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Propensity to Consider Cycling for Commuting Trips

Y L Sui, M Wardman, M Page, M Tight

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1. Introduction

The British Government launched the National Cycling Strategy (NCS) in July 1996. The aims of this strategy are to establish a culture favourable to the increased use of bicycles for all age groups, to develop sound policies and good practice, and to seek out innovative and effective means of fostering accessibility by bicycle. The central target is to double the amount of cycle trips on 1996 figures by 2002; and double it again by 2012. It is hoped that these increases in cycle trips are as a result of people switching their current mode to bicycle. With this increased interest from national and local governments, there is likely to be increasing demand for rigorous evaluation of proposed schemes in terms of increases in levels of cycling, modal shift and, ultimately, the quantified benefits to existing and potential cyclists.

Yet, in contrast to the vast amount of research which has been done on enhancing our understanding of the demand for motorised vehicles, relatively little attention has been paid to the slow modes (i.e. walk and cycle). Furthermore, most studies on existing and potential demands for cycling are qualitative rather than quantitative in nature. For instance, attitudinal factors of choosing or not choosing cycling are well documented. However, magnitudes of different factors are seldom calculated.

An Economic and Social Research Council (ESRC) sponsored project entitled "Cycling and Urban Mode Choice" (Grant Number: R000237103) started in mid-1997, aiming to identify and quantify the factors that might influence people's decision to travel to work in urban areas. The aim of this paper is to report the findings of the first stage study of this research project.

The first stage study of the "Cycling and Urban Mode Choice" project was to identify and measure the proportion of the general population who would or would not **consider** cycling to work in urban areas. This study was based on detailed surveys (door-to-door and telephone interviews) of people's actual mode choices on two what-if situations. The first hypothetical situation is based on provisions of cycle facilities and routes, and the second rests on drastic changes of the current situations of journey to work. Models were built on the survey data to explain people's choices between driving car, getting a lift, bus, walk and cycle for the journey to work trips.

2. Methodology

Two types of surveys were carried out in this study in 8 different geographical locations across England between 1998 and 1999. These eight locations were selected according to one of the topographical characteristics- hilliness. It was the intention of the study to select areas spreading across 3 spectrums according to

degrees of hilliness (i.e. flat, moderately hilly and hilly). The eight selected locations are listed below. Both types of survey were conducted in Leicester for the sake of data validation.

Topography Classification	**Urban Location**	**Measurement of Hilliness[1]**
Reasonably flat	York	1.74[2]
Reasonably flat	Norwich	1.2[3]
Reasonably flat	Hull	1.6[3]
Moderately hilly	Leicester	2.10[2]
Moderately hilly	Nottingham	3.00[2]
Very hilly	Bradford	5.38[2]
Very hilly	Sheffield	4.8[3]
Hilly	Blackburn	4.0[3]

Notes:

[1] Hilliness is measured by 25 ft contours per miles of A roads in built up area.

[2] These figures were taken from the Cycling Solutions model (Don Mathew, 1995: 27-42 & 56).

[3] These figures were calculated by ourselves according to the Cycling Solutions model definitions.

Two types of surveys were conducted in this study. They were the door-to-door and telephone interviews. In both types of surveys, respondents had to satisfy the following two criteria before entering the interview.

Criteria 1. The respondent must travel to work at least twice a week, using one of the following five modes:

- Car as a driver
- Car as a passenger
- Bus
- Walk
- Cycle

Criteria 2. The journey from home to work should be less than 7 miles.

Except existing cyclists, respondents were presented two types of hypothetical situations during the interviews. The what-if situations are:

Hypothetical Question (1). If cycle facilities and routes were drastically improved, would you ever consider cycling to work?

Available options are:
(1) Yes
(2) No

Hypothetical Question (2).	If the journey to work by your current means of travel became a lot worse, (e.g. much slower or much more expensive), would you consider using other means of travel or opt for other alternatives? Available options are: (1) Car as driver (2) Car as passenger (3) Bus (4) Walk (5) Cycle (6) Change job (7) Move house

Hypothetical question (1) was asked to all qualified respondents in both surveys. Hypothetical question (2) was implemented only in the telephone survey and only those qualified respondents who gave a valid answer to hypothetical question (1) would then be asked. In other words, hypothetical question (1) is the driving force of both surveys. By default, existing cyclists would consider cycling to work.

