Department for Transport

Motorcycles and Congestion: The Effect of Modal Shift

Phase 2 - Modelling Methodology

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EXECUTIVE SUMMARY

In May 1999 an Advisory Group on Motorcycling was set up by the Government after the White Paper "A New Deal for Transport" recognised that motorcycling had the potential to act as a viable alternative to car travel in certain circumstances. The Advisory Group had three primary terms of reference:

- To look at the safety record of motorcyclists and agree measures that would improve safety
- To look at the environment impact of motorcycles and if necessary agree measures to be taken
- To look at the role of motorcycles in integrated transport policy and to assess the scope for further enhancing their benefits through traffic management.

This study builds on earlier research carried out for the Department for Transport on the potential for increasing motorcycle use and reducing congestion and follows on from the study "Motorcycling and Congestion" completed by Halcrow. The first phases of this study collected data and developed improved methods to quantify the extent of motorcycle ownership and the propensity to transfer mode. The ownership and usage models developed during the earlier phases of the study were then incorporated into two test transport models for London and the South East Region (LASER) and the Cambridge Sub Region (MENCAM). Trips by motorcycle owners and non-owners were differentiated and the use of the motorcycle as a mode of travel considered.

This phase of work started by considering the modifications that would ideally be required to incorporate the mathematical models developed during Phase 1. Where necessary simplifications to the original model structures were proposed to enable the implementation to be carried out without changes to the modelling software. The differentiation of motorcycle ownership by size of bike was omitted from the implementation and the capacity requirements of motorcycles were simplified.

The model applications being used to test the motorcycle ownership and usage models are both integrated land use and transport models, carrying trip generation, distribution, mode choice and assignment. The segment of the market being considered during this study is very small, so to

minimise the variation in results due to the number uncertainties associated with forecasting, the work was all carried out in the base year of the models using the existing validated trip matrices. The subsequent phase of work could then consider variations in terms of mode and route choice and the subsequent impacts on congestion as a result of policy interventions.

The trip matrices by purpose and household car availability and for LASER by income were split into trips by motorcycle owners and those by non-owners. The division of the matrices into owners and non owners was achieved by applying the ownership model developed in Phase 1 to 2001 population data from the 2001 Census. This gave the probability at the home end of each trip segment being made by a motorcycle owner.

For the non motorcycle owners the mode choice models in LASER and MENCAM were unaltered. For the owners the motorcycle usage models developed in Phase 1 were implemented as closely as possible to their original form. The enhanced models were then run and the results compared with the original versions of the model to determine the scale of the changes. Some further modifications were made to the mode specific constants in order to minimise the overall change from the original model.

Due to the differences in the structures of the statistical model developed in Phase 1 and the mode choice models in both LASER and MENCAM, it was inevitable that the results obtained from the two phases of work would not be entirely consistent. For the LASER model the complexity and detail of the original model calibration made it difficult to obtain results that were not significantly different from the original model calibration. While the models could be made more consistent with one another the process is largely manual and the size of the LASER model made this impossible to consider in this phase of work.

For the Cambridge area the small manual adjustments to the implementation produced results that are reasonably consistent with the original model and should provide a good platform for policy testing in Phase 3 of the study.

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1 INTRODUCTION

1.1 In May 1999 an Advisory Group on Motorcycling was set up by the Government after the While Paper "A New Deal for Transport" recognised that motorcycling had the potential to act as a viable alternative to car travel in certain circumstances. The Advisory Group had three primary terms of reference:

- To look at the safety record of motorcyclists and agree measures that would improve safety
- To look at the environment impact of motorcycles and if necessary agree measures to be taken
- To look at the role of motorcycles in integrated transport policy and to assess the scope for further enhancing their benefits through traffic management.

1.2 This study builds on earlier research carried out for the Department for Transport on the potential for increasing motorcycle use and reducing congestion and follows on from the study "Motorcycling and Congestion" completed by Halcrow.

1.3 Phase 1 of the current study developed a motorcycle ownership model and a motorcycle usage model. The models were developed by analysing existing data sets such as the National Travel Survey, the Family Expenditure Survey, data from the London Area Transportation Study (LATS) and the Census of Population. In addition both revealed preference (RP) and stated preference (SP) surveys were undertaken specifically for the study to obtain additional information on aspects affecting motorcycle owners and users.

1.4 Phase 2 of the study, which is the subject of this report, developed the methodology by which these motorcycle ownership and usage models were then incorporated into two existing transport forecasting models: for Cambridge (MENCAM); and for London and the South East (LASER). The structure of the LASER model is described in detail in ME&P (2002). Each of these transport models was extended in a manner that takes explicit account of motorcycle owners and of their patterns of travel. As part of this work the characteristics of motorcycling commuters were compared with those of the employed population overall, so as to understand for which types of people and in which types of areas motorcycling is most common.

1.5 Phase 3 then carried out a number of exploratory runs of these extended test models. These runs examined the impacts on the transport system as a whole of a range of initiatives that can influence the pattern of travel on motorcycles.

Overview of the approach

1.6 This report describes the approach that was taken to introduce motorcycle movements explicitly within the two transport model implementations for London and Cambridge. In general the approach is similar for these two implementations except where explicitly stated otherwise. Both of the test models are strategic integrated land use and transport models that operate at a fairly aggregate level of spatial detail and with a significant number of traveller type categories. Their land use model components incorporate the trip generation and distribution stages of more conventional multi-modal models.

1.7 The motorcycle ownership models have been implemented by applying the models developed in Phase 1 to detailed zonal population information from the 2001 Census. The output from this stage was the probability of owning a motorcycle within each of six segments of the population in each zone of the model. These probabilities were applied to the trip matrices within the test models to provide separate matrices of trips for motorcycle owners and for non-owners. This step was required because there are no systematic sources available of observed travel matrices for motorcycle owners, so that synthetic trip distribution matrices needed to be generated instead

1.8 Both of the test models undertake mode choice and assignment to multi-modal transport networks. The networks are represented as a series of links each with its own capacity. They incorporate congestion and its impact on route and mode choice, but do not include any explicit junction modelling / delays. The existing parameters for the mode choice models in the LASER and MENCAM models have been retained for the non motorcycle owners. This ensures the base year calibration of the modelling system is not undermined. The new mode choice models developed specifically for this study have been incorporated for the motorcycle owners so that a new motorcycle mode of travel is defined for them.

1.9 An early draft of this report has benefited from discussions with Dr Marcus Wigan on various aspects relevant to modelling. It has also been informed by the work carried out in Phase 1 of this study by Rand Europe on the development of the motorcycle ownership and usage models.

1.10 The aims of this report are:

- To specify the form of the enhancements to the existing transport models for London (LASER) and for Cambridge (MENCAM) that were required to represent motorcycle movements explicitly in these models (Section 0),
- To document the data sources and processing that were required in order to implement these model enhancements (Section 3),
- To explain how the motorcycle usage model developed in Phase 1 was introduced in practice within these models (Section 4),
- To analyse the extent to which these models are representative of travel behaviour in Great Britain as a whole (Section 5),
- To analyse the spatial and socio-economic variations in motorcycle commuting across the employed population of Great Britain (Section 5).

2 ENHANCEMENTS TO THE TRANSPORT MODELS

2.1 The basic assumptions proposed for the enhanced model structure are introduced here, together with reasons underlying the decisions on these assumptions.

2.2 For both the MENCAM and LASER models it was assumed that the land use model structures remain largely as at present. It is not believed that policies on motorcycles would have impacts on land use and trip distribution patterns that are large enough to be measured in these models. Instead the model enhancements are aimed primarily at the mode choice, assignment and capacity restraint stages within the transport model. Nevertheless, it will be necessary to rerun the trip generation and distribution stages since this is the simplest means to increase the segmentation among travellers in order to distinguish sub-populations with homogeneous propensities for motorcycle use.

2.3 There are considerable uncertainties over whether the recent pattern of growth in motorcycle ownership will continue into the future, or will instead revert back to the longer term trend of gradual decline in ownership and use. For this reason, model runs for future years would have a high degree of uncertainty associated with them. They would have involved substantially more work, but be less informative, than policy test runs for the base / current year of the models. Consequently, it was decided that all policy test runs of the models were to be carried out only for 2001 in MENCAM or for 1997 in LASER. This decision also avoided the need to divert the limited resources of this study into developing and running the whole modelling system for future years.

2.4 To avoid introducing undue complexity, the enhancements to the models only include one composite motorcycle mode and do not segment this motorcycle mode by size of bike. Because of the relatively detailed segmentation by trip purpose (and income level in LASER), it would be possible subsequently to introduce some further subdivision by size of machine, which took account of observed propensities in usage that are empirically validated, such as:

- Females, the young and the poor tend to have smaller bikes
- Middle aged males with high incomes tend to have larger bikes.

2.5 The simplest means to introduce a differentiation by size of bike would be when post-processing the results. However, an alternative approach would be to introduce a sub-mode choice by size of bike. This would adapt the parameters and model structures from the usage model to best meet this requirement. However, any such extension to explicitly include multiple classes of bike would be a significant task that was not feasible within the current budget and so it has not been pursued at present.

2.6 It was more efficient to introduce the new motorcycle mode first in MENCAM, before tackling LASER. The much smaller network, number of zones and of flow types in MENCAM means that all the experimentation and testing could be carried out much more rapidly and efficiently therein than within LASER.

Summary of the model enhancement steps

2.7 Taking the existing LASER and MENCAM models in their current form, the main enhancement steps that were carried out are first summarised here. The enhancements to the mode choice and assignment modelling within the transport models are then discussed in greater detail later in this section, while the introduction of the segmentation by motorcycle ownership and the associated disaggregation of the demand matrices are discussed in Section 3. These main steps are:

- a Define the motorcycle demand and demographic segments and the travel purpose categories to be distinguished in the model – each model currently only operates the mode split and assignment for a single time period - the AM peak period – and extensions to this were not envisaged due to the resources that this would have consumed.
- b Obtain splits by zone from Census 2001 for the proportions of the main demographic segments that are to be distinguished in the motorcycle ownership model. Then use the motorcycle ownership model, together with motorcycle vehicle stock estimates by County/Unitary Authority, to estimate the zonal levels of ownership in each segment. The methodology is explained in Section 3.
- c Retain the existing travel purpose types in the mode choice models but further segment these trip matrices among a set of traveller types that are selected such as to have homogeneous propensities to use motorcycle. This creates a major increase in the number of matrices to feed into the transport models.
- d In the parameter files create a new main mode and a new network mode for motorcycle. This can use the existing road network but it includes a number of motorcycle specific operational parameters as listed in Table 2.2. It was assumed that a single overall motorcycle mode is sufficient, so that there is no need to create separate scooter and larger bike modes within the mode choice stage.
- e For the part of the population who do not own motorcycles, retain the mode split and assignment models in exactly their current form in each model.

f For those who do own motorcycles, modify the original mode choice model for each flow type to include the mode motorcycle. The multi-level choice structure and parameters were based on the findings from the stated preference (SP) and revealed preference (RP) research that is encapsulated within the calibrated models of motorcycle usage that have been produced in Phase 1.

Segmentation of the mode choice procedure

2.8 The revision to the segmentation within the mode choice models ensures that the transport model responses are supported by the empirical investigations that have been carried out in the estimation of the motorcycle ownership and usage models. The original household car availability (as well as income within LASER) dimensions were retained in order to minimise disruption to the existing structure of the models.

2.9 A new segmentation dimension was introduced into the mode choice model to distinguish between persons who do and do not own motorcycles. The original flow type segments that are used in the LASER mode choice model are presented in Table 2.1.

Table 2.1: LASER original traveller type segments for the mode choice model

Flow type	Flow name	Description
1	CmtgH0Car	Commuting trips, high income household, with no car.
2	CmtgHPCar	Commuting trips, high income household, with part car availability.
3	CmtgHFCar	Commuting trips, high income household, with full car availability.
4	CmtgL0Car	Commuting trips, low income household, with no car.
5	CmtgLPCar	Commuting trips, low income household, with part car availability.
6	CmtgLFCar	Commuting trips, low income household, with full car availability.
7	SchlH0Car	School trips, high income, with no car.
8	SchlHPCar	School trips, high income, with part car availability.
9	SchlHFCar	School trips, high income, with full car availability.
10	SchlL0Car	School trips, low income, with no car.
11	SchlLPCar	School trips, low income, with part car availability.
12	SchlLFCar	School trips, low income, with full car availability.
13	OthrH0Car	Other trips, high income, with no car.
14	OthrH0Car	Other trips, high income, with part car availability.
15	OthrH0Car	Other trips, high income, with full car availability.
16	OthrH0Car	Other trips, low income, with no car.
17	OthrH0Car	Other trips, low income, with part car availability.
18	OthrH0Car	Other trips, low income, with full car availability.
20	EBProf	Employers business trips, professional
24	Taxi/LGV/air	Journeys made by taxi, light goods vehicles or to/from flights.
25	OGV	Journeys made by heavy goods vehicles.

