefit of providing a considerable wealth of data. Business trips, i.e. trips individual's make for their employer, were described by the household in the questionnaire in order for us to have a full picture of their travel practices. They were, however, excluded from the scenarios and the analysis as the households were supposed to not pay for them.

Home interviews lasting about two hours were then conducted3 with the assembled household. The aim was for them to react to three scenarios and a discussion on three topics on the basis of two documents that were made available to them:

- The "fact base" which described the main features of all the trips they had made in the year (destination, purpose, mode, frequency, number of persons involved, etc.),
- An overall evaluation of their travel that described the annual travel distances, fuel consumption, CO_2 emitted and estimated cost for all non-business trips on a mode-by-mode basis.

The first scenario consisted in observing how the households reacted to the evaluation of their overall travel as shown above. The aim was to see whether they were aware of the number of kilometres they covered and the cost of their travel over one year, whether they were sensitive to their impact on the environment and whether they were spontaneously willing to reduce their amount of travel.

The second scenario was designed to simulate the introduction of a gradually rising carbon tax on motor vehicle fuel. Its aim was to identify how household travel behaviour would change in response to a price constraint. The price of a litre of fuel was set at €1.40, which corresponded to the current price at the time of the first interviews (October 2008). In order to maintain comparability this price was maintained throughout the subsequent interviews (until January 2009), which all the households accepted without difficulty. Three levels of carbon tax were proposed: €0.20, €0.50 and €1, which amounted to increasing the price of a litre of fuel from €1.40 to respectively €1.60, €1.90 and finally €2.40. The tax was made deliberately high in order to make the households react. At any time the household could monitor the impact of the increase in the carbon tax or the effects of its changes in behaviour on a computer display that showed an evaluation of its travel in kilometres, litres of fuel, tonnes of CO_2 and Euros.

The third scenario aimed to simulate the introduction of PCAs4. It set out to identify how households would change their travel practices in response to a constraint on the amount of

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between consumption for transport and housing. But in view of the complexity and duration of the survey on the transport sector itself, this idea was not pursued.

3 Between September 2008 and January 2009.

motor vehicle fuel they consumed. These allowances would take the form of a free allocation of a certain number of rights to consume fuel to each household at the beginning of the year. This allocation would be debited as the household purchased fuel from service stations at the normal fuel price of €1.40 a litre or bought air tickets. Depending on how much of their allowances they consumed each year, the households would be able to sell allowances if their consumption was below their allocated allowances, or purchase additional allowances if their consumption exceeded their allocated allowances, with the price of purchase or sale of an allowance (or right) being fixed at €1 per litre.

How many allowances should be allocated at the outset to each household? As the aim is to constrain households, it was decided to avoid situations in which the household begins with a total of allowances that exceeds its current consumption. Three levels of allocations were proposed: an allocation that represented a 10% reduction in annual fuel consumption, this being followed by reductions of 25 %, 50 % and finally 75 %. Throughout the game, the households could observe whether their changes in behaviour would put them in a position of surplus or deficit in relation to their allocation and they were able to find out the impacts of the surplus or deficit on the total cost of their travel.

Finally, in order to analyse their attitudes regarding these various instruments, the households took part in a discussion in order to evaluate the social acceptability of the carbon tax and the tradable CO_2 emissions. As the households were unfamiliar with the second system, a major part of the discussion was given over to it. The first topic that was discussed involved the nature of quota allocation, in terms of the types of fuel consumption it should cover – for example, car trips, car and plane trips and/or to domestic heating. The second topic related to the allocation of the allowances, in terms of how they should be allocated – for example, only to motorists, to each household, or to each individual, and whether it should vary according to residential location. Finally, the last topic for discussion related to whether the households preferred the carbon tax or the PCAs.

The structure of the survey is set out in Table .

4 In this scenario, the more neutral expression "the right to consume fuel" was preferred to the words "rationing" or "quotas".

Table 2: The Interactive Stated Responses Survey Plan.