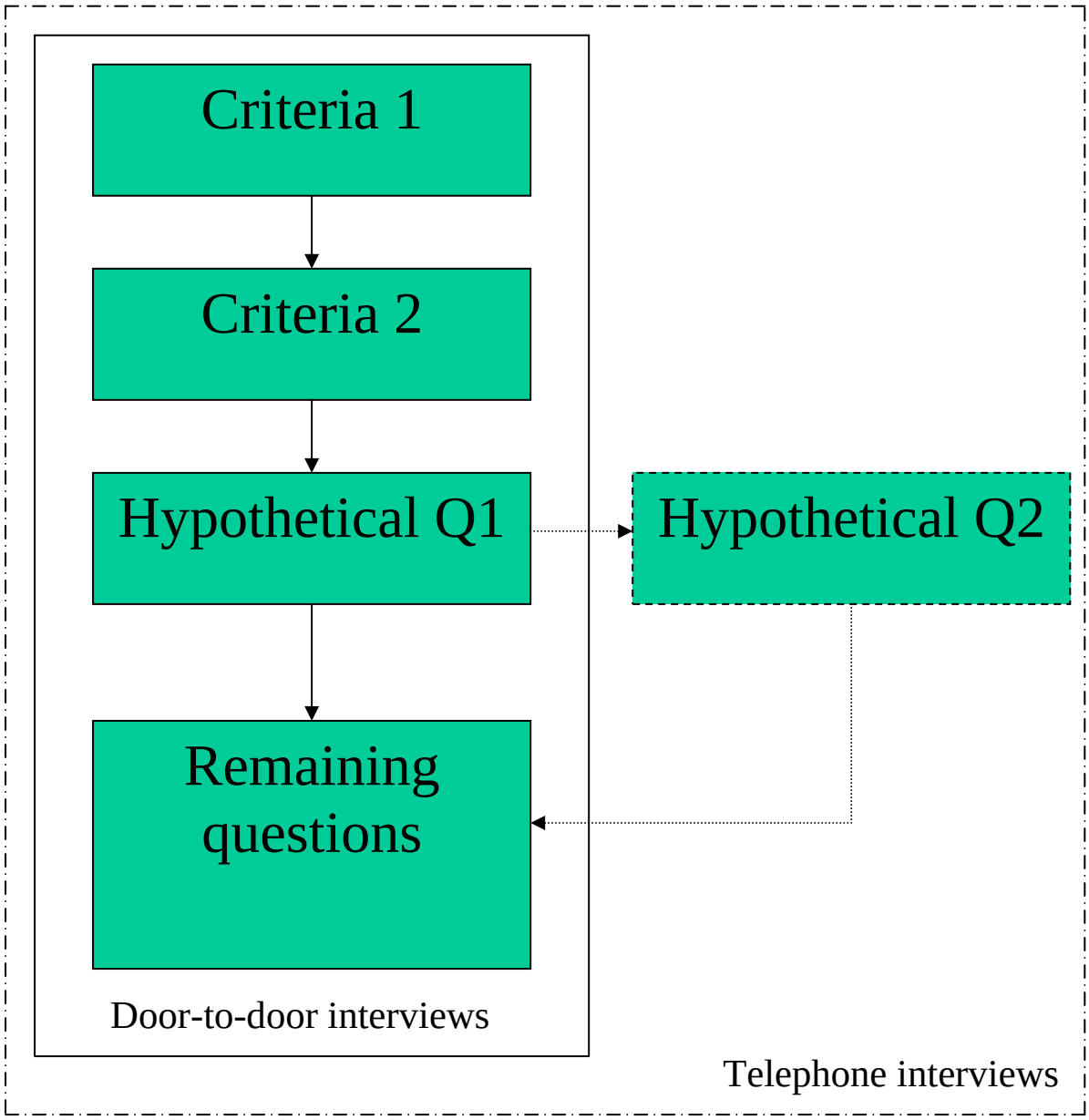
Only a valid answer received from the qualified respondents on the hypothetical question (1) would allow proceeding to the end of the interview. Three further questions were asked to the respondent in relation to their socio-economic characteristics. These questions were the age group, gender and occupation types. If wished, respondents could refuse to answer these questions. A flow chart of the interview procedures is depicted in Diagram 1.

2.1. Door-to-door interviews

The first survey was door-to-door interviews. This survey was conducted in late 1998 in Leicester, Norwich, Hull and York. Respondents were presented the first hypothetical question of whether he/she would consider cycling to work if cycle facilities and routes were drastically improved.

2.2. Telephone interviews

The second survey was telephone interviews. This survey was conducted between May and August 1999 in Bradford, Sheffield, Blackburn, Leicester and Nottingham. Respondents were first asked whether he/she would consider cycling to work if cycle facilities and routes were drastically improved. It was then followed by the second hypothetical question of if the journey to work by his/her current means of travel became a lot worse, (e.g. much slower or much more expensive), would the respondent consider using other means of travel or opt for other alternatives?


Criteria 1
Criteria 2
Hypothetical Q1
Hypothetical Q2
Remaining questions
Door-to-door interviews
Telephone interviews

3. Empirical Results

3.1. Door-to-door interviews

In the door-to-door interviews, the selected survey locations ranged from moderately hilly (e.g. the measurement of hilliness of Leicester is 2.10) to rather flat areas (e.g. the measurement of hilliness of Norwich is 1.2). 1053 valid observations were yielded from this survey.

In this survey, empirical results indicated that the average percentage of local population would consider cycling to work was rather high, about 72%, over the four selected areas. Hull was ranked the highest (82%) and Leicester was the lowest (56%) among the chosen locations (see tables below).

Number of valid cases by geographic location

Questionnaire	**Leicester**	**Norwich**	**York**	**Hull**	**Total**
Consider to cycle	136	282	202	136	756
Would not consider to cycle	107	98	53	26	284
Missing data	0	4	5	4	13
Total	243	384	260	166	1053

Percentage of valid cases by geographic location

Questionnaire	**Leicester**	**Norwich**	**York**	**Hull**	**Total**
Consider to cycle	55.97	73.44	77.69	81.93	71.79
Would not consider to cycle	44.03	25.52	20.38	15.66	26.97
Missing data	0.00	1.04	1.92	2.41	1.23
Total	100.00	100.00	100.00	100.00	100.00

In terms of current modes of transport, it is noted that there was a predominantly high proportion (41% in average) of car drivers in all locations except York. For instance, Norwich ranked the highest (48%) and was followed by Leicester and Hull (46% and 36%), respectively. Although York had the lowest proportion (29%) of car drivers, it was ranked the highest (35%) in terms of cycle population. Hull had a rather high proportion (28%) of cycle population too. Leicester had the lowest (9%) of cycle population among other areas. Concerning proportions of bus and walk populations, they were either ranked in third or fourth place among the five selected transport modes in each location. For car passenger, the proportion of this population in our survey was very low, ranging from the lowest 1.6% in Leicester to the highest 4.2% in Norwich (see tables below).

