ESRC Transport Studies Unit, University College London

Changing Travel Behaviour

Phil Goodwin, Sally Cairns, Joyce Dargay, Mark Hanly, Graham Parkhurst, Gordon Stokes, and Petros Vythoulkas

Script of a Presentation given at the Bloomsbury Theatre, London, 20.9.2004

In 1994 the Economic and Social Research Council designated its research centre in the field of transport, the ESRC Transport Studies Unit. Work began at Oxford University, and in 1996 moved to University College London. A final event was organised in London to mark the end of the 10 year programme; it was attended by some 400 people interested in transport research and its applications. Following a presentation by current and former members of the ESRC Transport Studies Unit, there were wide ranging debates and discussions. A response by the ESRC, a commentary from the point of view of transport journalism, and a full list of the published books, papers, substantial articles and research reports produced from the programme are published as annexes to this paper, on the website http://www.cts.ucl.ac.uk/tsu/tsuhome.htm The listed publications also contain full details of the data and methodologies used for the research, as well as acknowledgments to the co-authors, collaborators, colleagues and predecessors on whose work we have built.

Particular acknowledgments are due to ESRC, the primary sponsor over the ten years. Two Universities, Oxford and UCL, have both been essential hosts. The research has been augmented by many other agencies, including the Department for Transport, London Transport, Rees Jeffreys Road Fund, and others.

The final conference was given intellectual support of the Transport Planning Society and the Institution of Civil Engineers, organisational support from PTRC, and sponsorship from Steer Davies Gleave, the BAA, Colin Buchanan and Partners, VIPRE, Traffic Demand Management, and Lancashire County Council.

Changing Travel Behaviour: Presentation Script

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Introduction

Phil

From now until lunch we shall give an account of selected themes from our ten year research programme. This will be a straight presentation of research results from all seven of us, quite tightly organised, and without questions as we go along – I hope you'll bear with us on that. Some of it will be heavy-going, but most of it will be quite accessible, we hope. This afternoon, we have provided virtually all the time for discussion and debate from the floor, mostly about current short term and long term policy problems. During this, I already know about planned contributions from the Department for Transport, and the Highways Agency, and the Strategic Rail Authority, and local councils, and many of the influential voices[1] who have steered the transport debate – too many to list, but we'll hear from them later.

I should introduce the TSU team

Joyce Dargay, Sally Cairns and I, have been in the research throughout. **Mark Hanly** joined us in 1998. **Graham Parkhurst** was involved in the work from the beginning, and left to become senior lecturer at the University of West of England two years ago. **Petros Vythoulkas and Gordon Stokes** were involved in the early stages, and have returned for this final event.

We had a problem in deciding what to do. We've worked for ten years, and written over 200 books, journal articles and research reports, as well as lots of shorter pieces. The transport research agenda we have worked to is familiar to you: the role of transport in everyday life and the economy as a whole; the central importance of environmental considerations, and of social inclusion, and safety, and congestion, and price, and quality of operations; the short and long term objectives; British and overseas experience; ground, air, and sea transport; vehicles and walking; urban and rural differences; public attitudes, and the theory and practice of formal modelling; using quantitative and qualitative methodologies.

[1] Among those who spoke in the afternoon discussions were: David Adder, Richard Allsop, Jillian Anable, Steve Atkins, Bill Billington, Brenda Boardman, Denvil Coombe, Christopher Foster, Malcolm Grant, Gary Grubb, Carmen Hass-Klau, Peter Headicar, Mayer Hillman, Derek Halden, Martin Higginson, Stephen Joseph, Glenn Lyons, Ben Plowden, Rana Roy, Lynn Sloman, Juliet Solomon, John Swanson, Derek Turner, Jacqui Wilkinson.

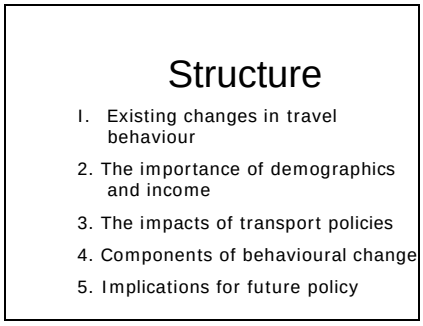
We had a voice in all of that, as have many people here. But it would make for a completely indigestible day to try to give you a summary of all this. So what we have done is select a single linking theme, and be rather brutal in selecting only that research which illuminates it. That theme - **Changing Travel Behaviour** - is important to every single one of the other topics. But I hope we will not be misunderstood – we are not saying this is the only topic of importance, to us or to you.

You'll notice that this title is, quite deliberately, ambiguous – Changing as a description of what actually happens, whether we will it or not. And changing as an active intent by public or private agencies. The twin basic propositions are

Travel behaviour does change,
and by understanding this
Travel behaviour can be changed.

You'll notice that there is a third, implied statement here: travel behaviour *should* be changed. That's *not* our topic for this morning, but it will be argued about this afternoon. In any case, all three statements are controversial, but the controversies are resolved by different methods, from empirical and theoretical analysis to public debate.

Structure of the Presentation



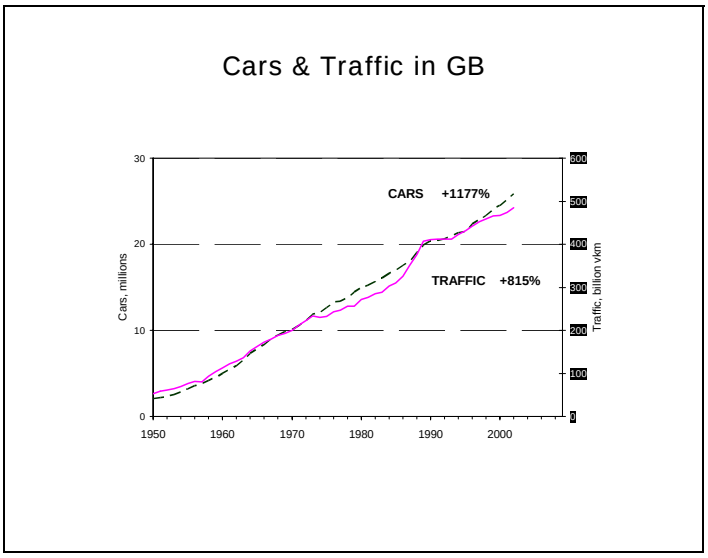
Here is the structure of the presentation. There are five parts: first we establish the nature of the changes in travel behaviour that have actually happened, at the aggregate and disaggregate level. Second we consider the specific effects of two of the most important general influences, namely income, and demographic forces. Third, we consider the evidence on the effect of the sorts of influences that transport policy deliberately bears on – new opportunities such as park-and-ride, increases and reductions in road capacity, increases and reductions in public transport fares and motoring costs, the effects of soft measures such as travel plans and information provision. Fourth, we generalise from these results to consider some theoretical and practical understanding of the nature of changes in behaviour. And lastly – very briefly – we will suggest some policy implications of the work, in the form of questions for wider debate this afternoon.

SECTION 1 - EXISTING CHANGES IN BEHAVIOUR

In one generation, car ownership and use have increased hugely

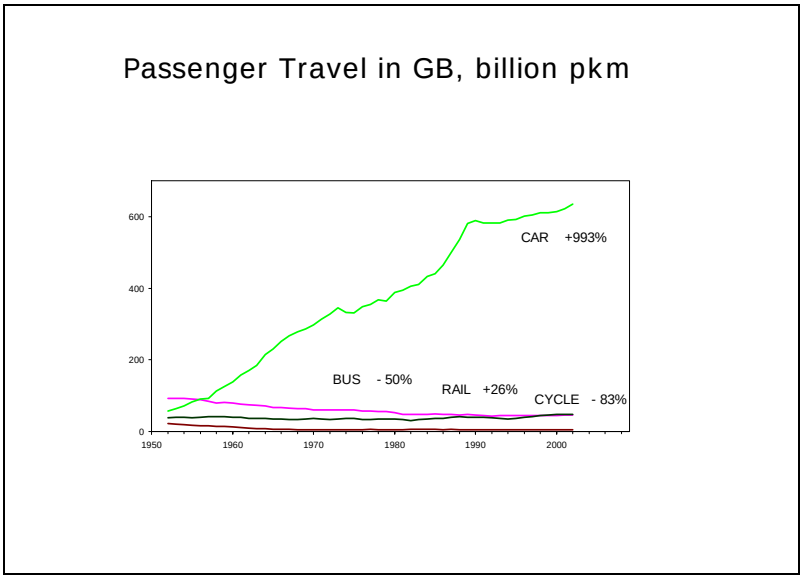
Joyce

It might seem odd to start the analytical part of the presentation by stating what you all know, but there is a reason for it. Travel behaviour has changed enormously in our lifetimes. This is well established at the aggregate level – you've all seen graphs of the increase in car ownership and traffic – as well as probably experienced the resulting congestion on our roads.



Since 1950 the number of cars in Britain increased nearly 1200%. Today 75% of households have access to a car, compared to only 14% in 1950. The increase in car ownership has been the main impetus to increasing traffic, over the same period traffic increased by over 800%.

As we are all well aware, the car has allowed us to travel further distances. 50 years ago we travelled on average 4 thousand kilometres each per year. Today we travel 3 times as far - over 12 thousand kilometres each, without even including air travel



During this period total passenger kms travelled by car increased by over 900%, while rail increased by 26%. All other modes have declined: bus travel by 50%, cycle by 83% and walking probably by more.

Thus we can say – there should be no argument at all – even in one generation, such changes in behaviour, and their consequences for the structure of everyday life, are enormous.

But not all individuals have changed in the same way

However, what we see here are aggregate net changes, which are composed of separate changes in travel behaviour by individuals. As we will see not all these individual changes go in the same direction. Such changes on an individual level are rarely considered in transport analysis. This is because empirical work has largely been based on aggregate time series data, which can only detect net changes, or disaggregate cross-section data, which contains no information about changes at all.

To understand individual behaviour, we need panel data

What we need for this is a different sort of data, in which the behaviour of individuals, or in some cases groups of individuals, is actually tracked over time. What we call panel data. The analysis of panel data has been at the heart of much of our analytical work. We'll now give you a few examples of what we can learn about travel behaviour – in a purely descriptive manner – on the basis of such data. Later we'll show what information these data can give us about the factors determining travel behaviour over time.

An early South Yorkshire Panel Survey

Gordon

Right at the start of the research programme we did some research using panel data from South Yorkshire which showed that apparently relatively slow and steady increases in car ownership across the whole population were actually made up of

many households losing cars and many (usually more) gaining them, with the largest group showing no change.

While some people's car ownership increases, other people's reduces.

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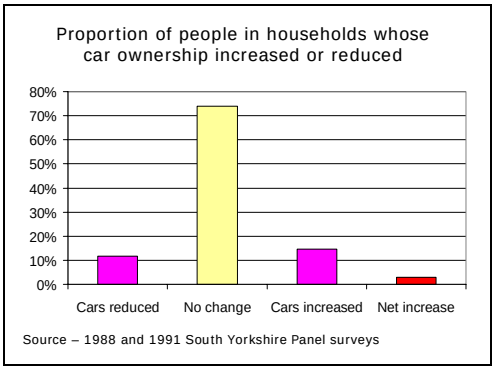
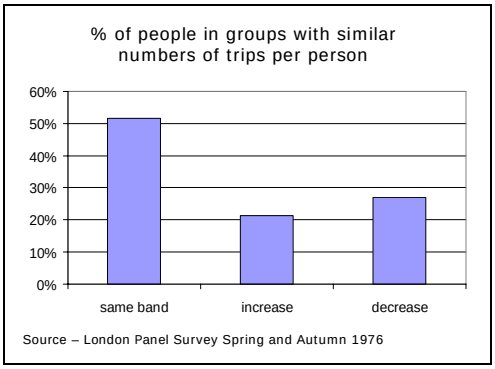


Between five separate panel surveys between 1981 and 1991 a similar pattern was observed. Car ownership would rise by about 3 or 4% over a 2 or 3 year period, but this would be made up by about 13 or 14% of people in households increasing the number of cars in their household, AND 8, 9, 10% reducing the number of cars in the household. This graph shows the figures for 1988 to 1991, and is fairly typical of the other surveys. So, as Joyce said, the individual changes are much larger than what you see if you take 'snapshots' of aggregate data. This has been described as 'churn'.