2.10 Each of the first nineteen passenger flow types within this list was further subdivided between those persons who own motorcycles and the non owners. Accordingly, the model size and run times approximately doubled, due to the inclusion of these extra flow types. A similar approximate doubling of flow types was implemented within MENCAM, which has some differences from LASER in the particular flow types it uses.

Introducing a new motorcycle mode

2.11 A single new main mode and a network mode for motorcycle were introduced to the model. In general, its characteristics are similar to those for the existing mode car, which was used as a starting reference point. The main changes identified are listed in Table 2.2, which also provides the locations in the input files where information specific to policy tests can be introduced.

Table 2.2: Features and parameters for motorcycle modelling

Element	File	Comments
Equivalent vehicle	UTM[4] CapFac	The congestion impact of an m/c relative to that of a car
Speed	UTM[4] TimeFac	Need to take a reasonable account of lane width effects as bikes may move faster than cars in traffic conditions
Parking cost	UTM[4] ChrgFac or a special link or UTT	
Parking time	UTM[4] TimeFac or a special link or UTT	
Vehicle operating costs	UTM[5] & UTF[4]	
Emissions	UTM[6, 7 & 8] for car and m/c	Bikes have fewer stops and so have different driving cycles
Occupancy	UTF[4] – FUPerMU	Adjust existing car occupancy to exclude m/c. Include m/c rate
Value of time factors	UTF[4] TimeVal	To ensure that the increased propensity to use minor roads is included (intrinsic pleasure and flexibility in rerouting after navigation error), separate the network modes by such road types and then adjust TimeVal by mode
Congestion	UTF[7]	
M/c tolls	UTM[4] ChrgFac	
Mode choice hierarchy & parameters	UTF[7]	Based on the Phase 1 m/c usage model parameters.

Validation of enhanced models

2.12 The enhanced models were run for the base year and the resulting travel flows on motorcycle and other public and private modes were assigned to the links of the respective model networks. A limited number of checks against observed traffic counts were carried out to make sure that the traffic estimates were realistic. Cambridgeshire County Council has a series of vehicle count data for the radial routes entering Cambridge against which numbers of cars and motorcycles can be compared. However the counts are only published for a 12 hour period.

2.13 For journeys to work, the mode shares can be compared against those from the residence statistics from the 2001 Census which are already published. Account will need to be taken of differences in year since the base year of the models is prior to 2001 and there has been a pattern of growth in motorcycle ownership in recent years. Care is also needed because the Census relates to persons at their usual place of work, by their usual mode of travel, which is different in definition to other transport data source definitions.

2.14 More detailed analysis cross-tabulating mode of journey to work against a range of household characteristics for the London, South East and East Regions cannot be carried out for 2001, since the SARs on which this depends is not available. However, a detailed analysis of the 1991 SARs has been carried out and is summarised in Section 5.

2.15 The statistics on travel by other modes that are output by the enhanced model were checked against the original model results, to confirm that the model enhancements have not diminished the quality of the existing calibration.

3 MOTORCYCLE OWNERSHIP AND DEMAND MATRIX CREATION

3.1 It was not part of the original study proposal to explicitly model for Cambridge or London the changes in motorcycle ownership in response to transport policy initiatives. The data required to set up such a model would have been expensive to collect. It would have entailed interviewing a large population of current non-owners in order to identify what is likely to be a small proportion that might consider purchase. Through adopting segmentation and the use of omnibus surveys the sample size might be lessened, but it would still be likely to be large and expensive. Consequently it was not included within the tasks of this study.

3.2 Instead some sensitivity tests were implemented which introduce exogenous increases in motorcycle ownership rates that represent a global agglomeration of the various influences on ownership rates. The choice modelling focuses instead on the usage of the motorcycles that are owned and on how that usage is influenced by policy initiatives.

Identifying spatial motorcycle ownership patterns in the base population – data sources

3.3 In order to introduce motorcycles into the model it was first necessary to segment the population of travellers between those that do and do not own motorcycles. Unfortunately the Population Census does not request information on the ownership of motorcycles but only of cars and vans. Accordingly, there is no spatially detailed national source of data that relates the stock of motorcycles back to the characteristics of their owners. Consequently, a method was needed to estimate for the base year the zonal level of motorcycle ownership by person type for the LASER and MENCAM study areas. The data sources and approach are now discussed in more detail.

3.4 The Census does have data on the use of motorcycles as the normal main mode for journeys to work and so provides some indirect guidance on implied ownership patterns. As discussed in Section 5 the 1991 Census SARs suggests that individuals are likely to use motorcycles for commuting if their workplace is in a congested, costly to park, urban area than elsewhere, and this may complicate the representativity of usage as a guide to spatial ownership patterns. The main use of the 2001 Population Census was to provide the basic underlying demographic data on the characteristics of the population resident in each zone. This data was combined with the propensity to own a motorcycle (as estimated via the motorcycle ownership model estimated in Phase 1 from NTS and FES data), for each such demographic segment in order to estimate the zonal split between those who do and do not own motorcycles. The practical details of this estimation procedure are outlined more fully in paragraph 3.11 onwards.

3.5 The method by which the population was subdivided into motorcycle owners was partially tied in with the current segmentation for car owners. In Australia, empirical research suggested that the proportion of car owners with motorcycles seemed stable at around the 10% mark for different groups of the population. Both the NTS and the SAR datasets demonstrate the relatively greater incidence of motorcycles in households with 1 car than in those with more than 1 car.

3.6 Although the phenomenon of multiple ownership of motorcycles has been included within the motorcycle ownership model, to avoid undue complexity it will not be represented explicitly within the transport models themselves. The research to date has suggested that motorcycle ownership is essentially a personal characteristic, and unlike car ownership it should be applied at the level of the individual and not as a household ownership. It appears not to be common for motorcycles to be shared among household members.

Introducing motorcycle ownership segments into the model

3.7 From the Phase 1 motorcycle ownership model it is possible to extract the probability that a person of age 16 or above who falls into one of a set of six basic categories will own one or more motorcycles. These categories are listed in Table 3.1. The formula for the residents within Greater London had an additional area specific modification.

Table 3.1: Population segments distinguished in the motorcycle ownership model

Category	Divisions
SEG	Managerial/Professional Manual semi- and un-skilled Other
Household car ownership	No cars or 2+ cars One car
Gender	Male Female
Age	16-19 20-24 25-34 35-39 40-44 45-49 50-59 60-69 70+
Children in household	None One or more
Income (£2003)	Under £7,000 £7,000-£9,000 £9,000-£15,000 £15,000-£20,000 Over £20,000

3.8 The 2001 Census data at ward level was used to provide the basic demographic information at the ward level. This was input to the ownership model to estimate the proportion of owners within each relevant ward of the study areas of the two models. The Census Tables that were used to assemble the required demographic information are shown in Table 3.2.

Table 3.2: Tables used from 2001 Census

Table	Contents
S42	Gender and NS- SeC by Age
S14	Adults in household by Age and Dependent children

3.9 The Age categories in these two Tables were not identical and assumptions had to be made about income distributions for each SEG/Car combination using information from the Family Expenditure Survey. Ownership probabilities were then calculated in each relevant ward for each of the six SEG/Car ownership combinations. The corresponding values for the MENTOR and LASER zones were then deduced using ward/zone equivalences to aggregate the results across all of the wards that comprise each zone in the models. The output from this stage was a sub-division of the residents by type in each zone between those who did and did not own motorcycles.

3.10 The probabilities obtained were validated for the study area by comparing the modelled resulting average probability with the expected level from the calibrated ownership models developed in Phase 1 and reported in Section 2 of the Phase 1 report. The ownership models in Phase 1 were recalibrated for the London, London, South East and East and Cambridgeshire Regions. The probability of owning a motorcycle in the LASER area came out very close to the target of 0.0257. The estimated probability of owning a motorcycle in the MENCAM area was however higher than the target at 0.0404 compared with 0.0289. There was insufficient data on multiple motorcycle ownership by Region to recalibrate the models, so this data continued to be for Great Britain as a whole and may partly explain the differences observed. To ensure the overall levels of ownership were realistic, global adjustment factors were applied to bring the overall level of ownership in line with the Phase 1 results, while maintaining the spatial variation due to different population profiles by area.

3.11 This process provides information to segment the existing trip matrices between those who do and do not have the potential to use motorcycles. For both the MENCAM and LASER models it was decided to split their existing trip matrices by processing the files containing the estimated O-D matrices in MS Access databases.

3.12 Two files of trip matrix information are available from the MEPLAN based integrated land-use and transport models:

- LAT file which contains Production/Attraction matrices denoting the home (production) zone and attraction zone for each zone pair – this contains daily movements
- FAF file which contains OD trip matrices for the AM peak period. While the majority of trips at this time of day will be in an outward (from home) direction, a few will be returning to home.

3.13 Since the LAT files denote which end of the trip is the home end and which is the work / other attraction purpose end of the journey these files are more appropriate for splitting into owners and non-owners. Accordingly, the probability of owning a motorcycle, as derived from the 2001 Census data, was applied at the home end of the LAT matrices.

3.14 The structures and segmentation in the two models are different, and as a result the processing carried out in MS Access is slightly different in the two cases, although the principles are the same.

MENCAM model

3.15 The MENCAM model contains the trade matrices in the LAT file as shown Table 3.3. These are then aggregated / disaggregated into the Flow types shown on the right hand side for the mode choice and assignment stages.

3.16 Where the matrices are disaggregated between the trip distribution and the mode choice stages of the model, additional information stored by the land use model is used to carry out the splitting. This information is the proportion of the home end of the matrix which is associated with the different household types in the model. There are 30 household types within the model denoting:

- 5 car availability categories (by number of adults and number of cars)
- 6 economic status categories (four socio economic groups (SEGs) for households containing employed persons plus unemployed and inactive households).

3.17 Each matrix can therefore be split into the 30 constituent parts and re-aggregated.

3.18 The ownership model provides the probability of owning a motorcycle for six segments of the population as shown in Table 3.4. By comparing Table 3.3 with Table 3.4 it can be seen that the two sets of segments match reasonably well – so long as the information is applied to the matrices output by the distribution model where the number of cars is either directly available or can be determined from the proportions relating the trades to the households.

Table 3.3: MENCAM trip matrices output by distribution model and aggregated for input to mode choice model

Trade	Trip Distribution - Description of Trade Matrix	Flow for Mode Choice
20	Home-based work (HBW) by SEG 1 from hhold with no car	3 HBW no car availability
24	HBW by SEG 2 from hhold with no car	
28	HBW by SEG 3 from hhold with no car	
32	HBW by SEG 4 from hhold with no car	
21	HBW by SEG 1 from hhold with 2+ adults and 1 car	2 HBW partial car availability
25	HBW by SEG 2 from hhold with 2+ adults and 1 car	
29	HBW by SEG 3 from hhold with 2+ adults and 1 car	
33	HBW by SEG 4 from hhold with 2+ adults and 1 car	
22	HBW by SEG 1 from hhold with 1 adults and 1 car	1 HBW full car availability
26	HBW by SEG 2 from hhold with 1 adults and 1 car	
30	HBW by SEG 3 from hhold with 1 adults and 1 car	
34	HBW by SEG 4 from hhold with 1 adults and 1 car	
23	HBW by SEG 1 from hhold with 2+ adults and 2+ cars	
27	HBW by SEG 2 from hhold with 2+ adults and 2+ cars	
31	HBW by SEG 3 from hhold with 2+ adults and 2+ cars	
35	HBW by SEG 4 from hhold with 2+ adults and 2+ cars	
11	Personal business trips	6 HB Other no car availability
12	Shopping trips	5 HB Other partial car avail.
15	Other trips	4 HB Other full car availability
13	Education	9 HB Educ. no car availability
		8 HB Educ. partial car avail.
		7 HB Educ. full car availability

Table 3.4: Motorcycle ownership models: probability segments distinguished

Ownership segment	Description
11	SEG1 – Professional – 0 or 2+ cars
12	SEG 1 – Professional – 1 car
21	SEG 4 – Manual – 0 or 2+ cars
22	SEG 4 – Manual – 1 car
31	Other (SEG2/3/Inactive) – 0 or 2+ cars
32	Other (SEG2/3 / Inactive) – 1 car

3.19 Each of the trade matrices 11 to 15 in the trip distribution model for non-commuting travel, as shown in Table 3.3, was split using the household proportions information. This step then provided a complete set of matrices by SEG and household car availability for each trip purpose. The appropriate probabilities of motorcycle ownership as derived from the Phase 1 Model applied to Census data on the demographic characteristics of residents in the zone in 2001 were then applied to each segment to produce a set of trade matrices for owners and non owners of motorcycles. These were then exported from the database as an extended LAT file. The TAD file of travel disutilities was also extended to duplicate the travel characteristics for a set of trips by owners and non owners. This file is required by the process to convert the LAT file of PA trips matrices by land use model zone to a FAF file of OD trips by transport model zone.

