The Choice of Mode and Parking in Birmingham

Initial Model Estimation Results – Third Interim Report to Birmingham City Council

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Third Interim Report to
Birmingham City Council

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1. INTRODUCTION

This is the third interim report on progress in the application of the CLAMP parking model to Birmingham City Centre. This report presents initial analysis and results from the estimation of disaggregate choice models based on data collected in the stated preference (SP) exercises carried out in the City Centre, Sutton Coalfield and Coventry during October 1989. The methodology used in these SP surveys was described in detail in the previous interim report (Polak and Axhausen, 1989), and will not be repeated here.

This report presents three sets of results;

- an analysis of the performance of the SP experiment in terms of the validity of travellers responses and its success in capturing relevant choice behaviour,
- estimation results for independent models of parking type choice calibrated for travellers to the City Centre, Sutton Coalfield and Coventry,
- estimation results for combined models of mode and parking type choice for travellers to the City Centre.

It is important to point out that the results presented in this report are provisional in nature and may be subject to minor modification in the light of ongoing work. Further, no estimation results relating to the modelling of destination choice are presented since the assembling of all the necessary auxiliary data to enable estimation of these models has not yet been completed.

2. PERFORMANCE OF THE SP EXPERIMENTS

Two aspects of the performance of the SP exercises are particularly important:

- The consistency of the results, that is, the degree to which participants responses in the SP exercises appear to be based on a reasonably sound comprehension of the decision task that was presented and are consistent with other information gathered during the interview.
- The choice behaviour of the sample, that is, the degree to which the variable levels and the statistical design of the SP exercises succeeded in generating decision contexts and responses that provide useful data for the estimation of model parameters.

This section presents a brief analysis of these two topics.

2.1 Validity of the Responses

The design of the SP exercises make it possible to gain some insight into the consistency of participants responses. In each SP exercise one of the decision contexts offered to participants was an approximate replication of their current situation. In these cases we would expect that, if the SP exercises were well understood, then there would be a reasonably high degree of correspondence between the actual decision of the respondent and the decision made in the SP context. Table 1 shows the percentage of the estimation sample in which the actual and the hypothetical decision were the same.

TABLE 1 Consistency of Responses in the SP Exercises

SP Context	Percentage of estimation sample in which actual choice is the same as choice in SP context
DESTINATION CHOICE	76
MODE CHOICE	76
PARKING TYPE CHOICE	76

We would not expect to observe complete correspondence between actual and hypothetical decisions for two reasons; (i) the influence of additional factors in the real world that were not represented with the hypothetical SP contexts, and (ii) the fact that some travellers may not have fully appreciate the costs of an alternative until they are presented with them in the SP. Taking into account these considerations, the overall results shown in Table 1 suggest that there was a reasonably high degree of comprehension of the SP exercises amongst the respondents.

2.2 Choice Behaviour of the Sample

Table 2 shows the distribution of responses in each of the SP exercises. These results indicate that the variable levels and experimental designs used in the exercises were successful in the aim of generating a range of decision contexts in which none of the available alternative were overly dominant and in which realistic trade-offs can take place. Table 3 shows the incidence of non-traders in each of the SP exercises. Non-traders were here defined as individuals who chose the same alternative in all the replications of a particular SP exercise. A relatively high proportion of the participants in the mode choice exercise were non-traders. This is probably accounted for by the higher proportion of inflexible work journeys within the mode choice exercise.

TABLE 2 The Distribution of Responses in the SP Exercises

SP Context	Distribution of responses in each SP context (%)
DESTINATION CHOICE	
Birmingham City Centre	49
Other centre	51
MODE CHOICE	
Car/Motorcycle	69
Bus/Taxi	4
Train/Plane	27
PARKING TYPE CHOICE	
Free	25
Metered	4
Surface P&D	32
Multi-storey	35
Illegal	4

Data from non-traders were excluded from the final estimation sample since they do not contribute any useful information for model calibration.

TABLE 3 The Incidence of Non-Traders in the SP Exercises

SP Context	Non-traders (%)	Work journeys (%)
DESTINATION CHOICE	24	0
MODE CHOICE	39	23
PARKING TYPE CHOICE	12	11

3. MODELS OF PARKING TYPE CHOICE

3.1 Description of the Models Estimated

The parking type SP exercises involved a 3-way choice between travellers currently used (or most favoured) type of parking, their most favoured alternative type of parking (were the first choice not available) and the option of parking illegally on a yellow line. Each parking type alternative was characterised by four attributes. For legal parking types these were; access time, search time, egress time and money cost and for illegal parking the quantity "chance of a fine" (measured on a scale from 1 to 10) was used instead of money cost.

