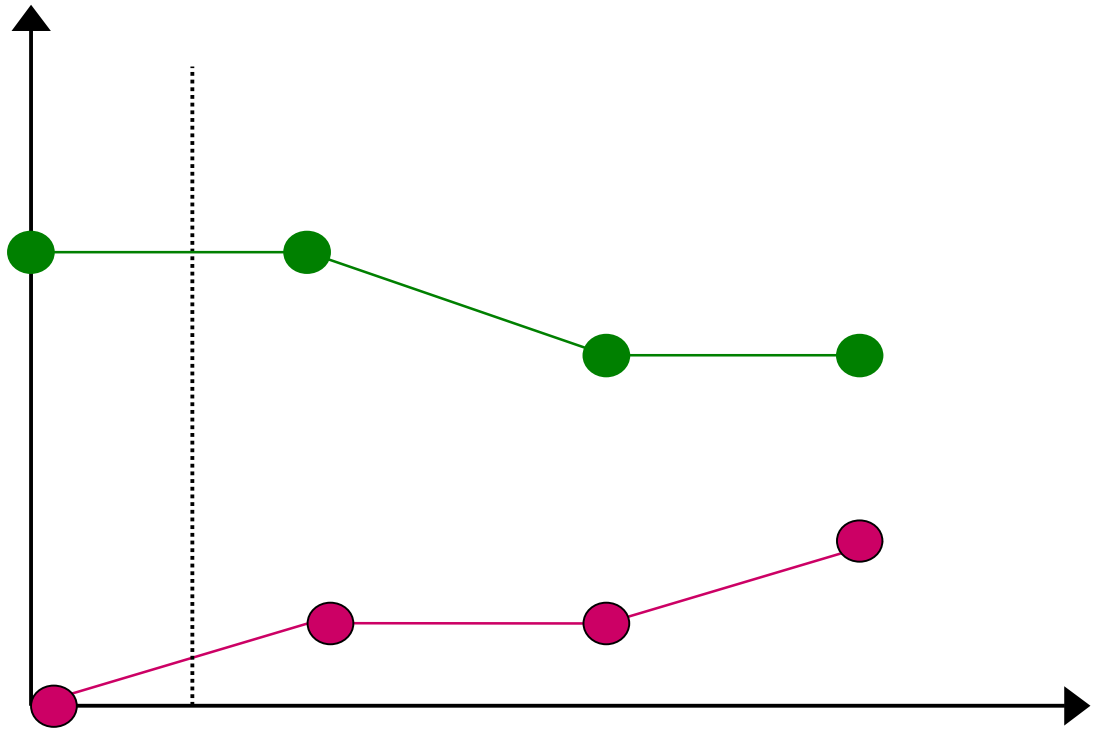

Behavioural Responses to a New Transport Option – A Dynamic Analysis Using a Six-Month Panel Survey

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Abstract

When new options are introduced into the transport market or existing options are modified it is found that travel demand responses are not instantaneous but evolve over time. Given the importance of behavioural change to transport policy it should be considered imperative to understand and predict the dynamics of travel behaviour responses. This paper uses a panel survey to seek greater understanding about the time-scale of behavioural responses to a new transport option and the factors that influence this. It first reviews existing work and finds a shortage of studies that have obtained appropriate data to investigate this. It is explained how a panel survey has been designed in order to monitor the responses made to a new bus service after its introduction. Analysis of the data shows that the rate of new users of the service has been modest but stable during the first four months of operation after which the number of new users appears to decline sharply. During the first six months of operation the awareness of the service, positive attitude towards it and overall usage has grown slowly. Of those residents that have used the service some are shown to become regular users while others are one-off users and others have increased their use over time. Taking into account change in frequency of use of the service by individuals over time is shown to improve estimation of overall demand for the service. An analysis of general bus use frequencies shows that 35 residents increased bus use and 13 decreased bus use in the period of the panel study. A complementary decrease in car driver trip frequencies was found to occur. The new service appears to have had a lasting impact on mode shares in the study area with the panel survey revealing the dynamic nature of the impact.

Keywords

Panel survey, Longitudinal, Dynamics, Buses

Preferred Citation

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1. Introduction

When new options are introduced into the transport market or existing options are modified it is found that travel demand responses are not instantaneous but evolve over time. Given the importance of behavioural change to transport policy it should be considered imperative to understand and predict the dynamics of travel behaviour responses. Conventional methods of travel demand analysis (based on cross-sectional travel data and on equilibrium principles) are static in nature and are not able to tell us anything about behavioural dynamics. They assume that travel demand (whether at the level of the individual traveller or the overall population) moves from one state to another when the transport environment changes. It is the dynamic, evolving change in demand that will determine the consequences of a new transport service for public welfare (user benefits, societal costs) and business viability (revenue streams), so efforts should be placed on forecasting dynamic behavioural responses.