Table 3.5: Correspondence between trades and flows in original and revised MENCAM models

Original Model		M/C Non owners		M/C Owners	
Trade	Flow	Trade	Flow	Trade	Flow
20 24 28 32	3	20 24 28 32	3	40 44 48 52	13
21 25 29 33	2	21 25 29 33	2	41 45 49 53	12
22 26 30 34 23 27 31 35	1	22 26 30 34 23 27 31 35	1	42 46 50 54 43 47 51 55	11
11 12 15	6 5 4	11 12 15	6 5 4	16 17 19	16 15 14
13	9 8 7	13	9 8 7	18	19 18 17

3.20 The expanded files were then run through the MEPLAN FREDA sub model to convert the daily trade matrices into AM peak trip matrices and in this case to carry out the zone matching between the different zoning systems used in the distribution and assignment models. To achieve this the original MENCAM model implementation was extended to include extra trades and flow types as listed in Table 3.5.

LASER model

3.21 The approach used to split the Cambridge LAT file was applied to the LASER LAT file. However the process had to be modified due to the size of the LASER model. The intermediate stages could not all be stored within a single Access database so the process was divided into separate stages in separate databases.

Table 3.6: Commuting trip matrices output from distribution model and input to mode choice

Trade	Description	Flow Type for Mode Choice
50 & 52 55 & 57 60 & 62	HBW by SEG 1 from hhold with no car HBW by SEG 2 from hhold with no car HBW by SEG 3 from hhold with no car	1 HBW medium/high income, no car availability
53 58 63	HBW by SEG 1 from hhold with 2+ adults and 1 car HBW by SEG 2 from hhold with 2+ adults and 1 car HBW by SEG 3 from hhold with 2+ adults and 1 car	2 HBW medium/high income, partial car availability
51 56 61 54 59 64	HBW by SEG 1 from hhold with 1 adults and 1 car HBW by SEG 2 from hhold with 1 adults and 1 car HBW by SEG 3 from hhold with 1 adults and 1 car HBW by SEG 1 from hhold with 2+ adults and 2+ cars HBW by SEG 2 from hhold with 2+ adults and 2+ cars HBW by SEG 3 from hhold with 2+ adults and 2+ cars	3 HBW medium/high income, full car availability
65 67	HBW by SEG 4 from hhold with 1 adult & no car HBW by SEG 4 from hhold with 2+ adults & no cars	4 HBW low income, no car availability
68	HBW by SEG 4 from hhold with 2+ adults and 1 car	5 HBW low income, partial car availability
66 69	HBW by SEG 4 from hhold with 1 adults and 1 car HBW by SEG 4 from hhold with 2+ adults and 2+ cars	6 HBW low income, full car availability

3.22 The trade matrices within the LASER trip distribution model and the associated aggregation into the trip matrices by Flow type for the mode choice and assignment models are shown in Table 3.6 and Table 3.7 for commuting and for other trip purposes respectively.

Table 3.7: Non commuting matrices output from distribution model and input to mode choice

Trade	Description	Flow Type for Mode Choice
200	Education – Medium/High income - 0 cars	7 HBEd High Inc no car
201	Education – Medium/High income – 2+ adults and 1 car	8 HBEd High Inc Part car
202	Education – Medium/High income – 1 adult and 1 cars Education – Medium/High income – 2+ adults and 2+ cars	9 HBEd High Inc Full car
203	Education – Low income - 0 cars	10 HBEd Low Inc No Car
204	Education – Low income – 2+ adults and 1 car	11 HBEd Low Inc Part Car
205	Education – Low income – 1 adult and 1 cars Education – Low income – 2+ adults and 2+ cars	12 HBEd Low Inc Full car
206 212	Shopping & Personal business – Medium/High Inc No cars Other HB trips – Medium/High income No car	13 HB Other High Inc No Car
207 213	Shop & Personal business – Medium/High Inc Partial car availability Other HB trips – Medium/High income Partial car availability	14 HB Other High Inc Part Car
208 214	Shop & Personal business – Medium/High Inc Full car availability Other HB trips – Medium/High income Full car availability	15 HB Other High Inc Full car
209 215	Shopping & Personal business – Low Inc No cars Other HB trips – Low income No car	16 HB Other Low Inc No Car
210 216	Shop & Personal business – Low Inc Partial car availability Other HB trips – Low income Partial car availability	17 HB Other Low Inc Part Car
211 217	Shop & Personal business – Low Inc Full car availability Other HB trips – Low income Full car availability	18 HB Other Low Inc Full Car
218 220	Home based employer's business - Local Non-home based employer's business - Local	19 Local business
219 221	Home based employer's business - Professional Non-home based employer's business - Professional	20 Professional business
222	Non-home based other	23 NHBO

3.23 As in the MENCAM model the commuting journeys are already segmented by socio-economic group, while the other journey purposes distinguish medium/high and low income – where medium/high income is defined as trips by households of SEGs 1 to 3, while low income denotes trips made by SEG4, Inactive and Unemployed households.

3.24 To obtain the socio economic group of the non-commuting trips a two stage process was required for the LASER model, since the households by socio economic group do not directly generate the trips. In LASER the households by socio economic group generate the population by high and low income who in turn generate the trips. Rather than a one step process to split the trips into the SEGs to match to the motorcycle ownership categories shown in Table 3.4 a two step process was required as shown in Figure 3.1. The relationships between the population categories and the trip categories was maintained and duplicated for the SEG categories within each income group.

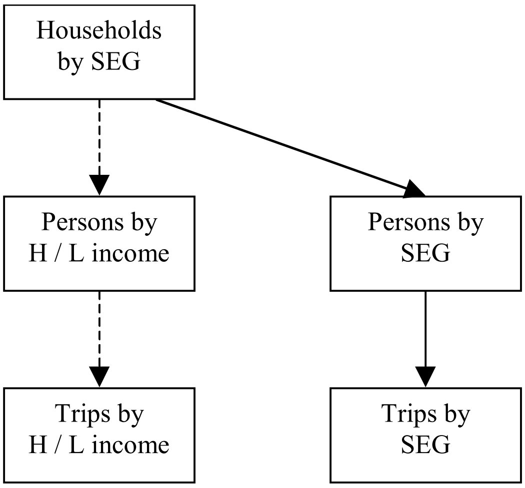


Figure 3.1: Relationship between household and trip segments

3.25 The probabilities of owning a motorcycle for the residents of each zone were then applied to split each trip matrix into those journeys by motorcycle owners and those by the rest of the population. The split matrices were then re-aggregated to the original dimensions for both owners and non-owners of motorcycles.

3.26 The original trade and flow matrix number codes and the new segments defined for the motorcycle owners are shown in Table 3.8.

Table 3.8: Correspondence between trades and flows in original and revised LASER models

Original Model		M/C Non owners		M/C Owners	
Trade	**Flow**	**Trade**	**Flow**	**Trade**	**Flow**
50, 52 55, 57 60, 62	1	50, 52 55, 57 60, 62	1	30, 32 35, 37 40, 42	31
53 58 63	2	53 58 63	2	33 38 43	32
51, 54 56, 59 61, 64 66, 69	3	51, 54 56, 59 61, 64 66, 69	3	31, 34 36, 39 41, 44 46, 49	33
65, 67	4	65, 67	4	45, 47	34
68	5	68	5	48	35
66, 69	6	66, 69	6	46, 49	36
200	7	200	7	100	37
201	8	201	8	101	38
202	9	202	9	102	39
203	10	203	10	103	40
204	11	204	11	104	41
205	12	205	12	105	42
206, 212	13	206, 212	13	106, 112	43
207, 213	14	207, 213	14	107, 113	44
208, 214	15	208, 214	15	108, 114	45
209, 215	16	209, 215	16	109, 115	46
210, 216	17	210, 216	17	110, 116	47
211, 217	18	211, 217	18	111, 117	48
218, 220	19	218, 220	19	N/a	N/a
219, 221	20	219, 221	20	N/a	N/a
222	23	222	23	N/a	N/a

4 INTRODUCING MOTORCYCLES INTO THE TRANSPORT MODEL

Units of measurement

4.1 The introduction of motorcycles into the MENCAM and LASER models required careful consideration of the units used in each and in the formulation of the Phase 1 motorcycle models of usage. These are shown in Table 4.1. The cost conversion was based on the change in the Retail Price Index (RPI) using the CHAWIndex.

Table 4.1: Units of Models

Model	Time	Cost	Cost conversion	Distance
MENCAM	Minutes	£ (1991)	0.74	Km
LASER	Minutes	Pence (1997)	87.0	Km
m/c usage models	Minutes	£ (2003)		Miles

Flow types

4.2 In both MENCAM and LASER each of the original types of person flow matrices were replicated as motor cycle owners to complement the existing matrices which were reclassified to now represent those who do not own motorcycles. The earlier Table 3.5 shows the correspondence for MENCAM between the original and the updated motorcycle owner and non-owner flow types. Table 3.6, Table 3.7 and Table 3.8 provide equivalent correspondence lists for the LASER model.

4.3 In both models each additional flow required the same data descriptions of the original modes as did the corresponding original flow and these descriptions were replicated as appropriate in the input files, including those which define terminal data and preset matrices of, eg, walk distances. In LASER the list of link types available to each flow for intrazonal travel had to be extended.

Network Modes and User Modes

4.4 In MENCAM a single additional Network Mode to represent the travel on the road network by motorcyclists was added:

Network Mode 2 Motorcycle ride.

4.5 In LASER the same structure as for the Car Network Modes was followed and new Network Modes were introduced in the manner presented in Table 4.2. Because the zones in the LASER model (typically 1 to 4 zones per District/Borough) are larger than in MENCAM (finer than ward level), LASER uses an explicit representation of intrazonal travel using a network of distance bands for each mode. This needed also to be created for motorcycles, together with explicit parking links and walking links to/from the parking locations.

Table 4.2: Network Modes

Network Mode	Description
27	M/c ride
37	M/c walk
47	M/cP PNR
57	M/cP OOS
30	M/cintra1
31	M/cintra2
32	M/cintra3
33	M/cintra4
34	M/cintra5
35	M/cintra6
36	M/cintra7

4.6 In MENCAM a single new User Mode was introduced so as to represent motorcycle trips within the mode choice procedure, and relating back to the motorcycle network mode on individual links of the highway network.

User Mode 6 using Network Mode 2.

4.7 In LASER the structure for cars was again followed and 8 new User Modes were created as shown in Table 4.3 to take account of both inter and intrazonal travel movements.

Table 4.3: User modes

User Mode	Name	Network Modes Used
39	M/c	27, 37, 47, 57
40	M/cIntra1	30, 37, 47, 57
41	M/cIntra2	31, 37, 47, 57
42	M/cIntra3	32, 37, 47, 57
43	M/cIntra4	33, 37, 47, 57
44	M/cIntra5	34, 37, 47, 57
45	M/cIntra6	35, 37, 47, 57
46	M/cIntra7	36, 37, 47, 57

Network Characteristics

4.8 For the base run in each model, the motorcycles modes were allowed on the same links as the corresponding car modes. In order to represent their superior ability to overtake, their travel time on motorway links was set to 90% of that of cars and on other links to 80% of car times. Ideally the capacity requirement for a motorcycle would be coded as some function of congestion. However this is not currently possible within MEPLAN, so they were assigned passenger car equivalent values of zero within the estimation of impacts on congestion. As used in the derivation of the usage models in Phase 1, the network calculated cost function for motorcycles was set at 10p per mile, translated into model units. In the LASER model charges on Dartford Tunnel links were multiplied by zero.

4.9 In both models the motorcycle occupancy was set to unity and the path choice parameters were copied from those for car modes.

Modal Hierarchies

4.10 Figure 4.1 for MENCAM and Figure 4.2 for LASER show the mode choice hierarchies: on the left for the non-motorcycle owners, and on the right for the motorcycle owners. For the subset of motorcycle owners only, the choice hierarchy was changed from its original structure in order to match it to that which had been derived from the survey based analysis of motorcycle usage within Phase 1. Because the sample of travellers that was surveyed was chosen so as to be representative of motorcycle owners, and not of the population of Great Britain as a whole, it would not have been appropriate to use this research to modify the modal hierarchy for the non-owners. Accordingly, their parameters and modal hierarchy were left unchanged from the original calibration of the LASER and MENCAM models.

4.11 For the motorcycle owner group only, the original parameters were used to combine Walk and Cycle modes into a Slow mode (MENCAM only) and also to combine various other components into a Public Transport mode (Bus and Rail for MENCAM - Bus, Coach, LU, BR and the various intrazonal Bus and Rail modes for LASER). This facilitated the reproduction as far as possible of mode choice hierarchy that was derived in Phase 1. The survey analysis had not included the mode Walk, so that Cycle mode that had been included was extended to represent both Walk and Cycle.

