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Policy Incentives to Change Behaviour in Passenger Transport

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OECD International Transport Forum, Leipzig, May 2008
Transport and Energy: The Challenge of Climate Change

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Summary

Travel behaviour is sometimes described as ‘too difficult to change’. This paper suggests that there are very many different sorts of behavioural choice, many of which are in continual flux, and subject to a very wide range of different incentives. The evidence base is very substantial, consisting of some thousands of studies which have produced specific quantitative results.

The evidence confirms that travel choices include the volume and location of travel, other modes notably walking and cycling, driving styles, levels of car ownership, where to live and work and shop, and the type of activities they participate in. In general it is found that responses are often rather small in the short run, but build up to very much more flexible life-style choices in the longer run, defined as the period 5-10 years and in some cases longer, in which habits are eroded and new ones form. There is a very large volume of empirical and case study evidence about the effect of changes in price, speed of travel, quality, information, new infrastructure, better use of existing infrastructure, planning, and other factors which can be influenced by public or private interventions. A common characteristic of those interventions on which evidence based on experience is available is that they have mostly been chosen for objectives other than carbon reduction (especially, but not only, congestion reduction and quality of life improvements) which in cost-benefit terms often bring a benefit greater than the cost of implementing them. Where this is the case, there are carbon benefits for zero or negative real resource cost.

The evidence available is rich concerning reductions in car use up to about 20%-30%, but very sparse, at the present time, for changes greater than that.

Introduction

This paper reviews available evidence on the nature and size of demand responses in passenger transport which would be relevant to setting and achieving carbon reduction targets.

This is often considered a rather intractable problem because of the 'strength of people's attachment to car use', and there have been some common methodological approaches which make it appear particularly difficult, especially when (a) only considering a very restricted range of behavioural choices; (b) treating behaviour only in the context of immediate constraints and preferences without considering how these change and adapt over time; and (c) extrapolating current trends in a way which makes pulling them back seem an impossibly huge task. This narrowness is seen especially in common discussions confined to mode choice, within a fixed journey pattern, predicated on car use, and influenced only by travel times and costs. Such approaches lie behind a feeling that the main contribution to carbon reduction will need to be found in other sectors.

On the other hand, when considering a wider range of behaviour, a wider range of influences on it, and a process of adaptation over time, the scope for making significant changes in the transport sector seems much greater. This is reinforced strongly by the observation that many aspects of sustainable, low-carbon travel behaviour also bring useful economic and other benefits, such as a reduction in congestion, better health and fitness, reduced injury and death, more enjoyable local environments, reduced stress, commercial advantages in town centres and the property market, reduced social division and conflict, less land-take, better air quality, and financial savings in public expenditure. Indeed in many cases of successful implementation it has often been these motivations, rather than carbon reduction, which have been the prime movers.

Therefore while excessive optimism may lead to unrealistic plans and disappointment, excessive pessimism may lead to the loss of very worthwhile opportunities.

Work on the paper makes use of material collected during a programme of research funded by the UK Economic and Social Research Council at the Universities of Oxford and UCL, 1994-2004, a recent review of demand changes conducted by the author for the UK Climate Change Commission (Shadow Secretariat), and other work as acknowledged in the text.

This paper does not review the evidence on the important effects on demand of factors which are not subject to policy intervention, such as demographic structure, GDP growth, wider social legislation and norms, political and market processes led by vested interests, or climate change itself, and it has not included air travel.

Overview of Travel Behaviour and Policy Incentives

Tables 1-5 contain an overview summary of as wide a range as possible of travel behavioural choices, related to a list of the type of incentives likely to influence them. This is based partly on empirical research summarised below, partly on theoretical, modelling and practical experience, and partly on logical extension from known results. Classification of the different types of behaviour has been influenced by the traditions of several different disciplines, not all well known to each other. For convenience I use that background for listing the behaviours concerned, under the headings:

Behaviour acknowledged in the civil engineering tradition of travel demand models

Behaviour recognised by other specialists and disciplines

'New' behaviours previously ignored but now seen as important to sustainable travel

Car ownership

The 'stationary' part of the journey

Table 1. Behaviour acknowledged in the civil engineering tradition of travel demand models

Nature of Behaviour Change	**Key Incentives**
Route Choice (assignment)	Relative journey times, sometimes money costs Inforrmation and expectation about routes, eg as implied by colour and thickness of roads on maps, broadcast news reports Real time route guidance, in-vehicle (eg satnav systems) and on road (eg variable message signs, recommended detours, speed limits) Traffic management – eg limited access to residential areas or shopping centres restricting through routes Pleasantness of scenery, landmarks, iconic sculptures Fear of certain types of road or area Availability of facilities on some routes (toilets, shops, etc) Differential priorities for different vehicles, eg general freeways versus roads with bus lanes
Mode Choice (usually excluding walking, cycling)	Generalised cost difference between modes (time and money) Unexplained 'irrational' preference for one mode over another Priority systems eg bus lanes, preferential traffic signals, turning

	movements Desire to experiment Habit ('sticky' preference for most commonly used mode), loyalty, grievance Quality aspects (comfort, cleanliness, privacy, sociability, security from crime) Safety Reliability, variability, punctuality, flexibility Possibilities of other activities (eg reading, working, sleeping, communications, entertainment) Peer acceptability, social esteem, responsible behaviour
Destination Choice (Distribution) (strictly, usually choices assuming variable matching between fixed origins and/or destinations)	Relative generalised cost (time and money) of access Number of options available Perception of attractiveness influenced by advertising and social fashion Differential property prices, wages, price of goods Life-style choices (eg occasional big shopping versus frequent small shopping; preference for surburban or inner city life styles, Availability of secondary facilities (eg interaction of work and school locations, or leisure facilities after work, etc))
Number of trips (Generation)	(Usually assumed to be unaffected by any incentives. This is disputed. Some consider that it is a stable part of human requirements at about 3 trips per day; others say that since it varies very substantially between individuals, and for individuals over time, it cannot be stable. Evidence unclear but logically likely that it is affected by generalised cost and life-style choices at least).
Time of day of trip (only occasionally included)	Likely to be similar to route and mode choices

Table 2. Behaviour recognised by other specialists and disciplines

Nature of Behaviour Change	Key Incentives
Econometric Studies of Aggregate Demand	
Passenger or vehicle kilometres by mode.	Price, sometimes travel times, service frequency
Passenger Transport operators	
Market building	Quality of service and value for money package, priority, information, individual and mass marketing
Choices as between single tickets, season tickets, and various special ticket types	Price (including special offers) Loyalty schemes (Frequent user discounts, points, clubs)
Supportive activities eg combined transport and other activities eg holiday bookings	Packaged offers, reduced hassle booking
Churn, capture from other operators or modes	Loyalty incentives (and to encourage disloyalty to competitors)
Road Safety Authorities	
Overtaking, inter-vehicle distance, speed control, braking manoeuvres, considerate driving	Enforcement Penalties Social pressure and acceptability Driver education
Property Market and Land-Use Planning	
Choice of where to live or locate activities	Price and availability of housing and other land uses, hence development control, zoning policies, planning incentives, density regulation Introduction of transport services (eg effect of light rail schemes on neighbouring property prices and social mix)

Table 3. 'New' Behaviours Previously Ignored but now seen as Important to Sustainable Behaviour change