Addressing the inability of models to forecast dynamic responses, Douglas (2003) has analysed patronage growth for 13 new or upgraded rail schemes from around the world and identified 'ramp-up' factors. Taking the experiences across the 13 schemes, he estimated an average 'ramp-up' factor of 79% for the first year of operation, 95% for the second year of operation and steady state patronage after three years. However, there was considerable variation in growth across the schemes. Douglas notes that demand stemming from induced demand may take longer to 'ramp-up' than diverted demand. He considers that 'ramp-up' may arise due to the 'learning curve', travel habits, operational 'teething' problems and marketing deficiencies. The 'ramp-up' factors provide useful indicative figures on average growth in demand across the schemes studied but are not able to indicate the growth in demand that can be expected for a particular transport system.

This paper seeks to discover more about the dynamics of behavioural responses to a new transport option and to identify requirements for dynamic modelling that follow from this. Section 2 of the paper considers behavioural explanations for dynamic responses and how much is known about these. In section 3 it describes a panel survey designed to obtain information on the behavioural responses of residents to a new bus service. In section 4 results are presented from the survey and section 5 provides concluding remarks on what has been learnt from the survey.

2. What is known about behavioural dynamics

Dynamic responses to a change in the travel environment may be explained from the perspective of the individual traveller by the behavioural factors identified in Table 1. Despite behavioural change being of major interest to transport planners, there is relatively little understanding of the importance of these factors and how they affect the time-scale of responses to a change in the travel environment (Chatterjee, 2001). What is known from previous work is now reviewed.

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Table 1 Behavioural factors influencing the time-scale of responses

Longer responses	Shorter responses
Habit prevents any conscious deliberation about behaviour	Conscious deliberation occurs due to goals not being achieved (e.g. roadworks) or due to decision context changing (e.g. move house)
Time is required to become aware of change and to acquire and process information about it	Awareness takes place of change in advance and preparation is made for it
Period of experimentation with alternative behaviours	Variety in behaviour is sought
Gradual modification of behaviour is made towards preferred behaviour	
Long-term commitments exist towards current travel behaviour (e.g. season ticket)	
An option is only be tried after sufficient time for positive attitude towards it to be developed	

Habit has been the focus of considerable attention by travel behaviour researchers in recent years. The role of habit has been conceptualized by Triandis (1977) and Verplanken *et al.* (1997). Empirical investigations have sought to identify the importance of habit and at the same time have provided insights on some of the other behavioural considerations identified in Table 1. We first review studies that have used experimental interventions in the travel environment to examine the role of habit and then we review studies that have looked more generally at the stability of travel behaviour.

Fujii and Kitamura (2003) looked at the effect of providing subjects with a one-month free bus pass and compared behaviour immediately before, immediately after and one month after the experiment. They found an increase in positive attitude towards bus, use of bus and a decrease in habitual car use after the experiment which was sustained to some degree one month later. Bamberg *et al.* (2003a) investigated the impact of providing students with a free bus pass for a semester and concluded from comparing behaviour two months prior to the experiment and eight months after the experiment that there was weak influence of past behaviour with the intervention producing changes in attitudes, subjective norms and perceptions of behavioural control. Bamberg *et al.* (2003b) investigated changes in car use of people after a residential move with half of the subjects studied being given a public transport information pack (including and free day ticket) and half not given the pack. They found from comparing behaviour before the move and six weeks after the move that for both sets of participants the change in decision context caused the subjects to re-evaluate their behaviour. As expected, the participants receiving the pack changed more to public transport use after the move.

The stability of travel behaviour has been explored using citizen panel surveys. Dargay and Hanly (2004) used eleven years of data from the British Household Panel Survey (BHPS) to analyse stability of car ownership and commute mode. They used random effects models (ordered probit), which take into account heterogeneity, to show that state dependence (last year's behaviour) is an important determinant of both car ownership and commute mode behaviour, after taking into account other determinants such as household income and fuel prices.

Structural equation modelling has been employed to analyse travel behaviour stability in the following three studies. Golob (1990) employed three waves of data (one year apart) from the Dutch National Mobility Panel and found inertial and lagged relationships between income, car ownership, car mobility and public transport mobility. Thørgersen (2006) used three waves of travel data (between 1998 and 2000) to study public transport use for a random sample of participants in Denmark. He found that current behaviour is strongly conditional on past behaviour but mediated by current attitudes and perceived behavioural control. He also found that current behaviour determines future attitudes and perceived control. Simma and Axhausen (2002) used panel data from both Germany and the Netherlands to examine the relationship within period and between period of travel commitments (car ownership and public transport season tickets) and mode usage, finding that commitments in one period affect mode usage in the next.

While the above studies have provided useful insights on the role of past behaviour and habit in determining current behaviour, they have not specifically examined the time-scale of behavioural responses. There has been substantial research carried out on the dynamic travel decisions of motorists which has involved measurement of the timing of changes to behaviour. This has focussed on route and departure time choices. A conceptualisation of drivers' decision making process incorporating information is provided by Ben-Akiva *et al.* (1991). A number of studies have used travel diaries and laboratory simulations to collect data and estimate models for day-to-day decision making of motorists (e.g. Polydoropoulou *et al.* (1994), Mahmassani and Liu (1996), Jha *et al.* (1997)). While these studies are informative on the timing of motorists' responses to information, they do not offer insights on travellers' mode choices and how these are affected by interventions designed to change the relative attractiveness of different modes. Mode choice is an aspect of travel behaviour where there are major barriers to change (as highlighted in Table 1) and change tends to take longer to occur.