The total amount of travel people do is also very volatile



We found the same was true of the number of trips people made. Analysis of quite old data from London panel surveys showed that over a six month period there were some major changes. For over 5000 people surveyed there was a very small reduction in the average number of journeys made during the diary week. But even just over this six month period 52% made a similar(ish) number of trips in each survey, 21% made significantly more trips, and 27% made significantly fewer. This survey was done in the aftermath of London's "cheap fares" experiment, and things were changing fast, but the pattern of greater churn is clear again.

We also found the same was true of total time spent travelling. In aggregate terms this is remarkably constant over time (60 to 65 minutes for each 'average' person), and from time to time it has been suggested that the travel time budget is a sort of

universal constant. But that only applies at the aggregate level – for individuals, there is no sign of stability or constancy at all: it can often change quite radically when you make some change in your life, and, apparently, for random reasons as well.

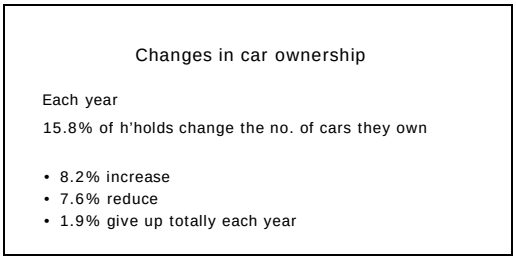
The BHPS – a bigger panel dataset allowing examination of individual changes in behaviour

Mark

Despite their usefulness for analysis of travel behaviour, there are few transport panel surveys that cover more than a small geographic area or a short time period. This is not only true for the UK, but for most other countries. Because of this, much of our work has been based on the British Household Panel Survey, BHPS, which though not a travel survey per se, contains information on car ownership and commuting mode & time, along with a large number of socio-economic and demographic variables which are important in determining travel behaviour.

BHPS confirms that car ownership reduces as well as increases

The BHPS lets us examine changes in car ownership for individual households. Over the past decade the number of cars per household has increased by 0.2% per year, on average.



This small net increase conceals the fact that a relatively large number of households – 15.8% - change the number of cars they own between any two years. Slightly less than half of these - 7.6% of households reduce the number of cars they own, and 1.9% give up car ownership totally.

Main mode for commuting changes from year to year

A similar volatility is noted for commuting mode – nearly 18% of commuters change main travel mode between any two years.

Main Commuting Mode, % of commuters

	rail	tube	bus	m'cyc	car driver	car pass.	cycle	walk
ave. yr	3.3	1.4	6.2	1.5	66.9	7.4	3.3	9.7
at least n years								
1	7.8	3.9	16.5	4.7	83.1	25.0	9.4	22.1
2	5.6	2.6	11.5	3.1	79.3	13.9	6.2	16.4
3	4.9	1.9	8.4	2.2	76.3	9.4	3.9	12.9
4	3.4	1.6	6.7	1.5	73.4	7.2	3.4	10.6
5	2.9	1.2	5.4	0.9	70.8	5.3	2.8	8.5
6	2.5	0.9	4.4	0.7	67.8	4.5	2.3	7.4
7	2.0	0.6	3.6	0.7	63.9	3.5	1.7	6.5
8	1.6	0.4	2.7	0.5	58.7	2.6	1.3	5.6
9	1.2	0.4	1.8	0.4	53.4	1.9	1.2	4.3
10	1.1	0.2	1.4	0.2	42.4	0.9	0.9	2.4

Here we track 'main' modes of transport for the journey to work for a sample of people for whom data are available over a 10 year period. For example, in the car passenger column, we see that for the average year, about 7.4% of journeys to work were made as car passengers. Of these, less than 1% were car passengers in **every** year out of the ten. But almost three times as many - 25% commuted mainly as car passengers **for at least one year** out of the decade.

What this implies is that although only a small proportion of the population may use a particular mode in any given year, they are not the same individuals each year, so that over a period of years the number of individuals using the mode in one year or another is much greater. Of course, if we include trips for purposes other than commuting, we'd find the proportion of individuals using any given mode over a longer time period is even greater.

So Individual Behaviour is Volatile. Can Demographics and Income Explain such Changes?

Phil

That's the end of Part 1. To summarise our findings: at the aggregate level, average travel behaviour has changed enormously during the period of one life time – mostly, apparently, in the same direction. But underlying that, individual behaviour changes more than the average, and includes substantial proportion of people changing in the opposite direction to the average. For whatever reason, behaviour is evidently very volatile.

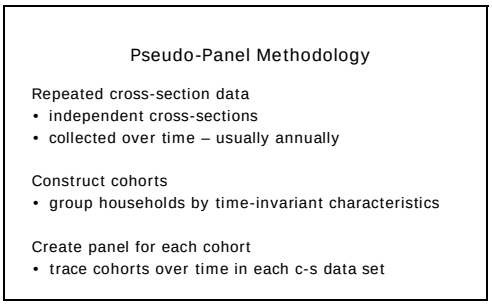
Simply to establish that change happens is important, in a policy debate where one argument is that nothing moves. But it's not useful information until we know something more about what drives those changes. We start with the factors that are normally not considered to be transport policy instruments at all, demographic trends, and movements in income.

SECTION 2 – THE IMPORTANCE OF DEMOGRAPHICS AND INCOME

Pseudo-panels can give insights about the factors affecting individual changes over time

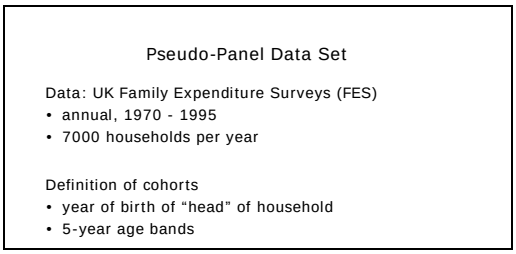
Joyce

Since existing panel surveys for the UK have relatively little travel information – like the BHPS – or are only for a specific region – like the South Yorkshire and London panel, we've needed to devise methods of looking at the process of behavioural change from other types of data. Early on in the ESRC programme Petros & I became interested in pseudo-panels, which had not previously been used in the transport field.

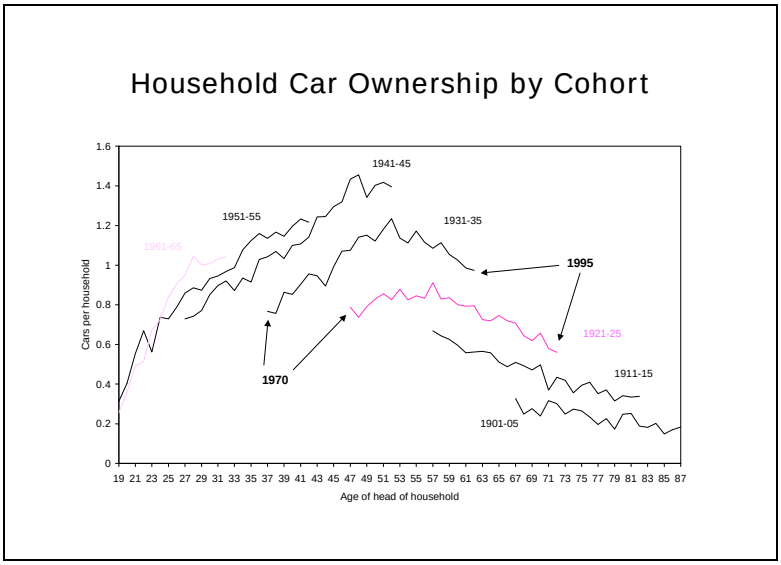


The idea behind this is to use cross-section data collected at different points in time to construct something resembling a panel – not of individuals, but of individuals sharing the same characteristics. Such groups of individuals – generally called cohorts - are then followed in each of the annual data sets, and the average values for car ownership, income etc are treated as observations in a panel.

We constructed a pseudo-panel from the Family Expenditure Survey



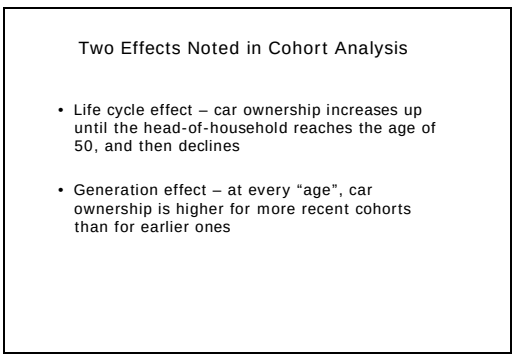
Our pseudo-panel data set is constructed from the annual UK Family Expenditure Surveys over a period of 25 years. We define the cohorts by the year of birth of the head-of-household in 5-year bands. These cohorts are then followed over time using the annual data sets.



This graph shows car ownership for a selection of these cohorts over time. The age of the household head is given on the horizontal axis, and car ownership on the vertical. The lines represent the different cohorts, with the birth-year bands given adjacent. The initial data point for each cohort is obtained from the first survey in which an observation for the cohort is available, generally 1970, while the final data point is obtained from the last survey containing a comparable observation, generally 1995. For example, for the cohort in labelled 1931-35, the head was born between 1931 and 1935. His/her mean age was 37 in the 1970 survey and 62 in the 1995 survey. The average household in this cohort owned about 0.75 cars when the head was 37 years of age. Household car ownership increased until the head approached the age of 50, reaching a maximum of 1.2 cars, thereafter declining to 1 car by the age of 62.

The work shows a 'life-cycle' and a 'generation' effect

Two effects are discernable in the figure: a *life-cycle effect* - car ownership increases until the head is in his/her early 50s, and then declines; and a *generation effect* - at every 'age' car ownership is higher for more recent cohorts than for earlier ones. A similar pattern of lifecycle and generation effects can also be seen for car use.



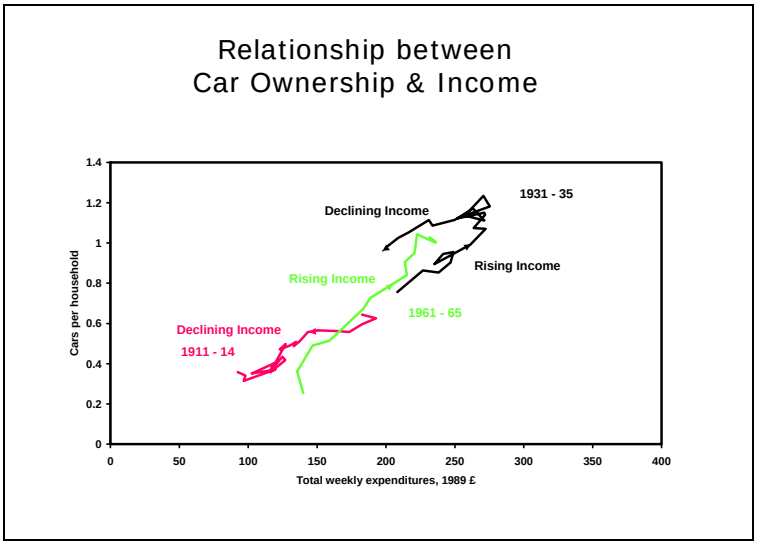
Income is a partial explanation

This pattern can partially be explained by differences in household income over the life cycle and differences in real income between generations. Household income increases up until the head reaches his/her late 40s and declines thereafter. Similarly, at each age, real incomes are higher for more recent generations, due to general real income increases over time.

The change in number of adults in the household over the life cycle is clearly an important determinant of household income, car ownership and car travel. As young adults form households, income increases, and first, then perhaps second, cars are purchased and car travel increases. This is compounded as their children grow up and learn to drive - often contributing to the household income and obtaining cars of their own. Later, both car ownership and use decline, as adult children leave home taking their car with them or through the disposal of second cars, and finally predominantly through the death of a spouse.

However, the relationship between income and travel behaviour is not symmetrical

In contrast to the aggregate trends shown earlier, we see that on an individual household level car ownership and car travel go down as well as up over time. Although this is largely explained by changes in income and household composition over the life-cycle, there is evidence that the relationship between car ownership and car travel and income may not be symmetric. This can be seen in the diagram.