Nature of Behaviour Change	Key Incentives
Walking	Safe, secure, well-lit pedestrian routes Maintenance of pavements (sidewalks) Traffic-free areas Traffic calming Sight-lines and connectivity Priority street design and traffic engineering (eg traffic light settings) Planning decisions affecting availability of small local destinations versus big distant ones (hospitals, schools etc) Availability and quality of public transport services Other motives, especially health and fitness
Cycling	Cycle lanes, routes Cycle hire facilities, eg Velib network Secure parking Accessibility on public transport Shower and changing facilities Traffic law and enforcement Other motives, especially health and fitness *(nb never combine 'walking-and-cycling' into one mode for planning or forecasting purposes)*
Combinations which can be treated as a mode in their own right such as 'park-and-ride');	Interchange and coordination arrangements Discounts
Car-sharing, pooling and clubs	Scale, efficiency, availability and pricing of support systems and organised schemes

	Incentives for use eg workplace parking
Consolidating trips from many separate errands into a single multi-legged round trip;	Likely to be affected by any schemes encouraging lower energy use, eg carbon trading.
Rearrangement of duties within households such that one person's trips may substitute for another;	Explanation and understanding
Replacing travel-intensive activity by other ways of achieving the same (or similar) basic needs, especially those using internet services such as working or shopping from home for part of the time.	Financial and time incentives – cheaper and quicker to order some shopping online Quality of on-line conference facilities Employers rules and workplace conventions

Table 4. Car Ownership (traditionally assumed invariant to policy or incentive)

Nature of Behaviour Change	**Key Incentives**
Number of cars per household	Vehicle prices Fuel prices Quality of public transport (especially for 2+ car households) Parking availability Life-style choices, eg 'car-free' housing Availability of 'car clubs' or similar shared/hired car services
Size, power, fuel-type and performance characteristics	Regulation and/or self regulation of acceptable design speeds, power-to-weight ratios etc Vehicle taxation bands favouring more efficient or smaller vehicles, or particular fuel types Access to certain areas restricted by emission class

	Social esteem and norms
Ancillary facilities such as heating, air conditioning.	Social esteem and norms Transparency of cost
Arrangements and frequency of purchase, maintenance and disposal.	Package deals Incentives or penalties for disposal Regulation and enforcement of vehicle standards
Age and conditions of acquisition, control and abandonment of driving license	Motivaions of young adults 15-20, and post-retirement older adults, and available alternatives Seriousness of driving test, and health, eyesight conditions Withdrawal of license for offenses

Table 5. The 'Stationary' Part of the Journey

Nature of Behaviour Change	**Key Incentives**
Choice of location and type of parking	Residents parking schemes Incentive parking rewarding other behaviour change Planning control over location of parking space Banned parking (including penalties and enforcement levels) Park and ride facilities Price and price structure (short-term/long-term, discounts, multi-use,)
Choice of interchange arrangements between or within modes	Coordinated timetables Cross-platform or concourse interchanges Facilities available at interchanges eg shops, toilets. Security, cleanliness, maintenance, supervision

Sources of Evidence

The literature is very extensive, but is distributed in many quite different types of media: refereed academic journals (about 20 in the field of transport studies, but many more if economics, business studies, planning, energy studies and other relevant disciplines are included), books, and series produced by specific institutions; a large body of consultants' studies carried out for public and private clients (much of which is in the public domain but elusive, or kept confidential), local and national government committee reports, and ad hoc studies for public inquiries or events. There are many conferences, seminars and workshops (several hundred a year) most of which produce proceedings or compilations of some kind. The EC supports many consortia with a partly research function, whose reports are typically published on-line and presented at conferences, but often never find other forms of publication. It is *not* the case that the formal academic studies are uniformly of higher quality or more authoritative, especially where practical local case studies are concerned.

I estimate that the source material for the subjects summarised below is probably of the order of 2000-5000 written pieces of work. There are a number of good reviews, mostly rather long. Normally these will themselves have summaries, but clearly there is a caveat in relying on summaries of reviews of source material: when there are issues of controversy or interpretation the source material must be assessed.

Table 6 is a suggested list of ten reviews available in English which give a good overview of sources and discussions of interpretation. I cite other references in the text as appropriate.

Table 6: Key References which give Overviews and Synthesis of Evidence

Citation and date	Sources used	Coverage	Comments
European Conference of Ministers of Transport (2007) Cutting Transport CO" Emissions: What Progress, OECD Publishing, Paris (Book, 263 pp)	63 references and a review of progress in 51 OECD and ECMT member countries	All modes, including freight, shipping and aviation	Identifies 400 measures, with orientation to efficiency and supply-side measures.
Balcombe R (editor) et al (2004) The demand for public transport: a practical guide, TRL593, Transport Research Laboratory, Crowthorne. (Book, 237 pp) www.demandforpublictransport.co.uk/TRL593.pdf	About 600 references, including good coverage of grey literature.	Public transport fares elasticities by area, purpose, time of day and other dimensions; quality of service, income, car ownership, and various policy impacts.	Replaces an influential earlier work (Webster & Bly, editors, 1980). Good on short term/long term distinctions.
Cairns et al (1998) Traffic impact of Highway Capacity Reductions: Assessment of the Evidence, Landor Publications, London (Book, 259 pp)	About 150 references, inc. many semi-published, some non-English (notably German), and	Effects of reducing road capacity by pedestrianisation, bus lanes, and also evidence from accidents, disasters, maintenance etc.(nb	Updated in a short paper Cairns et al (2002) Also contains useful summary of literature on dimensions and

	original material from interviews with local authorities.	designed as the complement of SACTRA report on induced traffic, ie about 'disappearing' traffic	dynamics of changing behaviour
Cairns et al (2004) Smarter Choices: Changing the Way We Travel, Department for Transport, London (Book, 2 vols, 676 pp) www.dft.gov.uk/ pgr/sustainable/smarterchoices/ctwwt	About 300 references plus citations from sets of interviews in 24 case study locations. Includes many sources in public domain, but not easily accessible.	Workplace and school travel plans, personalised travel planning, public transport information & marketing, travel awareness campaigns, car clubs, car sharing, teleworking, teleconferenceing, home shopping	(Sometimes called the 'soft factors' report) Some recent updating in separate DfT reports on each item
Commission for Integrated Transport (CfIT) (2007) Transport and Climate Change, HMSO (Booklet, 105pp)	About 120 references	Contribution of transport to carbon reduction	UK statutory advisory body.
Goodwin (2007) Practical evidence on the effectiveness of transport policies in reducing car travel, in Threats to the Quality of Urban Life from Car Traffic Problems, Causes, and Solutions, edited by T Gärling & L Steg, Elsevier, 2007 (Chapter in book)	Citations mostly to work carried out by ESRC Transport Studies unit 1994-2004	Overview of potential for reducing car use	
Goodwin, Dargay & Hanly (2004) Elasticities of Road Traffic and Fuel Consumption with respect to price and income: a review, Transport Reviews, 24 (3). Detailed results in www.cts.ucl.ac.uk/tsu/elasfinweb.pdf	About 85 references in last ten years. (With other review articles, source literature of about 500 references).	Road traffic and fuel consumption (includes some freight indirectly, but mostly personal)	Companion paper to Graham and Glaister in same journal, updating earlier literature reviews by Goodwin (1992) and Oum et al (1992). Other reviews by Espey, and Sterner & Dahl.
RAC (1995) Car Dependence, RAC Foundation for Motoring and the Environment, London (Book 153 pp)	About 85 references	Overview of factors causing car dependence, and possibilities of reducing it.	Approach extended in more recent work by Stradling, Anable and others.
Standing Advisory Committee of Trunk Road Assessment (SACTRA) (1994) Trunk Roads and the Generation of Traffic, London, HMSO (Book, 242pp)	About 70 references and some new results not published elsewhere	Effects of increasing road capacity on the total volume of traffic	Same authors summarised (and slightly updated) their results in a special issue of the journal Transportation, Vol 23 1996, and also briefly in Applied

			Economics 2003, some international papers in Round Table Report 105, ECMT, Paris,
Victoria Transport Policy Institute (2007) On-line TDM Encylopedia www.vtpi.org/tdm/index.php	Not easily countable due to format, but notably well-referenced. (eg elasticities section has 85 references including four to other reviews).	Very comprehensive compendium of information and advice on all forms of travel demand management. International sources, but with a focus on North American application.	A synthesis of information written substantially by one very well-read individual, Todd Littman. Strong policy orientation.