An important reason for the limited knowledge on the time-scale of transport mode behavioural responses is difficulty in obtaining suitable data. Bradley (1997) looked at the effect on mode choice of a new rail commuter line between Almere and Amsterdam. 'Before' and 'after' data were collected for 475 commuters and Bradley specified and estimated dynamic logit models accounting for response lags and state dependence. He found improved model estimation for dynamic model specifications and found that forecasts are quite different if dynamic specifications are used instead of static specifications. He concluded, though, that to understand and model the impacts of changes in the travel environment 'multiple "after" periods are necessary to determine whether policies grow, diminish, or remain stable over time'. Further to Bradley's remark, it should be pointed out that to improve potential for identifying causal impacts three or more time occasions are necessary to monitor the sequence of changes that occur in variables.

Golob *et al.* (1997) studied the impact of introducing a high occupancy vehicle (HOV) lane on 481 motorists in San Diego, California, using three waves of data (one year apart) with the second two waves after the intervention. Structural equation modelling was used to explore the inter-relationship within period and between periods of: (i) individual perceptions of traffic conditions; (ii) attitude towards HOV lanes; (iii) car sharing behaviour; and (iv) average travel times. The analysis found that, except for the period after the HOV lane was introduced, car sharing behaviour is determined solely by travel times. After the HOV lane was introduced car sharing behaviour was also determined by perceptions and attitudes showing that these are re-formulated at the time of an intervention.

Hensher (1997) studied the switching of motorists from free highway routes to a new urban toll road in Sydney, Australia. In this case data was available of the precise date of switching to the toll road for 170 motorists and this was used to estimate a duration model to identify the factors influencing the time of switching to the toll road. This is a rare example where the challenge of measuring, understanding and predicting the time-scale of behavioural responses has been addressed.

When studying the impact of a new or improved transport service it should be remembered that changes that take place are unlikely to be in one direction only. While the majority of people switching modes may switch to the new or improved service, some may switch in the opposite direction (perhaps taking advantage of freed up capacity). For example, analysis of before and after travel data from the London congestion charging scheme has shown that 44 (out of 329) car drivers switched to other modes while 5 (out of 486) non-car drivers switched in the opposite direction (Ma and Chatterjee, 2006). Additional to this there will be changes to the travelling population as some people no longer need to travel and new people join the travelling population. It is important that changes due to countervailing factors are taken into account in studying the dynamics of travel behaviour in order to understand the overall impacts of a transport intervention.

3. Panel survey

From the above review it is clear that further investigation is required to examine the dynamics of behavioural responses to interventions in the travel environment. The case study and survey that are now described have been intended to enable the monitoring of responses to a new, high quality bus service after its introduction.

3.1. Fastway Case Study

The Fastway bus system began operating in the Crawley and Gatwick Airport area in West Sussex, Southern England, in September 2003 (Fastway, 2006). It is intended to be a modern, high quality public transport system providing a frequent, reliable service and offering a real alternative to the car. The Fastway buses travel in dedicated lanes and guideways along significant parts of their routes and also benefit from barrier controlled bus gates and priority at signal controlled junctions. Real-time information is provided at bus stops and on the internet and the buses are a modern fleet of high specification vehicles with low floor access, comfortable and modern interiors and low-noise and low-emission engines.

The Fastway system supplements existing bus services within the area and is designed to provide a more direct service than otherwise available connecting residential areas with the town centres in Crawley and Horley, Gatwick Airport and other key employment sites. The first Fastway route (Route 10) experienced steady growth in passengers from 4,000 passengers per day in September 2003 up to 6,000 in May 2005 and the second route (Route 20) has been introduced in August 2005. The route maps are shown in Figure 1.

Source: Fastway (2006)

Figure 1 Fastway Route Maps

3.2. Survey methodology

Longitudinal data is required to study temporal change in behaviour. For this case study a classic panel study has been used. A panel study involves asking the same individuals similar

questions at different points of time. A classic panel study involves the same respondents being surveyed at the different time points. Event history data recording behaviour in continuous time was not a possibility and a retrospective cross-sectional study requesting subjects to report past behaviour is unlikely to have resulted in accurate enough information regarding past travel choices.

Douglas (2003) identified an average of 79% 'ramp-up' one year after a rail scheme introduction or upgrade. This suggests that most but not all responses take place within a year. For a new bus service the time-scale of responses is likely to be shorter than for a new rail service, as it will be used for local journeys and is likely to be more readily known to potential users. The Fastway panel study involved four waves with wave one taking place one month before the introduction of the Route 20 service, wave two taking place one month after the introduction of the service and waves three and four taking place at subsequent two month intervals. The overall length of the panel study of seven months aimed to cover a sufficient period for behavioural responses to take place and start to diminish. The two month intervals between waves aimed to be sufficiently short in duration in order to identify approximately when a change in behaviour occurred.

The target population for the panel study was residents living close to the route of the new Fastway Route 20 service and not living close to the route of the Route 10 service. This resulted in residents in two areas being targeted: Broadfield and Three Bridges. These residents gained from Route 20 a significantly faster public transport connection to key destinations in the area such as Crawley Town Centre and Gatwick Airport.