SCENARIO 1	SCENARIO 2	SCENARIO 3	DISCUSSION
Reaction to analysis of annual travel behaviours Amount in: kilometres litres of gasoline CO_2 emissions travel expenses in Euros	Carbon tax Price per litre: €1.40 Stage 1: tax of €0.20 per litre Stage 2: tax of €0.50 per litre Stage 3: tax of €1 per litre	PCAs Price per litre: €1.40 Allowance selling or purchasing price: €1 per litre Stage 1: less 10 % of annual consumption Stage 2: less 25 % of annual consumption Stage 3: less 50 % of annual consumption Stage 4: less 75 % of annual consumption	Topic 1: Scope of PCAs Topic 2: Mode of allowances allocation Topic 3: Preference as regards proposed systems

2 THE CHANGES IN TRAVEL BEHAVIOUR ENVISAGED BY THE HOUSEHOLDS

We shall deal first of all with the changes in travel behaviour envisaged by the surveyed households, then go on to describe the type of trips affected by these changes and finally the characteristics which may explain these changes whether at the individual or trip level.

2.1 The types of changes that were envisaged

The surveyed households considered five types of behaviour change: 1) changing transport mode, 2) reducing the frequency of trips, 3) car sharing, 4) changing their vehicle, and 5) changing their place of work or place of residence. Households at times mentioned the possibility of reducing the distances they covered, for example by travelling less far during weekends or holidays, but never actually stated that they will do so.

The changes in travel behaviour which households considered the most readily involved changing transport modes and reducing trip frequencies. Of the twenty households that were surveyed, half considered changing transport mode, generally in favour of public transport (bus, tram, train) and more rarely in favour of walking or cycling. Likewise, half the households considered changing the frequency of their trips, either by reducing the frequency of some trips or not making them at all. In most cases households considered either changing transport mode or reducing the frequency of their trips, but rarely both.

A fifth of the households considered car sharing, three of them for commuting trips and one for weekend trips. Two of these four households no longer mentioned this possibility in the PCAs scenario, which makes one wonder if a real change was involved. Car sharing was frequently seen as a constraint by households and was generally limited to one or two days a week because of the personal obligations of the individuals involved and their work colleagues.

However, as a result of the progressive increase in the tax or the progressive reduction in the amount of allowances in the course of the scenarios, changing modes, reducing trip frequencies and car sharing rapidly proved to be inadequate. The households were then forced to apply more radical, long-term, solutions, such as changing their vehicle or their place of residence or work.

A third of the households considered changing their vehicle to reduce their fuel consumption, but a range of approaches was involved. Two households thought of replacing an old car with a new one: they were already thinking of doing this, and the introduction of the carbon tax or PCAs hastened their decision. Three households considered replacing one of their two cars with a hybrid car: these households were conscious of environmental issues and were looking more for a "clean" car than one with lower consumption. Next, two households were thinking of replacing one of their two cars by a motorized two-wheeler, one on financial grounds and the other because they wanted to reduce their car use. Last, one household was considering getting rid of one of its two cars, which it did not use very much, and using public transport more for short distance trips and a hire car for long distance trips.

A third of the households considered changing their place of residence or their place of work, the second of these being mentioned more frequently. Three households mentioned the possibility of changing their place of work, two of changing their place of residence and two of changing both. This type of change must of course be considered with caution, in that doubts remain about whether such changes would be made in reality, but the fact that households mentioned them in itself constitutes a characteristic of their adaptation strategy.

The three households who considered changing their place of work had already thought about the issue and were well aware of the possibilities either of finding work in another firm or obtaining a transfer from their employer. In married couples, this decision was usually made by the women.

The two households who thought about changing their residential location did so for very different reasons. The first had two residences, one "pied-à-terre" for during the week and its main home, 120 kilometres away, which it used at weekends. When its transport costs increased as a result of the introduction of the carbon tax or PCAs, this household was compelled to think about changing its residential location in order to move nearer both partners workplaces, even though it was very attached to its principal residence: however they mentioned the difficulty of purchasing a dwelling in the centre near their workplaces. The second household, which was under a great many constraints in its daily life, thought about leaving the suburbs and moving into the inner city in order to reduce its transport

costs: this decision was particularly easy to consider as the household was already thinking of moving due to problems to do with the local school's social profile for their children.