Range of Instruments Used to influence Behaviour

Because there are so many different dimensions of choice that can change, there is a correspondingly wide range of instruments that are or can be used to influence them. The VTPI Encyclopaedia suggests the following structure, as shown in table 7.

(Note that when reading this document in electronic form on an online computer, the blue labels are hyperlinks connecting to the relevant chapter of the Encyclopaedia, which may be convenient as an entry to further reading. This source is not necessarily the most authoritative on each separate instrument, and is somewhat independent from the procedures of academic and government review, but it is probably the best single starting point for an exploration of the evidence base on the topics listed).

Table 7. Travel Demand Management Instruments –

Structure Used by VTPI On-line TDM Encyclopaedia

Improved Transport Options	
Address Security Concerns	Strategies for improving personal security.
Alternative Work Schedules	Flextime, Compressed Work Week (CWW), and staggered shifts.
Bus Rapid Transit	Bus Rapid Transit (BRT) systems provide high quality bus service on busy urban corridors.

Cycling Improvements	Strategies for improving bicycle transport.
Bike/Transit Integration	Ways to integrate bicycling and public transit.
Carsharing	Vehicle rental services that substitute for private vehicle ownership.
Flextime	Flexible daily work schedules.
Guaranteed Ride Home	An occasional subsidized ride home for commuters who use alternative modes.
Individual Actions for Efficient Transport	Actions that individuals can take to increase transport system efficiency.
Light Rail Transit	Light Rail Transit (LRT) systems provide convenient local transit service on busy urban corridors.
Nonmotorized Planning	Planning for walking, cycling, and their variants.
Nonmotorized Facility Management	Best practices for managing nonmotorized facilities such as walkways, sidewalks and paths.
Park & Ride	Providing convenient parking at transit and rideshare stations.
Pedestrian Improvements	Strategies for improving walking conditions.
Ridesharing	Encouraging carpooling and vanpooling.
Shuttle Services	Shuttle buses, jitneys and free transit zones.
Small Wheeled Transport	Accommodating wheeled luggage, skates, scooters and handcarts.
Taxi Service Improvements	Strategies for improving taxi services.
Telework (Telecommuting, Distance-Learning, etc.)	Use of telecommunications as a substitute for physical travel.
Traffic Calming	Roadway designs that reduce vehicle traffic speeds and volumes.

Transit Improvements	Strategies for improving public transit services.
Transit Examples	Describes successful transit programs.
Universal Design (Barrier Free Planning)	Transport systems that accommodate all users, including people with disabilities and other special needs
top **Incentives To Use Alternative Modes and Reduce Driving**	
Walking And Cycling Encouragement	Strategies for encouraging nonmotorized transportation.
Commuter Financial Incentives	Parking cash out, travel allowance, transit and rideshare benefits.
Congestion Pricing	Variable road pricing used to reduce peak-period vehicle trips.
Distance-Based Pricing	Vehicle fees and taxes based on a vehicle's mileage.
Fuel Taxes	Increasing fuel taxes to achieve TDM objectives.
HOV (High Occupant Vehicle) Priority	Strategies that give transit and rideshare vehicles priority over other traffic.
Parking Pricing	Charging motorists directly for parking.
Pay-As-You-Drive Insurance	Converting vehicle insurance premiums into distance-based fees.
Road Pricing	Congestion pricing, value pricing, road tolls and HOT lanes.
Road Space Reallocation	Roadway design and management practices that favor efficient modes.
Speed Reductions	Strategies to reduce traffic speeds.
Transit Encouragement	Strategies for encouraging public transit use.
Vehicle Use Restrictions	Limiting vehicle traffic at a particular time and place.

Parking and Land Use Management	
Bicycle Parking	Bicycle racks, lockers and changing facilities.
Car-Free Planning	Strategies to reduce automobile travel at particular times and places, and create pedestrian oriented streets.
Strong Commercial Centers	Creating vibrant downtowns, business districts, urban villages, and other mixed-use activity centers.
Connectivity	Creating more connected roadway and path networks.
Land Use Density and Clustering	Locating common destinations close together to increase accessibility and transport diversity.
Location Efficient Development	Development that maximizes accessibility and affordability.
Multi-Modal Access Guides	Providing customized directions to a particular destination by various modes.
New Urbanism	Accessible, livable community design.
Parking Cost, Pricing and Revenue Calculator	Excel spreadsheet calculates parking facility costs, prices and revenue.
Parking Management	Strategies for more efficient use of parking.
Parking Management: Strategies, Evaluation and Planning	Comprehensive parking management guide (PDF format).
Parking Pricing	Charging motorists directly for using parking facilities.
Parking Solutions	Comprehensive menu of solutions to parking problems.
Parking Evaluation	Guidelines for evaluating parking problems and solutions.
Shared Parking	Sharing parking facilities among multiple users.

Smart Growth	Land use practices to create more accessibile, efficient and livable communities.
Smart Growth Reforms	Policy and planning reforms that encourage Smart Growth.
Smart Growth Reforms - Comprehensive	This report provides detailed information on policy and planning reforms that result in more accessible land use development. (PDF Format)
Streetscape Improvements	Various ways to improve urban street design.
Transit Oriented Development (TOD)	Using transit stations as a catalyst to create more livable communities.
Land Use Impacts on Transport	Describes how land use factors such as density, mix and regional accessibility affect travel behavior.
Land Use Impacts on Transport - Comprehensive	This comprehensive report provides detailed information on how land use factors affect travel behavior. (PDF Format)

Issues of Synergy and Complementarity

It is usually taken as axiomatic that the effects of these policies and interventions interact in such a way that 'packages' will be more effective than single initiatives, but paradoxically most project appraisal takes place by consideration of the effect of one specific intervention while (in principle at least) holding everything else constant. As a result the evidence base on complementarity is limited. The most notable examples have included the following:

- In recent years the UK Government has recommended that new road capacity should be accompanied by measures to 'lock-in' the benefits, usually taken to mean demand management by economic or engineering methods to prevent induced traffic from eroding the benefits of new capacity.

- While more active and sensitive marketing of public transport services does seem to have an impact of its own, it is more effective if the quality of the services being marketed is also improved.

- The success of road pricing initiatives is closely bound up with explicit use of the revenues collected, which should be transparent (for reasons of public acceptability) and relevant (for reasons of effectiveness). In London this has been mainly applied by improving bus

services, and in some other cities a wide range of alternative transport improvements have been used, from road or rail infrastructure to improved pedestrian facilities.

- Success of park-and-ride initiatives on the outskirts of towns can be enhanced (or undermined) by the town centre parking policy.

- Measures to reduce traffic by carrots rather than sticks (eg in the Smarter Choices agenda) can be undermined unless some form of restriction prevents other induced traffic from taking up the road space released by the evidence.

- There is a strong geographical synergy for example shown when town centre schemes reducing traffic are accompanied by bypass schemes which tend to increase it. (In some case studies the latter effect has been bigger than the former, as reported in Cairns et al 1998).

- Parking is a recurrent theme in discussions of synergy, especially as a risk factor where good intentions are undermined by inappropriate parking decisions.

- It is more difficult to change behaviour in one direction if price signals are going in the opposite direction.