The vertical axis shows car ownership per household while the horizontal axis is real income. The earliest cohort shown (1911-15), is representative of pensioner households. The head ages from 59 to 80 over the observed time period and both car ownership and income are declining. The most recent cohort shown (1961-65) – is an example of a relatively young household, with the head ageing from 20 to 30. Both income and car ownership are increasing rapidly.

The impacts of income increases are not necessarily the exact reverse of the impacts of income reductions

Comparing these two cohorts, it is apparent that the slope of the line indicating the car ownership – income relationship is greater for the increasing income case (green line) than it is for the decreasing income case (red line). Rising income leads to increased car ownership, but when incomes fall car ownership is not reduced to the same degree.

This asymmetry is clearly exemplified in the middle-aged cohort (1931-35). Here, we follow the cohort as the head ages from 35 to 60. Between the ages of 35 and 50, household income and car ownership are increasing; while after the age of 50 or so both income and car ownership begin to decline. But the same path is not followed. As income declines, car ownership declines, but to a lesser degree than it rose as income increased. For each income level we have **two** rather than **one** level of car ownership depending on whether income is increasing or decreasing. Thus there is no unique car ownership-income relationship, but rather what we call a hysteresis loop. The explanation for this is a simple one: households have become accustomed to the advantages car travel. Such car dependency is not easily reversed, so there is a tendency to maintain car ownership in spite of falling income.

SECTION 3: THE IMPACTS OF TRANSPORT POLICIES

So behaviour is complex, and changes over time. Can policy affect this?

Phil

So in part 2 we identified the powerful effects of demographic influences, and of income. I should say, of course, that this in itself is not new – everybody accepts they are powerful. What is new is the nature of that influence, and in particular that the relationships take place over very long periods of time – decades – and the two factors interact with each other. This feature of asymmetry, or hysteresis, is important. It means that even though change is universal, it is more difficult to reverse a long-established trend than to accelerate it.

That is manifestly important when it comes to those policy initiatives which are intended either to provide capacity for demand growth, or to reduce or reverse that growth – if hysteresis applies, the two would not be opposite and equal. Part 1 demonstrated that habits cannot be overwhelmingly powerful, but part 2 suggested that they still have some degree of power.

So what we do next is consider the question directly: what effects do policies really have?

Caveat – observations of difference do not translate into forecasts of change

Here I should briefly mention an analytical problem in the tradition of transport studies. The longest-established methods of forecasting the effects of a new policy or facility is to use a model which is itself based on observing differences in choices

made by different people at a point in time, not by changes made by the same person over time. The presumption is –if we understand and estimate models which explain *what is,* then the relationships we find can be extended to predict what will happen if one of the influences *changes*.

That's not always true. And it's sometimes very misleading indeed. Observation that people with cars make fewer public transport trips than people without cars does not of itself tell us what happens if a non-car owner buys a car, and certainly not if a car owner stops being so.

So what we have done is to seek contexts where such a change has happened, and observe or measure the change in travel behaviour that follows. The next section does in part use formal models for analysis of the data, but most of the changes we will discuss are those that have actually happened, *not* modelled forecasts of change.

We'll start off with a problem that arose from a rather simple policy, park-and-ride.

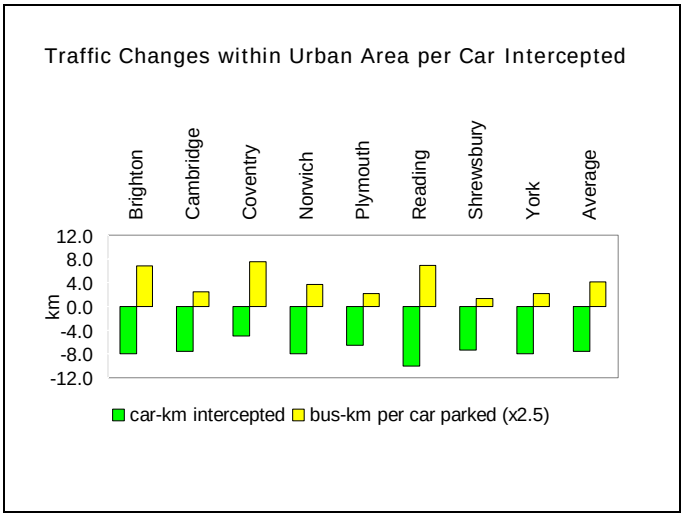
Park and Ride – the problem of unintended effects on behaviour

Graham

One unexpected example of complex behavioural responses to a new system emerged from investigations of the effects of bus park and ride schemes.

The policy intention behind park-and-ride was reasonably straightforward: by placing car parks at the edge of the urban area and linking them to the town centre using superior bus services, targeted specifically at motorists, it would be possible to capture cars before they entered the congested urban area.

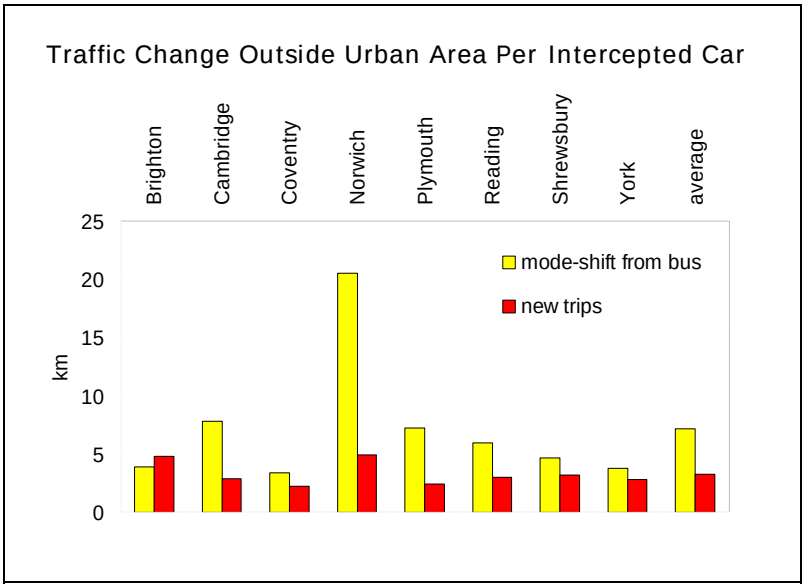
This work was initially focussed in Oxford and York, but was later extended to consider data from around ten other towns and cities.



To cut a fairly long story short, the first key finding was that around half of park and ride users were people who would have driven all the way to the town centre but were instead intercepted at the car park and travelled the last 4 or so kilometres of their journeys on the P&R bus.

An increase in bus traffic also occurs, in providing the additional park and ride bus services. But, as shown by this graph, overall some traffic in the central area is avoided.

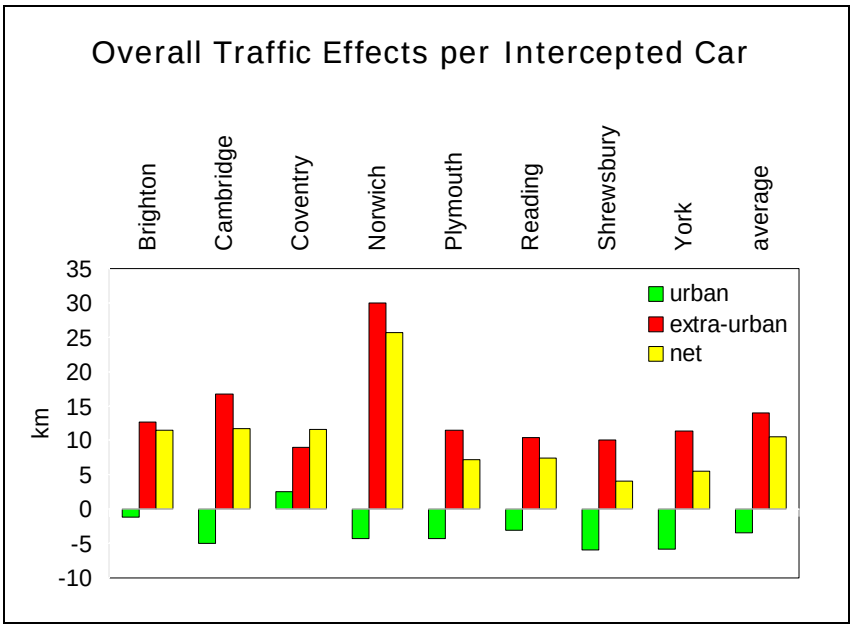
The problems associated with the policy emerge when considering the other half of users who showed different behavioural responses.



In every case-study, and to varying extents, two other types of response were found. Some users indicated that their trips to the particular town were in some way extra compared to the period before park and ride had been made available. This was sometimes the case because a life event such as a new job had led them to alter travel patterns, or perhaps as a result of realising that P&R turned out to be a cheaper way to

travel than using either car only, or bus only, to access the city centre. This occurs because park and ride schemes must often be subsidised to provide an incentive with respect to town centre parking costs.

Now I'm not saying that creating additional traffic to a traditional town centre is necessarily always a bad thing. The more significant source of unintended behavioural response, though, was the observation that an often sizeable minority of users had changed mode of travel from public transport-all-the-way to park and ride, rather than from car-all-the-way to park and ride. As the park and ride sites were located at the edge of the city, some of the trips now made by car as far as the park and ride site, would be relatively long ones, of perhaps 15-20 km.



Park and Ride can reduce some bus use and increase car use overall

This means that only relatively few public transport users with a car available choosing to transfer to park and ride would be necessary for the reduction in traffic in the town centre to be more than compensated for by the growth in traffic outside the urban area.

Clearly, the outcome that investing in park and ride facilities for motorists resulted in reduced use of public transport was not the intention of either the local authorities or the bus companies. It must of course be acknowledged that many of the schemes have their origins in a period of recent history when the traditional commercial centres were under threat from out-of-town retail development, and central government favoured further road building over placing restraints on car use and promoting public transport.

Things have moved on since. Awareness that there are disadvantages to park and ride as well as advantages has grown. Whilst the problems have not disappeared, park and ride schemes are generally being better integrated with policies to discourage car use and in some cases innovative approaches to park and ride provision are being pursued,

such as providing the car parks on existing bus routes, and locating the car parks further from the towns they serve, so more of the car trip can be intercepted.

Increases in road capacity also has unintended consequences

Induced traffic erodes congestion relief, and increases environmental costs

Phil

The next example is that of induced traffic due to road building, which I'll summarise briefly because it's been widely discussed: I was a member of the SACTRA team which produced the famous report on induced traffic in 1994, right at the beginning of our programme of work, and the empirical side of this was extended later in a number of articles, local studies, and international comparisons.

Where are we on this? What we can say is that we now have observations of hundreds of cases where road capacity has been increased, for reasons of reducing, or displacing, or pre-empting, congestion and traffic has subsequently increased. This is very widely reported, I would not say the we ourselves are the only or even the main contributors to it.

But to be emphatic, there simply is not an empirical case any more to say that induced traffic does not exist.

Its size, or course, varies according to circumstances: an average road improvement, we calculated, had induced roundly 10% of the base traffic in the short run, and about 20% in the long run, and there were some schemes with induced traffic at double this level. Embarrassingly, the biggest levels of induced traffic were on the alternative routes that the scheme were intended to relieve.

If there is little congestion to start with, or expected, then the induced traffic from its relief will naturally be small. But in the average conditions where road capacity increases are considered in the UK, existing or expected congestion is usually rather high. As a rule of thumb, we can say that when extra road capacity initially reduces congestion, which saves some time for drivers, something between half of the time saved, and all of the time saved, will be ploughed back into more, or longer distance, travel, which erodes the benefits and creeps back – sometimes rushes back – towards the conditions of congestion observed before.

It would be nice to leave it there – a problem solved. And for many people here, solved long enough ago to make you wonder why we are bothering to report it all. The reason, alas, is that even now highways schemes are still being assessed on the basis of an argument that induced traffic can be ignored. It's bizarre - a debate which simply refuses to go away, independently of the overwhelming nature of the evidence. Only a few months ago, I saw a statement from the CBI (who were entirely on board in the original SACTRA study) seeming to suggest that induced traffic was unreal or unimportant.