Number of valid cases by modes of transport

Current Mode Of Transport	**Leicester**	**Norwich**	**York**	**Hull**	**Total**
Car Driver	112	186	76	59	433
Car Passenger	4	16	8	3	31
Bus	52	48	14	12	126
Walk	48	70	56	44	218
Cycle	23	55	90	47	215
Not willing to answer	0	0	0	0	0
Missing data	4	9	16	1	30
Total	243	384	260	166	1053

Percentage of valid cases by modes of transport

Current Mode Of Transport	**Leicester**	**Norwich**	**York**	**Hull**	**Total**
Car Driver	46.09	48.44	29.23	35.54	41.12
Car Passenger	1.65	4.17	3.08	1.81	2.94
Bus	21.40	12.50	5.38	7.23	11.97
Walk	19.75	18.23	21.54	26.51	20.70
Cycle	9.47	14.32	34.62	28.31	20.42
Not willing to answer	0.00	0.00	0.00	0.00	0.00
Missing data	1.65	2.34	6.15	0.60	2.85
Total	100.00	100.00	100.00	100.00	100.00

In terms of gender breakdown, we had rather evenly distributed male and female populations in our survey, 50% and 42% in average, respectively. Due to the fact that interviewers had forgotten to record the gender information, we recorded missing data in our survey. The highest missing data was recorded in York (17%) and the lowest was in Leicester (2%) (see tables below).

Number of valid cases by gender

Gender	**Leicester**	**Norwich**	**York**	**Hull**	**Total**
Male	102	161	100	79	442
Female	137	195	115	79	526
Missing data	4	28	45	8	85
Not willing to answer	0	0	0	0	0
Total	243	384	260	166	1053

Percentage valid cases by gender

Gender	Leicester	Norwich	York	Hull	Total
Male	41.98	41.93	38.46	47.59	41.98
Female	56.38	50.78	44.23	47.59	49.95
Missing data	1.65	7.29	17.31	4.82	8.07
Not willing to answer	0.00	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00

In this survey, over 70% of the respondents were below 45 years old. York and Hull had rather high proportions (32% and 36% respectively) of respondents taken between age 17 and 25. In Leicester, the highest proportion of age group was between 26 and 35. In Norwich, the first rank was age group between 36 and 35. Respondents aged 65 and above also recorded in our survey but the proportion was less than 1% on average over the four locations. Regarding missing data, once again, York had the highest record (22%) and the lowest was Leicester (1%) (see tables below).

Number of valid cases by age group

Age group	Leicester	Norwich	York	Hull	Total
17-25	72	71	82	60	285
26-35	77	89	32	47	245
36-45	50	101	48	31	230
46-55	28	73	26	12	139
56-64	10	17	14	4	45
65 or 65+	3	2	2	1	8
Missing data	3	31	56	11	101
Not willing to answer	0	0	0	0	0
Total	243	384	260	166	1053

Percentage of valid cases by age group

Age group	Leicester	Norwich	York	Hull	Total
17-25	29.63	18.49	31.54	36.14	27.07
26-35	31.69	23.18	12.31	28.31	23.27
36-45	20.58	26.30	18.46	18.67	21.84
46-55	11.52	19.01	10.00	7.23	13.20
56-64	4.12	4.43	5.38	2.41	4.27
65 or 65+	1.23	0.52	0.77	0.60	0.76
Missing data	1.23	8.07	21.54	6.63	9.59
Not willing to answer	0.00	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00

In terms of occupation classification, we had a rather high proportion of “other” occupation type in each selection location. The overall average was 28% for all four areas. About 25% of population samples were from professionals and managers in

Leicester and Norwich. In York and Hull, most respondents were semi- and non-skilled manual workers (15% and 13%, respectively) (see tables below).

Number of valid cases by occupation type

Occupation	**Leicester**	**Norwich**	**York**	**Hull**	**Total**
Professional/ Managerial	61	96	19	22	198
Clerical	37	37	19	15	108
Skilled manual	57	53	20	17	147
Semi- and non-skilled manual	27	75	38	21	161
Other	56	95	88	58	297
Missing data	5	28	76	33	142
Not willing to answer	0	0	0	0	0
Total	243	384	260	166	1053

Percentage of valid cases by occupation type

Occupation	**Leicester**	**Norwich**	**York**	**Hull**	**Total**
Professional/ Managerial	25.10	25.00	7.31	13.25	18.80
Clerical	15.23	9.64	7.31	9.04	10.26
Skilled manual	23.46	13.80	7.69	10.24	13.96
Semi- and non-skilled manual	11.11	19.53	14.62	12.65	15.29
Other	23.05	24.74	33.85	34.94	28.21
Missing data	2.06	7.29	29.23	19.88	13.49
Not willing to answer	0.00	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00

3.2. Telephone interviews

A total of 913 valid observations were yielded in the telephone interviews, ranging from moderately hilly (e.g. the measurement of hilliness of Leicester is 2.10) to very hilly areas (e.g. the measurement of hilliness of Bradford is 5.38). The following two tables showe the highest and the lowest absolute numbers and proportions of local residents who would consider cycling to work over the five selected locations. The proportion of local population cycling to work for Leicester was highest at 40%, Nottingham 36%, Blackburn 30%, Bradford 19% and that for Sheffield only 18%. On the average, only 32% of the total sample population in the telephone interviews would cycle to work compared to about 72% in the door-to-door interviews. Hilliness of the location seems to play a vital role in affecting people's choice of commuting mode of transport (see tables below).