- The most successful applications of multi-element packages in practice have probably been the large-scale pedestrianisation of town centres accompanied by parking restriction and enhanced public transport, where successful cases have been good for mobility, commerce and public enthusiasm with few or no undesirable side effects.

Because of the nature of the relationships and evidence, knowledge in direct elasticities is relatively robust to issues of synergy, and evidence on cross-elasticities is bedevilled by them. Thus it is reasonably well established how much less traffic there will be as a result of a fuel price increase, say, and how many extra public transport passengers will result from a fare reduction. But the proportion of any reduced traffic that will divert to public transport will be entirely different according to the quality, location and status of the public transport concerned. (As rules of thumb it is often taken that about a quarter to a half of reduced car traffic switches to public transport, and a similar proportion of increased public transport use may have been attracted from car, but both are very variable and context-specific).

It is widely agreed that examples like this support the general idea that the most effective form of transport interventions will be a coherent overall package whose elements are all consistently pulling in the same direction, and sustained for a number of years. Until now that remains a logical, but theoretical proposition, as in the real world inconsistency has been more common. In general the experience is that both sticks and carrots are effective in changing behaviour of the individuals concerned. Carrots alone are popular, but a large part of the effect may be offset by the responses of other people, and sticks alone are effective but cannot maintain the public acceptance which enables them to continue.

Thus the strong conclusions on synergy are that different policy measures must be *consistent,* and must include a *mix of both restrictive and enhancing interventions.*

There is one important theme in consideration of synergy which is as yet unresolved. Much research suggests that reductions in car use of the order of 20% to 30% are realistically achieved,

in a reasonably short period of time, as a result of applying measures which are practical and available under present conditions. But it is not yet known whether the second tranche of reduction – eg to go from 20% to 40% - would be *easier* than the first tranche or *more difficult*. There are good arguments supporting either interpretation in theory, but we simply do not yet have the practical experience to determine which applies. Certainly when considering the historical experience of increasing car use, the process increased in momentum as it developed. The discussion is often conducted in terms of 'vicious circles' and 'virtuous circle'. The vicious ones have shown a positive feedback effect tending to reinforce them, and we do not know if the same will apply in reverse.

Quantitative Results

The theory and practice of estimating the effects of changes in policy or circumstance on travel behaviour has been led by the study of road traffic (mostly applied to calculation of value for money of road building) and this evolved since the 1950s. There is an academic and scientific literature of many tho**u**sands of studies, and an 'official' practice in the UK issued in detailed guidelines published from time to time by the Department for Transport. There was a pivotal official paper[1] in 1970 in which the core relationship suggested was that travel demand is influenced by the 'generalised cost' of travel, being the sum of the money costs of the journey and the time costs of the journey. Travellers would respond rationally to the relative advantage defined in this way: at that time the issue of how long it would take for them to respond was not explicitly considered, but in practice it was often assumed that this would be instantaneous or very swift. In the 1970s, it was the common assumption in analyses of travel behaviour that when there were changes in material influences such as price, speed, comfort, and so on, travellers moved swiftly (or in the extreme instantaneously) from one settled pattern of behaviour to a new one.

In the ensuing decades, there emerged very substantial evidence that adaptation to changes in travel conditions was not instantaneous, but built up over time. In parallel with this, evidence accumulated that factors other than time and cost could be very important. The literature is substantial, and I focus below on four studies which are reviews or syntheses of many other studies, and have an accepted stature in the literature. For avoidance of confusion, this evidence relates to the issue of whether there are longer term responses to changes in travel conditions, and the time scale involved in these responses, not at this stage to 'churn' itself which will be discussed later.

Studies of the Effects of Road-Building

The official but independent government advisory committee SACTRA (1994)[2], updated with new Department of Transport data by Goodwin (1996)[3], studied the effects on traffic of 151 schemes in outline, and 12 in more detail, with a supporting literature referring to several hundred additional studies. They noted that the longer term impacts of schemes were different from, and usually

[1] McIntosh, P.T. and Quarmby, D.A. (1970). Generalised Cost and the Estimation of Movement Cost and Benefit in Transport Planning, MAU Note 179. Department of the Environment, London.

[2] Standing Advisory Committee on Trunk Road Appraisal (1994) Trunk Roads and the generation of Traffic, HMSO, London

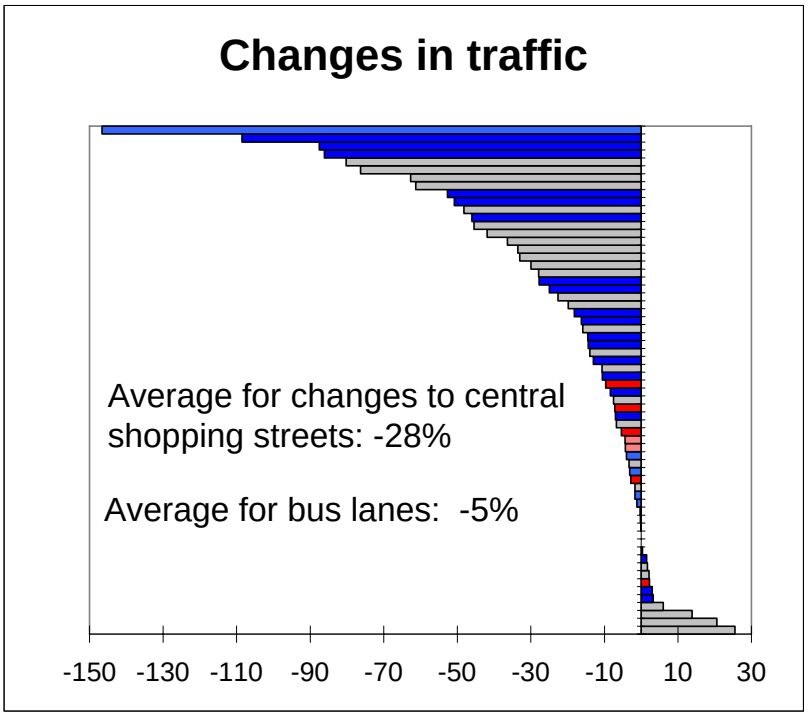
[3] Goodwin P B (1996) Empirical Evidence of Induced Traffic: a review and synthesis, Transportation 23: 23-54

bigger than, the shorter term effect. The data available ranged from effects for a few months (defined as the short term, though later it became more common to define one year as the short term) up to two decades, which was the longest period visible from the available data. The build up of effects allowed the conclusion that adaptation was still going on in periods of 'greater than five years'.

Studies of the Effects of Reduction in Road Capacity

In a research project initiated by London Transport and the Department of Transport, Cairns et al (1998)[4] reviewed about 200 studies of the effects of accidental reductions in road capacity (such as bridge collapses, earthquakes) and planned reallocations of capacity (such as pedestrianisation and bus lanes).

The study suggested that effects were still building up in 'the years following implementation' though the data were not available to say how long after. The Study's main impact was to establish that when road capacity is reduced, in conditions of congestion, there will be a lasting reduction in the volume of traffic, which had not previously always been expected, this reduction being due to complex processes of around twenty different types of adaptation, not only change in the mode of transport or route taken. The longer term traffic loss was greater than the shorter term loss in those cases where longer data sets were available, though this was only apparent after allowance was made for the changes in traffic (typically increases) due to other factors such as income and car ownership.



[4] Cairns, S, Hass-Klau C & Goodwin P (1998) Traffic impact of highway capacity Reductions: Assessment of the Evidence, Landor Publishing, London

Studies of the effects of changes in fuel price

This has been a particularly rich area of research, studying both the effects on fuel consumption and on traffic levels. Goodwin, Dargay and Hanly (2004)[5] cited 69 studies published since the previous round of literature reviews in 1992, summarised in Table 8.