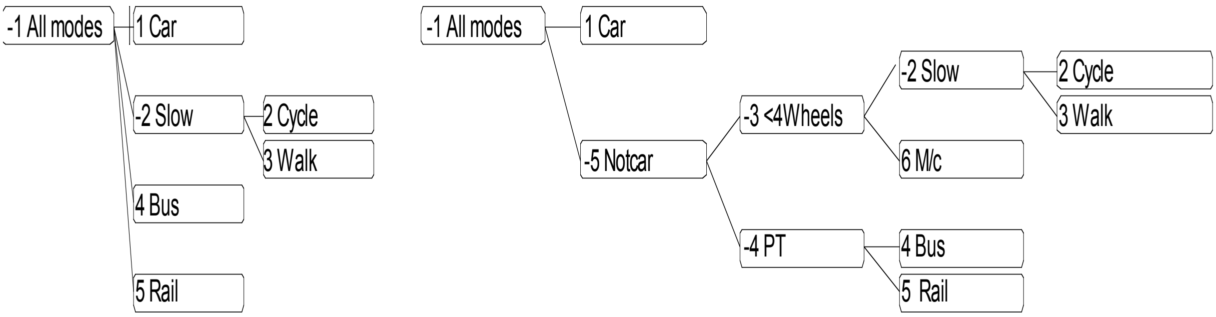


Figure 4.1: MENCAM modal hierarchies for original and motorcycle owner flows

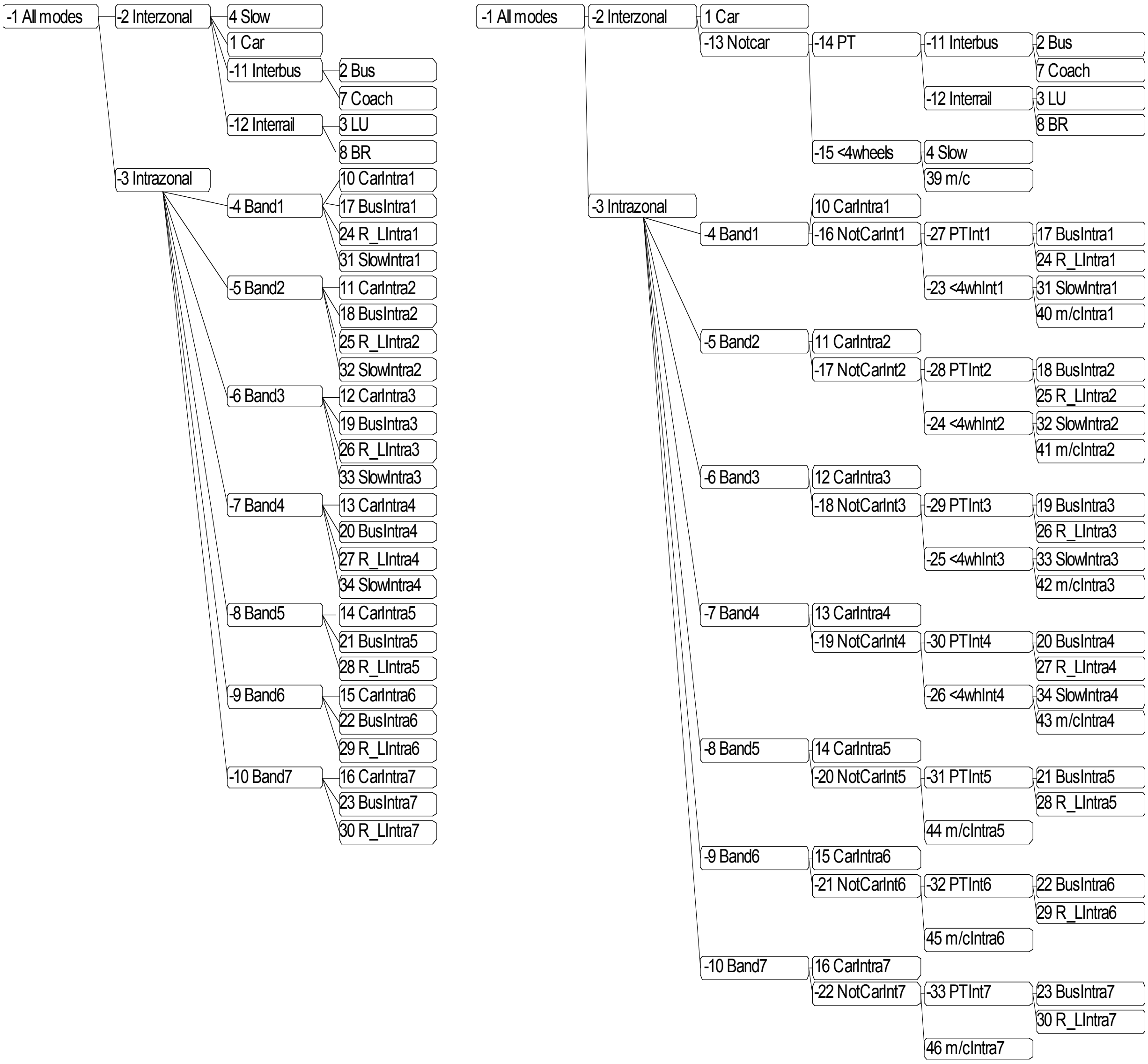


Figure 4.2: LASER modal hierarchies for original and motorcycle owner flows

Modal Disutilities for Motorcycle Owners

4.12 The original definitions of disutilities and the presentation of these disutilities to the mode split process was modified in various ways in order to conform to the Phase 1 mode choice model. A particular concern was that the Phase 1 model specifies the composite disutilities of a set of modes as

$$\Sigma_I \exp(-\theta D_i),$$

where $\exp(-\theta D_i)$ is proportional to the relative probability of choosing mode i, while MEPLAN uses

$$(1/\lambda) \Sigma_I \exp(-\lambda D_i)$$

where $\exp(-\lambda D_i)$ is proportional to the relative probability of choosing mode i. Thus the coefficients used to build up disutilities must be multiplied by the factor appropriate to the mode choice parameter for any given modal aggregation.

4.13 Also MEPLAN constructs the disutilities of a basic mode for a given flow by combining the information from three separately assembled functions of distance, cost and time. This feature conveniently enabled the assembly of the unusual disutility specified for the motorcycle mode, which has a negative time multiplier for the first 20 minutes of journey time. Table 4.4 and Table 4.5 show the multipliers of distance, cost and time used for fully car available flows in each of the two models. Parking costs associated with motorcycles were assumed to be zero.

Table 4.4; Contributions to Modal Disutilities in MENCAM

Mode	Values	Notes / Comments
Motorcycle First term	Min(0.272, 0.0136*time)	Max(0.544, 0.027*time) all mult by 0.5=theta3 to compensate for lambda
Motorcycle Second term	.0043531*distance +1.0*cost +-0.01035*time	DistVal (0.1893*10*0.74/100/1.609/2) TimeVal (-.544/2) CostVal still 1.0 to pick up link & cost function component
Motorcycle Third term	0.12975 +0.09465*terminal distance +0.0148*terminal time	Constant = -0.544/2 (Part 3 of time formulation) + 0.8035/2 (commute) + 1.9420/2 (educ) CostPar = 0.1893/2 in case of parking costs TimePar = walk time coeff = 0.0296/2
Car Second term	-0.01478*distance +0.0148*time	Price component to 1991 prices (*0.74) Dist coeff = 0.1893*16*0.74/100/1.609/1 - 0.0462/1.609/1 (commute) - 0.0895/1.609/1 (non-commute)
Car Third term	0.1893*terminal cost +0.0366*terminal distance	Distance coeff still 0.1893/1, Time for walk time = 0.0366/1
Bus Second term	0.151440*cost +0.00536*time	
Bus Third term	2.0 +0.151440*terminal cost +0.00536*terminal time	
Rail Second term	0.151440*cost +0.00536*time	
Rail Third term	0.1	
Walk Third term	3.0 +0.140*time	
Cycle Third term	0.100*time	

Table 4.5; Contributions to Modal Disutilities in LASER

Mode	Values	Notes / Comments
Motorcycle First term	Min(0.272, 0.0136*time)	Max(0.544, 0.027*time) all mult by 0.5=theta3 to compensate for lambda
Motorcycle Second term	.005118*distance +1.0*cost -0.01035*time	
Motorcycle Third term	-0.272 +0.09465*terminal distance +0.0148*terminal time	Parking walk time * 0.0296*0.5 MSC = -0.544*0.5 for all, +1.9420*0.5 for non-bus, non-commute
Car Second term	-0.01234*distance +0.0148*time	
Car Third term	-0.01234*terminal dist +0.0148*terminal time	Phase 1 car MSC, no multipliers needed. Parking costs and walk time *1 but change pence to £
Bus Second term	0.00151440*cost +0.00536*time	PT CostVal=0.1893*0.8/100, TimeVal=0.0067*0.8
Bus Third term	-2.0 +0.00151440*terminalcost +0.00536*terminal time	
Rail Second term	0.00151440*cost +0.00536*time	
Rail Third term	-2.0 +0.00151440*terminalcost +0.00536*terminal time	
Slow Second	0.024674*dist	
Slow Third term	-0.08555 +0.024674*dist	

Validation of motorcycle trips modelled

4.14 Having implemented in the MENCAM and LASER models both the motorcycle ownership models as described in Section 3 and the usage models described in the preceding sections of this chapter, some validation of the results obtained was undertaken.

4.15 As described previously the levels of ownership were controlled for the modelled area to the levels derived in Phase 1 based on data from the 2001 Census, the Vehicle Information Database, the National Travel Survey (NTS) and the Family Expenditure survey (FES). The numbers of motorcycle trips were then estimated with the usage model. The first check undertaken was a comparison the mode split of the trips (owners and non-owners) compared with the original model to check how the new mode choice models for owners affected the overall results. This process highlighted the differences between the application models and the statistical models developed in Phase 1. The main differences occurred due to the inclusion of short trips in the application models – a large number of which are made on foot. As already noted the walk mode was not included in the usage models developed since it is not considered a viable alternative to motorcycle journeys. To improve the mode split in the base year some adjustments were made to the mode specific constants derived from the Phase 1 work, the models rerun and the comparisons repeated.

4.16 For the MENCAM model this process was repeated a number of times and reasonable results obtained as shown in Table 4.6. Here it can be seen that approximately half the trips by owners use motorcycles, taking trips from all other modes, particularly car and bicycle. Overall trips the enhanced model includes slightly more car journeys and fewer cycle and walk trips than the original model.

Table 4.6 : Mode split in MENCAM model before and after introduction of motorcycles

Mode	Original Model	Enhanced model with motorcycles		
		Non Owner	MC owner	All
Car	61%	63%	35%	62%
Cycle	14%	11%	1%	11%
Walk	9%	8%	4%	8%
Bus	15%	16%	6%	15%
Rail	2%	3%	3%	3%
M/C		0%	52%	2%
Total	100%	100%	100%	100%

4.17 Introducing the ownership and usage models into MENCAM has altered the modelled behaviour slightly, altering the numbers of trips on each mode. However the impacts are small and it was considered that the improvements made will not have undermined the original model calibration. Comparing counts of motorcycle trips on links entering Cambridge and crossing the River Cam screenline, suggested the MENCAM model was predicting higher motorcycle usage than observed (around 3% of motorised movements rather than 1% to 2%).. However the count data available was for a 12 hour period while the model focuses on the AM peak and it is not unreasonable to expect the largest proportion of motorcycle trips to take place in the peak when congestion is at its worst.

4.18 For the LASER model, the separate structure for the intrazonal trips complicated the process and it was more difficult to adjust the constants to improve the mode split without significantly affecting the usage models derived in Phase 1. Table 4.7 shows the overall mode split of trips in the original LASER model and then in the enhanced model for the non owners and owners as well as overall trips. The mode choice model for the non-owners (the majority) is unchanged so the results would be expected to be virtually the same.

Table 4.7: Mode split in LASER model before and after introduction of motorcycles

Mode	Original model	Enhanced model with motorcycles		
		Non M/C owners	M/C owners	All trips
Car / Taxi	54%	54%	24%	53%
Bus	7%	7%	21%	7%
LU / Rail	7%	6%	24%	7%
Slow	32%	32%	12%	32%
M/C		0%	19%	1%
All modes	100%	100%	100%	100%

4.19 As can be seen from the table, the modal split for the motorcycle owners appears to have been changed radically from the original mode choice model in LASER. While the distinction of motorcycles would inevitably lead to a reduction in car and possibly cycle trips, it would not be expected to lead to such significant changes in the likelihood of using public transport.

4.20 Since only a small proportion of the journeys are by motorcycle owners the overall mode split of trips within the model is not significantly altered as shown in Figure 4.3 with the enhanced model results shown in the left hand column of each pair and the original model results shown in the right hand column. Here it can again be seen that the most noticeable changes between the pairs of the columns is the change in propensity to use rail or London Underground – even once adjustments have been made to the mode specific constants.