Number of valid cases by geographic location

Questionnaire	**Blackburn**	**Bradford**	**Leicester**	**Nottingham**	**Sheffield**	**Total**
Consider to cycle	74	21	98	88	11	292
Would not consider to cycle	175	87	150	159	50	621
Missing data	0	0	0	0	0	0
Total	249	108	248	247	61	913

Percentage of valid cases by geographic location

Questionnaire	**Blackburn**	**Bradford**	**Leicester**	**Nottingham**	**Sheffield**	**Total**
Consider to cycle	29.72	19.44	39.52	35.63	18.03	31.98
Would not consider to cycle	70.28	80.56	60.48	64.37	81.97	68.02
Missing data	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00

Among other modes, car drivers had the largest share in all locations. The highest proportion of car drivers was Bradford (70%) and the lowest was Nottingham (45%). In general, a higher overall proportion of car drivers, 56%, was obtained from the telephone interviews and only 41% were derived from the door-to-door interviews. In terms of ranking, proportions of population taking a bus or walking to work were either in second or third place in each location. The results obtained from the telephone interviews were not much different from those in the door-to-door survey. There was a higher proportion (8% overall) of population getting a lift to work than in the door-to-door interviews (3% overall). In most areas, proportion of car passengers ranked the fourth place. It was then followed by proportion of population cycling – the lowest in the rank. However, in Nottingham, ordering of the fourth and fifth rank were reversed (see tables below).

Number of valid cases by modes of transport

Current Mode Of Transport	**Blackburn**	**Bradford**	**Leicester**	**Nottingham**	**Sheffield**	**Total**
Car Driver	157	76	133	111	32	509
Car Passenger	23	3	24	17	4	71
Bus	21	15	35	62	11	144
Walk	44	14	40	37	12	147
Cycle	4	0	16	20	2	42
Not willing to answer	0	0	0	0	0	0
Missing data	0	0	0	0	0	0
Total	249	108	248	247	61	913

Percentage of valid cases by modes of transport

Current Mode Of Transport	Blackburn	Bradford	Leicester	Nottingham	Sheffield	Total
Car Driver	63.05	70.37	53.63	44.94	52.46	55.75
Car Passenger	9.24	2.78	9.68	6.88	6.56	7.78
Bus	8.43	13.89	14.11	25.10	18.03	15.77
Walk	17.67	12.96	16.13	14.98	19.67	16.10
Cycle	1.61	0.00	6.45	8.10	3.28	4.60
Not willing to answer	0.00	0.00	0.00	0.00	0.00	0.00
Missing data	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00

In terms of gender distribution, we had a slight increase in female population than males. In general, proportions of female and male population were approximately 54% and 46%, respectively, over five locations (see tables below).

Number of valid cases by gender

Gender	Blackburn	Bradford	Leicester	Nottingham	Sheffield	Total
Male	108	46	115	115	31	415
Female	141	62	133	132	26	494
Missing data	0	0	0	0	4	4
Not willing to answer	0	0	0	0	0	0
Total	249	108	248	247	61	913

Percentage of valid cases by gender

Gender	Blackburn	Bradford	Leicester	Nottingham	Sheffield	Total
Male	43.37	42.59	46.37	46.56	50.82	45.45
Female	56.63	57.41	53.63	53.44	42.62	54.11
Missing data	0.00	0.00	0.00	0.00	6.56	0.44
Not willing to answer	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00

In terms of age breakdown, it varied from one location to another. In Blackburn, about 75% of the total population were from respondents between 26 and 55 and only 9% were between 17 and 25. Bradford and Leicester experienced similar patterns of age distribution. Both areas had the highest distribution (30%) in the 46-55 age group. It was followed by the 36-45 age group (22%) and then for those between 26 and 35 (19%). In Nottingham, the highest distribution was the 26-35 age group (34%) and the second was those between 36 and 45 (23%). In Sheffield, the first two ranks were those aged 26 to 35 (23%) and 56 to 64 (21%), respectively. In general, the ratio was the lowest (2% overall) for people aged 65 or above. Compared to the door-to-door interviews, we had rather low ratios for ages 17 to 25 over all areas (see tables below).

Number of valid cases by age group

Age group	Blackburn	Bradford	Leicester	Nottingham	Sheffield	Total
17-25	23	16	31	32	10	112
26-35	62	21	46	85	14	228
36-45	63	24	55	58	9	209
46-55	61	32	74	41	12	220
56-64	36	12	31	25	13	117
65 or 65+	3	2	9	4	1	19
Missing data	1	1	0	0	2	4
Not willing to answer	0	0	2	2	0	4
Total	249	108	248	247	61	913

Percentage of valid cases by age group

Age group	Blackburn	Bradford	Leicester	Nottingham	Sheffield	Total
17-25	9.24	14.81	12.50	12.96	16.39	12.27
26-35	24.90	19.44	18.55	34.41	22.95	24.97
36-45	25.30	22.22	22.18	23.48	14.75	22.89
46-55	24.50	29.63	29.84	16.60	19.67	24.10
56-64	14.46	11.11	12.50	10.12	21.31	12.81
65 or 65+	1.20	1.85	3.63	1.62	1.64	2.08
Missing data	0.40	0.93	0.00	0.00	3.28	0.44
Not willing to answer	0.00	0.00	0.81	0.81	0.00	0.44
Total	100.00	100.00	100.00	100.00	100.00	100.00

In contrast to the door-to-door interviews, we did not have a high overall proportion of occupation type “other” in this survey. Overall proportion of the “other” occupation type in this survey was only 2% when compared to 28% in the door-to-door survey. Also, professional and managerial occupation type was in the first place and followed by clerical workers in second in Bradford and Sheffield. For Blackburn, Leicester and Nottingham, semi- and non-skilled manual workers were predominant and followed by professionals and managers (see tables below).