Table 8: Summary of Literature Review on Elasticity of Fuel Consumption and Traffic volume With Respect to Fuel Price

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

There are two results here which are robust and important, namely

(a) The elasticity of fuel consumption is around twice as high as the elasticity of traffic volume. The difference between the two indicates responses such as buying more or less fuel efficient vehicles, trading up or down in vehicle size, driving styles, and possibly driving context.

(b) The long term elasticity is about twice as great (in both cases) as the short term (after allowing for other effects such as income etc), indicating that behavioural responses build up over a period of time.

They focussed on effects over a period of about five to ten years, showing that such effects were typically of the order of about twice as great as those observed in the first year. They comment:

"Short term is defined as responses made within one period of the data used for the study, most commonly, in this context, within 1 year. Long term refers to the asymptotic end state when responses are (as close as may be estimated) completed, and might vary according to what sort of behaviour is under consideration: for much of the transport literature, periods of 5-10 years are estimated empirically, within which the greatest part of the response is in the first 3-5 years".

Note that in the asymptotic form used, the *full* effect is actually never completed, though becomes more and more difficult to distinguish as the years advance. It is worth mentioning in passing that

[5] Goodwin P, Dargay J and Hanly M (2004) Elasticities of road traffic and fuel consumption with respect to price and income: A review, Transport Reviews 24, 3, 275-292

whether the residual *un*completed effect after, say, 10 years, is important or not depends on the purpose of application. In traffic volumes it will almost always then be overtaken by other and more substantial effects, and is normally ignored.

Studies of the effects of 'soft' influences on travel choice.

In recent years there has been special attention to the effect of psychological and other influences on travel choices, especially in the context of travel plans designed to reduce car use without making substantial differences to the money or time cost of travel. Cairns et al (2004)[6] carried out a very substantial (some 700 pages) review of UK and overseas practical evidence, at the request of the Department for Transport. The significance of this study was not to address delayed build-up of effects (in few places had initiatives been on the ground long enough to observe these) but to assess whether initiatives *not* primarily focussed on changing the speeds and costs of travel could have a significant influence on travel choices. They concluded that such initiatives, implemented with some vigour, were capable of reducing peak period urban traffic levels by some 21%, and traffic nationwide by around 11%, these figures being rather more than twice those which had been previously recommended by the Department for Transport. (The Department published the results swiftly and with Ministerial approval, and has since found similar results in a programme of trial studies currently under way).

Estimates were made of the impact of each of the 'soft' instruments separately and together (albeit with considerable caveats) with estimates of the money costs of implementing them per vehicle mile of travel reduced, and the associated benefits in terms of congestion relief. The calculations were rather complex and really should be read in the context of the whole report rather than this summary, but to give an idea of the orders of magnitude the following three tables (9, 10 and 11 here, the table numbers below referring to their original source) are taken directly from the report.[7]

Table 13.13: Impacts of soft factors on future traffic levels

Impact on…	Low intensity scenario	High intensity scenario
National traffic	**2%**	**11%**
Peak-time national traffic	**4%**	**17%**
Off-peak national traffic	**2%**	**10%**
Urban traffic	**3%**	**14%**
Peak-time urban traffic	**5%**	**21%**
Off-peak urban traffic	**3%**	**13%**
Non-urban traffic	**2%**	**8%**
Peak-time non-urban traffic	**3%**	**14%**
Off-peak non-urban traffic	**1%**	**7%**

We emphasise again that these are projections of what *could* happen. Achieving these reductions in traffic (especially those in the 'high intensity' scenario) will depend on the priority and support accorded to soft factors, and the extent to which their benefits are locked in by other measures to control induced traffic.

[6] Cairns S, Sloman L, Newson C, Anable J, Kirkbride A, and Goodwin P (2004) Smarter Choices: Changing the Way We Travel, Department for Transport, London

[7] http://www.dft.gov.uk/pgr/sustainable/smarterchoices/ctwwt/chapter13projectionsandcosts

Table 13.14: Contribution made by each soft factor to overall traffic reduction figures, national average

(with adjustment to avoid double-counting; columns are additive not multiplicative; no adjustments to allow for synergy of impact; assumption that there are 'just enough' supporting measures to lock in effects without enhancing them)

	High intensity scenario	Low intensity scenario
Measures targeting the journey to work, of which:	5.4%	1.4%
Workplace travel plans	*1.2%*	*0.7%*
Car sharing	*2.0%*	*0.1%*
Teleworking	*2.2%*	*0.6%*
Personalised travel planning	1.9%	0.4%
Teleconferencing	1.9%	0.3%
Travel awareness	0.7%	0.1%
Public transport information and marketing	0.5%	0.1%
Home shopping	0.3%	0.08%
School travel plans	0.2%	0.04%
Local collection points	0.06%	0.06%
Car clubs	0.02%	0.01%
Total*	**11%**	**2.5%**

* Figures in this row may not match column totals, due to rounding

Table 13.15: Indicative public sector costs, in terms of pence/vehicle kilometre reduced, for soft factors

Factor	**Source**	**Indicative Cost*** pence/vehicle km reduced
Workplace travel plans--	Birmingham case study	0.1 – 0.3
	Bristol case study	0.6 – 1.6
	Buckinghamshire case study	0.7 – 1.5
	Cambridgeshire case study	0.4 – 0.9
	Merseyside case study	0.4 – 0.7
	Nottingham case study	0.6 – 2.0
	York case study	0.4 – 0.6
School travel plans	Buckinghamshire case study	1.4 – 2.6
	Merseyside case study	2.0 – 3.8
	York case study	5.3 – 9.9¬
Personalised travel planning	Gloucester case study (pilot)	3.3
	Bristol case study (Vivaldi phase 1)	3.4
	London proposed large-scale	1.2
	Nottingham proposed large-scale	0.7
Public transport information and marketing +	Brighton case study	4.4
	Nottingham case study	4.1
Travel awareness	York case study	0.2 – 2.7
Car clubs#	Edinburgh case study	4.8
	Bristol case study	5.1
Car-sharing	Buckinghamshire case study	3.3
	Milton Keynes case study	0.7
Teleworking	In all three cases, private sector investment is needed, but cost savings should outweigh investment costs. However, public sector intervention may be needed to stimulate developments and changes in business practice^.	
Tele-conferencing		
Home shopping		

In social cost-benefit terms, these financial costs were more than offset by the saving in congestion produced (ranging from 3p per vehicle kilometre in rural and town streets, to about 45p in city streets). In the same study, it is significant that some of the responses found were due to the application of better, or different, types of information being offered to travellers, including some which involved giving detailed personalised information to residents of an area about the public transport services available. (This approach is sometimes called 'personalised travel planning'). The evidence collated in the 'Smarter Choices' report showed cases in which people then typically reduced their car use by between 5%-and15%, using alternatives which they had not previously been aware of or taken seriously. In these cases the inference may be drawn that a proportion of people were not initially choosing alternatives which were genuinely better for them, but did not realise this due to an impoverished appreciation of the advantages of alternatives of which they had no experience: some habitual motorists, for example, reject even the idea of trying public transport and therefore do not bother to keep up to date with news of service changes or current opportunities. When they are informed, a proportion of them find they have attractive options available, and willingly use them. Thus habitual behaviour is also marked by a reduction in knowledge of alternatives. (In classical economic approaches this would count as 'irrational' behaviour, though it is probably more helpful to see it as a broader definition of rationality, as discussed below).

Other relevant cases from the same review included examples of choices being influenced by a wide range of factors other than the simple comparison of costs and journey times, being more about convenience, or sometimes image and social acceptability.