‘Locking-in’ any benefits of road building, by discouraging induced traffic

But things do move on, and the Department for Transport last year introduced the new buzz-word of ‘locking-in’ – referring to the importance of having complementary policies to make sure that improvements in traffic conditions are not eroded by the extra traffic that the improvements themselves attract. This is the first really useful and original policy response to induced traffic in the decade since the SACTRA report, and we’ll hear from the Highways Agency and others this afternoon.

But the significance of the induced traffic discussion for ‘Changing Travel Behaviour’ was that it provided evidence of changes which were big enough to be seen, and important, at the aggregate level. We are evidently not only talking about detailed changes by individuals which get lost in the great volumes of traffic, but changes which are big enough radically to effect total volumes of traffic, and the appraisal of policies aimed at providing for it. It is simply the existence of induced traffic which undermines the legitimacy of ‘predict-and-provide’ – for logical reasons, not political ones. The provision influences the prediction.

In a way, the more interesting point was what came next.

Road capacity reductions

Sally

Following on from the SACTRA report, which showed that increasing road capacity could induce traffic, there was strong interest in the opposite question. What happens if you reduce road capacity, by taking space away from cars ? Joyce has highlighted that all relationships are not precisely reversible. But even if they are only approximately reversible, you’d expect reductions in capacity to have some effect on travel choices.

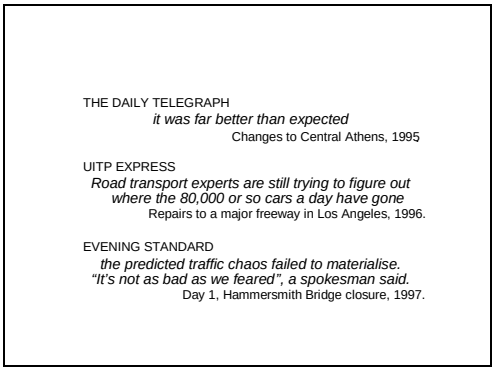
What were then London Transport and the Department for Transport, Environment and the Regions commissioned a study. Phil and I worked on this, together with Carmen Hass-Klau, who brought together the evidence from European cities. MVA did a parallel study of the modelling implications. Our part of the work was empirical – bringing together evidence from real world examples where road capacity already had been reduced.

Many widespread examples of reductions in road

Perhaps the first thing to mention is quite how often road capacity for cars is reduced. Many changes to town centres – pedestrianisation schemes affecting the whole centre - or little schemes affecting only a couple of streets all involve taking some road capacity away from traffic – for example, this slide shows changes made in the centre of Wolverhampton. Road space for cars is also usually reduced by nearly all bus priority schemes - and street-running light rail systems - and cycle lanes – and pavement widening. And, of course, there are a large number of other reductions in capacity due to earthquakes, bridge maintenance, road works and so on. Of course, these situations are all very different – but in all cases, people still have to decide what to do if they can no longer drive along the route that they are used to. In total, we have now been able to analyse information from over 70 locations, in 11 different countries.

Widespread predictions of 'traffic chaos' – usually inaccurate

And these suggest that, usually, when it's planned to take road space away from cars, there are often dire predictions of 'traffic chaos'. However, examining the reports shows that these predictions rarely, if ever, prove accurate. Certainly, where congestion is already bad, it does often stay bad, there can be short-term chaos, and there can be increasing problems on specific local streets. However, wide-scale, long-term major disruption is simply not reported. Instead, some typical quotes are as follows:

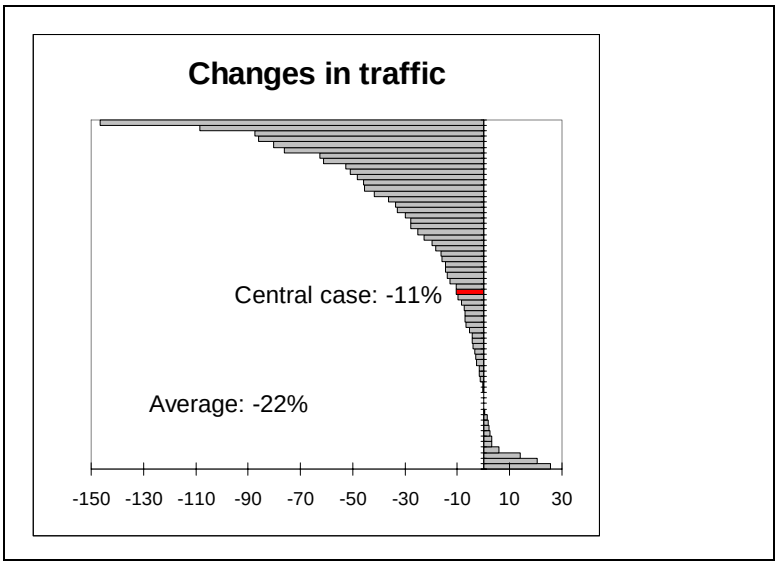


"it was far better than expected": Daily Telegraph, commenting after changes to central Athens in 1995.
"Road transport experts are still trying to figure out where the 80,000 or so cars a day have gone": UITP Express, reporting during repairs to a major freeway in Los Angeles in 1996.
"the predicted traffic chaos failed to materialise. It's not as bad as we feared": the Evening Standard, reporting on day one of the Hammersmith Bridge closure.

Many of you will also remember the forecasts of traffic chaos leading up to the introduction of the congestion charge – which again, didn't seem to occur.

Substantial reductions in the volume of traffic following reduction in road capacity

The core of our work was to get at the data behind these situations. The results from that are summarised here.



In this graph, each bar corresponds to an individual case study of road capacity reduction, and shows the overall change in traffic after road capacity was reduced.

In most cases, traffic levels went down on the streets where capacity was reduced – but then reappeared on neighbouring streets. However, often not all of it reappeared.

Across all case studies, the average traffic reduction overall was 22%, and the median was 11% - in other words, in half the situations that we looked at, more than 11% of the traffic previously using the affected street or area could not be found on the local network afterwards.

The data we had was not sufficient to say whether the decrease in traffic caused by a reduction in capacity is equal and opposite to the increase in traffic caused by an increase in capacity. The orders of magnitude can be similar – observations of 20% and more being not uncommon in both cases. However, we are not aware of any studies, based on controlled experimental principles, that have investigated this.

It was in this work that we were also able to put together some of the evidence about the different type of behavioural responses that people were making, which we'll come back to in Part 4.

Price

Phil

But before that, the next influence we consider is that of price: this changes partly for reasons of policy, and partly for reasons of underlying developments in technology or the economy, but we are interested in the responses that people make in either case.

Elasticity – a convenient indicator of the impact of changes in prices

Elasticity

The percentage change in demand caused by a 1% change in price.

'Elasticity = -0.5' means, if price increases by 10%, demand goes down by 5%

I guess most of you are familiar with the word of elasticity, and some of you will be quite irritated about how often it is oversimplified. Which I shall now do: elasticity is a measure of how sensitive the volume of travel is to specific influences such as price, speed, etc. It is a convenient dimensionless constant, very easy to interpret: an elasticity of -0.5, for example, means that if price goes up to 10%, demand will go down by 5%. It is always driven by individual disaggregate choices by specific people for specific journeys, but usually expressed for the whole market.

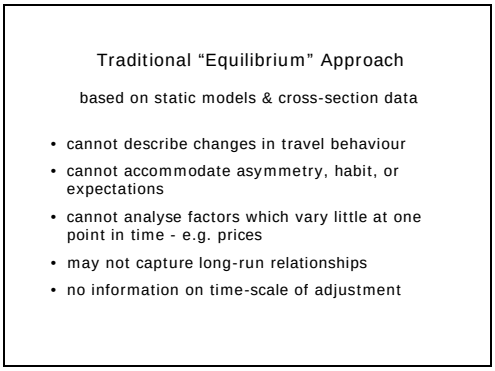
For decades, it was thought that these measures were reasonably well established. The bus fare elasticity, for example, was -0.3. If you put bus fares up by 10%, you'd lose 3% of your market, but still make extra revenue. And the fuel price elasticity was smaller. The DfT assumed, for a while, a figure of about -0.1 to -0.15, ie an increase in fuel price of 10% would reduce traffic volume a little, 1% or so, but not enough to make a difference to anything in practical terms.

Transport elasticities – formerly estimated from equilibrium models and methods

Joyce

But what sort of elasticities are these? Let's look at how they have probably been arrived at.

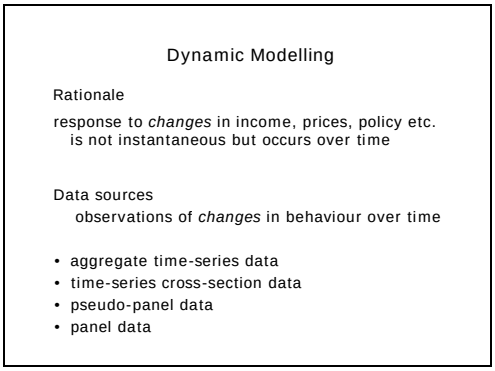
Transport modelling has typically employed an equilibrium approach, generally estimating static models on the basis of cross-section data. The elasticities resulting from equilibrium models are hard to interpret, since they relate to differences in behaviour *between* individuals at *one* point in time rather than *changes* in the behaviour of individuals *over time*. Because of this, static models cannot take into account asymmetry, habit or expectations, nor can they measure the effect of factors which vary little at one point in time – for example, prices. It is thus unlikely that they capture true long-term effects. In fact nothing is known about **when** the response occurs.



The elasticities quoted above – and typically used for policy analysis – are generally estimated using an equilibrium approach and thus most probably underestimate the true long-run response.

Dynamic methods – a better way of estimating elasticities which distinguish between short and long run effects

Our work rejects equilibrium modelling in favour a dynamic approach.



Why dynamics? Well, it seems pretty clear that the response to changes in prices, policy etc is a process which occurs over time. This is because of the existence of factors such as habits, uncertainty, imperfect information, and costs of adjustment. To analyse this process we thus need to observe how travel behaviour changes over time. This can be only be done with longitudinal data, for example, aggregate time-series data for the country or a region; a combination of cross-section time-series data – eg, regions over time, pseudo-panel or true panel data.

The process of change is described by a dynamic model.

Dynamic Model

$$D_t = f(X_t, X_{t-1}, ..., X_{t-N} D_{t-1}, ..., D_{t-M})$$

D_t = rail kms, bus journeys, car ownership

X_t = prices, income, other characteristics of individuals or modes

Dynamics represented by demand and/or X in earlier periods (t-1, t-2,…)

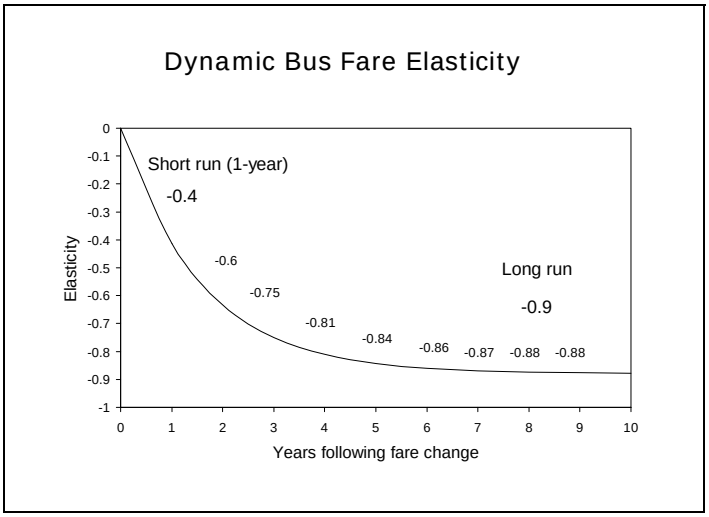
A dynamic model necessarily contains variables relating to different time periods: demand (D) in period t is related not only to values of the explanatory variables (X) in the same period, but also to demand and/or values of the explanatory variables in previous periods (t-1, t-2 etc). Dynamic models do not result in a single elasticity, but a series of elasticities measuring the effects over different periods of time. The short-run elasticity is the defined by the time period of the data. For example for annual data, the short-run price elasticity would be the effect on demand that occurs within one year of the change. The long-run elasticity is the total response after all adjustment has been made. The time period required for full adjustment is estimated from the data.