The two households which thought of either changing their place of work or place of residence were atypical in that they lived a long way from their work, at respective distances of 80 and 65 kilometres. In response to an increase of their transport costs, they hesitated over what strategy to adopt. The first household, consisting of a young single man initially thought of changing residential location to move nearer his work, without wishing to move very close to it. However, as this solution proved to be ineffective after a certain amount of time, he then thought of changing his place of work. The second household thought of either changing the woman's place of work for it to be nearer their place of residence or changing the place of residence in order to live in company accommodation, at the husband's place of work, which would also mean the wife would have to change her place of work.

Last, three of the households did not consider any change in their travel behaviour, whatever the proposed scenario. In the case of two of them, this was because they preferred to pay rather than change and in the case of the other, this was because they were unable either to pay or to change.

2.2 Types of trip involved

The behaviour changes involved various types of trips which we can characterize on the basis of their purpose and distance. Six trip purposes were identified: work, shopping, drop-off, leisure, weekends and holidays. With regard to range, a distinction has been made between short distance trips5 and long distance trips.

The households more readily envisaged changing their travel behaviour for short trips: of the twenty households in the survey, half envisaged making changes to their short distance shopping, drop-off and leisure trips. On the other hand, households were least willing to consider change for their commuting trips as these were highly constrained: only one-fifth of households considered changes to these trips, mainly through car sharing.

Finally, households attempted to conserve the long distance trips they made at weekends and during the holidays, either because they made many such trips and saw them as an essential part of their lifestyle, or because they only make a few of them and did not wish to give them up; only one third of households considered changing their behaviour with regard to long distance trips. Three households considered giving up some weekends or even their annual holidays as they had no other margin of manoeuvre and had to cope with extremely strong financial constraints. The other four households were willing to change their transport mode, taking the train instead of the car for some trips when it is convenient, but were unwilling to change their other trips.

5 Defined as trips involving straight-line distances of less than 80 km from home.

2.3 Resources and constraints for the envisaged changes

Many characteristics may influence the changes in travel behaviour that can be implemented. These characteristics can be categorized as contextual, socioeconomic or individual variables. These variables may constitute at the same time a resource, insofar as they enable households to envisage changes in their travel behaviour, but also a constraint as they may also prevent them from envisaging such changes.

The contextual variables which explained why the households were willing or unwilling to change their travel behaviour were: access to local services (shops, schools, leisure facilities) and the supply of public transport (bus, tram, train) in their residential location; the availability of alternative vehicles (hybrid car, electric car or bicycle, biofuels, etc.); access to new information and communication technologies (Internet shopping).

The socioeconomic variables which explained why the households were willing or unwilling to change their travel behaviour were: income, type of household (in particular the presence of dependent children), and their type of work. This last variable had many dimensions: the location of the place of work, working hours, business trips, whether teleworking was possible or not, whether it was possible to obtain a transfer, whether colleagues were available for car sharing, etc.

Last, the individual variables that explained whether the households were willing to change their travel behaviour were: the household's attitudes towards the environment; the household's attitude towards the car (some being very sensitive to its potential benefits, others wishing to reduce its use); the household's attitudes towards its activity pattern was rigid or flexible.

3 HOUSEHOLD ATTITUDES TOWARDS THE CARBON TAX AND PERSONAL CARBON ALLOWANCES

The aim of the three discussions that were proposed to the households was to analyze their attitudes towards a carbon tax and PCAs in order to gain a better understanding of the social acceptability of these measures. As the PCAs system was new to the households, many of the questions dealt with it. The first topic of discussion concerned the scope of PCAs: what type of fuel consumption should be covered? The second issue related to the allowances allocation mode: how should allowances be distributed between households? The third related to the preference of households with regard to the proposed system: would they prefer the carbon tax or PCAs?

3.1 Attitudes concerning the scope of PCAs

The first question we considered was whether PCAs should apply only to car trips or to both car and plane trips.