The time scale taken for the Smarter Choices projections was ten years, but this was a refelction of assessments about realistic time frames for taking decisions and building up implementation, not the time scale of behavioural response. Most empirical work in this area has focussed on responses within a year of the initiative, with a little evidence on whether the changes are sustained for the following year or two (which they seem to be), but without any evidence on build-up of responses over a five to ten year time scale as in the case of price changes.

Studies specifically on public transport demand.

The main sources of information on factors affecting the demand for public transport are contained in two substantial collaborative studies coordinated by the Transport Research Laboratory (formerly the Transport and Road Research Laboratory), in 1980 and 1994, each compiled by large expert teams of the leading research specialists of the time. These give a good overview of what was already known at the end of the 1970s, and what has been added since.

Webster et al (1980)[8] cited over 350 research studies on the then state of the art of research on factors affecting public transport demand. Almost nothing was said about the timescale of responses, but there was already some evidence that the quality of service offered had an effect quite apart from fares and travel times. The report commented

> "In general, much less information is known about the effect of the various service factors than about the effect of fares... (but) A sizeable body of data is available concerning the effects of changes in vehicle kms operated, service frequencies, and passenger walking and

[8] Webster FV and Bly OH (editors) The demand for public transport, report of the International Collaborative Study of the Factors Affecting Public Transport Patronage, Transport and Road Research laboratory, Crowthorne, UK

> waiting time.... there can be no doubt that passengers regard service reliability as being of great importance (though) available information must rely largely on attitudinal studies and theoretical considerations.... The 'comfort and convenience' factors associated with public transport are many and varied, but several ad hoc studies have been made of particular aspects. Being able to find a seat appears to be of considerable importance (particularly, of course, for longer journeys), and so is protection from the weather... Interchange is generally disliked" (Extracts from Executive Summary).

By 2004, knowledge had advanced significantly. A study designed explicitly to update the earlier results was published by Balcombe et al (2004)[9]. About 600 references are cited, with special attention to those which had been published since the 1980 Report. The quotations in Table 12 are extracted from this study whose authors report three important developments in knowledge.

> First, there is reference to a significant shift of view about demand responses, seen to accumulate over a period of up to around twenty years. (Extracts A, B).
>
> Secondly, there is reference to research indicating that aspects of quality of public transport service are now understood as of being importance. (Extract C).
>
> Thirdly, there is reference to the significance of new research on churn (of which more below) which implied that longer time periods are of importance. (Extract D)

Table 12 Extracts from Reviews in Demand for Public Transport 2004

Extract A: Demand Responses Larger in the Long Run

"The most widely estimated parameters have been price elasticities of demand and, in particular, public transport fare elasticities. Evidence collected during the study suggests that short-term elasticities, relating to changes in demand measured soon after changes in fare, may be substantially different from long-term elasticities, based on measurements made several years after fare changes. Broadly speaking: bus fare elasticity averages around -0.4 in the short run, -0.56 in the medium run and -1.0 in the long run; metro fare elasticities average around -0.3 in the short run and -0.6 in the long run, and local suburban rail around -0.6 in the short run. These results appear to indicate a significant change from those reported in the 1980 study." (Exec. Summary p 1).

Extract B Long Run Up to Twenty Years

"Fare elasticities are dynamic, varying over time for a considerable period following fare changes. Therefore it is increasingly common for analysts to distinguish between short-run, long-run and sometimes medium-run elasticity values. There are various definitions of short-, medium- and long-run, but most authors take short-run to be 1 or 2 years, and long-run to be around 12 to 15 (although sometimes as many as 20) years, while medium run is usually around 5 to 7 years." (Exec. Summary p1)

Extract C: Quality of Service Effects on Public Transport

"The examination of quality of service identifies seven categories of attributes of transport services that collectively determine quality, and examines evidence as to how these components of quality affect

[9] Balcombe R (editor), et al (2004) The Demand for Public transport, A Practical Guide, Report TRL 593 Transport Research Laboratory, Crowthorne, UK. http://www.demandforpublictransport.co.uk/TRL593.pdf

demand. The findings are presented either in the form of elasticities, or as weights to be given to the various quality components when incorporating them in generalised costs for purposes of modelling. There is limited evidence on elasticities with respect to in-vehicle time (IVT). The available evidence suggests that IVT elasticities for urban buses appear to be roughly in the range -0.4 to -0.6, while those for urban or regional rail range between -0.4 and -0.9....Attribute values have been derived for various aspects of bus shelters, seats, lighting, staff presence, closed-circuit TV and bus service information. Estimates for individual attributes of the waiting environment range up to 6p per trip (subject to a limiting cap of around 26p on the total), or up to 2 minutes of in-vehicle time per trip." (section 3.1.1)

Extract D: Changes in Travel behaviour Linked to Life Cycle Changes

"Changes in travel behaviour are often associated with critical events in the life cycle, such as setting up a new home, or changing jobs. Many people may change their mode of travel for such reasons, at least in the short run, rather than because of differences in modal characteristics. This leads to a high turnover in the market, such that net changes between one year and the next are often small compared with the gross changes that produce them. For example, panel surveys in Tyne and Wear revealed a net reduction in the public transport share for the journey to work of 2 percentage points between 1982 and 1983. This proved to be the net result of 7% of respondents ceasing to be public transport users, while 5% became new users in that period. A net change of 2% thus involved about 12% of the sample in changing modes (Smart, 1984).

These changes are likely to be particularly noticeable if individual services are examined, since people may change routes used when changing homes or jobs, while remaining in the public transport market. Even in a zone of apparently stable land use and total population, such as a well established residential area, constant change is occurring. On a typical urban bus or rail route, as many as 20% of users may have begun to use that specific service within the last 12 months. Hence, if examining the impact of a recent change (such as introduction of a 'Quality Partnership' upgraded bus service) it is important to distinguish users who have switched to a route for such personal reasons, as distinct from those attracted by service characteristics...

Patterns of individual behaviour may influence trip frequencies over a very long period. For example, based on work in South Yorkshire and elsewhere, Goodwin and others have suggested that trip rates developed in early adult life may strongly influence subsequent modal use.

The implication of this for transport operators and planners is that responses to change in fares and service quality should be assessed not only in the short run, but over long periods. Much short run change is caused primarily by non-transport factors, but in the long run transport characteristics will affect other choices. For example, individuals may be firmly committed to a specific mode of travel for their existing home to work trips, which may not be affected even by large changes in price or service quality, but when relocating, will have to reconsider the routing, and perhaps mode, of those trips." (Section 2.4.6)

Together these suggest a broad consensus among travel demand analysts that the longer term effects of changes in the attractiveness of travel are different from the short term effects, that the effects are not instantaneous but build up over time, and that factors other than time and cost also affect travel choices. I emphasise that this change of view has not occurred because longer term effects were previously absent and are now present. It has happened because the longer term effects which were always there, have more recently been discovered by the use of more appropriate analytical techniques. All studies which have reanalysed old data using techniques capable of discovering longer term effects, have found them. Conversely, new studies using techniques incapable of discovering long term effects, have (not surprisingly) failed to find them.

This point is relevant to all applications of trajectories of change which involve the dynamic build-up over time, as the projections of future carbon use which have been carried out so far have (as far as I am aware) all used equilibrium models with no path dependency or dynamic build up. (Some have used short term elasticities and others long term elasticities, but that is a different matter).

How Long is the Long Run?

There is a wide range of evidence about how long these longer term responses to changes in travel conditions take to complete. Those studies which have had data for very long periods of time (such as some of the 'before-and-after' studies of road construction, and some of the better studies of fuel prices) have found that there are still, just, detectable effects continuing after 20 years or more. I am not aware of studies whose authors have asserted with confidence that they have been able to make statistically significant measurement of responses to changes in travel conditions which have still not been completed after periods of longer than twenty years, bearing in mind that the technical definition of 'significance' in statistical terms is different from that of 'substance' in financial terms. However, it is commonplace to say that longer term effects must logically exist for impacts which affect preferences for where to live and work, and therefore have effects on land-use development and property markets, which then have further effects on choices for some generations. Thus on longer term effects, there is statistical evidence for processes up to around 20 years, and logical arguments for longer processes which are inherently difficult to measure.