Number of valid cases by occupation type

Occupation	Blackburn	Bradford	Leicester	Nottingham	Sheffield	Total
Professional/ Managerial	85	44	72	80	32	313
Clerical	34	29	33	38	9	143
Skilled manual	9	21	11	9	8	58
Semi- and non-skilled manual	109	11	130	117	7	374
Other	12	3	2	1	3	21
Missing data	0	0	0	0	2	2
Not willing to answer	0	0	0	2	0	2
Total	249	108	248	247	61	913

Percentage of valid cases by occupation type

Occupation	**Blackburn**	**Bradford**	**Leicester**	**Nottingham**	**Sheffield**	**Total**
Professional/ Managerial	34.14	40.74	29.03	32.39	52.46	34.28
Clerical	13.65	26.85	13.31	15.38	14.75	15.66
Skilled manual	3.61	19.44	4.44	3.64	13.11	6.35
Semi- and non-skilled manual	43.78	10.19	52.42	47.37	11.48	40.96
Other	4.82	2.78	0.81	0.40	4.92	2.30
Missing data	0.00	0.00	0.00	0.00	3.28	0.22
Not willing to answer	0.00	0.00	0.00	0.81	0.00	0.22
Total	100.00	100.00	100.00	100.00	100.00	100.00

3.3. Combining door-to-door and telephone interviews

The total sampling size is 1966 cases when combining the door-to-door and the telephone surveys. However, 13 cases are invalid due to missing answer of the hypothetical question (1). Therefore, the total valid sample cases for both surveys are 1953. When we grouped the eight selected locations into three broad topographic characteristics according to hilliness, we found that proportion of local residents would consider cycling to work decreased significantly when the measurement of hilliness increased. 32% of population might cycle to work in flat areas, 16% in undulating regions and only 5% for that in hilly areas (see tables below).

Crosstabulate choice by geographical features (in total respondents)

	Topography			
Choice	FLAT	UNDULATE	HILLY	Total
Consider to cycle	620	322	106	1048
Not consider to cycle	177	416	312	905
Total	797	738	418	1953

Crosstabulate choice by geographical features (in percentage)

	Topography			
Choice	FLAT	UNDULATE	HILLY	Total
Consider to cycle	31.75	16.49	5.43	53.66
Not consider to cycle	9.06	21.30	15.98	46.34
Total	40.81	37.79	21.40	100.00

If we crosstabulated mode choice by current mode of transport, results were 21% of car drivers would consider to cycle to work, 2% for car passengers, 6% for bus users and 11% for walkers. By default, existing cyclists would consider cycling to work (see tables below).

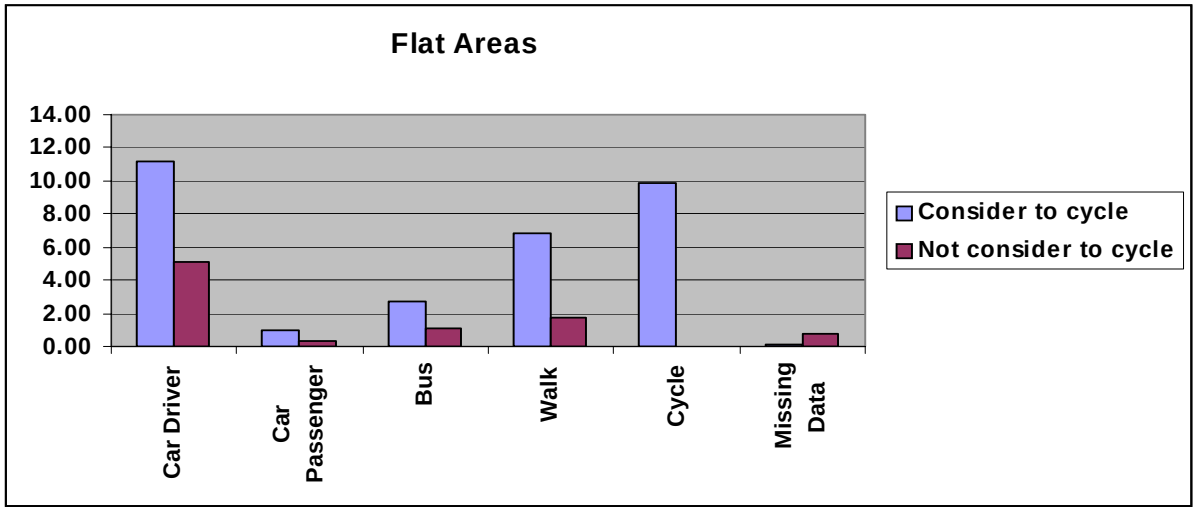
Crosstabulate choice by current mode of transport (in total respondents)

	Current Mode						
Choice	Car Driver	Car Passenger	Bus	Walk	Cycle	Missing Data	Total
Consider to cycle	408	37	118	221	257	7	1048
Not consider to cycle	532	65	152	141	0	15	905
Total	942	102	270	365	257	30	1953

Crosstabulate choice by current mode of transport (in percentage)

	Current Mode						
Choice	Car Driver	Car Passenger	Bus	Walk	Cycle	Missing Data	Total
Consider to cycle	20.89	1.89	6.04	11.32	13.16	0.36	53.66
Not consider to cycle	27.24	3.33	7.78	7.22	0.00	0.77	46.34
Total	48.23	5.22	13.82	18.54	13.16	1.13	100.00

If we crosstabulated mode choice by topographic characteristic (i.e. hilliness) and then by current mode of transport, we noted that there was a decrease of willingness to cycle to work from all modes when degrees of hilliness increased. The decrease was dramatic especially for the current car drivers. For instance, the rate of decrease was about 41% from flat areas to undulating areas, and about 54% from undulating to hilly areas (see diagrams below).