Table 1: The PCAs should apply to car and plane trips

For	Against	Undecided6	Total7
30	5	3	38

Most of the households thought that the PCAs should apply to both car and plane trips (see Table 3). They were not worried about the PCAs being applied to plane trips as these only involve a small proportion of the population. In addition, these people often have high incomes, and are able to pay for the allowances. They would also avoid paying by cancelling the trips in question which are frequently made for holidays. The households also thought that plane trips consume large amounts of fuel and generate high CO_2 emissions and should therefore be subjected to the quota system in the same way as car trips. Last, some households pointed out that a failure to introduce quotas for plane trips would amount to encouraging people to use the plane in preference to the train as an alternative to the car.

The second issue was whether the PCAs should be applied to fuel consumption for domestic heating purposes, as is considered in the United Kingdom (DEFRA, 2008).

Table 2: Should the PCAs apply to domestic heating?

For	Against	Undecided	Total
11	24	3	38

The majority of the households were opposed to the introduction of allowances for the consumption of fossil energy for domestic heating (see Table 4). This hostility is explained by the inequalities which exist between households with regard to heating. First of all, they felt that all households do not have any choice about how they heat their dwelling, either because they are tenants, particularly in the case of social housing, or because they own a house which they did not build themselves. Under these circumstances the introduction of allowances for domestic heating would be unfair. Last, they considered that all households do not have the same heating needs, as these vary according to the region, the age of the occupants (young babies, elderly people), the surface area of the dwelling, as well as from one year to another (mild or severe winters). So the measures would ultimately benefit some households and penalize others ─ in particular, low income households living in dwellings which are less well insulated and which do not have the resources to carry out improvements in order to reduce their energy consumption. The issue of inequalities put aside, the households were against these proposals because they felt that heating is a natural need which should not be subjected to PCAs and that it would be shocking to have to choose between travel and heating.

Some households nevertheless thought that the measure could be made acceptable under two conditions. The first was if improvements carried out to reduce domestic heating

6 Those household members who did not express a personal opinion or agreement with their partner's statement during the discussions were considered to be undecided.
7 As opinions sometimes diverged within a household, analysis was conducted at individual member level and therefore involved thirty-eight respondents.

consumption (insulation or installation of a wood-fired boiler) were taken into account: it would be possible to introduce PCAs for domestic heating if at the same time there were financial aids for carrying out improvements or if private individuals who had already made improvements were not subjected to the PCAs system. The second was if the PCAs were applied on the basis of the household's level of consumption: it would be possible to introduce quotas for domestic heating if they only applied beyond a certain level of consumption.

3.2 The method of allocating PCAs

The second discussion attempted to determine what households considered to be the most equitable way of allocating allowances, i.e. should they be allocated on the basis of household car ownership, household size or residential location?

Table 3: The allowances should not just be allocated to motorists

For	Against	Undecided	Total
20	9	9	38

Most of the households were opposed to the idea of allocating the allowances only to motorists. They considered that the measure was too restrictive: everybody should have a right to consume fuel and individuals who do not own a car may also need allowances under some circumstances (hire car, car sharing, taxi, etc.). They also thought the measure would be counterproductive as it would not reward individuals who use modes of transport other than the car (public transport, bicycle, walking) and could even encourage them to have a car in order to obtain allowances which they could then sell.

However, the majority of the households were in favour of modifying the allowances allocation according to the size of the household.

Table 4: Allowances should be allocated on the basis of household size

For	Against	Undecided	Total
23	10	5	38

They felt that household size, in particular the presence of children, influences fuel consumption, as it is responsible for additional drop-off trips and because it makes it necessary to own a particular type of car, which generally consumes more fuel, or even to own two cars. Some of the respondents nevertheless suggested that the allocation should be varied by giving fewer allowances to children than to their parents.

Last, most households felt that it would be more equitable to give more allowances to households that lived a long way from a city than to households which lived in one.

Table 5: Allowances should be allocated according to the residential location of households

For	Against	Undecided	Total

24	8	6	38

They considered that households who live a long way from cities have poorer public transport services than those who live in a city. They also thought that households who live a long way from cities have to make more car trips as they lack local services. Last, they considered that households who live a long way from cities should not be penalized in terms of their access to the resources of the city (leisure, employment, services).