At the other extreme, studies using methods which rely on month-by-month tracking of patronage figures have often found that the longer term effect seems to have settled down within a year or even less. Thus Meaney et al (2005) suggests.

"the majority of rail market studies, including NERA (2003) and Wardman and Whelan (2004) reported that, for all panels, over 90% of the demand adjustment occurred within a year after a fares change".

That had, indeed, been the 'orthodoxy' within the rail industry for many years. However, the authors of the report used this as their starting point to reconsider whether the conclusion was valid or not. They drew particular attention to the methodological problem that evidence of potential longer-term impacts is not easily revealed when using data arranged in four-weekly records, because the high volatility in the very short term tended to obscure the slower longer term processes. They then proceeded to carry out new analysis to test this possibility. They reported:

"the long run is of an order of 16 to 20 times longer when obtained from annual rather than four-weekly data"

The study's own preferred results then found a range of time scales with 99% of the effect completed in periods of up to 8 years, depending on the exact model form and market segment considered.

Habits and lags

Most, perhaps all, official projections use a framework of equilibrium economic behaviour with rather simple view of rationality, and no lags, inertia or non-symmetrical relationships. That may be useful when the task is extrapolating 'business as usual' trends, from which small modifications are made resulting from specific well-defined projects.

The problem with this approach is that it produces a really very unfavourable 'base' forecast for the future, from which the scale of behavioural change necessary to achieve carbon reduction targets seems huge and implausible. An alternative approach would be to start from now, and consider a different trajectory influenced by policy interventions or instruments now. In this case we would need to build a dynamic year-by-year trajectory of change, distinguishing short run and long run effects, and considering the importance of habit and other forms of resistance to change.

The related, but different, constructs of habit, lags, lifecycle changes, and churn, have become important aspects of a new transport research scene. My own work on this subject dates back to a theoretical paper[10] which proposed that 'habit' is a form of resistance to change which can be entirely rational, and a series of papers exploring different properties of changes in travel choice over time in various locations. Later, a particularly relevant paper was written with my colleague Joyce Dargay[11] which described how even when travel choices were marked by habit, or prolonged delays, it was still appropriate to use the concepts of economic analysis including the calculation of economic costs and benefits. In that case, the class of economic benefit considered was the concept of 'consumer surplus' a sort of profit made by the individual traveller when the benefits of a journey exceed the cost, which is important in the assessment of social costs and benefits for public sector investments, but the same logic applies for the private financial profit of a commercial operator. Naturally, the work done in my own institute was only part of a larger literature on the subject, and the 2004 volume 'The Demand for Public Transport', discussed above, summarises some other evidence in the field, and may be taken as the assessment of the broad group of authors of that report.

Habit may be defined simply as a resistance to changing a currently adopted pattern of behaviour: that resistance is unlikely to be infinitely strong – it will give way to some countervailing pressure, but only if that pressure is strong enough to overcome some hurdle or threshold. Much public and professional discussion of habit focuses on 'bad habits', either bordering on addictive behaviour such as tobacco, alcohol or drugs, or with undesirable individual, social or environmental consequences such as over-eating or excessive car use. Thus there has been much research on how to break habits, and change behaviour: this has been the primary concern of research aimed at informing public policy. There has been a legacy of presumption that habits are bad, or irrational, or both.

However habits are not necessarily either harmful or irrational. Habits may be harmless, or even beneficial, if they tend towards behaviour patterns which are benign or approved. In particular, habits may also be entirely beneficial (from the point of view of a commercial company) if behaviour patterns can be fostered which favour the product of that company for reasons of loyalty, status, image, or even misconception. Many commercial companies, for example supermarkets, spend quite a lot of money to encourage their customers to get into the habit of using them in preference to their rivals, even if their rivals are just as good. If their rivals are better, it may become even more important to foster habits which reduce that disadvantage. Similarly a transport operator will naturally seek to encourage customers to consider that it is better than a competitor, as is shown by efforts that operators spend not only on the travel times and charges for their services, but also on livery, image, staff training, customer relations (announcements, complaints procedures, information services, even a 'good morning' from the

[10] Goodwin P B (1976) Habit and hysteresis in mode choice, Urban Studies (14) 95-98

[11] Dargay J M and Goodwin P B (1995) Evaluation of consumer surplus with dynamic demand, *Journal of Transport Economics and Policy,* May, 179-193

ticket inspector), the availability of refreshments, and branding and image. In this context, the formation of habits is a commercial asset, and their breaking would be a commercial liability.

Habits may not be irrational from the point of view of the customer either. It would be widely agreed, I think, that 'getting into the habit of walking more' may not only be good for the national health budget and for the environment, but also be entirely in the interests of the individual. In this case, the problem derives from too narrow a definition of 'rational', as determined only by considerations such as speed and time, but not other objectives. More generally, habit can be a *rational* contribution to peace of mind and a bearable quality of life: it would be intolerable if every morning one had to collect new information, review, assess and choose between all the options for travel before going to work. Such reviews will sensibly be done at less frequent intervals.

It has been common when studying choices between different modes of transport (e.g. car versus train) to use a form of equation in which as well as the relative costs, travel times and such other factors as are found to be relevant, allowance is also made for a parameter called a 'mode-specific constant'. Such a parameter frequently makes a model more closely correspond to the statistical data such as travel survey results. The behavioural basis of the parameter is not well understood, but it is thought to reflect a sort of prejudice towards one mode or another, which means that it will be favoured even if the cost and times tend to favour its competitor. In most cases this is reported as a built-in preference towards car as compared with public transport, and for rail as compared with bus, other things being equal. (It is not infinite in value, of course: a very large advantage can overcome this preference).

Among the many studies of this type, one (and there may be more) used a special form of analysis, looking at the built-in preference not towards any specific mode, but towards the 'used mode', in this case in the choice between train and coach for commuting journeys to London from North Kent. The results are summarised in Goodwin (1985)[12]. The analysis suggested that even after taking account of cost and time factors, coach users had an attachment to coach, and rail users had an attachment to rail, of exactly the character which would be expected from a theoretical analysis of habit, which is considered further below. This finding, like that of the car users who are ignorant about public transport services, would lead to the expectation that a proportion of travellers at any one time can be using a method of transport which does not, at the time of a survey, give them the best deal in terms of time and money.

Life-cycle changes.

There is evidence that change in one's own personal circumstances, such as changes in life style or major life events, are associated with the timing of reviews of the transport options open to travellers. The evidence here, as summarised in the 'Demand for Public Transport' and its source references) is sensible, has some empirical support from several countries, and is entirely consistent with the bigger statistical studies.

This approach therefore suggests that many, perhaps most, people will *not* make continual adjustments to their travel choices every time there is a change in speeds or costs or quality of service. If a rejected option becomes more attractive, it takes them time to learn about that. If their

[12] Goodwin P (1985) Changes in transport users' motivations for modal choice: passenger transport, Report of the 68th Round table on Transport economics, European Conference of Minsters of Transport, OECD, Paris.

chosen option becomes less attractive, of course they do notice, but if the change is small it doesn't justify the effort of upsetting a well ordered routine. Thus the initial responses will be confined to a smaller proportion of the population, for whom the changes are relatively large or altering their behaviour is easier.