Flat Areas
14.00
12.00
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2.00
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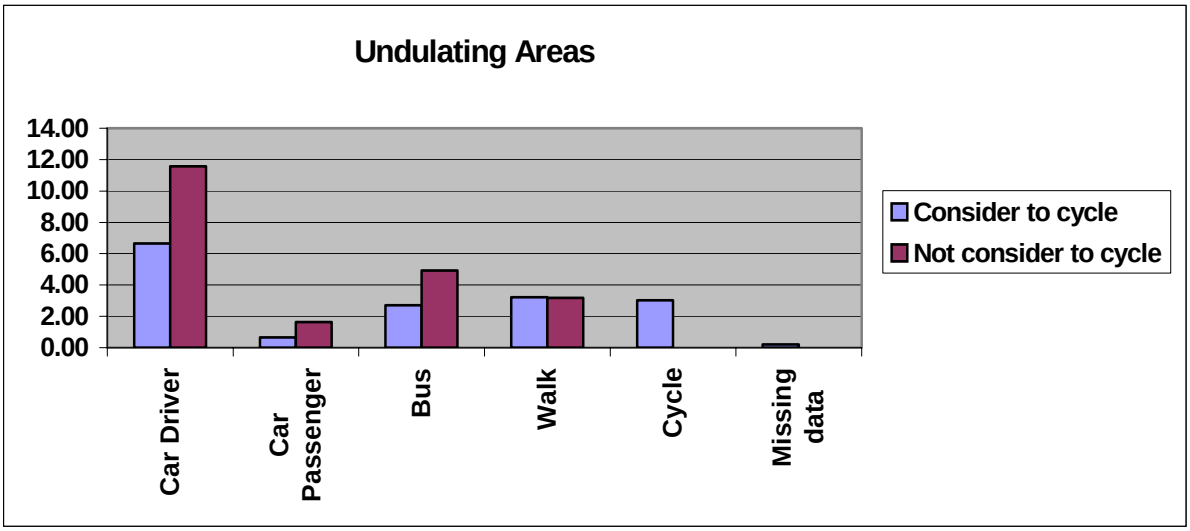
Car Driver
Car Passenger
Bus
Walk
Cycle
Missing Data
Consider to cycle
Not consider to cycle


Undulating Areas
14.00
12.00
10.00
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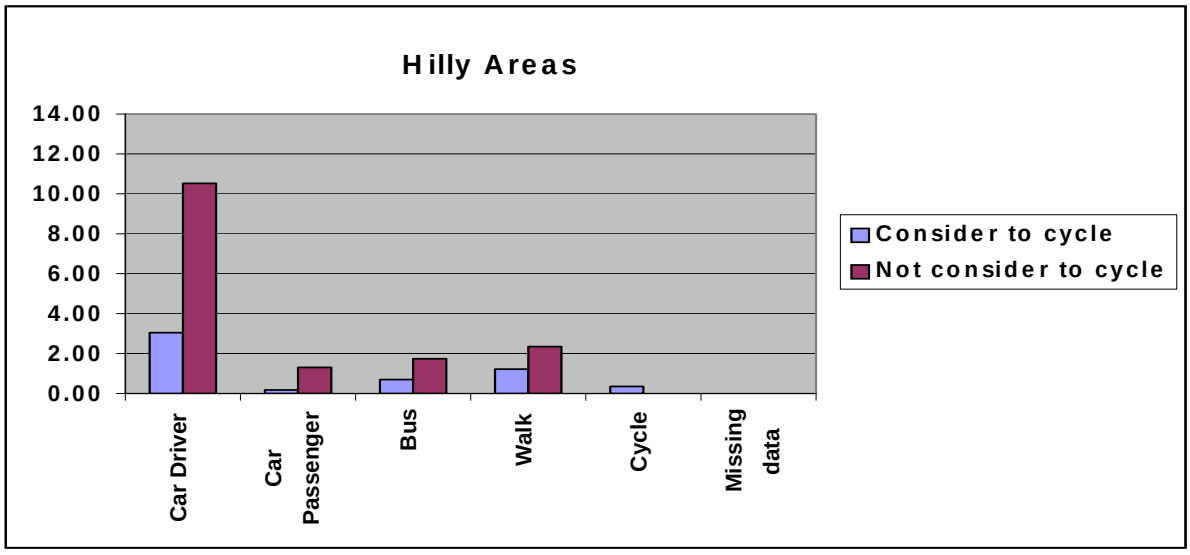
Car Driver
Car Passenger
Bus
Walk
Cycle
Missing data
Consider to cycle
Not consider to cycle


Hilly Areas
14.00
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8.00
6.00
4.00
2.00
0.00
Car Driver
Car Passenger
Bus
Walk
Cycle
Missing data
Consider to cycle
Not consider to cycle

Modelling the door-to-door questionnaires and telephone interviews

4.1. Model Equations and Model Software

In this study, our aim is to model the effects of gender, age group, occupation, current mode of transport and topographical characteristic (in terms of hilliness) of the survey location on people's choice of cycling to work.