Nevertheless, some respondents imposed a number of conditions on this proposition. They agreed that households who live a long way from urban areas should receive more allowances, but on condition that the households in question need to travel into the centre. For example, a farmer who works on his land would not need a greater number of allowances. Other respondents agreed that households living in a central urban area should have fewer allowances, as long as the central areas in question is part of a large city like Paris or Lyon where public transport supply is genuinely better (metro, tram, bus), which is not the case in the central areas of medium-sized towns and cities, for example.

3.3 Preferences as regards the proposed system

The households did not display a clear preference for one or other of the systems, but seemed highly divided, with a slight preference for PCAs.

Table 6: The preference as regards the proposed system

Carbon tax	PCAs	Undecided	Total
16	19	3	38

In relation to the carbon tax, it is important to stress that the households were more familiar with the system which they often compared with the Value Added Tax (VAT) or the current fuel excise. Its supporters claimed that it has three advantages. First, its operation is simpler, both for the households, as they pay each time at the pump, and for society, as this type of instrument does not require the setting up of a national agency to regulate the system and simply resembles an additional tax. In addition, they felt that the carbon tax is more equitable: all households pay the same and the more households consume and pollute, the more they pay. Last, they considered the carbon tax to be more effective: the households felt that it does not indicate an a priori quantitative target with regard to the reduction of consumption and only presented gains, unlike the PCA system where the consumption reductions made by certain individuals may be offset by increased consumption by others who purchase allowances.

Those who were opposed to the carbon tax considered that it has three disadvantages. First, they did not think the way it operates has any benefits: it is similar to an additional tax, does not provide households with a stimulus and will just increase over the years, without any guarantee about how the revenue will be used. In addition, they did not think it would be effective: households would not calculate the additional cost generated by the carbon tax but would continue to pay, absorbing the increases in the tax as they occur rather than reducing their consumption and hence their CO_2 emissions. Last, they considered that it is not

equitable: all households pay the same irrespective of their income and high income households would be able to continue to consume while low income households would have to limit their consumption.

The PCAs elicited more impassioned reactions and changes of mind than the carbon tax: households who were deeply hostile to the system at the outset, at the end stated that they preferred it. The supporters of PCAs felt they offered four advantages. The first two of these would make the PCAs more effective: first because they set an upper limit on fuel consumption and therefore on CO_2 emissions, since when the national agency has no more allowances to sell, it will be no longer possible to consume fuel; second because setting an allocation would make households aware of a limit to their fuel consumption which would encourage them to reduce it. Third, they saw PCAs as being more equitable: households would be able to manage their allocation according to their budget. Fourth and last, they felt that PCAs would be better able to make households aware of the environmental issues: having an allocation to manage would make the households aware of the issues associated with reducing their fuel consumption and hence their CO_2 emissions.

Those who were opposed to the PCA system thought that it had five disadvantages. First, they were shocked by its underlying principle which reminded them of the rationing coupons and black market during the Second World War. Second, people would be likely to misappropriate PCAs: these respondents thought the system would generate all sorts of illicit dealing as it would be impossible to make it completely secure (development of a black market, illegal fuel production, fraudulent use, as is currently the case with driving licence points when individuals claim that an elderly person was driving their car when an offence was committed, etc.). Third, they did not view PCAs as being equitable: high income households would be able to buy more allowances and continue to consume fuel, while low income households would be forced to limit their consumption. Fourth, they did not think the PCAs would be effective: households would not reduce their consumption and therefore their CO_2 emissions as they would aim to consume their exact allocation or purchase extra allowances in order to continue to consume as before. Fifth and last, PCAs system would be expensive as in order to operate the system would require large-scale logistics.

The attitudes of households towards the proposed systems therefore seem highly contrasted and their social acceptability appears to be determined by three factors: the system's mode of operation, its effectiveness and its equity.

4 A TYPOLOGY OF THE ADAPTATION STRATEGIES EMPLOYED BY THE SURVEYED HOUSEHOLDS

As they did not all have the same resources or face the same constraints, the surveyed households did not all envisage making the same changes to their travel behaviours or share the same attitude towards the carbon tax and PCAs. In response to the changes in their travel conditions brought about by these systems, households developed adaptation strategies that were appropriate to their specific situation. However, if we look beyond these specific characteristics, applying a typological approach allows us to identify certain adaptation strategies that were shared by a number of households and which explain their

decisions as regards changes to their travel behaviour and their attitudes to the proposed systems. Analyzing the constraints and resources that are involved in the households' decision to change their travel behaviour and the arguments that underpin their attitudes to the proposed systems allows us to identify four types of adaptation strategy: "refractory", "flexible", "constrained" and "cornered".