One of the most important themes of our work has been to provide more reliable estimates of price sensitivities. Our estimates are obtained from the application of econometric – or statistical – methods to dynamic models using various sorts of longitudinal data. The models aim to give as full a representation as possible of all of the factors determining demand – prices, income and other socio-economic and demographic factors. We'll report two specific sets of results, first for bus patronage, and then for car ownership.

Bus Fare Elasticities

Mark

Our study of bus fare elasticities was carried out for the Department for Transport in collaboration with TAS Partnership Ltd. The main objectives were to estimate elasticities which could be used in policy calculations to project the change in bus patronage nationally as a result of a given 'average' fare change. We used national, regional and county data on bus patronage, fares, service and income over time and a dynamic model.



If bus fares increase by 10%, patronage will reduce (on average) by 4% on the short term and 9% in the long term

We found the fare elasticity for Great Britain as a whole to be about –0.4 in the short run and –0.9 in the long run. This means that if the average fare *of all operators in a local market* increases by 10%, total patronage will decline by 4% within one year. The complete response takes around 7 years, by which time patronage will have declined due to the fares change, by a further 5%, giving 9% in total, not taking account of changes due to other factors such as income, car ownership, or inflation. The dynamic elasticity is illustrated in the figure. The fare elasticity increases over time, but at a declining rate, finally to reach its long-run value. Clearly, the estimated long-run elasticity of -0.9 is much higher than the elasticity of -0.3 previously taken as given.

Other results of this study are that the fare-elasticity increases at higher fare levels, and is greater for non-urban than in urban areas. Service – in terms of vehicle kms – is also found to have a substantial impact on patronage.

Car prices, fuel price and income – all affect car ownership and use

Joyce

As another example, will look at our estimates of elasticities for car ownership and car travel. These have been obtained by applying suitable dynamic models to the pseudo-panel data shown earlier. A number of different model specifications were estimated and the results shown here are average values.

Average Elasticities

	Car ownership		Car travel	
	short run	long run	short run	long run
Car purchase costs	-0.1	-0.2	-0.3	-0.4
Fuel price	0	0	-0.1	-0.2
Income	+0.3	+0.7	+0.7	+1.0

Again we find a significant difference between short- and long-run elasticities. Car travel response more strongly and more quickly to price and income changes than car ownership. Both car ownership and car travel are more sensitive to car prices than to fuel prices, but income is by far the most important determinant of both.

Car Ownership & Car Travel

- car use responds more rapidly than car ownership
- more sensitive to car prices than to fuel prices
- income most important explanatory factor
- car travel more responsive than car ownership

- rural households less-sensitive to prices
- price elasticities decline with increasing income

- asymmetry wrt rising & falling income
- saturation - income elasticity declines with increasing car ownership & use -

Our modelling work also provides evidence of differences in elasticities between individuals. For example, households in rural areas are less price-sensitive than urban households regarding car ownership and use – opposite to what we found for bus use. In addition, high income households are less-price sensitive than others. Both of these findings have implications for the distributional effects of price-related policies.

We also find statistical evidence of saturation – the income elasticity declines at higher levels car ownership and use – and of asymmetry with respect to income.

The long run effects of price on behaviour are bigger than the short run effects

Finally, from a recent review of the literature we find that the elasticity of traffic with respect to the fuel price is -0.1 in the short run and -0.3 in the long run. This is about half the elasticity of fuel consumption with respect to the fuel price, implying that a significant part of the response to fuel price increases is through the use of more fuel efficient vehicles, rather than through reducing car use.

Elasticities wrt Fuel Price per Litre
Literature Review

	short term	long term
fuel consumption	-0.25	-0.60
traffic volume	-0.10	-0.30

Taken together, these and our own results give pretty clear evidence that price has a greater effect on demand than was previously thought – particularly in the long run.

'Soft' methods of changing travel behaviour, by changing the quality, perceptions and provision of transport alternatives

Sally

In terms of affecting travel behaviour, as well as interest in pricing and road provision, there has also been increasing interest in the **quality** of transport alternatives, and the information and perceptions that people have about those alternatives.

This is the so-called 'softer' side of transport policy, and there are various 'soft factor policies' which specifically aim to alter the quality of alternatives, people's knowledge and perceptions about them, or which aim to provide entirely new ways of doing things altogether.

As part of a collaborative team, together with Lynn Sloman, Carey Newson, Jillian Anable and Alistair Kirkbride – all here today, I'm pleased to say - we recently looked at 10 soft factor policy measures for the Department for Transport. These were

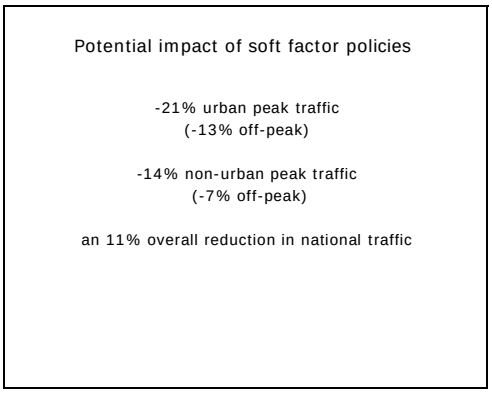
- workplace and school travel plans
- personalised travel planning
- public transport information and marketing
- travel awareness campaigns
- car clubs and car sharing schemes
- telework and teleconferencing, and
- home shopping schemes.

Most of these policies are relatively new – dating back 10 years or less - although the amount of local authority experience of implementing them is growing rapidly – largely because there are some very positive reports of their effects – particularly in terms of their effectiveness at cutting traffic levels.

We were specifically asked to estimate the overall effect that they might have on future traffic levels, in about ten years time, if they were made a serious part of mainstream transport policy.

Soft measures can have a substantial impact on traffic levels

In brief, our conclusions were that they might lead to:



- a 21% cut in urban peak hour traffic
- a 14% cut in non-urban peak hour traffic
- an 11% reduction in national traffic, overall

Such large effects are only feasible because of the volatility of individual behaviour

The higher end of the results – a 21% reduction in traffic in the urban peak period – is obviously very substantial, although, interestingly, it's quite similar in magnitude to the reported effects that occur after changing road capacity. Achieving this scale of traffic reduction would obviously involve a large number of people changing their behaviour over the next 10 years. And this is partly where some of the earlier arguments come in – it only seems credible to assume that such changes are possible, because there is so much volatility in what people do anyway.

But depend on 'locking-in'

The arguments from SACTRA about induced traffic also have particular relevance. Clearly, if car use amongst one group of people is reduced, freer road conditions may attract others onto the roads, unless – to use the buzz-word that Phil mentioned earlier – the benefits of the soft factor policies are carefully 'locked in' using other traffic restraint measures.

Conclusions on the effects of policy on travel behaviour

Phil

That brings us to the end of section 3. Let me give the headlines. We've looked altogether at about twenty different influences on travel choice that transport policy uses as instruments, and there's good news and bad news. The good news is that these effects really are quite substantial. It's quite commonplace to see changes at the aggregate level of 10%, 20%, even 30%, sometimes more, in conditions that we might describe as within the bounds of 'normal life', as most people perceive it, not those of extreme emergency or revolutionary change.

The bad news – or at least, the problematic news – is that these changes are complex, take a long time to work through, and are easily offset by other unintended changes especially where the policy instruments are not all pulling in the same direction – which, let's face, is rather rare.

We'll come back to these policy problems in the final part, but these is one more stage in the argument we'd like to take you through first: what can we say about the actual content of these behavioural changes? What do they consist of? What are their component parts? What is the *process* of behavioural change?

You see, all these changes are taking place over time, but the time scales are different.

SECTION 4 – COMPONENTS OF BEHAVIOURAL CHANGE

Insights from a study of Sheffield Supertram

Graham

People do not usually make decisions about daily travel several years in advance

What we've been talking about so far shows that travel behaviour does change significantly and quite naturally, over the years. There are several questions that arise from that. One question is: how much do standard models comprehend this? Another question is: how much do people themselves comprehend it?

After all, when you are asked questions about your behaviour in a survey, you will naturally be very much more preoccupied with how your life is now – not how it was 10 years ago, or how it will be in ten years time.

We had the opportunity to consider this early in our programme of work, through monitoring the effects of providing the Supertram light railway as a new travel opportunity in Sheffield.

You may know that the Sheffield Supertram had rather fewer passengers than forecast when it opened, but my research was not so much concerned with how many people

used it as with how they went about deciding whether to use it, and how far their own predictions about what use they would make of it were matched by their actual behaviour two years later when the system opened.

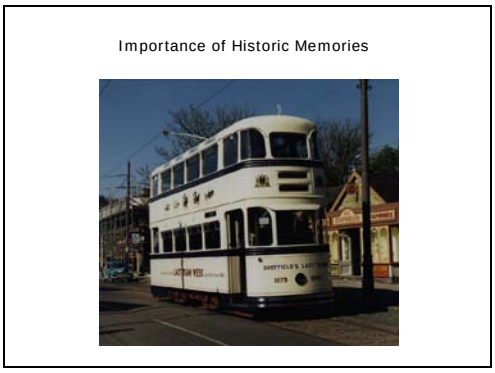
In part, the findings confirmed common sense

- since individuals could not accurately foresee their own circumstances in two years time, it was hard for them to predict accurately what their behaviour would be.
- And in any case, people often don't plan routine local travel even days in advance, never mind years ahead.

Some made it clear that they would wait until the opportunity was a real, operating one, before investing time in finding out how it would work, and whether it would be useful to them.

This does raise questions about the usefulness of research which seeks to discover people's future stated travel intentions at one point in time, in one set of circumstances, when those circumstances are very likely to have changed by the point in time in the future for which we are seeking to make the prediction.

The importance of memory



Other interesting results came from a particular focus within the study on the importance of people's mental images or maps in their decision-making about whether the tram was attractive and relevant for their needs.

What emerged was the importance of a person's own history and sense of place, in determining those perceptions.

For some of those over the age of about 40, there were strong expectations about what the routes ought to be like, based on experience earlier in life of the Sheffield trams that ran until 1960. That is, memories of the 'old' tram were still important in determining attitudes to the new one.

Effects of changes to the built and natural environments

Negative Association with Disruption of Construction

Alterations to the existing built and natural environments created negative attitudes for some observers. This could result from permanent change, such as the felling of trees, or temporary interventions, as shown in this picture, due to the effects of construction. In contrast, others welcomed novelty in the environment, and for them this was a motivation to try out the new network.

Understanding Routes

For Sheffield adults in general, understanding of the most direct, logical routes between places was usually strong. This did cause conflicts between expectations and reality, because it had been decided to operate the tram along some routes which were neither those of the former tramway, nor the most direct ones.

Supertram 'Detour' into the 'Countryside'

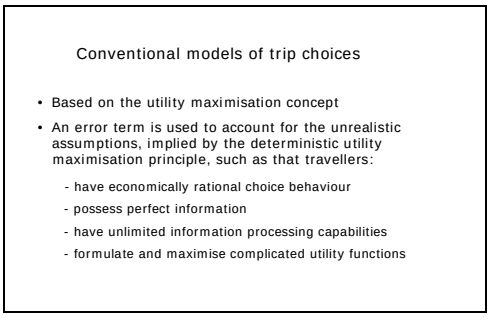
In the case shown in this picture, routing decisions resulted in the tramline leaving the direct route on the road network to travel through open fields known by many to be outside the city boundary. Although some enjoyed the views, others perceived this to be a time-consuming detour.

Such planning decisions were taken for traffic engineering, social and economic reasons – and each had its rational justifications. The outcome was, though, that the route as constructed did not fit with some respondents' expectations about the logical routing. This was one reason for the appeal of the system being lower than had been hoped.

A new approach to modelling choices, based on fuzzy logic, not depending on the assumption that all choices are logical and fully informed

Petros

As well as identifying the changes in travellers' choice behaviour, we have also developed a new formulation of the mechanism that represents the way that travel choice decisions are made.