Tables 4 to 7 present the results of an initial set of models estimated using the data collected in this manner. Table 4 presents results for the aggregate of all travellers in Birmingham while Tables 5 and 6 present the results of separate models estimated independently for workers and shoppers in Birmingham. In each of Tables 4 to 6, the results of two alternative model specifications are given, Model I uses a generic coefficient for all the components of total travel time (defined as access time plus search time plus egress time) whereas Model II allows independent coefficients for each of the separate components of total travel time. Table 7 gives the results of models estimated for Sutton Coldfield and Coventry using the Model II specification. In all the models estimated the chance of a fine associated with illegal parking has been transformed into an expected money cost using the respondents own estimate of the fine associated with illegal (yellow line) parking.

3.2 Discussion of Results

A number interesting patterns emerge from these results.

- All the choice models presented provide an excellent fit to the data with ρ^2 values generally well in excess of 0.4. All cost and time coefficients have the expected negative sign and, with the exception of the one or two access time components, all are statistically significant at the 5% level.

- There is wide variation between the relative valuations placed on the different components of total travel time. Figure 1 shows the relative valuations of search and egress time expressed as a proportion of access time, for each major market segment. All segments place a consistently higher value on search and egress time than on access time, with egress time being the most highly valued of all. Shoppers appear to be particularly sensitive to the search and egress components of total travel time. These result are consistent with the findings of earlier studies of parking choice behaviour (e.g., Axhausen and Polak, 1990; Feeney, 1986; Gillen, 1977) and emphasise the importance of separating out the different components of total travel, especially when modelling parking choice.

TABLE 4 **Estimation Results for Parking Type Choice Model: All Birmingham Travellers**

Parameter	Coefficient (t-statistic)	
	Model I	Model II
Parking Cost	-0.7777 (-8.7)	-0.7645 (-8.5)
Time	-0.0554 (-9.3)	
Access time		-0.0434 (-3.8)
Search time		-0.0510 (-6.9)
Egress time		-0.0863 (-6.4)
Constants		
Metered	-0.4711 (-2.0)	-0.4804 (-2.0)
Surface	0.3270 (1.6)	0.3348 (1.6)
Multi-storey	0.7868 (3.2)	0.7297 (3.0)
Illegal	-1.6070 (-5.6)	-1.7580 (-6.0)
Implied VOT (p/min)		
Total time	7.1	
Access time		5.68
Search time		6.67
Egress time		11.29
Diagnostics		
N	684	684
ρ^2 (Constants)	0.2517	0.2589
ρ^2 (Zero)	0.4373	0.4227

- The pattern of alternative-specific constants indicates that shoppers have a greater inherent bias against parking illegally than do workers.
- Workers in Birmingham are approximately 50% more sensitive sensitive to the cost of parking than do shoppers. This is understandable given the higher frequency and generally greater duration of stay of work journeys.
- There is little difference between shoppers in Birmingham and Coventry in terms of their sensitivity to parking costs. However, shoppers in Sutton Coldfield are less than a third as sensitive to parking costs as those in Birmingham or Coventry. This is probably attributable to a combination of an income effect and the relative plentifulness of free on-street and private (store) parking in Sutton Coldfield.

TABLE 5 Estimation Results for Parking Type Choice Model: Birmingham Workers

Parameter	Coefficient (t-statistic)	
	Model I	Model II
Parking Cost	-0.9833 (-6.7)	-0.9879 (-6.6)
Time	-0.0666 (-6.2)	
Access time		-0.0517 (-2.3)
Search time		-0.0689 (-4.7)
Egress time		-0.0882 (-3.1)
Constants		
Metered	-2.1652 (-3.6)	-2.1110 (-3.5)
Surface	0.2037 (0.6)	0.2549 (0.7)
Multi-storey	1.0216 (2.5)	1.0480 (-2.5)
Illegal	-0.7659 (-2.0)	-0.7989 (-2.0)
Implied VOT (p/min)		
Total time	6.8	
Access time		5.23
Search time		6.97
Egress time		8.93
Diagnostics		
N	259	259
ρ^2 (Constants)	0.3773	0.3791
ρ^2 (Zero)	0.5227	0.5240

- The overall values of total travel time implied by the choice models are consistent with expectations, based on previous studies (e.g. MVA et al., 1987).