The electoral register was used to obtain details of residents in the two target areas. In the UK the edited version of the electoral register contains details of residents eligible to vote who do not elect to be omitted from the publicly available version of the register. Less than half of people opt out of the elected register. The edited version of the electoral register for July 2005 was obtained from the local authority (Crawley Borough Council) and this provided the names and addresses (but not telephone numbers) of approximately 2500 residents in the target areas.

The panel study used self-administered postal questionnaires as the survey instrument with these mailed out to residents identified from the electoral register. For the first survey occasion the two possibilities available to contact residents were postal questionnaires or doorstep interviews and the former was chosen, as staff and resources were not available to conduct personal interviews. For subsequent occasions we continued to use postal questionnaires.

Telephone interviews were considered for the follow-up occasions but a significant number of respondents had not provided telephone numbers in the wave one questionnaire and it is known that response rates to telephone interviews have been decreasing in recent years (Dillman, 1999). Online questionnaires were another possibility but they have been criticised in terms of bring subject to a number of sources of error (Dillman and Bowker, 2002). Also consistency is more likely when the same survey instrument is used throughout a panel study. It should be recognised that postal surveys are less accessible to people who have difficulties reading and writing or who may be put off by a written format and this may introduce a non-response bias into the survey.

Well known difficulties with panel studies are sample aging, attrition and response contamination (Raimond and Hensher, 1997). Sample aging concerns the sample becoming unrepresentative over time as it ages. Given the limited duration of the panel study (seven months) this is not a serious issue, although it should be recognised that the study will not collect information on new residents moving to the two areas.

Attrition involves loss of respondents over the course of survey waves due to survey burden and loss of interest and it needs to be minimised in any panel study to avoid the composition of the sample changing over the course of the study. To reduce attrition various steps were taken:

- presenting the survey as a study of ‘Changing Travel Behaviour of Crawley Residents’ conducted by a university, supported by local councils and responses assisting in transport planning for the town;
- including photographs of local area in questionnaire to highlight that it has been designed to reflect local circumstances;
- provision of freepost envelope with which to return completed questionnaire at all survey occasions;
- offering a £250 prize draw for residents completing and returning a questionnaire in each of first three waves (the name of the winner was identified in the letter accompanying the questionnaire for the next wave);
- offering in wave three a £20 payment at the end of the study to all participants completing the wave three and four questionnaires;
- recognising that questions are repetitive from one occasion to the next and explaining that this is necessary for study;
- stating that confidentiality would be assured.

The first wave of the postal survey (in August 2005) achieved a 22% response rate (554 responses) which is typical of experience with a self-completion postal questionnaire. 361 respondents said they were willing to participate further in study. These were sent the second questionnaire and 220 responses were received (in October 2005). To maximise subsequent participation a £20 incentive was offered to those participating in the final two waves. 254 responses were received for wave 3 (in December 2005) and 247 responses were received for wave 4 (in March 2006). This demonstrates that offering an incentive for participation can be very successful in ensuring a high response rate. In retrospect incentive for full participation in the study might have been offered in wave 2 to maximise response rate at this stage but financial resources were not thought to be available to do this. The implications for non-response error of offering incentives must be considered but do not appear to be a serious issue in this study as is seen subsequently when comparison is made between the wave 1 sample and all-wave sample.

No attempt was made to refresh the sample during the course of the study, due to there being no further source of participants (all those for which details could be obtained had been obtained already). This can be justified as it was not the expressed aim of the panel study to obtain a representative sample of the population of interest. Instead of seeking statistical generalisations, the study intended to develop greater understanding of dynamic behavioural responses.

Response contamination concerns behaviour itself or its reporting being affected by panel membership and the quality of information provided decreasing (or increasing) over the course of study. This was minimised by the design of the questionnaire being kept as simple and neutral as possible and emphasising the importance of providing complete responses even if this involved repeating information provided in a previous questionnaire.

3.3. Questionnaire design

At each wave the postal questionnaire survey was designed to obtain a variety of information on the travel behaviour of residents. The structure and design of the questionnaire was similar in each wave to ensure as far as possible that responses were directly comparable. Respondents were asked to provide information on the following:

- Views and perceptions of local transport/travel;
- Weekly frequency of use of different transport modes;
- Travel to work details;
- Leisure travel details;
- Shopping travel details;

– Awareness, perceptions, attitudes and use of Route 10 and Route 20 bus services;
– Personal and household information.

3.4. Characteristics of sample

Of the 554 residents responding to the first questionnaire 187 participated in all four waves of the questionnaire. Results on travel behaviour dynamics are presented in the next section for this all-wave sample. Another sample that is considered is those respondents whose residential circumstances did not change during the survey period and who participated in at least waves 1 and 3. This results in a sample of 247 respondents. Table 2 compares the characteristics of the sample of 554 wave 1 respondents, the 187 all-wave respondents and the Crawley population in general. It shows that car ownership was higher for the survey samples than the Crawley population in general and that differences between the wave 1 respondents and all-wave respondents are relatively small and therefore that attrition does not affect the sample characteristics adversely.