4.1 "Refractory" households: paying the tax or buying allowances rather than having to change

The "refractory" households above all set out to preserve their lifestyle. They had high incomes, lived either in the inner city or the outer suburbs and travel long annual distances by car, in particular at weekends and during their holidays. They were ready to pay the carbon tax or purchase more allowances in order to be able to maintain the same travel behaviour.

The small number of changes these households considered making to their travel behaviours is explained not only by the constraints they faced but also by their resources. The constraints included: public transport supply, which they considered to be inadequate, whether they lived in the inner city or the outer suburbs; the nature of their jobs which required the use of a car; the fact that they have children which makes drop-off trips necessary; and, last, the desire to maintain their trips at weekends and during the holidays.

But their lack of change was also due to their resources. The most important of these was income: these households stated clearly that the additional price they paid over the year was not enough to encourage them to change their travel behaviour, whatever system was introduced, even when the price of fuel was raised to €2.40 with the carbon tax or they had to purchase allowances to cover 75% of their fuel consumption. The second resource available to them is related to their job-related benefits: they often had a company car whose maintenance and fuel for daily trips were paid for by their employer.

The "refractory" households were extremely hostile to PCAs because the system introduces a constraint. These households had the financial means to cope with the increase in their transport costs and wished above all to preserve their lifestyle. However, they saw having to limit their fuel consumption, even if they were able to get around this by purchasing additional allowances, as an infringement of their liberty and a criticism of the way they usually organized their travel. The carbon tax, on the other hand, had the advantage of being less visible on a daily basis as households pay whenever they buy fuel and no limit is involved.

4.2 "Flexible" households: changing rather than paying the tax or buying allowances

Unlike the refractory households, the flexible households tried to modify their travel behaviour to avoid paying the additional cost resulting from the carbon tax or the purchase of allowances. They had moderate incomes and kept a close watch on their transport budget. They travelled long annual distances by car, in particular to visit family and friends, and travelled more than other households for shopping or drop-off purposes. They lived either in

the inner city or the inner suburbs and made more use than other households of modes of transport other then the car (walking, bicycle, urban public transport, train).

First of all, these households decided either to reduce the frequency or change the modes they used for their non work-related daily trips (shopping, drop-off, leisure and visiting). Once they had exhausted all the possibilities, most of these households then thought about changing their car. It was relatively easy for them to consider this, as the majority of them had already thought about doing so. However, while some of them were simply thinking about replacing an old car with a new more efficient model, others were wondering whether they needed two cars, or whether it was right to buy a conventional (petrol or diesel) car. Thus, households which previously owned two conventional cars changed to one conventional car and a hybrid car, or a hybrid car and a motorized two-wheeler or a conventional car and a hire car. Their ability to change their travel behaviour is explained both by the financial constraints facing them and their resources. The latter included a critical attitude towards cars, public transport supply which was adequate for some of them and a flexible activity pattern for others.

Most of these households were fundamentally hostile to the carbon tax, judging it to be inequitable as the same tax is applied to all households irrespective of income. They showed a clear preference for PCAs, and thought the allocation would help them manage their budget better. They also feel that the allocation principle, as it provides households with an objective, would be more likely to encourage them to reduce their fuel consumption, give them a sense of responsibility and make them aware of the environmental impact of their changes in travel behaviour.

4.3 "Constrained" households: changing when they can no longer pay the tax or buy allowances

The "constrained" households paid the carbon tax or bought additional allowances as long as they could afford to do so, but were forced to make radical changes when the cost really became too high. These households had moderately high incomes and mostly live either in the inner or the outer suburbs. They travelled large annual distances by car, but, unlike the other households, this travel was mainly for work-related purposes rather than weekends and holidays, as many of these individuals worked very far from home. Many of them already used modes other than the car when possible (walking, bicycle, bus, train).