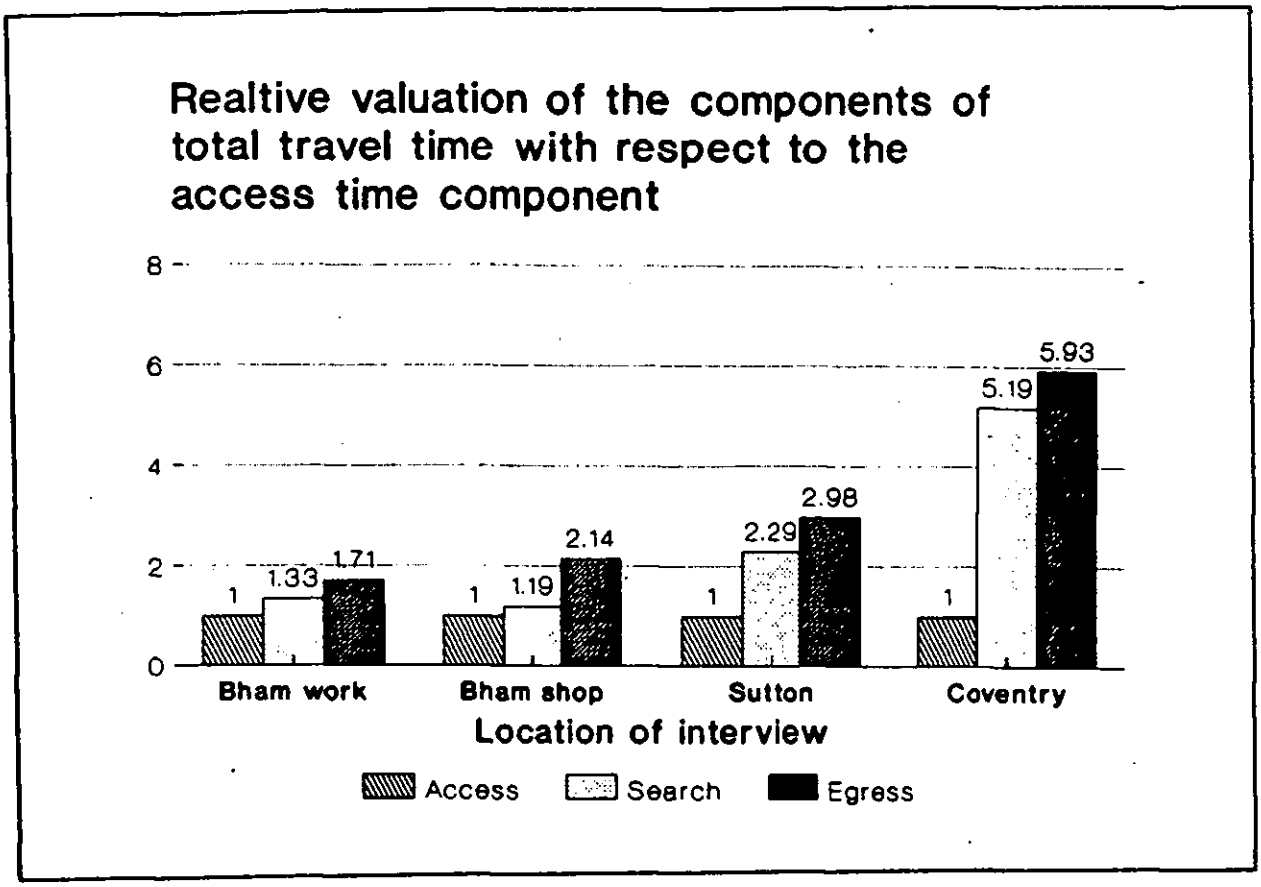
TABLE 6 Estimation Results for Parking Type Choice Model: Birmingham Shoppers