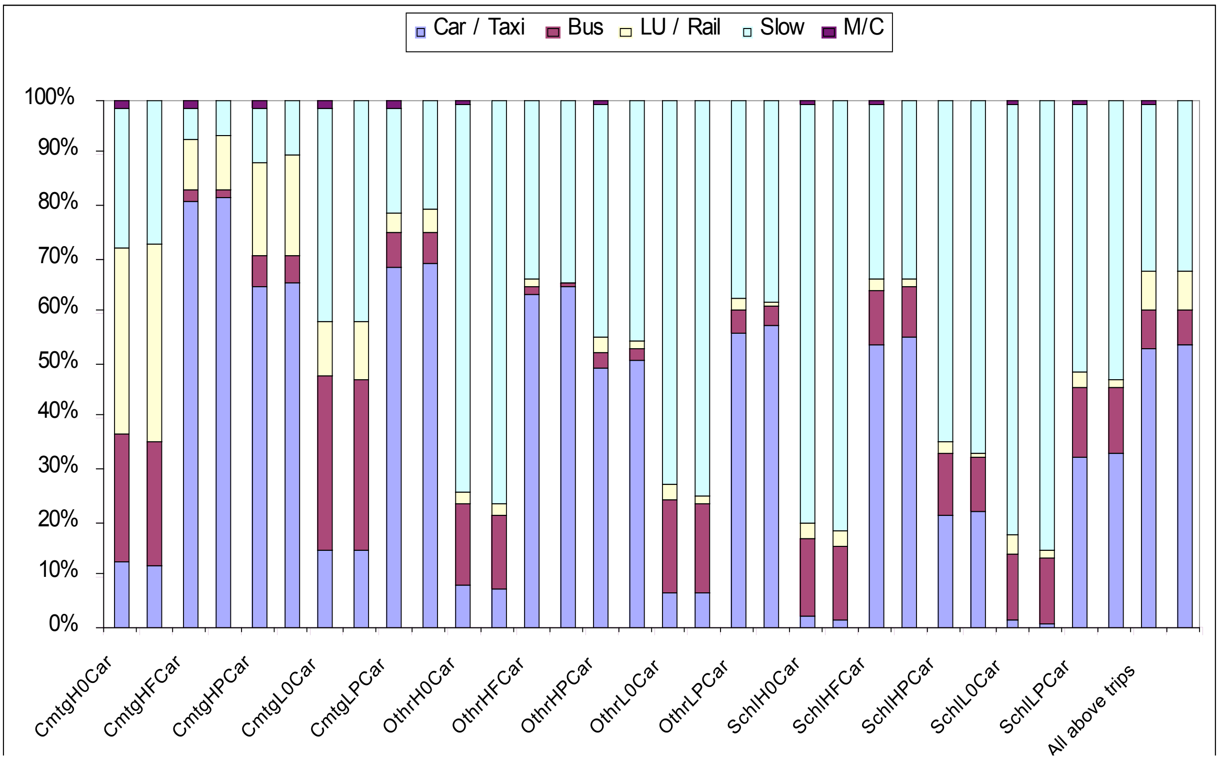


Figure 4.3: Mode split of trips in LASER before and after introduction of motorcycles

4.21 For the journeys to work some comparisons were possible against the 2001 Census journey to work data. The 2001 Census provides the number of people who usually use motorcycle to their usual place of work. At any one time there may be more or less motorcycle commuting journeys as people are away from their normal workplace or use an alternative mode.

4.22 Figure 4.4 and Figure 4.5 compare the MENCAM and LASER models respectively against 2001 Census journey to work data. The Cambridge model slightly underestimates the number of motorcycle journeys overall with some zonal estimates high and others low. The LASER model underestimates the number of motorcycle journeys in significantly more zones than it over estimates them. The LASER model application is for 1997 with the results being compared with the 2001 Census. The growth in motorcycle trips from 1991 to 2001 in the Census in London is far greater than in other parts of the country. LASER would therefore be expected to produce low estimates of motorcycle journeys to work compared with the 2001 Census. The figure for LASER is in two parts the first showing all zones which enables the zones with many motorcycle trips to be seen clearly. The second focuses the lower quadrant of the first chart showing those zones with fewer motorcycle trip origins.

4.23 The validation undertaken suggests that the level of motorcycle usage predicted by the models is reasonably in line with the results from the 2001 Census. In the LASER model however the results for the other modes of travel have altered significantly from the original model. Without further work it is not clear whether these effects are reasonable for the motorcycle owners. While further improvements could be made to the implementation of the motorcycle usage model within LASER, the process is complicated by the detailed segmentation used in the original calibration of the model. Taking the implementation further to understand and potentially improve the mode choice models for the motorcycle owners was beyond the scope of this study.

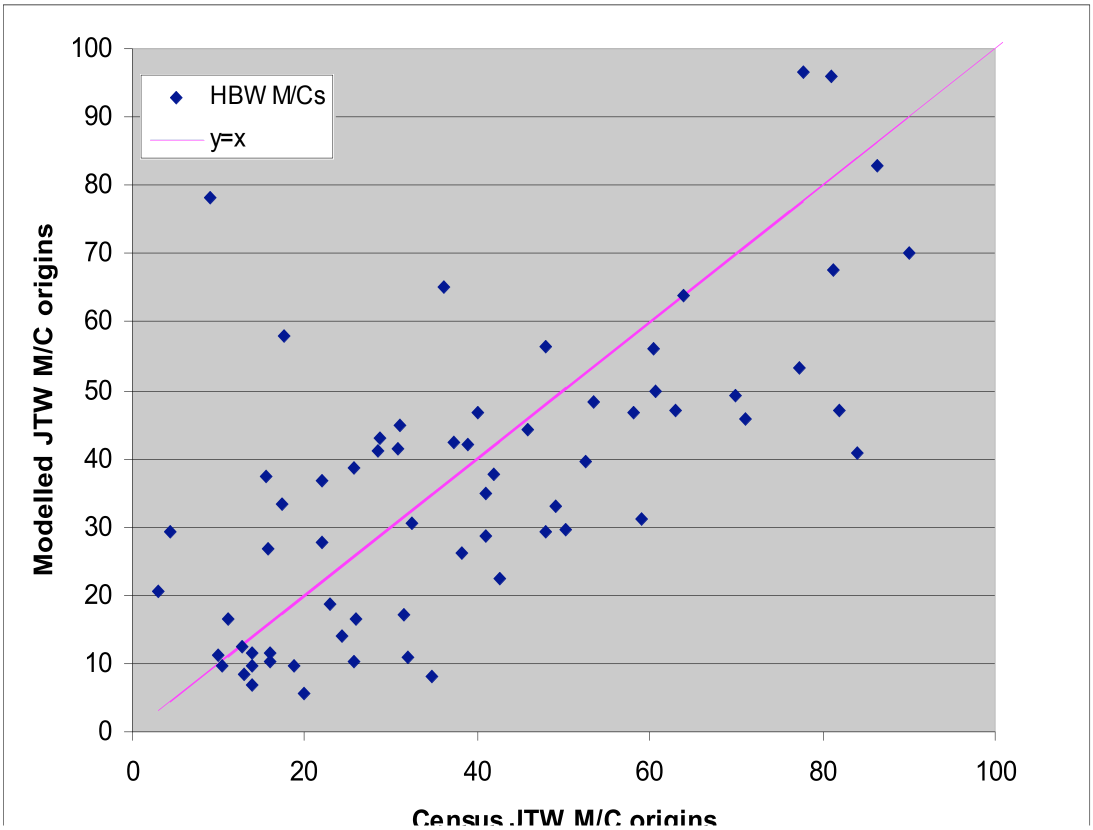


Figure 4.4: Comparison of 2001 Census and MENCAM model journeys to work by Motorcycle

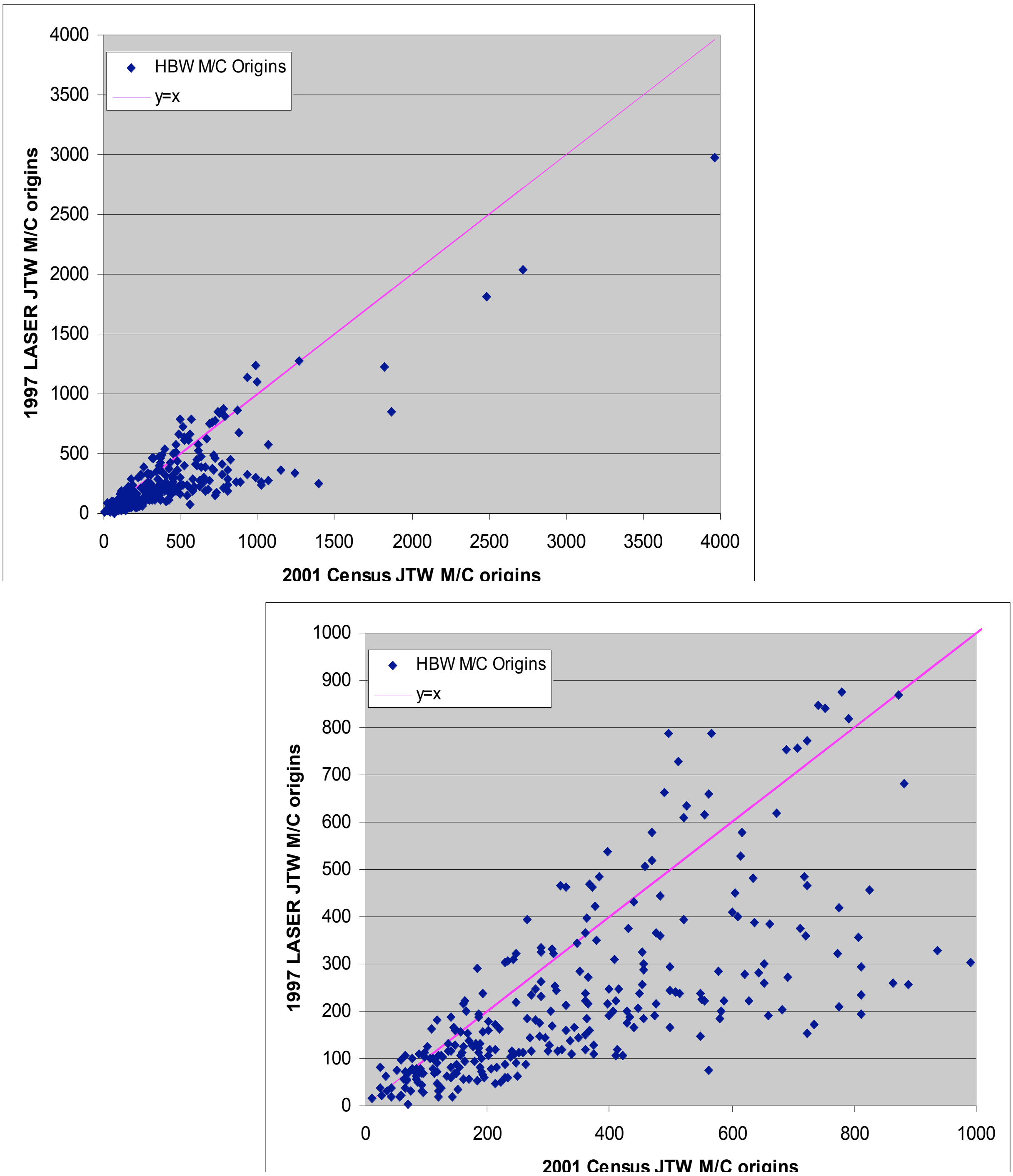


Figure 4.5: Comparison of 2001 Census and 1997 LASER model journeys to work by Motorcycle

5 THE REPRESENTATIVENESS OF THE STUDY AREAS OF THE MODELS

5.1 The reason why two models were selected to explore the impacts of initiatives related to motorcycling was to provide an understanding of how such findings might be generalised to the country as a whole. For this reason it is important to understand the ways in which each of the two study areas match to or differ from other parts of the country. As part of this analysis many other aspects of the incidence of motorcycle usage within the employed population were also analysed and are summarised below.

5.2 Some analyses were carried out with the Sample of Anonymised Records (SAR) from the 1991 Census in order to examine the characteristics of those who do and do not use motorcycles. The SAR gives access to data on individuals and this is what allows the characteristics of those who commute by motorcycle to be distinguished from the population as a whole. The standard aggregate tables that are published for the Census do not facilitate this distinction, which is why the analysis presented below was carried out for 1991 data rather than 2001 data. The SAR for 2001 is not available yet to users. The SAR was used to relate information on journeys to work by motorcycle to various household and individual characteristics – in addition to some information on the journey to work itself. The usual caveat applies, that the Census only provides: usual mode of transport to work, main location of residence, and usual workplace address. The Census does ask households whether they own cars or vans but not whether they own motorcycles. Consequently, the analysis presented below is based on those who use motorcycle as their usual method of travel to work. These persons will be a subset, rather than the totality, of those who own motorcycles.