Logit models were used in this study for building the forecasting models. The logit model is essentially a formula that represents the influence on people's choices of each of the explanatory factors. Because not all aspects of human behaviour can be fully understood, these explanatory factors can only be modelled as affecting the probabilities that people will make certain choices: the possibility always remains that specific individuals will not make the choices indicated as most probable by the model. Nevertheless, for the total population, general effects can be found and predictions can be made with reasonable accuracy. The logit model works by assigning to each of the alternatives available to an individual an attractiveness or 'utility'. The higher the utility, the more likely an alternative is to be chosen. The utility of an alternative is made up of a number of modelling components such as age/sex, occupation, geographic locations, etc. These different modelling components are combined together, in a way that is not usually known *a priori*, to give the total utility of the alternative as seen by the individual.

The logit model predicts the probability of choice of each alternative by the logit formula, which gives the probability of choosing alternative 1 as:

$P_1 = \exp(V_1) / \{\exp(V_1) + \exp(V_2) + \exp(V_3) + \ldots\ldots + \exp(V_k)\}$

Whereas,	P	Probability function
	$V_{1,2,3,..,k}$	represent the utilities of each of the alternatives 1,2,3,…,k.
	exp	exp stands for exponentiation. exp(V) can be written as e^V whereas e is natural logarithm=2.7183…

From the above formula, it can be seen that each alternative is assigned a share of the probability exactly proportional to the exponential of its utility. Once the probabilities of choice of each of the alternatives are known, predictions can then be made about respondent choices in total. It is worth mentioning that any given individual may do something differently; however, on average, because the probabilities are known, the whole population will tend to conform to the probabilities.

In this study, there were only two respondent choices (i.e. utility functions). The first utility function, V_1, defines people's choice of cycling to work and the second function, V_2, represents choice of not considering cycling to work. Also, it was assumed that relationships of each explanatory factor in a given utility function were linear.

$V_1 = B_1*D_1 + B_2*D_2 + B_3*D_3 + \ldots.. + B_n*D_n$

$V_2 = 0.$

Whereas,

V_1	Denotes the utility function 1 (i.e. respondent would consider cycling to work)
V_2	Denotes the utility function 2 (i.e. respondent would not consider cycling to work).
$B_{1,2,3,..,n}$	Represents the coefficients of unknown types 1,2,3,..,n.
$D_{1,2,3,..,n}$	Represents the modelling factors 1,2,3,…,n.
*	Indicates multiplication.

The method that is used in this study for the estimation of the unknown coefficients, $B_{1,2,3,..,n}$, is the statistical theory of maximum likelihood (i.e. finding the values of B that maximise the likelihood). A computer software, ALOGIT, was used in our modelling runs.

4.2 Modelling Factors

The data from the responses to both door-to-door and telephone interviews has been processed to produce an internally consistent data set. The modelling variables for both surveys are:

Variable Name	Description
Car	Car as a driver is the current chosen mode of transport from home to work
Lift	Car as a passenger is the current chosen mode of transport from home to work
Bus	Bus is the current chosen mode of transport from home to work
Walk	Walk is the current chosen mode of transport from home to work
Choice	Replies from respondents whether they would or would not consider cycling from home to work in the hypothetical situation (1)
Cdrive	Replies from respondents whether they would or would not consider driving from home to work in the hypothetical situation (2)
Clift	Replies from respondents whether they would or would not consider getting a lift from home to work in the hypothetical situation (2)
Cbus	Replies from respondents whether they would or would not consider taking a bus from home to work in the hypothetical situation (2)
Ccycle	Replies from respondents whether they would or would not consider cycling from home to work in the hypothetical situation (2)
Cwalk	Replies from respondents whether they would or would not consider walking from home to work in the hypothetical situation (2)
Cjob	Replies from respondents whether they would or would not consider changing their current job in the hypothetical situation (2)
Chouse	Replies from respondents whether they would or would not consider moving home in the hypothetical situation (2)
S_lei	Leicester (door-to-door survey)
S_nor	Norwich (door-to-door survey)
S_york	York (door-to-door survey)

S_hull	Hull (door-to-door survey)
P_black	Blackburn (telephone interviews)
P_lei	Leicester (telephone interviews)
P_not	Nottingham (telephone interviews)
P_brad	Bradford (telephone interviews)
P_shef	Sheffield (telephone interviews)
Hilly	Topographical classification- hilly areas
Undulate	Topographical classification- moderately hilly areas
Flat	Topographical classification- flat areas
Male	Male
Female	Female
Age1725	Age 17 to 25
Age2635	Age 26 to 35
Age3645	Age 36 to 45
Age4655	Age 46 to 55
Age5664	Age 56 to 64
Age65	Age 65 or above
Prof[1]	Professional or managerial (i.e. professional workers, employers and managers, including professional self-employed and farm managers)
Cler[1]	Clerical (i.e. intermediate and junior non-manual workers, and personal service workers)
Skill[1]	Skilled manual (including foremen of manual workers, skilled manual, own-account farmers, and own-account manual workers)
Semi[1]	Semi- and non-skilled manual (i.e. all other manual workers)
Other[1]	Other occupation types (e.g. armed forces, etc.)

Registrar Generals Classification of occupations is adopted in both surveys.

5. Model Runs and Model Results

5.1. The Disaggegrate Level

At the disaggregated level, the variables of the base models are:

Gender = Male
Current main mode = Walk
Age group = Age 17 to 35
Survey location = York
Occupation = Professional/managerial

The analysis was based on 1953 valid observations. In our final model, the estimation of the unknown coefficient, $B_{1,2,3,..,n}$, converged after 4 iterations. The model results are listed in the following two tables.