Parameter	Coefficient (t-statistic)	
	Model I	Model II
Parking Cost	-0.6025 (-4.6)	-0.6239 (-4.7)
Time	-0.0655 (-8.1)	
Access time		-0.0495 (-3.4)
Search time		-0.0588 (-6.0)
Egress time		-0.1059 (-6.1)
Constants		
Metered	-0.2074 (-0.7)	-0.2853 (-0.9)
Surface	0.2565 (1.0)	-0.2048 (-0.8)
Multi-storey	0.4838 (1.6)	-0.3386 (-1.1)
Illegal	-3.0192 (-6.3)	-3.3130 (-6.6)
Implied VOT (p/min)		
Total time	10.89	
Access time		7.93
Search time		9.43
Egress time		16.97
Diagnostics		
N	433	473
ρ^2 (Constants)	0.2159	0.2294
ρ^2 (Zero)	0.4473	0.4569

TABLE 7 **Estimation Results for Parking Type Choice Model: Non-Birmingham Centres**

Parameter	Coefficient (t-statistic)	
	Sutton	Coventry
Parking Cost	-0.1892 (-3.6)	-0.4543 (-5.9)
Time		
Access time	-0.0265 (-1.5)	-0.0326 (-1.8)
Search time	-0.1374 (-5.3)	-0.0747 (-4.2)
Egress time	-0.1571 (-5.4)	-0.0974 (-4.4)
Constants		
Metered	-1.3620 (-4.2)	-1.7012 (-3.7)
Surface	-0.4379 (-2.1)	-0.7972 (-3.9)
Multi-storey	-0.7562 (-3.6)	-0.7817 (-3.4)
Illegal	-2.2680 (-6.7)	-1.6470 (-5.0)
Implied VOT (p/min)		
Total time		
Access time	14.00	7.18
Search time	72.62	16.44
Egress time	83.03	21.43
Diagnostics		
N	434	414
ρ^2 (Constants)	0.1640	0.1851
ρ^2 (Zero)	0.3753	0.3739

FIGURE 1 The Relative Valuations of the Components of Total Car Travel Time



4. MODELS OF MODE AND PARKING TYPE CHOICE

4.1 Estimation Procedure

A subset of the respondents who took part in the parking type SP exercise in Birmingham City Centre also participated in a mode choice SP exercise in which they were required to choose between travelling to the city centre by their currently used mode or by their most prefered alternative. This approach enabled the estimation of combined models of mode and parking type using a sequential estimation procedure based on the use of an inclusive value term to capture the influence of the available set of parking opportunities (Ben Akiva and Lerman, 1985; Daly, 1987).

4.2 Estimation Results

Table 8 shows the results of the sequential estimation procedure for workers and shoppers contacted in Birmingham City Centre. A number of interesting points arise from these results:

- Both models provide a good fit to the data with ρ^2 values approaching 0.4. All time and cost coefficient estimates have the expected negative sign, and with the exception of the slow mode access time components, all are statistically significant at the 5% level.

- The coefficient associated with the parking inclusive value in the shoppers model is less than unity, as is required by utility theory. This indicates that the nested structure of the current model provides a satisfactory description of travellers decision making in this context. However, in the worker segment this coefficient has a value greater than unity indicating the need for further refinement of the model specification in this case.