Most conventional models of travellers' choice behaviour are based on the random utility framework which follows the utility maximisation concept, and introduce an error term to:

- capture the uncertainties and ambiguities inherent in the choice problem
- and account for the unrealistic assumptions, implied by the deterministic utility maximisation principle, such as that travellers:
  - have economically rational choice behaviour
  - possess perfect information regarding the attributes of the available alternatives,
  - have unlimited information processing capabilities and
  - formulate complicated utility functions which they try to maximise.

But what if travellers do not compare alternatives in terms of exact values of their attributes? This is especially likely in the context of making short term decisions, as for example in the case of drivers receiving real-time travel information. This information might be vague and not quantified, for example "*Slow movement of vehicles in Road A*", or "*Heavy traffic congestion in junction B*", and drivers might have a few minutes – sometimes even less than a minute – to change their plans.

The vagueness of perceptions is also evident in the more general context of transport related choices, as for example in the choice of destination.

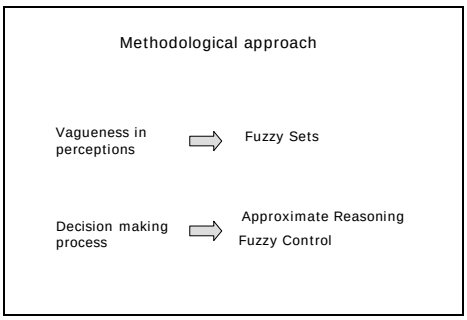
Example of destination choice
Measured values of attributes & Travellers' perceptions

destination / attribute	A	B	
Travel time (mins)	9	21	Travel time to A is much **LOWER** than to B
Parking search time (mins)	5	1	It's much **EASIER** to find a parking space in B than in A
Cost of shopping (£)	58	53	A is more **EXPENSIVE** than B

Imagine a traveller who has to select a shopping destination. It is rather unlikely that he will think that:

- travel time to shopping centre A is 9mins and to B 21 mins,
- parking search time is 5 mins if he selects A, and 1 min if he selects B, and
- cost of shopping will be £58.0 in A and £53.0 pounds in B.

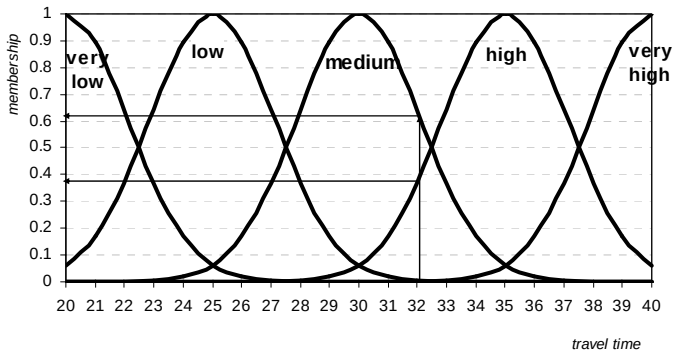
Instead it is more likely that he/she will characterise the attributes of the alternatives using linguistic values such as high, very high, low etc for example
- "*Travel time to A is much **lower** than to B*",
- "*It is much **easier** to find a parking space in B than in A*"
- "*A is more **expensive** than B*"



To take account of the vagueness in travellers' decision–making process, we developed an alternative formulation of the discrete choice problem, in collaboration with professor H. Koutsopoulos now at Northeastern University in Boston and Dr T. Lotan. This formulation models the vagueness in the decision maker's perceptions of the attributes of the various alternatives using Fuzzy Sets and, the decision process itself, using concepts from approximate reasoning and fuzzy control.

The term fuzzy derives from the notion that the boundaries of fuzzy sets are vague rather than clearly defined, and the transition from belonging to not belonging to a given set is gradual rather than abrupt. Members belong to fuzzy sets with a degree of possibility or membership. The grade of membership takes values within the interval [0,1], and represents the degree to which an element is similar or compatible to the

concept represented by the fuzzy set. Fuzzy Sets can overlap and therefore an element can belong to a number of fuzzy sets with different degrees of membership.



Example of membership functions of possible linguistic values of travel time

In the example presented here, if the travel time from a certain Origin to a certain Destination is equal to 32 mins, it can be considered as medium and as high. The grade of membership to the fuzzy set "*Medium travel time*" is 0.62 and the grade of membership to the fuzzy set "*High travel time*" is 0.38.

The main component of the decision making mechanism is the fuzzy rule base which contains rules describing the preferences of the decision maker given possible perceptions of the system's attributes both of which are expressed in terms of their linguistic values represented by fuzzy sets.

FUZZY RULES

"IF…<*system perceptions*>….THEN ….<*preferences towards alternatives*> …."

for example

IF *the toll cost is **HIGH*** THEN *I would **PROBABLY NOT** use the tolled motorway.*

IF *Parking in Shopping Centre A is **DIFFICULT*** THEN *I would **NOT** go to Shopping Centre A*

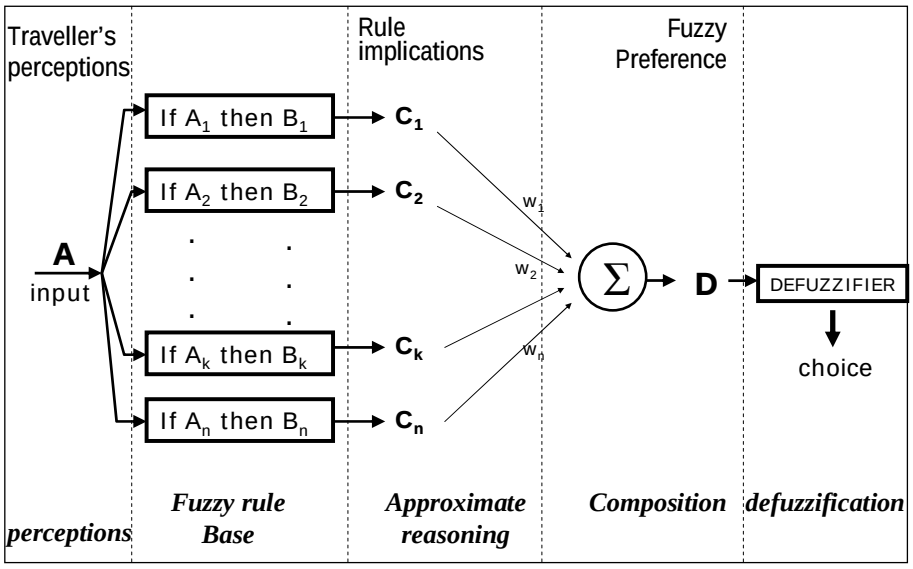
For example

"IF ….. < *the toll cost is **HIGH*** > … THEN …..<*I would **PROBABLY NOT** use the tolled Motorway*>…"

"If .. < *parking in Shopping Centre A is **DIFFICULT*** > … THEN …..<*I would **NOT** go to Shopping centre A*> .."

The final choice results from the combination of various rules each of which is executed to the degree of similarity between the individual's perceptions and the rule's premise.

A representation of the general model of fuzzy decision making is illustrated in the following diagram



The fuzzy decision making framework

The traveller's perception A is matched to the premises of each rule k. An implication mechanism called approximate reasoning, is then used to deduce the resulting implications C, given the perceptions A. The rules are processed simultaneously and a composition mechanism aggregates all implications C to a fuzzy preference D, expressed in terms of its membership function. Furthermore each rule is assigned a weight (w) that captures the importance of the particular rule in the decision making process.

The nature of this modelling approach which assumes that during the decision making process a number of rules are executed simultaneously and are then processed in parallel implies that this framework can be represented by a neural network structure.

Neural Network Representation of the fuzzy decision making framework

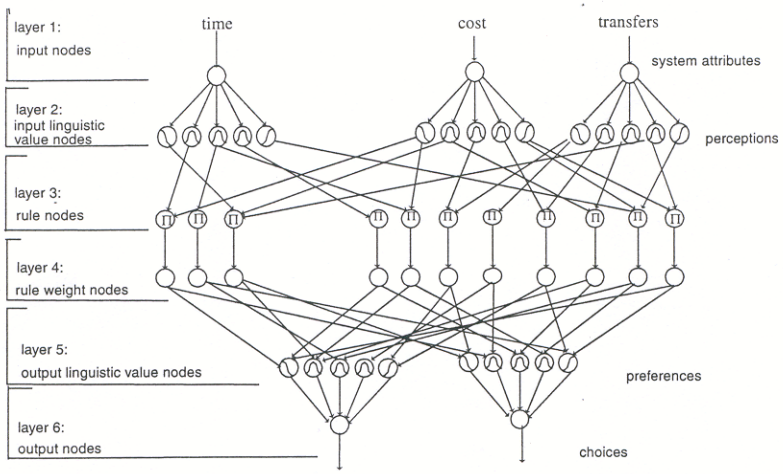


Fig. 3. Neural network representation of the fuzzy decision making framework.

This new approach of modelling traveller's choice behaviour was applied successfully to the problem of mode choice in a steady state situation, and to the problem of route choice in a dynamic situation where drivers in the presence of information have to decide under time pressure whether to keep or change their current trip choices.

Analysis of longer term dynamics

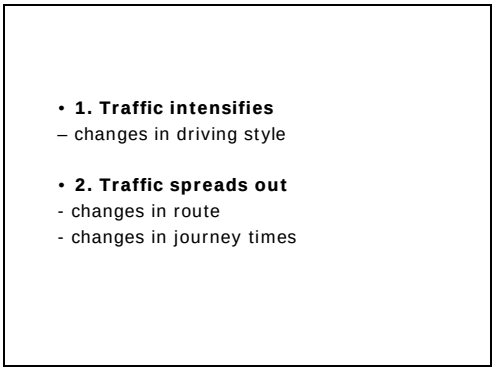
Phil

So that was mainly about the short term processes, for example those that take place during a journey – though it might have application to the longer ones as well. The question is, what happens on the second day? And the next week, next month, next year? Do drivers learn from their experience, and how do the effects build up over time?

Sally

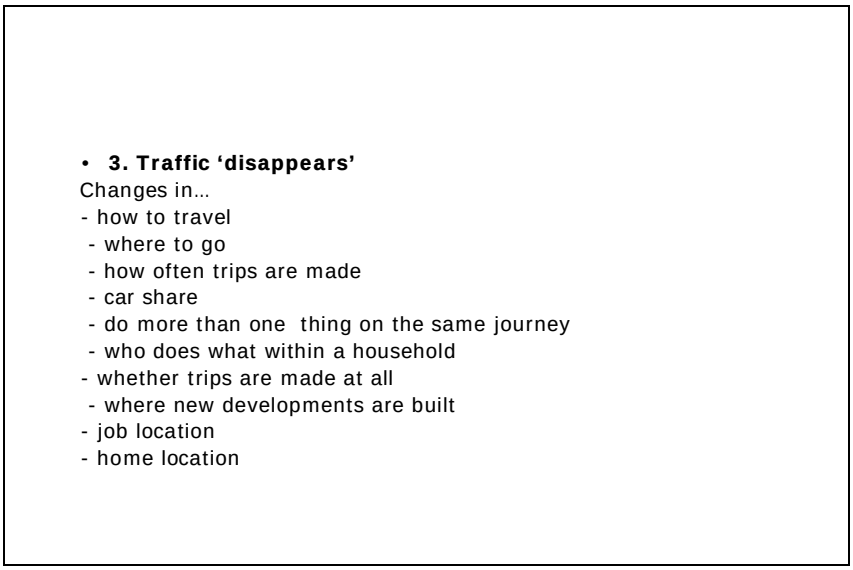
There are some insights about this from the work on reducing road capacity, since one of the things we looked at was - what do people do when road capacity is reduced for a significant period of time ?

The evidence suggested a wide range of responses, that can be broadly divided into three groups.



In the first instance, traffic doesn't reduce, it just intensifies, as people change their driving styles - driving closer together, getting through traffic lights quicker, and so on, in order to maximise the road space.

Second, traffic spreads out over time and space, with people swapping to alternative routes, or changing their journey times by leaving a bit earlier or later.



Third, as it becomes more difficult to make such adjustments, a whole variety of changes get mentioned in surveys, which would explain why traffic can disappear from a network overall. These range from people saying that they've altered how they travel, or where they go, right through to moving job or moving home.

Credibility of important changes in behaviour following small changes in conditions? Relationship with other changes arising from other causes.