Table 2 Characteristics of survey samples

Characteristic	Crawley population (from Census 2001) (%)	Wave 1 (N=554) (%)	All-wave (N=187) (%)
Female	51	55	56
Aged under 35 (and >16)	34	27	19
Aged 65 and over (and >16)	19	19	18
Full-time employed	Not known	52	49
Part-time employed	Not known	13	16
Households without car	20	9	10
Used Route 10 service	Not applicable	29	32
Intending to use new Fastway service	Not applicable	27	26

4. Survey findings

This section reports descriptive statistics from the panel study. These include changes over the survey waves in awareness, perceptions and behaviour relating to the new bus service and results for the time taken for residents to first use the new service. This section also examines transitions in individual bus use and how the new service affected overall bus use.

4.1. Changes in awareness, perceptions and usage of Route 20

To enable direct comparison results are reported in section 4.1 with respect to the 187 residents who participated in all four waves of the questionnaire. Of the 187 all-wave respondents, 60% were aware of the new Fastway service one month before it was introduced and 76% were aware of it one month after it was introduced. Respondents were not asked about general awareness of the Route 20 service after wave 2, as it was assumed most would be aware of the service (through the panel study if not another source). They were asked about awareness of specific Route 20 service characteristics in waves 2, 3 and 4. The change in awareness over the three waves is shown in Figure 2. This shows that greater awareness existed about where to catch the bus service than destinations served, timetable or fares. There were consistent increases in awareness over time for each of the service characteristics.

Figure 3 shows how agreement with the statements ‘It is easy for me to reach my nearest bus service in terms of distance and convenience’ and ‘Buses provide a realistic option for most of my journeys in Crawley’ changed over the course of the survey. It also shows the numbers of respondents who had used the Route 20 service at the different waves. Figure 3 shows small increases in positive perceptions towards bus services through the survey period. The number of residents who used the Route 20 service increases from 34 in wave 1 to 61 in wave 3.

4.2. Timing of responses to Route 20 introduction

The timing of responses to the introduction of Route 20 is shown in Figure 4 in terms of new users of the service. This refers to the sample of 247 respondents. Residents were asked in waves 2, 3 and 4 to indicate if they had used the service and which preceding week they had first used the service. It must be recognised that respondents will not always have recollected this accurately but it can be expected that they will be accurate to within at least four weeks given the two month intervals between survey occasions. The number of new users is largest in the first week after introduction of the new service and tends to decline over time. ‘Spikes’ in new users occur in weeks 10-13 and week 21. These weeks correspond to times when

questionnaires were returned and may reflect some survey subjects indicating the current week as the first week they used Route 20 when actual first use occurred earlier.

Comparison is made in Table 3 of how the percentage of residents using Route 20 by the end of the survey period (March 2006) varies according to resident characteristics. This shows that use of the new bus service was higher for Broadfield residents, younger residents and residents without a car. Further analysis of the factors influencing use of the new service and timing of use has been carried out using duration modelling and is reported in Chatterjee and Ma (2006).