5.3 There are 2 SAR datasets: the Individual SAR and the Household SAR. Contrary to their names they both contain many variables pertaining to both individuals and households. The level of spatial detail is however much greater in the Individual SAR than in the Household SAR. The Individual SAR enables analysis by residence zone at district level while the Household SAR only provides a breakdown to the Region level. The Individual SAR was therefore the preferred SAR for use in this study. In some aspects, the SAR was too sparse in coverage or contained insufficient information to be of use (for example, the suppression of workplace locations in the SAR was a significant problem which prevented the comparison of work and home ends of the journey to work). Therefore, in such instances, it was more beneficial to use instead the Special Workplace Statistics which represent a 10% sample of the 1991 Census data.

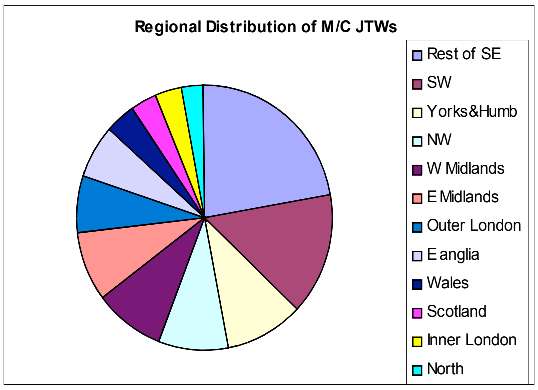
5.4 The SAR data was used to examine questions such as:

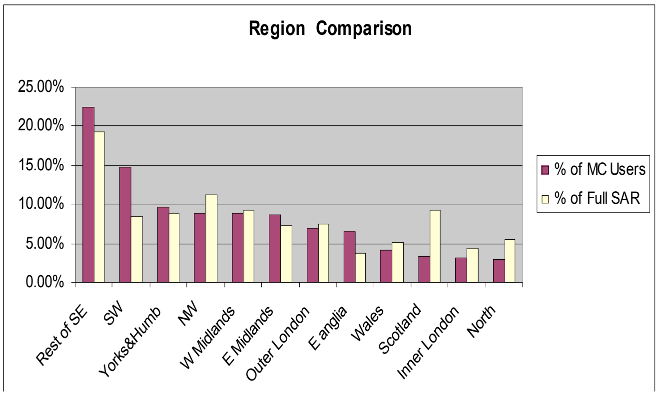
- Does the propensity to commute by motorcycle vary by location (eg as a % of journey to work totals does it vary significantly between regions). Some care was required here as the numbers of motorcycle trips can be small (about 1% of all journeys to work).
- How does the profile of motorcycle commuting vary by age and sex across the country – eg North v South and urban areas of different sizes v more rural areas.
- Are motorcycle users more likely to belong to particular types of households in terms of: car ownership or the socio-economic group of the individual?
- Do London and Cambridge (the two areas being used as pilot models to test a range of policies) represent a reasonable cross-section of the country?

5.5 Firstly the population was split between those who do and those who do not use motorcycle to travel to work. Then the characteristics of these two classes, as well as of the households in which they reside, were contrasted for various characteristics. This comparison served to highlight patterns within the motorcycle commuters class which deviate from the typical national trends. The main findings observed from analysis of the 1991 Census SAR and Special Workplace Statistics data regarding motorcycling for journeys to work are now discussed, based on pie charts and bar chart comparisons for individuals commuting by motorcycle relative to the full SAR samples for Great Britain.

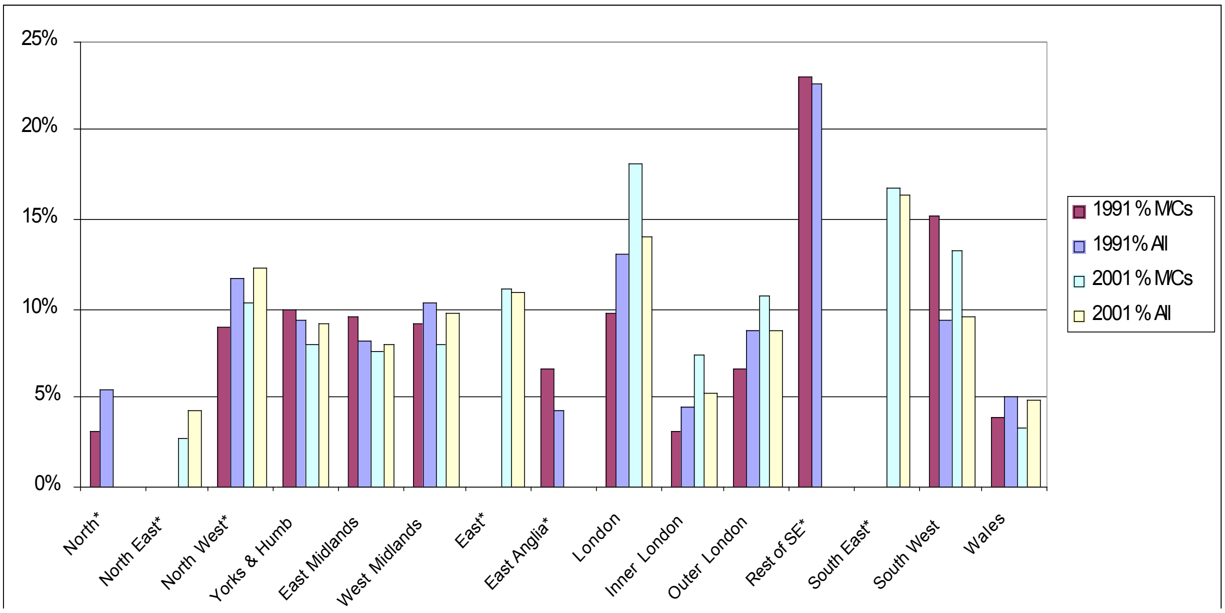
i) Regional Distribution:

5.6 The majority of individuals using motorcycle for journeys to work reside in the rest of the South East (23%) or the South West (15%). This proportion is slightly higher than the percentages of total journeys to work by employed individuals in these areas according to the full SAR. Similarly, percentages for E. Midlands and E. Anglia are also somewhat higher. On the other hand, however, percentages of journeys to work on motorcycle for the North West, Outer London, Wales and Scotland are lower than the national percentages. Values for other regions show a close match between motorcycle and overall journeys to work.





5.7 Once the 2001 Census information on usual mode for journey to work was available a check was made of the pattern of motorcycle trips by Region and compared with the earlier results from the 1991 Census journey to work data.



5.8 The definition of some Regions has changed (most notably the South East and the North / North East). From the chart above it can be seen that the South East and the South West remain important in terms of the number of motorcycle trips. However, London has grown significantly in importance over the last decade and now accounts for 18% of motorcycle journeys to work. In the south of the country the proportion of motorcycling is greater than the proportion of all trips.

ii) Gender:

5.9 The vast majority of motorcycle journeys to work are undertaken by men. Men account for 83% of the total whilst only 17% of journeys to work on motorcycle are by females. This is an entirely different picture from the gender trends evident in the full SAR for employed individuals - the total working population is 56% male and 44% female. There are some regional variations about this trend. Motorcycle journeys to work in East Anglia are more likely to be by females than in any other Region, while Outer London has the lowest representation of female motorcyclists in the country.

Table 5.1: Variation in split of journeys to work by males and females by Region

	Male:Female split of M/C trips			% of GB M/C trips	
Region	**Males**	**Females**		**Males**	**Females**
North	85%	15%		3%	2%
Yorkshire &Humberside	80%	20%		9%	11%
E Midlands	82%	18%		9%	9%
E anglia	78%	22%		6%	8%
Inner London	90%	10%		3%	2%
Outer London	91%	9%		8%	3%
Rest of SE	81%	19%		22%	25%
SW	80%	20%		14%	17%
W Midlands	83%	17%		9%	8%
NW	86%	14%		9%	7%
Wales	87%	13%		4%	3%
Scotland	81%	19%		3%	4%
Great Britain	**83%**	**17%**		**100%**	**100%**

Suitability of Cambridge and the wider South East plus London as test beds for modelling

5.10 We now use the SAR from the 1991 Census to examine how closely the characteristics of motorcycle commuters that are resident within Cambridgeshire and within London match those of the motorcycle commuters of Great Britain as a whole.

i) Age profile

5.11 For Great Britain as a whole, the blue and maroon bars in Figure 5.1 contrast the proportion within the different age groups of all those employed versus those commuting by motorcycle. This shows that employees in the 16 to 35 year age groups are more likely than average to be motorcyclists, whereas those in older age groups are less likely than average to be motorcycle commuters.

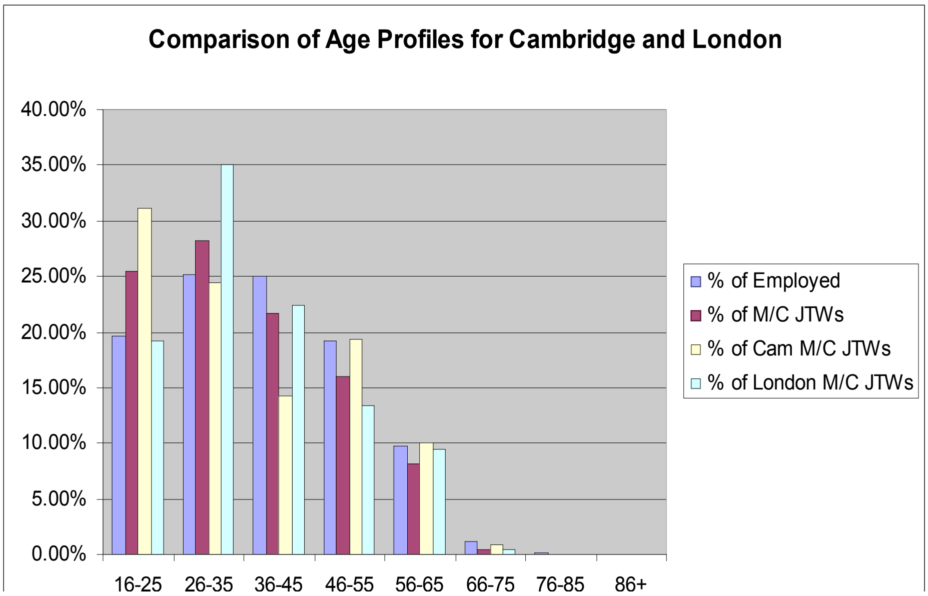


Figure 5.1: Proportion by age group of all employed and of motorcycle commuters (1991 Census of Great Britain)

5.12 The age profiles of motorcycle commuters who are resident in Cambridge and in London tend to oppose each other – when one is higher than the GB proportion, the other tends to be lower, and vice-versa. Neither sample offers a close match to the GB sample of motorcycle commuters except in the older age ranges, where all of the samples are quite similar to each other.

5.13 In Cambridge, the majority of motorcyclists are in the age ranges 16-25 or 26-35. Also the 46-55 age group shows a relatively higher representation in Cambridge than is found in the GB sample. The age group 36-45 is under represented in Cambridge it contains only 14% as compared to 22% of the GB motorcycle commuters. In contrast, the London sample has 10% less than the GB sample for ages 16-25, and 10% more than the GB sample for the range 26-35 years of age.

ii) Socio-economic profile

5.14 For those in employment in GB as a whole, the blue and maroon bars of Figure 5.2 show that motorcycle commuters are proportionally more heavily represented within the skilled manual (SEG3) and semi- and unskilled manual (SEG4) socio-economic groups, than in the managerial/professionals (SEG1) and the other non-manuals (SEG2) groups. When compared with employed personnel, motorcycling for commuting purposes is relatively popular amongst manual workers (skilled, semi-skilled, foremen and supervisors), agricultural workers and members of the armed forces. It is comparatively unpopular among junior non-manual workers (who are mainly female), managers/employers and ancillary staff/artists.