This, in turn, begs the question - are the results believable ? Does it really make sense that people would change how they travel, where they go to, or even their home or job, just because, say, a bus lane is put in ?

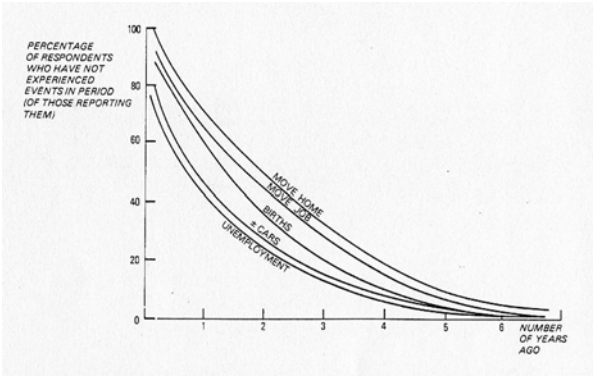
So we looked at this closely. And basically the evidence suggested - no, in general, people do not make such changes 'just because' of a change in road capacity. But again, this is where the earlier material comes in. Precisely because there is a lot of natural variability in travel choices anyway, a change in road conditions may help to tip the balance in an individual decision about how to travel that is already being made for other reasons – in a way which, when aggregated up, leads to less traffic overall.

Speed of behavioural response related to pace of 'life-shocks'

Gordon

It makes sense of some of the earliest work we did in South Yorkshire. People whose life is changing for other reasons – they retire, or get married, change job, … whatever … are the ones showing the biggest changes in travel choices.

The early research:
Frequency of life events enabling choice



The significance of this might be seen in this way. The habits and constraints, based on your existing circumstances, may be very strong indeed – so strong that you could not change your behaviour in response to some policy initiative at all, because your life simply doesn't allow you to do so. Even so, after a while, something is going to change in your life anyway – a 'life-shock' of some sort. At that point, you have no choice: you *must* change your behaviour in some way. And then, you will change it in a way that enables you to respond to the new circumstances, higher costs, or lower costs, more reliable buses, less road space, or whatever.

The interesting thing is that, as the diagram shows, year by year fewer and fewer people will be left who have not had some such upset in their routine. And the time-scale – 1 to 5 years or so, for the majority of the population – is very close indeed to the sort of lags that Joyce and Mark were finding in their elasticity results.

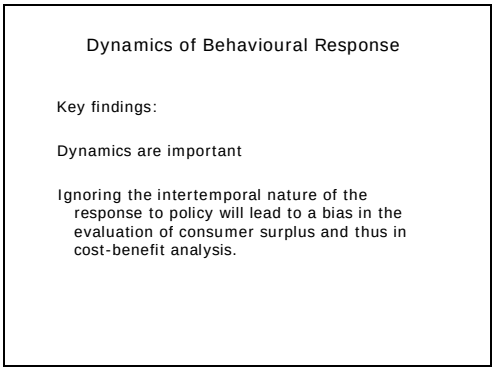
And what we also found, was that the people who have had the biggest changes in their lives, were also the people who showed the largest response to policy effects such as, in this case, bus fares.

Three dynamic attributes of behavioural response – churn, hysteresis, and differences between the short and long runs

Joyce

So the policy monitoring work, and the econometric analysis, converge. The elasticities are an estimate of the combined effect of all these different responses. Of course, that's why long term elasticities, in general, are higher than short term ones. It is precisely because people learn, and adapt, and are able to include in their behaviour not only the change of route, but a different pattern of life.

This process – or the dynamics of travel behaviour – is an important strand running through much of our work.



What we have done is actually identify a number of quite separate dynamic processes, each of which require longitudinal data. In part 1, we found that changes in the opposite direction to a well established aggregate trend are very common at the individual level. This process of **churn** is invisible in cross section surveys. In part 2 we discovered that the 'upwards' and 'downwards' movements are not necessarily symmetrical – what goes up does not necessarily come down, or at least not until later, or with greater difficulty. This process of **hysteresis** requires knowledge of the history or path that a process has followed. In part 3 we discovered that the distinction between **short and long run** is crucial to estimating the effects of policies, which cannot be done without defining the time period and process of change.

The existence and importance of dynamics is one of our key findings. As illustrated early on in our research, ignoring the inter-temporal nature of the response to policy will lead to a bias in the evaluation of consumer surplus and thus in cost-benefit analysis.

SECTION 5 – WHAT QUESTIONS ARISE FOR TRANSPORT POLICY AND PRACTICE?

Phil

I'm now into the final part. What follows, for policy and practice?

Of course, not everybody will agree with everything we've said, and some of you will doubt one part or another of the methodology, or one part or another of our conclusions. That's fine – no holds barred this afternoon.

But even supposing everybody here agreed with *everything* we said. What would follow?

What follows is that we do have a different perception of the nature of policy difficulties ahead, and of their relative priority, and of how to solve them. Let me just list some examples.

Public transport Fares, Motoring Costs, Soft Measures, Road Building – and how to assess them

- The *public transport fare elasticities*: our results imply that attempts to raise revenue by fare increases will work in the short run, but so erode the market that in the long run the net advantage in the long run is very small indeed, financially, and negative in terms of congestion and environmental impacts. What can we do about the dynamics of revenue, in a world where the accountants don't really want to look beyond next year? And where, then, would the funding come from for the continued environmental improvement of public transport systems, which is already a problem.

- The effects *of motoring costs*. The results imply that traffic levels do respond to these – up and down – which strengthens the transport effectiveness of road pricing, but raises less revenue than expected – a lot, but not quite so much. What will the Chancellor have to say about that?

- *Soft measures*. We have been very pleased at the speed with which the DfT has responded to this work – we'll hear more about that this afternoon. But this does presuppose a very big increase in the priority of these measures at local level, and at the moment some local authorities (not those represented here, of course) do not even count the staff employed in this area as being on the proper establishment. They are the poor relations, the staff on bursaries or temporary contracts – unlike the engineers in the drawing room, whose career track is simpler, and a lot more favourable. And then, suppose that a local authority does decide to treat this area as a proper job, and does put priority on it – but does *not* manage to secure support for the complementary traffic

policies to prevent induced traffic. What then – is the game worth the candle at all?

- There's the question of *road-building*. 'Locking-in' is the answer to one question: if we have the right road scheme, how to protect its benefits. But a *programme* of locking in, and demand management, and congestion charging, and soft measures, and public transport improvements… that changes our definition of what constitutes the right road scheme. The entire list of schemes in the current programme has been inherited from assumptions on policy and behaviour that no longer apply. We can't ignore that.

- And then think about the analytical side. At root, the concepts of dynamics are simple – simpler, in fact, than the standard transport models based on a utility maximising achieved equilibrium, whose precepts about behavioural change are, at heart, self-contradictory and elusive. But it's a problem of familiarity. Where are the consultants who will offer a dynamic forecast with as much confidence as they now offer an equilibrium forecast. That's a challenge for this afternoon as well.

An important caveat is that everything we have done has really been in the context of a world in which, we assume, there is *time* to develop policies, and adapt them, and make errors, and use concepts like five year or ten year plans. We have not focussed on the sixty year horizon that DfT appraisal rules now allow, because we do not know how to make and sensible forecasts such a long time ahead. Nor have we addressed the issues of how to handle a different degree of urgency, if environmental requirements do not allow us the luxury of the time scales we have been talking about.

But it's really about what sort of vision one has about people's resilience and adaptability when conditions change. Responses are bigger, and more complex, than we have allowed for. I think that strengthens the ability to take sensible action.

Conclusion

So, the conclusion. Travel behaviour is not fixed in stone – it's very much more volatile and changeable than is usually assumed. Car ownership and use do go down as well as up, though the strength of the effects is different.

The effects of policy on behaviour are bigger than expected. But they are also more complex than expected, and take several years to work through – not all in the intended direction.

Policies – all policies – interact, and have substantial effects, bearing on 10, maybe 20 different sorts of choice, not just the traditional four in the models, and certainly not just the route choice that has dominated practical assessment.

We say you cannot derive understanding of change from obervation of states at a point in time – quite the reverse: you can only understand what is, by consideration of the pathways, the history, the process of adaptation. That requires observations of data

over time, and models using dynamic methods, which need to become more part of the standard toolbox than the off-the-shelf surveys and models that are there already...

So: policy makers and transport industries have more scope to influence travel behaviour than they think – but only if transport interventions are consistent with each other, and maintained over a lengthy period. We do not offer the sort off false comfort that says – **we can't achieve much, so we don't have to do much**. The stakes are bigger than that.

That is the end of our presentation. Thank you for giving Joyce, Sally, Mark, Graham, Gordon, Petros and me such a considerate hearing.

Annex 1 Bibliography

(See ESRC Transport Studies Unit (2004) Research Reports and Publications 1994-2004 (available on website http://www.cts.ucl.ac.uk/tsu/tsuhome.htm) for a full bibliography including all source material, technical details on data and methodology, co-authors and acknowledgements).

ANNEX 2

ESRC and Transport Research – Celebrating the Successes of TSU and Looking Forward
A Response by Gary Grubb, Economic and Social Research Council

Firstly, on behalf of ESRC and ESRC's Chief Executive - Ian Diamond who would have liked to be here but is unavoidably required elsewhere – I should to thank so many of you for attending this conference.

The ESRC is the UK's leading research and training agency addressing economic and social concerns.

As has been illustrated very well today, we aim to provide high quality research on issues of importance to business, the public sector and government. We cover a broad spectrum of issues including economic competitiveness, the effectiveness of public services and policy, sustainable development and our quality of life.

This conference marks the end of 10 years during which ESRC has been proud to provide core funding of approximately £2m for TSU. It has been an opportunity to celebrate the successes of the TSU.

Although TSU has been one of ESRC's smallest research centres it has nevertheless been one of its most important because of its central role in demonstrating the crucial role and need for top quality social science research in an area of consistently high public and policy concern. As I'm sure you'll agree on the basis on what we have heard today we have received excellent value for the tax payers' money from our investment, especially when compared to amount of funds involved in transport policy initiatives and infrastructure and the role of transport to economic competitiveness, quality of life and sustainable development are taken into account.

We often summarise the key features of ESRC funding into three words – Quality Relevance and Independence – and it seems to me that the work of TSU epitomises these qualities.

- Work of the highest scientific quality which has contributed both nationally and internationally to our understanding of transport issues, and made important theoretical and methodological contributions.
- Work which has informed and contributed to key policy debates and to professional practice – as we have heard today there have been shifts in transport policy over recent years not least, for example, in moving away from a simple 'predict and provide' approach to policy, at least in road building, and the greater emphasis on 'locking in' benefits which recognises the need for complementary measures to avoid benefits being undermined by 'induced traffic' and the greater emphasis on 'soft factor interventions' – all of which I believe have been influenced by TSU work in these areas.
- And, as I sure some in the audience may be painfully aware, a preparedness to present the findings from its research in an open and forth-right way, even if the conclusions may not always be what the audience wants to hear.

Under ESRC's New Strategic Framework we also increasing emphasising a fourth dimension to the Councils work in *building sufficient capacity for the UK to undertake top class social science*. Here again it is clear that TSU has made an important contribution particularly through the many research students and researchers who have benefited from their engagement with the Unit and will form an important part of its enduring legacy.

In addition, a key theme emerging from the consultation on our strategic framework has been the importance of the international dimension to social science work and here again TSU has made an important contribution through its international comparative and collaborative work.

As well as looking back, today has been an opportunity to look forward to the future and the new transport research challenges that we face, building on the strong foundations which the TSU has been so central in laying and the centrality of social science research to addressing future transport issues – as TSU's work and the debates today have so ably demonstrated.

It clear that transport research remains a key area for future social science research and for the ESRC. The end of ESRC core funding for TSU does **not** mark the end of ESRC funding for or interest in transport research.

In particular there is a pivotal role for the Council in supporting fundamental social science research that will enable us to understand the economic, social, behavioural and cultural factors that drive changing patterns of mobility – the root causes referred to in debates earlier today.

The Council also has a crucial role in sustaining and developing the high quality research capacity that will be needed to underpin future transport research and policy.