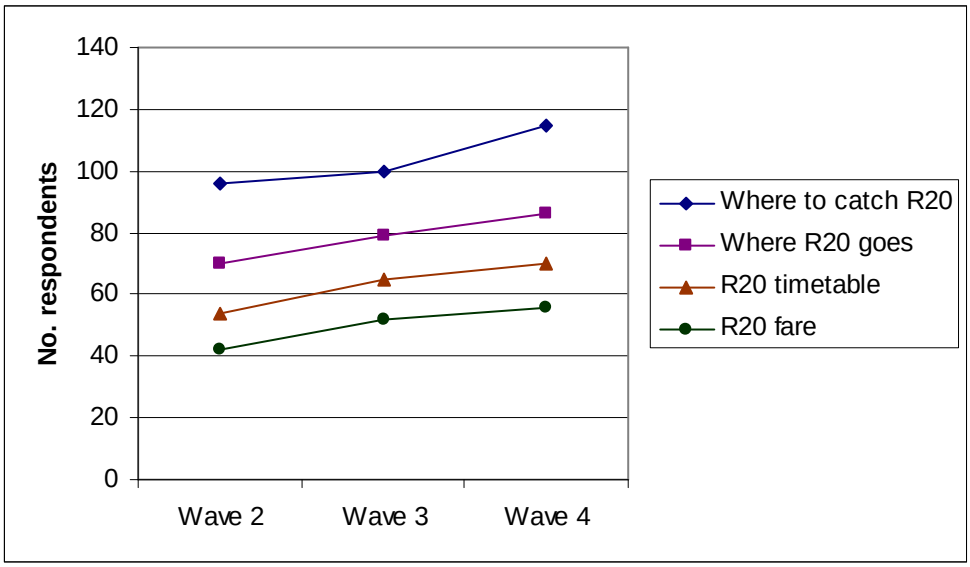

Figure 2 Awareness of Route 20 service characteristics

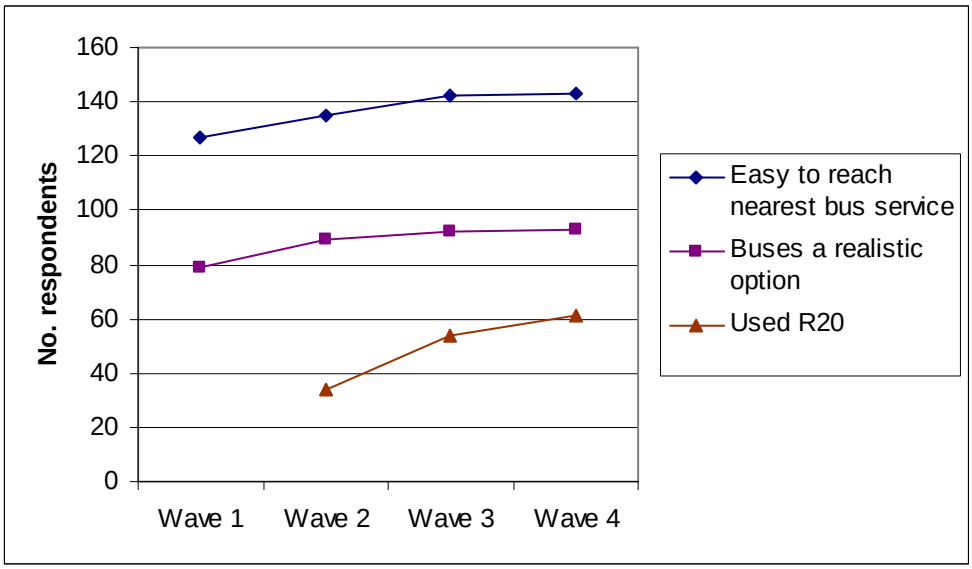

Figure 3 Perceptions of local bus services and use of Route 20

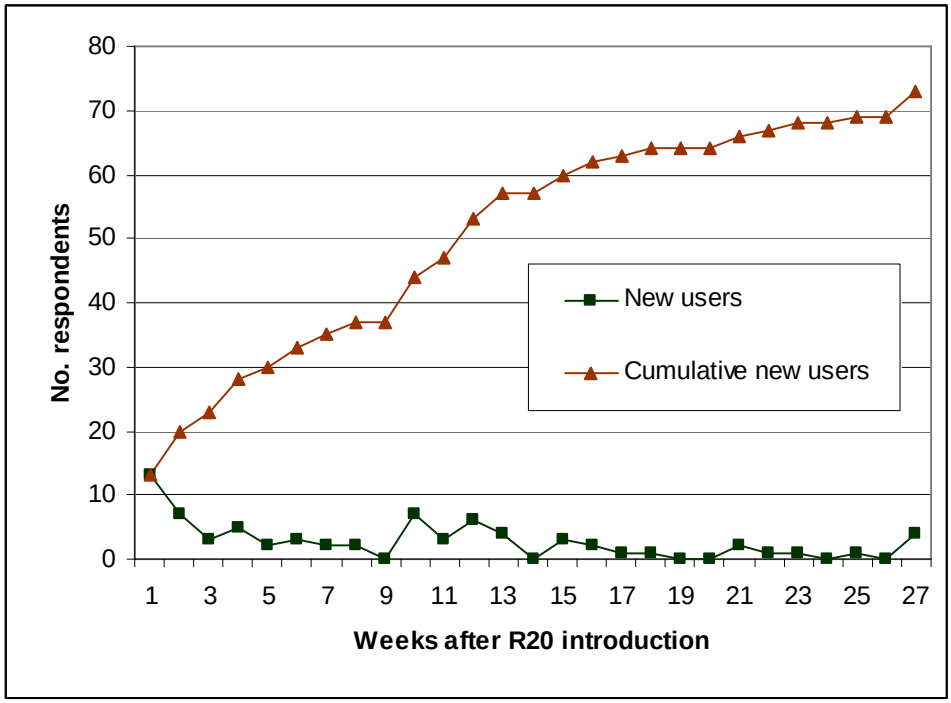

Figure 4 Number of new users of Route 20 in the weeks after Route 20 Introduction

Table 3 Variation of Route 20 use by resident characteristics

Resident Characteristic		Total number of respondents	Percentage used Route 20
Analysis sample		247	30
Gender	Male	111	27
	Female	136	32
Residential area	Broadfield	98	50
	Three Bridges	149	16
Age	Under 25	20	45
	25-34	33	30
		56	32
	35-44	51	29
	45-54	46	20
		41	29
	55-64		
	65 and over		
Driving licence	Yes	211	26
Employment status	Full-time employed	129	29
Children in household	Yes	54	33
Cars in household	0 car in household	24	88
	1 car in household	121	25
	2 cars in household	102	22
Bus pass	Yes	29	29
Car use frequency at wave 1	Not at all	44	57
	Less than once per week	12	42
	1 to 2 days per week	32	34
	3 to 4 days per week	33	21
	5 days a week or more	126	20
Bus use frequency at wave 1	Not at all	156	11
	Less than once per week	40	53
	1 to 2 days per week	27	52
	3 to 4 days per week	13	77
	5 days a week or more	11	100
Route 10 used at wave 1	Yes	73	73
Route 20 awareness at wave 1	Yes	146	25