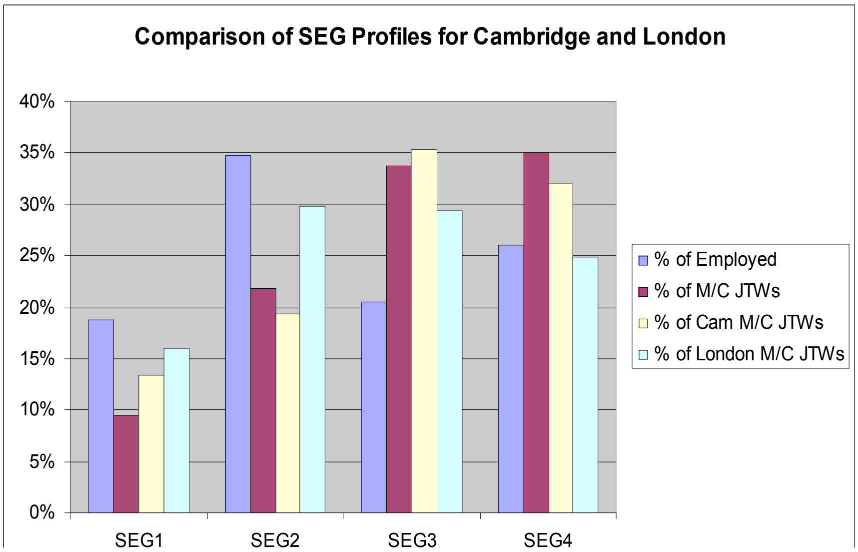
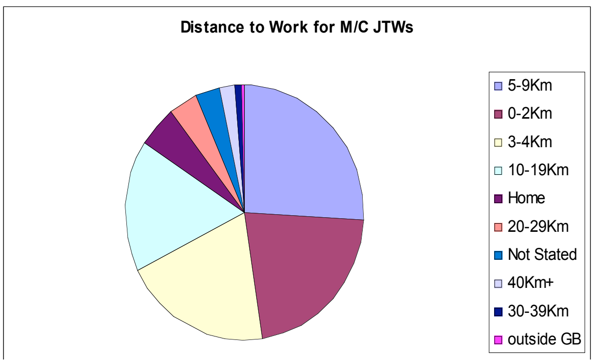


Figure 5.2: Proportion by socio-economic group of all employed and of motorcycle commuters (1991 Census of Great Britain)

5.15 The SEG profile of motorcycle commuters in Cambridge is reasonably close to that of the full GB sample of motorcycle commuters. The sample for London has a higher proportion of motorcycle commuters than the GB sample for managerial/professionals (SEG1) and for other non-manuals (SEG2) and is somewhat lower for SEG 3 and 4. Much of this differentiation will be due to the fact that within this area the overall incidence of SEG1 and SEG2 residents is proportionally much higher than for GB as a whole.

iii) Journey to work distance

5.16 The propensity to use motorcycles is highest amongst those individuals working within the same district as that in which they live, as shown in Figure 5.3. More than 80% work within 20km crowfly distance from their home. The greatest proportion (26%) occurs in the 5-9km range which Figure 5.4 demonstrates is significantly higher than the percentage of the total journeys to work that lie in this range (19%). The proportion of journeys to work by motorcycle is also above average for 3-4km and to a lesser extent for 10-19km journeys. Figure 5.4 shows that it is the longest journeys that are least likely to use motorcycle.



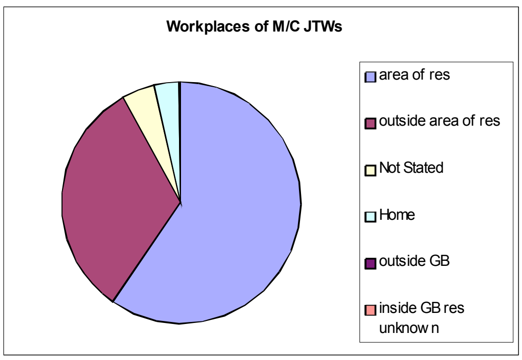


Figure 5.3: Proportion by distance and within district of residence of motorcycle commuters (1991 Census of Great Britain)

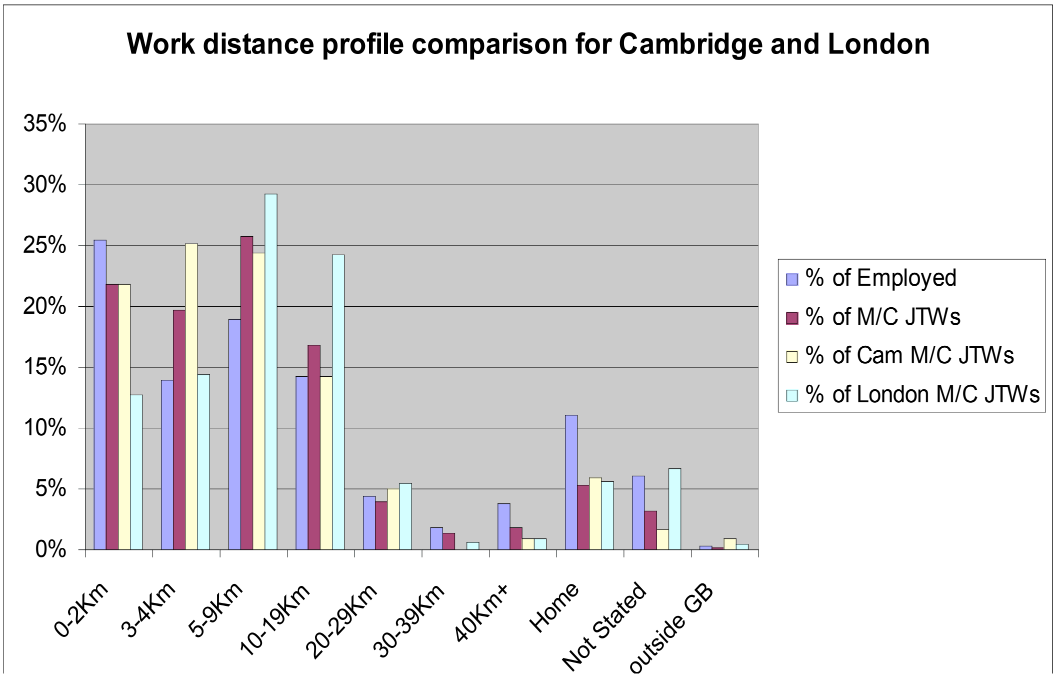


Figure 5.4: Proportion by journey length of all employed and of motorcycle commuters (1991 Census of Great Britain)

5.17 Work distances in the Cambridge sample are broadly similar to those of the GB sample, except for a significantly higher number in the 3-4km distance band than the national sample, and lower frequencies in the highest distance bands.

5.18 London on the other hand, shows a rather different pattern to the GB profile, with lower frequencies in the shortest and longest distance bands, and higher proportions than the national sample for middle distance bands 5-29km.

5.19 However, it is likely that in this case, the data may not show the complete picture since the SAR samples are taken at the home end and so only include people who actually live in London and Cambridgeshire. In both of these areas, there is significant competition for housing and many of the people who work in the area tend to travel longer than average commuting distances from areas outside the Census wards included in these samples.

iv) Working hours

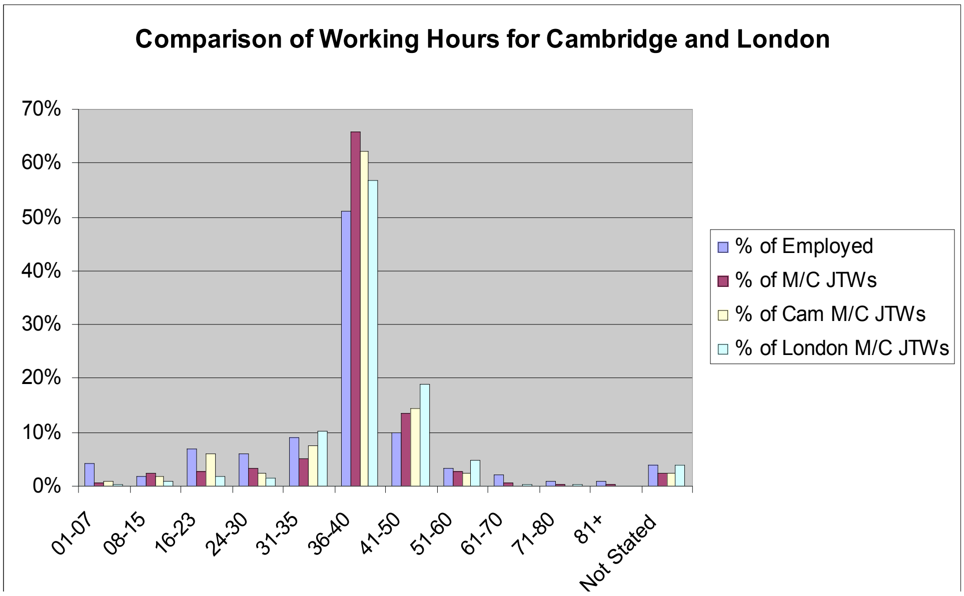


Figure 5.5: Proportion by hours worked of motorcycle commuters (1991 Census of Great Britain)

5.20 For those in employment in GB as a whole, the blue and maroon bars of Figure 5.5 show that in 1991 the motorcycle commuters predominantly worked 38 hours or more– fewer of them than the national average are part-time workers.

5.21 The typical working hours for motorcyclists in Cambridge reflect those evident in the GB sample, though in London, motorcyclists work marginally longer hours than the national sample suggests.

v) Car availability and household composition

5.22 For those in employment within GB as a whole, the blue and maroon bars of Figure 5.6 show that motorcycle commuters are proportionally more heavily represented within the no car and the one car household categories than in households with two or more cars. It can be seen by adding the third and fourth blue bars together that for GB employees as a whole in 1991, the number of households with two or more cars was only a little below the number with one car. However, Figure 5.7 shows that households with motorcycles are much less likely to be from households with two or more cars. This suggests that the majority of motorcyclists live in households with one car, and in these situations motorcycles may be a substitute for a second or third car.

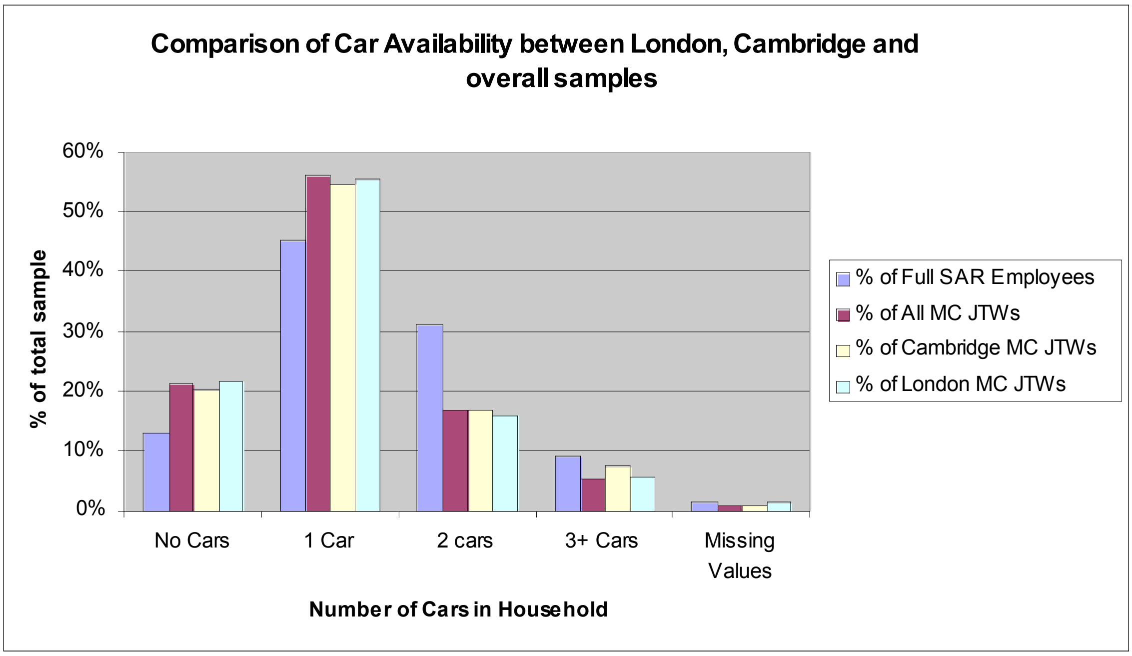


Figure 5.6: Proportion by car ownership of motorcycle commuters (1991 Census of Great Britain)

5.23 For motorcycle commuters the car ownership figures for both London and Cambridge match closely to the GB pattern. This is further confirmed in Figure 5.7 which subdivides the households of motorcycle commuters by combinations of the number of cars and number of adults.