As some of you will be aware the Council has been developing proposals for a major new research programme on mobility to address such issues and these are due to be considered further by our Council next month.

Transport is also an area where inter-disciplinary collaboration will be vital and the ESRC is committed to working with in partnership with our Research Council UK (RCUK) colleagues in supporting such work.

For example, I was very pleased to see that the recently approved research and networking programme of new Cross-Council UK Energy Research Centre includes transport, energy and environmental sustainability as a key theme, with work co-ordinated by Professor David Begg at Robert Gordon University and Dr Dan Osborn at the Centre for Ecology and Hydrology. This work will draw together social, natural and engineering sciences and will complement the on-going transport research supported by the cross-Council Tyndall Centre for Climate Change Research.

The ESRC is also committed to working in partnership with other research funders and organisations whilst preserving on emphasis on quality, relevance and independence. For example, we have recently been discussing opportunities for

research collaboration with the Department for Transport to follow up the emphasis on social science research and capacity in its new *Evidence and Research Strategy*.

Finally, on behalf of the ESRC, I would like to thank all those who have contributed to making the TSU such a success over the last 10 years, particularly the:

- Directors
- researchers
- students
- administrative and support staff

And also

- The host institutions, particularly our hosts today, UCL
- All the sponsors and co-funders of research as well as of today's event
- The many project partners and collaborators
- And all those who have contributed to the development of TSU's work through participation in its many and varied activities over the last 10 years

About the Economic & Social Research Council:

The ESRC is the UK's largest funding agency for research and postgraduate training relating to social and economic issues. It provides independent, high-quality, relevant research to business, the public sector and Government. The ESRC invests more than £93 million every year in social science and at any time is supporting some 2,000 researchers in academic institutions and research policy institutes. It also funds postgraduate training within the social sciences to nurture the researchers of tomorrow. More at http://www.esrc.ac.uk

Annex 3

A Commentary

Changing how Britons travel

Christian Wolmar

If there is one theme that links the ten years work of the ESRC's Transport Studies Unit, it is that as far as travel behaviour and patterns are concerned, human beings are a cussed bunch. Much transport modelling is based on the notion that desired outcomes can be reached quite easily as long as the correct inputs are entered. But the experience of this decade long research centre, funded by the Economic & Social Research Council (ESRC), suggests that changes in transport are nothing like that simple, and, moreover, that such crude modelling will lead to an underestimation of the effect of policy initiatives on transport outcomes.

Of course, no one thought this linear approach represented the real world. But at least people expected that it was broadly correct. In fact, it is often wrong, sometimes quite drastically so and, moreover, the field is littered with unintended effects and perverse outcomes which sometimes lead to completely unexpected outcomes.

The message that rings through this research is that human beings are not herds of sheep being corralled by a couple of well-trained collies. We do not fit into patterns and we will almost consciously act in what transport policy makers will see as a perverse way, unravelling their plans. This research was carried out by the Transport Studies Unit at University College London and directed by Professor Phil Goodwin.

One of the clearest examples of this is the creation of park and ride facilities outside urban areas in order to reduce the number of people entering city centres with their cars. The idea, of course, is to attract the drivers out of their cars and onto buses. But these new bus passengers are by no means solely people who would formerly have driven into town. Many, instead, had previously used the bus for longer journeys and now drive to the park and ride to take a shorter ride into town. Indeed, in Oxford this phenomenon was particularly marked with around a third of users of park and ride having previously used a conventional bus. Overall, of all park and ride users in Oxford, under half had previously driven into the town centre, and in York it was just under two thirds.

That is not to say that park and ride is a misconceived idea. It is just, as the researcher, Graham Parkhurst, now of the University of Western England, put it, that this result ‘was not the intention of either the local authority or the bus company’ and that ‘when I started reporting this effect, I did not find that the result was a very popular one, especially with local authorities who were very proud of their park and ride initiatives’.

It is not surprising, therefore, that if human beings refuse to fit into expected patterns in their responses to stimuli concerning their transport behaviour, then it is difficult to predict how they will react if those stimuli are removed or intensified. In other words, their behaviour is not simply reversible. Yet, conventional transport modelling is largely based on the idea that as Phil Goodwin puts it, ‘what goes up must go down, in response to similar stimuli of equivalent strength’.

Indeed, the whole body of transport empirical work has been constructed using either aggregate time series, which only detects large scale and sustained reversals; or disaggregate cross-section data, which contains no information about reversibility.

The work of the Transport Studies Unit has therefore focussed on a different sort of information, in which the behaviour of individuals or groups is tracked over time. This provides more accurate information because simple aggregation is based on the assumption that, mostly, the same people move in the same way most days. But that is not true. Sure there may be some commuter carriages where the occupants take the same train every day and have card schools or discussion groups, but this phenomenon which was never as universal as portrayed, is becoming weaker as we enter the 21st century. As patterns of work develop with growing self-employment, a higher proportion of women in the workforce and a rise in homeworking for at least part of the week, looking at individual behaviour over time becomes an ever more essential method of analysis.

The concept of churn is relevant here, an expression which measures loyalty to a cause or produce over time. Take those rail commuters, researched by Joyce Dargay and Mark Hanly of the Transport Studies Unit. In an average year, about 3 per cent of journeys to work are by rail. However, while that figure is relatively consistent over time, very few people commute year in and year out. Only about 1 per cent of people used rail in every year out of the past ten. However, a total of 8 per cent of all people in work used rail as their main method of transport for at least one year out of the decade.

There are similar patterns in other modes and there is much churn on a daily basis. For example, surveys show that vehicles making up the traffic stream are not, in general, the same set of cars from day to day. Up to 50 per cent of the cars on a given day will not be present at the same time on the following day, and many will not be there at all.

There are seasonal differences, too, with over 20 per cent of employees changing their main mode of journey in the summer. In another survey, a fifth of the respondents increased or reduced the number of trips they made by more than 10 trips weekly – out of an average of 25 weekly trips - between one year and the next. Moreover, the time that journeys take varies quite significantly. Out of a hundred journeys to work, between 10 and 20 will be travelled with an overall door to door time 20 per cent faster than the average and a similar number 20 per cent slower.

Therefore, those familiar pictures of traffic jams or crowded commuter trains are deceptive in that they suggest we all do the same things every day, year in year out. They do not. It just happens that a whole lot of different people make decisions that results in similar, but not the same, type of congestion every day.

This complex situation, too, helps explain why behaviour is more influenceable than may at first be thought. If people are not doing the same thing in the same way all the time, they are more open to change and they can be influenced by the right stimuli.

An even more unexpected finding is that this type of strong variation over time even exists for something as rigid as car ownership which obviously requires a major investment from the purchaser. Within a two or three year period, net increases in car ownership of 2-6 per cent can mask a much more complex pattern with as many as a quarter of the population changing its car ownership level, and around 10 per cent of those, mostly second car owners, reducing the number of cars they have. As Gordon Stokes, now at the Countryside Agency, put it, from a survey in South Yorkshire: ‘In any period of a year or two, a very large proportion of the population radically change the amount of travel they do, and the time they spend travelling, and a significant proportion change their car ownership’.

Given that there is this untidy pattern of constant churn, people are much more ready to accept change and readily adapt their behaviour when the transport facilities available to them are varied. Take pedestrianisation and other schemes involving a reduction in the amount of road space available. Whenever schemes to reduce road space are suggested, there are always

predictions of chaos. This was true, too, of the introduction of the London congestion charge scheme when dire warnings of gridlock in London were issued almost daily in the run-up to its introduction in February 2003.

The research uncovers a very consistent pattern, here. And what is interesting is that there are far more examples and much more evidence available than might be first thought of. For example, all pedestrianisation whether it affects a whole town centre or just a couple of streets involves taking road capacity away from cars. There are other events that lead to road capacity reduction - ranging from earthquakes and bridge closures to the introduction of bus lanes and tram systems and even the ring of plastic around the City of London - and evidence of the effect is available for many of these. The table listing the effect of these various events shows that traffic reduction can be very marked, quite commonly in the order of 30-40 per cent.

Where does this traffic go? For pedestrianised areas, some, but by not means all, of the displaced traffic reappears on other streets outside the new restricted area. Despite this rise in neighbouring areas as Sally Cairns puts it, one of the recurring themes of the research into road capacity reduction was that 'unfulfilled predictions of chaos' were almost universal. The main reason for this is that people can change their behaviour in a number of ways – travelling at different times, on alternative modes or by varying their route. This process is less painful than expected precisely because patterns of travel are not as firmly established and unvarying as the aggregated figures, collected day by day, suggest.

The research found that the average reduction on the affected road or area was 41 per cent, of which migrated to neighbouring roads. That meant, however, that overall the average reduction in traffic was 22 per cent, a very significant drop.

The effect on the wider economy is interesting. There is evidence from Europe, and more recently from the UK, that reducing traffic levels in town centres improves local turnover and the competitive position of the town, as well as offering improvements to the environment, provided this is done as Goodwin has put it, 'with style and ambition and with favourable related policies including high quality public transport access'.

The broad conclusion from the various case histories available is that while the reduction in traffic caused by a cut in capacity is not quite equal to the increase generated by greater capacity, the orders of magnitude are certainly similar. There have been, though, no controlled studies using experimental principles, clearly an area with great scope for further research.

This is the corollary, of course, of the groundbreaking SACTRA report on which Goodwin worked and which was published in 1994 which showed that providing new capacity generates extra traffic. This is now taken as axiomatic but the fact that the converse applies – even if not quite proportionately - opens the way for a whole host of interesting and innovative policies of which the congestion charge is merely the most well-known.

And the impact of those policies appears to be greater than previously thought. Conventionally, it has been thought elasticities were rather low – in other words that people did not respond much to changes in price. On buses, for example, the evidence has been that the fare elasticity was – 0.3. In other words, if bus fares went up by 10 per cent, the operator would lose 3 per cent of their market but still make extra revenue. On fuel, the figure was thought to have been as little as – 0.1 to – 0.15 which was not enough to make a difference. However, the empirical evidence suggests that the elasticity is much higher. In relation to fuel consumption it is 0.25 in the short term, but as people become more able to change their behaviour, it is 0.65 in the longer term. In terms of the number of cars on the road, it is 0.1 and 0.3 respectively.

Again, the result is consistent with other research. Change is more significant than expected and therefore the policy instruments available are stronger than might first be thought. In this case, the stronger elasticities suggest that people are more adaptive to price than expected and therefore reducing prices has a bigger effect on increasing travel and vice versa. Consequently, price increases to raise revenue are less successful than expected, but as a policy instrument to damp down demand, they are more beneficial than anticipated. The experience of the London congestion charge precisely fits into that outcome.

The overall lessons of a decade of research are powerful and consistent. As Phil Goodwin sums up, 'the effects of transport policy on behaviour are bigger than expected. But they are also more complex than expected and take several years to work through – and not all in the intended direction.'

These results offer a tantalising prospect for policy makers in government. They are not as impotent as they often suggest they are when faced with difficult decisions. More people can be attracted on to public transport if fares are reduced and the service made more attractive. This has clearly been borne out in London where the massive increase in the numbers using buses has been a result of a combination of low fares and better service. The consistent theme of the research that the elasticities are higher than expected, means that change – for the better or worse – is more easily achievable than was originally thought.

Politicians and civil servants therefore cannot hide behind bland statements such as Alistair Darling's oft repeated refrain that since the economy is growing, traffic must increase as well and there is nothing that he can do about it. As the research argues, 'well designed and well implemented schemes to reallocate road space away from general traffic can help to improve conditions for pedestrians, cyclists or other public transport users, without significantly increasing congestion or other related problems'.

It is mistaken, therefore, to view transport policy in the conventional way: as simply a 'lose lose' area where inaction is better than action because benefits seemingly can never be realised within a politician's term of office. The message of the research is the opposite – it can be a 'win win' field of endeavour for the brave, as Ken Livingstone has shown. It is a scary prospect for politicians and perhaps they will not grasp the message until much more work is done and they can feel safe in overriding short term concerns for longer term gain.

There are, too, implications for researchers. If simple linear models do not work, their results have to be much more solidly based. The various forces must be understood and therefore their work is more complex. But that, surely, is a source of excitement rather than concern.