4.3. Transitions in Route 20 use and overall dynamic demand profile

Figure 3 and 4 are helpful in showing the growth in users but they do not tell us anything about the pattern of usage over time of individuals. Further insight can be gained by considering how frequency of usage of Route 20 changed over waves 2, 3 and 4 for the 187 all-wave sample of residents. Residents who had used the service were asked in waves 2, 3 and 4 to indicate how many times they had used the service in the last week and could select from ‘1 = did not use it’, ‘2 = one day’, ‘3 = 2-3 days’, ‘4 = 3-4 days’ and ‘5 = 5 or more days’. Table 4 summarises the

pattern of usage. It shows that there is a lot of variety in the pattern of usage with about one third being one-off or intermittent users (22 residents), one third being regular users (19 residents) and one third increasing usage or being late starters in using the service (17 residents). It can be hypothesised that one-off or intermittent users have been curious to try the service or had short term journey requirements, regular users have existing travel needs that were met by the new service and that increasing users and late starters have experienced changes in circumstances or adapted their journey requirements.

Table 4 Patterns of usage of residents from 187 all-wave sample

Pattern (example response pattern)	Number of residents
Did not use (0 0 0)	126
Missing information (5 0 0)	3
One-off user (2 1 1)	16
Intermittent user (1 1 2)	6
Regular low usage (0 2 2)	5
Regular high usage (4 3 4)	14
Increasing usage (3 5 5)	12
Late starter (0 0 2)	5
Total	187

We have aggregated individual frequencies of use of Route 20 at waves 2, 3 and 4 for the 247 residents sample taking account of non-response at each wave. This produces an index of aggregate usage at each wave. This is plotted on Figure 5 with a linear trend line fitted. Also shown on Figure 5 is an index of cumulative number of Route 20 users from the panel survey (again taking account of non-response at each wave). Finally, an index of aggregate passenger

journeys on the Route 20 service is shown on Figure 5. This is derived from passenger journey data provided by Metrobus, the bus service operator. It should be noted that this demand profile may be affected by seasonal factors (holiday periods in December, January and April).

Comparison of the three constructed demand profiles shows significant differences in growth rates. The index of cumulative number of users shows the highest growth but it has been shown that as some new residents start using the service some old users stop using the service and so this index will give an overestimate of aggregate usage levels. The index of aggregate usage from the panel survey shows slightly higher growth than the bus operator data but appears to provide a fairly reliable indication of demand growth.

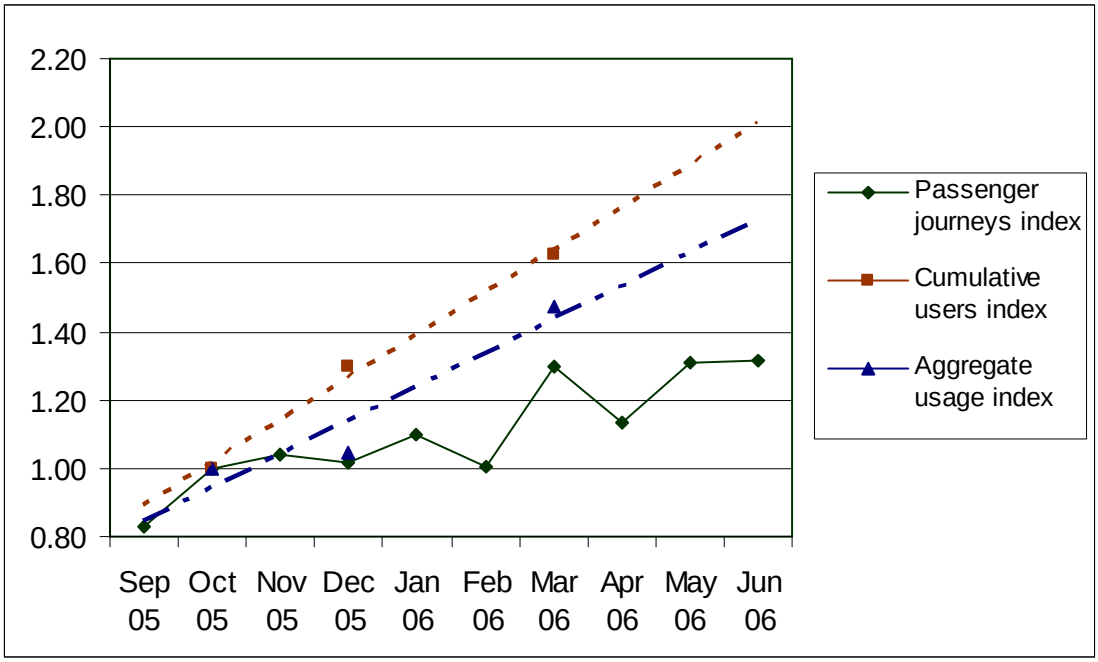

Figure 5 Dynamic demand profiles for Route 20

4.4. General bus use

A key transport policy question is what impact has the Route 20 service had on general bus use of the residents of Broadfield and Three Bridges. The residents participating in the survey were asked at each wave to indicate how often they used different modes of transport including the bus. The turnover in bus use frequency between the waves is shown in Tables 5 to 7. There are about 40 (one in five) residents reporting a change in their level of bus use between each wave. The numbers of residents increasing and reducing bus use is the same between wave 1 and

wave 2 (from one month before to one month after the intervention) but 18 more residents increase their bus use than decrease their bus use between waves 2 and 3 (one month after new service to three months after). Between waves 3 and 4 five more residents increase their bus use than decrease their bus use. The McNemer-Bowker test indicates there is a statistically significant ($p = 0.009$) increase between waves 2 and 3.