Statistical results after 4 iterations.

Likelihood with Zero Coefficients	-1353.7164
Likelihood with Constants only	-1348.4765
Initial Likelihood	-1353.7164
Final value of Likelihood	-1090.3939
"Rho-Squared" w.r.t. Zero	0.1945
"Rho-Squared" w.r.t. Constants	0.1914

Model results of the estimates obtained at iteration 4 at the disaggregated level.

Modelling variables	Estimate	Standard Error	t-ratio
Male	0.1354	0.0273	5.00
Car	-1.1600	0.1250	-9.20
Lift	-1.3780	0.2460	-5.60
Bus	-1.0730	0.1690	-6.30
Age3645	0.0901	0.1000	0.90
Age4655	-0.0630	0.1050	-0.60
Age5664	-0.0260	0.1250	-0.20
Lei	-1.3850	0.2000	-6.90
Norwich	-0.1557	0.2090	-0.70
Hull	0.1723	0.2790	0.60
Blackburn	-2.1020	0.2270	-9.30
Nottingham	-1.8940	0.2250	-8.40
Bradford	-2.6060	0.3050	-8.60
Sheffield	-2.7790	0.3830	-7.30
CONSTANT	2.0890	0.1840	11.30
Final value of Likelihood	-1090.3939		
"Rho-Squared" w.r.t. Constants	0.1914		

We noted the following outcomes in the final model.

- Males are more likely to consider cycling to work than females.
- Current car drivers, car passengers and bus users have significant adverse effects on opting for cycling to work compared to walkers.
- Area locations have very strong influence on people's choice of cycling to work. Variations occur across different areas. Compared to York, people in Blackburn and Nottingham are two times less likely to opt for cycling to work. For those people in Bradford and Sheffield, they are almost three times less likely to consider cycling to work. Also, from our survey results, Norwich and Hull do not have significant effects on people's choice of cycling to work.
- Age has negative but insignificant effect on people's choice of cycling to work; the older the age group, the less likely people would consider cycling to work when compared to people who are between 17 and 35.

- Occupation types do not have any influence on people's choice of cycling to work.

5.2. The Aggregate Level

At the aggregate level, the variables of the base models are:

Gender = Male
Current main mode = Walk
Age group = Age 17 to 35
Survey location = Flat areas (i.e. York, Norwich and Hull)
Occupation = Professional/managerial

The analysis was based on 1953 valid observations. In our final aggregated model, the estimation of the unknown coefficient, $B_{1,2,3,..,n}$, converged after 4 iterations. The model results are listed in the following two tables.

Statistical results after 4 iterations.

Likelihood with Zero Coefficients	-1353.7164
Likelihood with Constants only	-1348.4765
Initial Likelihood	-1353.7164
Final value of Likelihood	-1098.8848
"Rho-Squared" w.r.t. Zero	0.1882
"Rho-Squared" w.r.t. Constants	0.1851

Model results of the estimates obtained at iteration 4 at the aggregated level.

	Statistics		
Modelling variables	Estimate	Standard Error	t-ratio
Male	0.1356	0.0267	5.10
Car	-1.1720	0.1240	-9.50
Lift	-1.3880	0.2450	-5.70
Bus	-1.1280	0.1670	-6.80
Age3645	0.0920	0.0998	0.90
Age4655	0.0598	0.1050	-0.60
Age5664	-0.0317	0.1240	-0.30
Hilly	-2.2580	0.1500	-15.10
Undulate	-1.4940	0.1230	-12.20
CONSTANT	2.0500	0.1240	16.50
Final value of Likelihood	-1098.8848		
"Rho-Squared" w.r.t. Constants	0.1851		

We noted the following outcomes in our final aggregated model.

- Males are more likely to consider cycling to work than females.
- Compared to walkers, current car drivers, car passengers and bus users have adverse effects on people's urban mode choice. Users of these modes are less likely to consider cycling to work.
- Area locations have very strong influence on people's choice of cycling to work. Compared to flat lands, the more hilly the survey locations, the less likely people would choose to cycle to work. The results from our model runs are 1.5 and 2.3 times less likely people would consider cycling to work in moderately hilly and hilly areas, respectively.
- Although age has adverse influence on people's mode choice, figures from the model runs show that they are statistically insignificant.
- Occupation types do not have any influence on people's choice of cycling to work.

6. Conclusions

The study reported in this paper is part of an ESRC project "Cycling and Urban Mode Choice". The aim of this study is to model the effects of gender, age group, occupation, current mode of transport and topographical characteristic (in terms of hilliness) on people's choice of cycling to work.

Two types of surveys were conducted in eight different urban locations over England. The two surveys were the door-to-door and telephone interviews. The eight selected survey locations were York, Norwich, Hull, Leicester, Nottingham, Bradford, Sheffield and Blackburn, ranging from very hilly to rather flat areas. Over 2000 interviews were conducted in our surveys and 1953 valid observations were used in building our forecasting aggregated and disaggregated models. Our models were based on simple, linear logit models. We applied PC-based software, ALOGIT, in our model runs.

Similar results were found from our model runs at the aggregated and disaggregated levels. Both findings indicate that males are more likely to consider cycling to work than females. Other socio-economic characteristics such as age groups and occupation types are statistically insignificant in affecting cycling population. Geographic location of a survey site plays a significant role in either stimulating or inhibiting cycling population. It appears that hilliness is a great deterrent to cycling.

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