After a period, however, some other change happens in everybody's life which forces a reappraisal – this might be a change of home or job, or retiring, or getting married or divorced, or children growing up and leaving home. Each of these changes has its own specific impact on travel demand, but the relevant point is that *some* change is triggered, and therefore there will be a period of reappraisal during which there can finally be a delayed response to the transport changes which happened some time earlier.

The effect is twofold:

> People whose lives are more stable and uneventful tend to respond less to changes in the relative attractiveness of the current travel choice, whether that change affects their current choice getting worse or an alternative getting better.
>
> People whose lives are being changed by some important event or development, tend to respond more to whatever changes in relative attractiveness there have been.

Thus the process by which the market as a whole adapts to changes may be seen as influenced by the pace at which the incidence of such life events is rolled out over the population. This is connected with demographic trends, concerning the number of people who change jobs each year, change home, and so on. As it happens, such changes tend to happen in frequencies which lead to an expectation that on average over a period of around ten years, a substantial majority of the population will have undergone at least one such event, though for a smaller proportion of the population it may be several decades. Thus the timescale of the incidence of such life events will *influence* the time scale of adaptation to changing circumstances, but it is not, or not necessarily, the *same* as the time scale of adaptation. Some responses to transport changes will not wait on an associated life cycle transition: even if the entire population were stable and settled in their lives, there would still be responses to fares changes or service changes.

Churn

Some life cycle transitions and similar events will also take place, and result in changes in travel choices, without necessarily being linked to a response to external changes in costs and speeds and service quality. From an operator's point of view, these changes in the market appear random: people arrive, stay for a while, and leave, as their personal circumstances dictate, even if the transport offered stays identical. If the passenger base numbers are stable overall, then the number of customers dropping in will approximately equal the numbers dropping out, while a core middle group stays unaffected. The relative size of the incomers, outgoers and loyal customers will influence whether patronage is growing or declining.

This form of analysis has been imported into travel marketing from political science, where it has been used for many years to analyse voting patterns and calculate 'swing', being the net effect after the people moving in opposite directions have balanced out. The approach is not any longer particularly unusual or revolutionary: I am not aware of a convenient overall state-of-the-art literature review on this topic in application to transport, though one is probably overdue, but the description is close to that given in to 'Demand for Public Transport' ('Extract D' above) which in

turns cites further studies. I am not aware of any critique which dismisses the approach or its general findings, though I am bound to say that the concepts of lag, habit, inertia and churn have not found their way into an mainstream forecasting or appraisal at a national level, and this may be critical in assessing the potential for seeking changes in travel choices in order to pursue explicit policy objectives.

This turnover or churn effect has been investigated by several researchers. A review by Chatterjee (2002) identifies 'asymmetric churn' in which the numbers of new and lost users over a given period are not necessarily equal. He cites the case of data from the Netherlands for the period 1984 to 1987, some 123 'high users' of public transport in 1987 were shown to comprise only 58 who had been 'high users' in 1984, 48 previous 'non users' and 17 previous 'low users' (from Goodwin, 1989). Work by Dargay and Hanly on the British Household Panel Survey (2003) indicates that over a nine-year period, over 50% of commuters change their main mode at least once. Of those who both move house and change employer during two consecutive years, 45% also change mode. Exceptionally high rates may be found in areas such as central London, a recent survey in July 2002 of office workers showing that nearly half had changed their place of work, home or means of transport since October 2000 (Brook, 2002).

Studies of Attitudes and Stated Intentions

In recent years there has been much interest in whether peoples' concern with climate change and the contribution of transport to it will be a sufficient motivator to behavioural change even apart from policy incentives such as those discussed above. This paper does not review this field fully, but work is progressing to that end. A current review[13] of available published evidence on attitude surveys has produced preliminary evidence that varying proportions of members of the public assert that they do, or would, change their travel choices for reasons of environmental sustainability.

Table 13 Indicative Evidence on People's Expressed Willingness to Change Behaviour

Question about behaviour	Answers	Notes
'Individuals should try to limit their car use for the sake of the environment'	About three quarters said they would undertake 'some form of activity to reduce car journeys, mostly non-essential journeys	Only 5% of cars users said they had done so in the previous year.
'Driving one's own car is too convenient to give up for the sake of the environment'	44% agree, 26% disagree	Unstable 1997-03
'Suppose you were forced for some reason to cut your regular car trips. How inconvenient would you find it?'		
.....by half	Only 6% 'not inconvenient'	Stable 1997-2001

[13] Carried out for the UK Department for Transport by a research team of the Centre for Transport and Society, UWE Bristol, of Jillian Anable, Kiron Chatterjee, Geoff Dudley, Phil Goodwin (editor), Mark Hanly, Glenn Lyons (editor), Yusak Susilo and Peter Wiltshire.

.....by quarter	13% 'not inconvenient'	
'Many of the short journeys I now make by car I could just as easily go by...' Bus Walk	 26% agree, 53% disagree 37% agree 39% disagree	 Rather stable
Reduce the number of flights made in the following year for environmental reasons	About 10% of those who had flown in the last year.	
Would change behaviour if road pricing introduced Limit car use *currently* due to Price of petrol The environment	10% of total said would change mode, time, frequency or route. 5% a great deal, 22% to some extent, 20% not very much 2% a great deal 18% to some extent, 22% not very much	Nb total included non-drivers
'Would reduce my car use *if* Pavements better maintained Safer walking routes Cycling facilities better Charges on car use... ...plus with better public transport	 30% 37% 20% of those who currently do not cycle 40%-60% 52%-72%	 Nb *size* of reduction in use not specified

Sources: UK National Omnibus Survey, British Social Attitudes Survey, DEFRA Evidence Review, 2002-2007

Thus quite large numbers of people express willingness to change travel behaviour in general terms, and say they would do so *if* public transport, walking and cycling conditions were improved, or car costs were higher, or both.

These results cannot be taken at face value without linked evidence on actual journey patterns over time by the people saying so, which is not available. However the proportion of people saying they would change their behaviour, or would entertain doing so, or have already done so, has rather similar orders of magnitudes to the sensitivities to different policy instruments noted in the evidence review above, and therefore with due caveats increases rather than reduces confidence in it.

A particularly useful approach has been developed by Anable (2005) in which a series of stated attitudes are used to suggest a series of segments of the population who are more nad less amendable to changing their behaviour for environmental reasons. These span from diehard motorists who resist any such idea, to aspiring environmentalists who welcome it: the essence of the approach is that different incentives will be appropriate for different people, and surely that is the most positive direction for policy development.

Conclusion

Travel behaviour is sometimes described as ‘too difficult to change’. This paper suggests that there are very many different sorts of behavioural choice, many of which are in continual flux, and subject to a very wide range of different incentives. The evidence base is very substantial, consisting of some thousands of studies which have produced specific quantitative results.

The evidence confirms that there are very many more travel choices which people make other than between cars and public transport, including the volume and location of travel, other modes notably walking and cycling, driving styles, levels of car ownership, where to live and work and shop, and the type of activities they participate in. In general it is found that responses are often rather small in the short run, but build up to very much more flexible life-style choices in the longer run, defined as the period 5-10 years and in some cases longer, in which habits are eroded and new ones form. There is a very large volume of empirical and case study evidence about the effect of changes in price, speed of travel, quality, information, new infrastructure, better use of existing infrastructure, planning, and other factors which can be influenced by public or private interventions. A common characteristic of those interventions on which evidence based on experience is available is that they have mostly been chosen for objectives other than carbon reduction (especially, but not only, congestion reduction and quality of life improvements) which in cost-benefit terms often bring a benefit greater than the cost of implementing them. Where this is the case, there are carbon benefits for zero or negative real resource cost.

The evidence available is rich concerning reductions in car use up to about 20%-30%, but very sparse beyond that.

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