Centre for Transport & Society

RESEARCH BRIEFING SHEET 015

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Investigating Travel Behaviour Dynamics and Their Incorporation into Transport Models

This briefing sheet describes a two-year project funded by the Engineering and Physical Sciences Research Council (EPSRC) that sought to understand and model, as the transport system changes, the dynamics of people's travel behaviour.

Background

When the transport system changes it can be expected that some individuals may react immediately and change their behaviour, others will take some time before changing their behaviour and others will not change at all. The overall change in travel patterns at any time point will depend on the aggregation of individual responses.

Longitudinal data can be used to study how people's behaviour changes over time and to develop dynamic models that can forecast this. A dynamic model will recognise time as a dimension and that travel choices at a point in time will be dependent on earlier conditions and events. Longitudinal data is commonly used in other fields (e.g. health, employment) but has been used to a limited extent in transport where it is usual practice to collect cross-sectional data, compare different people's behaviour at a single point in time and infer how behaviour may change in the future from this. It is well known that longitudinal data offers advantages in terms of plausibility, insights provided on process of change, statistical efficiency and reliability and forecasting capabilities.

Research Justification

In 2001 a report for the UK Department for Transport *A New Look at Multi-Modal Modelling* concluded that future transport models should incorporate dynamic characteristics. In the 2000 *Handbook of Transport Modelling* (chapter 7) Kitamura suggested that advances in computing and methodological capabilities are such that there is potential that 'longitudinal methods can be developed and applied with the same ease as cross-sectional models, to make transportation analysis more coherent, accurate and richer'. Panel data is the most common form of longitudinal data and Bradley noted in the 1997 *Panels for Transportation Planning* book (chapter 11) that when studying the impacts of interventions 'multiple "after" periods are necessary (in panel surveys) to determine whether policies grow, diminish, or remain stable over time'.

Methodology

The following steps were taken in the project.

1. Review of dynamic methods of modelling travel behaviour.
2. Collection of new panel data.
3. Development of dynamic relationships of travel behaviour from panel data.
4. Application of dynamic relationships of travel behaviour in the Dynamic Urban Model system for forecasting.
5. Preparation of guidelines on incorporating dynamics in travel demand models.

The new data collection involved a four wave panel survey of the travel behaviour of residents of Crawley, West Sussex, before and after the introduction of a guided bus service route (Fastway Route 20) in September 2005. Self-completion postal questionnaires were used as the survey instrument throughout the survey. The first wave of the survey took place one month before Route 20 was introduced with subsequent waves at two month intervals. 550 responses were achieved for wave 1 and over 200 responses at each subsequent wave.

Outcomes and Benefits

Two main forms of dynamic analysis were conducted using duration modelling and discrete choice modelling.

Duration modelling was used to analyse the factors influencing the time taken by survey respondents to first use, or 'adopt', the new Route 20 service. Mode choice is a new application area for duration modelling. In Figure 1 observed data is compared to predictions from two different duration models. The split population duration (SPD) model performs better than the standard duration model. The SPD model relaxes the assumption that all respondents will eventually use the new travel mode option.

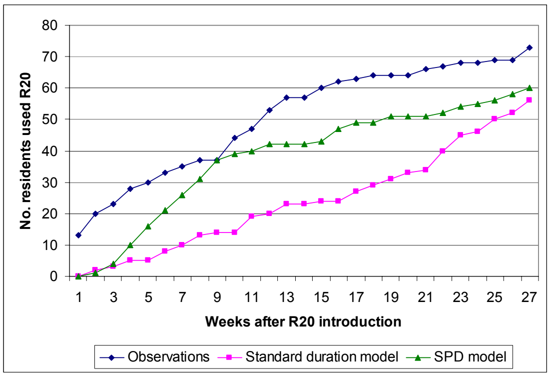

Figure 1. Comparisons of observed data and predictions

Discrete choice modelling was applied to model the transition in bus usage frequency of respondents over the survey period. Various model specifications were tested to capture aspects of dynamics such as lagged responses, state dependence (past behaviour affecting current behaviour) and influence of life events. Reference was made to the latest advances in panel data analysis to address issues such as distinguishing unobserved heterogeneity and state dependence and specifying initial conditions (in state dependence models). As an example of one of the simpler dynamic models tested, Figure 2 illustrates different first-order impulse models. The model that fitted the data best was with $\delta=0.75$, indicating that growth in Route 20 use was sustained over the six month survey period but declining at such a rate that about three-quarters of total eventual bus use growth had occurred after six months.

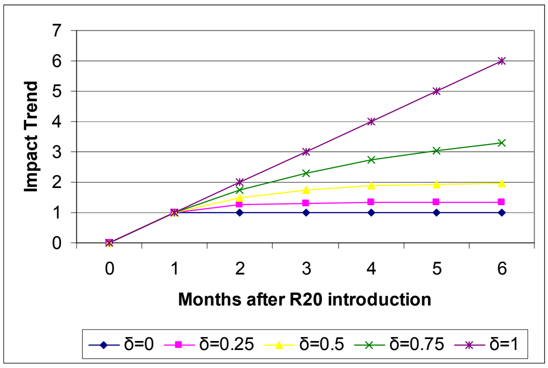

Figure 2. Impacts over time of first-order impulse models

The implications of behavioural dynamics for forecasting were explored through sensitivity tests with different lag response values for mode choice in the Dynamic Urban Model system developed by Steer Davies Gleave. The tests showed how the overall evolution of travel demand is affected over a longer period than the specific lag period assumed.

The project has enabled a set of guidelines to be developed which cover motivations for dynamic modelling, conduct of panel surveys, methods of model estimation and forecasting using dynamic relationships. The project has shown that with appropriate data it is feasible to develop dynamic models of travel demand that incorporate important aspects of behavioural dynamics.

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