Overall, between waves 1 and 4 there is a statistically significant ($p = 0.002$) change in general bus use with 35 residents increasing bus use and 13 decreasing bus use. A similar analysis for car driving showed that between waves 1 and 4 there is a statistically significant ($p = 0.006$) decrease with 16 residents increasing car driving and 37 decreasing car driving. These results suggest that the impact of Route 20 on general bus use was not immediate but took place most substantially between one and three months after its introduction. Earlier though in Figure 4 we found that there were many new users of Route 20 in the first month after it was introduced. This apparent contradiction can probably be explained by initial users of Route 20 switching from other bus services while later users switched from other modes of transport or made completely new journeys taking advantage of the service.

Table 5 Turnover in general bus use from wave 1 to wave 2

Wave 2 Wave 1	Not at all	<1/week	1-2/week	3-4/week	5+/week	Total
Not at all	101	11	1	2	0	115
<1/week	10	18	2	1	0	31
1-2/week	1	4	9	2	1	17
3-4/week	1	1	4	6	1	13
5+/week	0	0	0	0	11	11
Total	113	34	16	11	13	187

Increasing bus use = 21, decreasing bus use = 21, McNemer-Bowker test $\chi_1^2 = 0.024$, df=1, p = 1.00

Table 6 Turnover in general bus use from wave 2 to wave 3

Wave 2 / Wave 1	Not at all	<1/week	1-2/week	3-4/week	5+/week	Total
Not at all	98	12	1	2	0	113
<1/week	6	22	4	2	0	34
1-2/week	0	2	8	6	0	16
3-4/week	0	1	2	5	3	11
5+/week	1	0	0	0	12	13
Total	105	37	15	15	15	187

Increasing bus use = 30, decreasing bus use = 12, , McNemer-Bowker test $\chi_1^2 = 6.88$, df=1, p = 0.009

Table 7 Turnover in general bus use from wave 3 to wave 4

Wave 2 / Wave 1	Not at all	<1/week	1-2/week	3-4/week	5+/week	Total
Not at all	91	11	0	0	3	105
<1/week	4	30	2	1	0	37
1-2/week	1	3	8	2	1	15
3-4/week	0	2	3	9	1	15
5+/week	0	0	0	3	12	15
Total	96	46	13	15	17	187

Increasing bus use = 21, decreasing bus use = 16, McNemer-Bowker test $\chi_1^2 = 0.432$, df=1, p = 0.511

5. Concluding discussion

The preceding survey findings have provided empirical evidence on the dynamics of individual responses to a new transport option. Analysis of the data shows that the rate of new users of the Fastway Route 20 service has been modest but fairly stable during the first 3-4 months of operation after which the number of new users appears to decline. A much larger proportion of

residents in Broadfield, where the service provides a more significant addition to public transport, have started using the service. Taking into account the transition over time of individual usage of the Route 20 has been shown to lead to more accurate estimation of overall use of the service than simply considering cumulative users. It is clear that there is a considerable degree of turnover or 'churn' in use of buses by the residents.

The analysis of the panel survey has provided some insights on policy and service factors which influence the response of residents to a new bus service. It is not sufficient to expect local residents to find out about destinations served, times of operation and fares from bus stop information and the internet alone. The importance of marketing the new service in advance to those living close to the service is highlighted. In particular in Three Bridges very few residents have used the service and, although there are other public transport services available to them, there must be greater potential for its residents to use the service. Some car users have used the Route 20 service but proportionately far fewer than bus users and additional measures will need to be considered to persuade car users to try the service.

In section 2 we identified behavioural factors influencing the timing of individual responses. The survey results have shown that some residents were aware of the new service in advance which explains why 20 of the 247 residents started to use the service in the first two weeks after its introduction with many of these indicating on the questionnaires that they switched from other transport modes/services for an existing journey. The results also show that gradual increases in awareness and positive perceptions regarding bus services have occurred during the survey period, contributing to the increasing number of users of Route 20. Many residents did not start to use the new service until some months after its introduction and there is evidence from comments made on the questionnaires that this occurred due to new journey requirements. The influence of past behaviour (and perhaps habit) has been shown with past bus users much more likely to become users of a new bus service.

This paper has carefully presented descriptive results on the dynamics of travel behaviour and found much variation in the timing of behavioural responses and the pattern of responses in the example considered. It has found evidence of countervailing influences that influence behaviour in the opposite direction to that expected. Dynamic models should be developed to take account of these considerations. Indeed, we are continuing our work using duration modelling to analyse the factors influencing the time taken to first use the Route 20 service (Chatterjee and Ma, 2006) and using ordered probit modelling to analyse the change in frequency of bus usage of individuals over the study period.

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