These households had little margin for manœuvre as regards modifying their travel behaviour, due to the large number of constraints they were under: their jobs often obliged them to use a private car; they often had children and therefore had to make drop-off trips; they wished to preserve the small number of trips they made at weekends and during the holidays; they suffered from poor public transport supply and the inadequacy of alternative transport (hybrid vehicles, biofuels, car sharing); and they were devoted to the car which enabled them to cope with all the foregoing constraints. The only resource these households possessed was their income level, but as this was only moderately high, after a certain time they were compelled to think about changing where they live or where they work. They often

chose the latter, because in many cases they had already considered it as they were aware of the job opportunities near where they live.

The opinions of the "constrained" households about the proposed systems were divided. Some of them prefer the carbon tax because it seemed easier to implement and more egalitarian because all households pay the same tax. Others are more in favour of PCAs which they considered to be better regulated and more able to adapt to specific situations. However, they all stressed the need for measures of this type to take better account the constraints arising from working a long way from home.

4.4 The "cornered" households: unable to change and unable to pay the tax or buy allowances

The increase in their transport costs as a result of the carbon tax or the PCAs forced the "cornered" households to try to reduce the small number of their trips for which they have some margin of manoeuvre, but they very soon exhausted the possibilities. They had low incomes, lived in the inner or outer suburbs and travelled large distances annually, almost exclusively by car. They differed from the other households because they covered as many kilometres for their work as at weekends or during their holidays. Their weekend and holiday travel was usually restricted to visits to friends and family.

When faced by an increase in their transport costs, the only solution available to these households was to reduce the frequency of their visiting trips. However, they soon exhausted all the possibilities and, as they were not able to pay the additional price that resulted from the fuel tax or purchase additional allowances, they soon reached breaking point and left the game. The difficulty these households had in adapting was due to the combined effect of the constraints facing them: they had low incomes, public transport supply was inappropriate, the nature of their jobs was not conducive to a change in transport mode or car sharing, and alternative vehicles (bicycles and electric cars) were inadequately subsidized.

The difficulties these households had in changing their travel behaviour made them feel that they were victims of the systems and above all revealed the disadvantages of both the carbon tax and the PCAs. They criticized these types of measures on the grounds that they introduced constraints without proposing any alternative solutions.

CONCLUSION

The results of this study are based on a small sample of households and of course no generalisation can be inferred from. However the richness of the material gained from these in-depth interviews about new policies, that may be implemented but are not yet experimented by people offer some fruitful insights.

We have identified the types of travel behaviour changes envisaged by households, the explanatory variables for these behaviour changes and analysed household attitudes to the

carbon tax and PCAs. Finally, we have drawn up a typology of the strategies employed by households in relation to the introduction of systems of this type.

The travel behaviour changes the households most readily envisaged were modal transfers or reducing the frequency of their trips. Other adaptations were also envisaged, for example car sharing, changing vehicle or changing their place of work or place of residence. However, although the households occasionally mentioned the possibility of reducing the distances they travelled at weekends or during the holidays, they never finally decided to do so.

The households were most willing to consider changing their daily trips, and their shopping, drop-off and leisure trips more than their commuting trips. However, the majority of households attempted to maintain their long distance trips at weekends and during the holidays.

The attitudes of the households towards the tax or the PCAs seem very contrasted and the social acceptability of these instruments seems to be determined by how well the households understood their operation and how effective and equitable they perceived them. The households did not show a clear preference for either of the instruments, and on the contrary seemed to be very divided.

Most of the households felt that the PCAs should apply equally to car and plane trips. However, they thought the PCAs should not apply to domestic heating. With regard to allocation, most households were opposed to the idea of allocating allowances only to motorists. Moreover, they thought that allowances should be allocated according to household size and residential location.

Last, we have classified households on the basis of their adaptation strategies, the four categories being “refractory”, “flexible”, “constrained “ and “cornered”.

This qualitative survey now requires a quantitative stated preferences survey in order to validate or invalidate this typology but also specify the trades-off observed between long distance and short distance trips, and assess the thresholds of tax or quotas at which the changes would occur and their impacts on CO2 emissions.

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