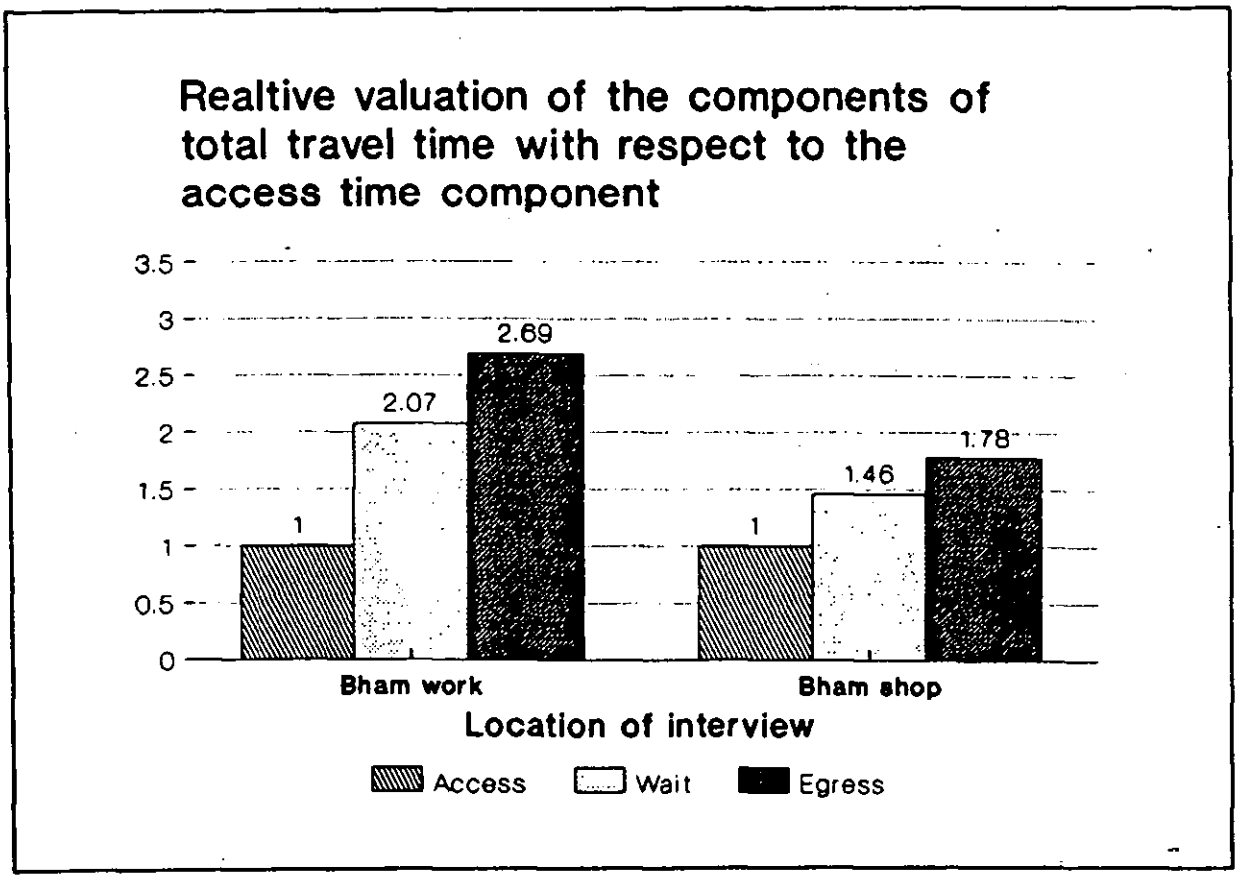
- Workers are more than twice as sensitive to changes in the level of public transport fares than are shoppers. The sensitivities of workers and shoppers to travel time components are comparable, but due to their greater sensitivity to cost, workers show significantly lower overall values of time. The values of the public transport time components are generally somewhat lower than those found in the parking choice context.

- As in the case of parking type choice, there is strong evidence of significant variation in the valuation of different components of total travel time. Figure 2 shows the relative valuations of public transport access, wait and egress times. As observed in the parking choice context, egress time is the most highly valued component of total travel time.

TABLE 8 Estimation Results for Nested Model of Mode and Parking Type Choice

Parameter	Coefficient (t-statistic)	
	Workers	Shoppers
Parking Inclusive Value	1.3682 (6.3)	0.7748 (3.7)
Public Transport Fare	-1.678 (-5.7)	-0.8042 (-3.0)
Public Transport Time		
Access time	-0.0366 (-1.7)	-0.0416 (-2.6)
Wait time	-0.0758 (-2.7)	-0.0606 (-2.9)
Egress time	-0.0983 (-5.4)	-0.0747 (-3.1)
Slow Mode Access Time	-0.0271 (-1.2)	-0.0503 (-1.6)
Constants		
Bus	1.043 (-1.0)	0.6211 (1.2)
Train	-1.380 (-3.6)	0.7106 (1.3)
Slow Modes	-0.447 (-6.7)	1.0190 (1.1)
Implied VOT (p/min)		
P.T. Access time	2.18	5.17
P.T. Wait time	4.51	7.53
P.T. Egress time	5.86	9.29
Diagnostics		
N	198	414
ρ^2 (Constants)	0.3555	0.1851
ρ^2 (Zero)	0.3652	0.3739

FIGURE 2 The Relative Valuations of the Components of Total Public Transport Travel Time



5. CONCLUSIONS

This report has presented some initial results from the estimation of mode and parking type models using data from SP exercises carried out in Birmingham City Centre, Sutton Coldfield and Coventry. Although model development work is still in progress and some important issues of specification and estimation remain outstanding, the results obtained so far are encouraging and provide valuable insights into the behaviour of travellers.

6. REFERENCES

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