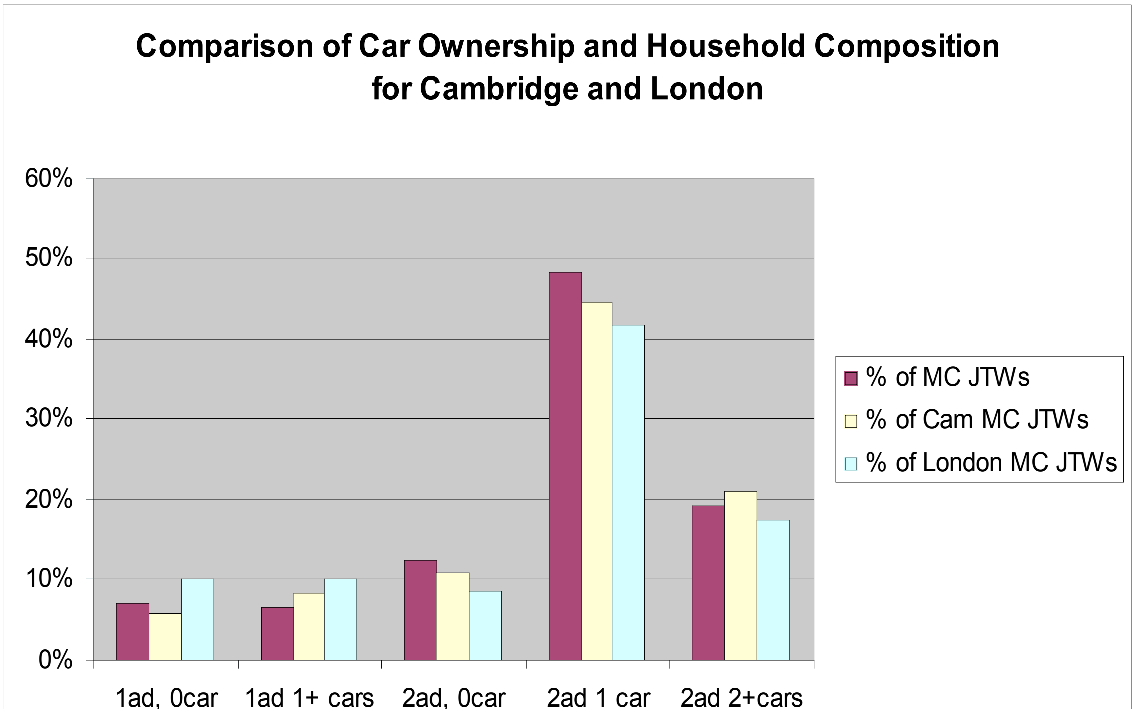


Figure 5.7: Proportion by car ownership and household composition of motorcycle commuters (1991 Census of Great Britain)

5.24 Table 5.2 shows the distinct relationship between household composition and car availability, in that 52% of motorcycle commuters from 1-adult households have no car, whilst only 15% of motorcycle commuters in 2-adult households have no car.

Table 5.2: Proportion of motorcycle commuters by household size and car ownership (1991 SAR for Great Britain)

CARS	% of 1 adultHH	% of 2 adult HH	% of total
0	52%	15%	21%
1	38%	61%	57%
2	8%	18%	17%
3	2%	6%	5%
Number of Households	957	5544	6501
% in adult categories	15%	85%	

Spatial distribution of motorcycle journeys to work

5.25 Figure 5.8 presents the spatial distribution of motorcycle journeys to work for England and Wales. These are based on ward totals from the Special Workplace Statistics tables from the 1991 Census. It contains four maps – the first two are the total motorcycle journeys to work segmented by gender in which the home end totals for each sex have been added to the corresponding work end totals. Although, under normal circumstances this is not a very logical concept; in the case of motorcycle commuting, it is a useful indicator for identifying hotspots, given that the sample sizes are very small and that the journeys to work tend to be confined to neighbouring wards. The second pair of maps aggregate the motorcycle journeys to work for male and female riders by trip end – the bottom left map shows the male and female total at the home end and the bottom right map shows the totals at the work end.

5.26 The following spatial patterns are evident from the maps in Figure 5.8 for the pattern of motorcycle commuting in 1991:

i) Urban Areas

In terms of absolute ward totals, the main hotspots for motorcycle commuting appear to coincide with predominantly urban areas and industrial heartlands such as Yorkshire and Humberside, Nottingham and Derby. The concentrations are less pronounced around London than most other urban areas.

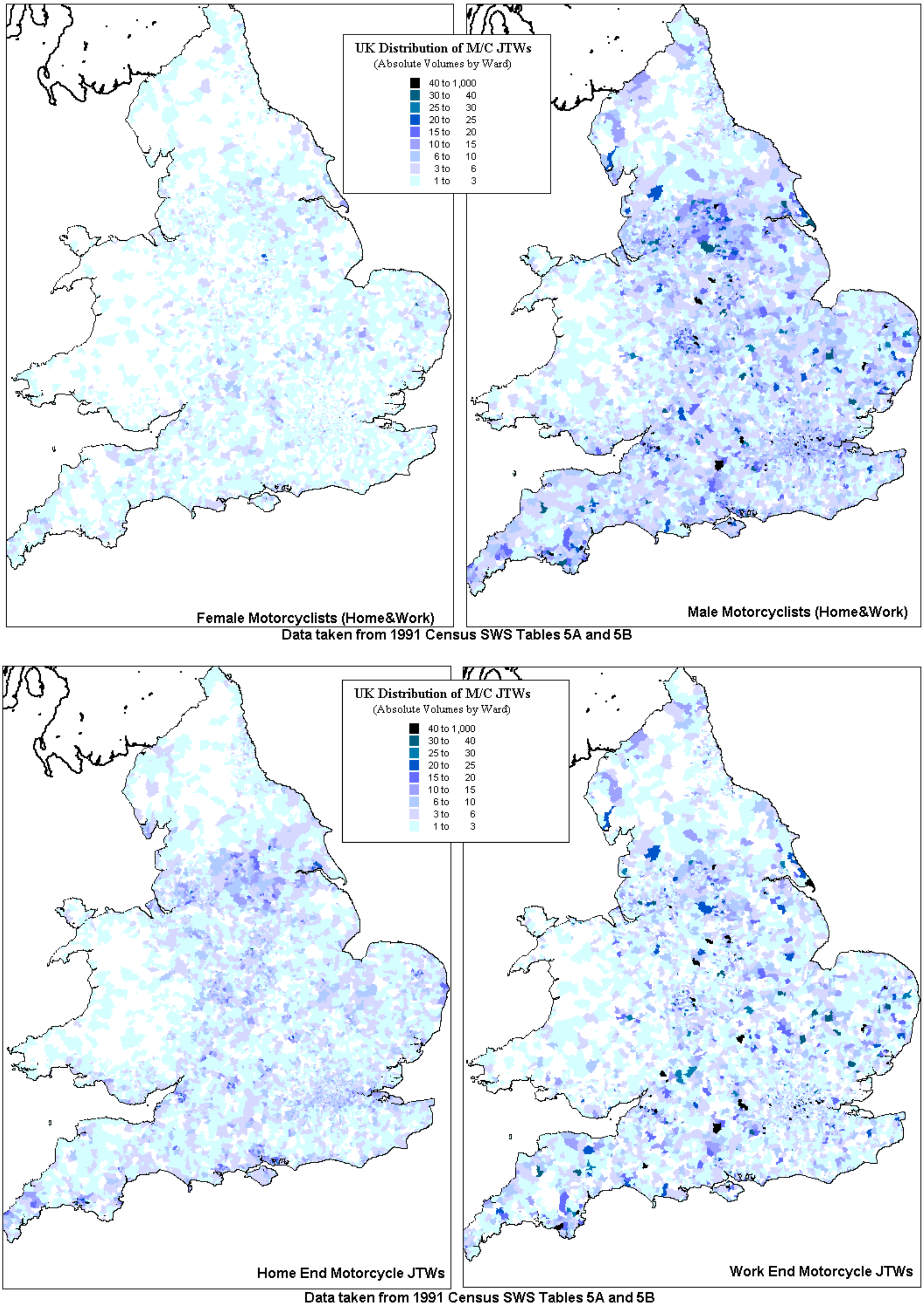


Figure 5.8: Pattern of motorcycle commuting (1991 Census – Special Workplace Statistics)

ii) Coastal Areas

Another evident pattern is the tendency for motorcycle hotspots to occur in coastal locations, especially around the major sea ports and along coasts with popular tourism resorts such as the east coast from Whitby to Spurn Head Point, the north Norfolk coast around Great Yarmouth, the south coast from Eastbourne to Cornwall and the Blackpool area.

iii) Inland Tourism Attractions

Other inland tourism areas also seem to attract motorcycling commuting– for example many of the national parks in England and Wales show high frequencies and attractions such as Stonehenge and Alton Towers have hotspots associated.

Summary of findings

5.27 The outputs from the analyses have been used to answer the questions at the start of this Section on the major factors affecting an individual's propensity to use motorcycle as the main mode for commuting:

I. Does the propensity to commute by motorcycle vary by location

The map-based analysis of the Census sample indicated that there is a higher tendency for motorcycle commuting in urban areas which indicates that the propensity to choose this mode is higher in congested areas. Coastal and inland tourism hotspots are also evident which suggests areas attracting many recreation trips may also be areas attractive to motorcycles for both commuting and recreation.

II. Does the profile of motorcycle commuting vary by age and sex across the country?

The analyses demonstrated that the motorcycling population is overwhelmingly male (males account for 82% of the total commuting by motorbike) and in general, there is a higher propensity to use motorbike amongst the younger generations with the highest numbers of motorcyclists in the age ranges 16-36. Some variations were observed across the country with females being more likely to use motorcycles in East Anglia and much less like to use them in Inner London.

III. Are motorcycle users more likely to belong to particular structure households in terms of: car ownership or the socio-economic group of the individual?

The most significant observations from the analysis of the household attributes of individuals commuting by motorcycle showed that motorcyclists are most likely to belong to 2 adult households with at least one car. The SEG patterns observed indicated that motorcyclists were likely to be in SEG 3 or SEG 4 in the majority of cases. However, the data from London and Cambridge does suggest that there is a higher tendency for professionals to adopt motorcycling in congested areas.

IV. *Do London and Cambridge (the two areas being used as pilot models to test a range of policies) represent a reasonable cross-section of the country?*

The evaluation of the London and Cambridge SAR samples for motorcycling commuting showed that although neither of these two areas are fully representative of Great Britain, there is significant variation between the two in terms of the characteristics of motorcyclists in each location. This offers a good basis upon which to build two pilot models.

6 REFERENCES

ESRC Census Microdata Unit (1996) *Codebook and Glossary for the Derived Variables From the Samples of Anonymised Records: 1% Household File and 2% Individual File (Version 3.0) SARs Version3, April 1996*. Faculty of Economic and Social Studies, University of Manchester on behalf of ESRC Economic and Social Research Council

ME&P (2002). LASER Enhancement Project: Final Report, prepared for Contract No. PPAD 9/65/71 for ITEA, DfT.

http://www.dft.gov.uk/stellent/groups/dft_transstrat/documents/page/dft_transstrat_023836.hcsp

WSP and Rand Europe (2004). *Motorcycles and Congestion: The Effect of Modal Shift, Phase 1 report.*

WSP Group

APPENDIX A

FURTHER ANALYSIS

This Appendix analyses further tabulations from the 1991 SAR of the characteristics of motorcycle commuters, in order to provide greater detail on topics that have been outlined previously in Section 5.

i) Age v gender

Male motorcyclists are most likely to be in the age range 26-35years (30%), however, female motorcycle commuters are more likely to be in the age range 16-25 (29%) or 46-55 (22%).

Table 6.1: Proportion of motorcycle commuters by age and gender

	SEX					
Agegp	M	F	Grand Total	% of M	% of F	% of Total
16-25	1420	345	1765	25%	29%	25%
26-35	1718	242	1960	30%	20%	28%
36-45	1255	248	1503	22%	21%	22%
46-55	847	261	1108	15%	22%	16%
56-65	455	109	564	8%	9%	8%
66-75	29	2	31	1%	0%	0%
76-85	2		2	0%	0%	0%
86+		1	1	0%	0%	0%
Number of MC Users	5726	1208	6934			
% in gender group	83%	17%				

ii) Journey to work distance v car availability

6.1 In the earlier Figure 5.4 the most common work distance for motorcycle commuters was shown to be in the range 5-9km. When patterns of motorcycle commuting are further broken down by car availability, 5-9km remains the most popular for those from car owning households but 0-2km is the most popular journey length amongst non-car owners who travel shorter journeys in general. This may be because the non-car owning households that contain employees are particularly concentrated in the denser inner city areas in which adjacent jobs will be plentiful.

Table 6.2: Proportion of motorcycle commuters by household car ownership by journey distance

Workdist	% of No Car HH	% of 1 Car HH	% of 2 CarHH	% of 3+ Car HH	% of Total
Home	5%	5%	5%	6%	5%
0-2Km	27%	21%	20%	17%	22%
3-4Km	22%	19%	19%	17%	20%
5-9Km	24%	26%	26%	27%	26%
10-19Km	14%	18%	17%	17%	17%
20-29Km	2%	4%	5%	7%	4%
30-39Km	1%	1%	2%	3%	1%
40Km+	2%	2%	2%	2%	2%
Not Stated	4%	3%	3%	4%	3%
outside GB	0%	0%	0%	0%	0%
Number of MC Users	1468	3874	1172	367	6934
% in each Car Ownership Group	21%	56%	17%	5%	

iii) Work distance v socio-economic group

6.2 Table 6.3 shows that the distance patterns for motorcycle commuters presented in Figure 5.4 hold true for in SEG1-3. However, semi- and unskilled manual workers (SEG4) have a different distribution across the distance to work ranges - the highest percentage (26%) work 0-2km from home. There is also a much lower percentage of this SEG group working more than 10km from home, indeed 10% appear to work at home, which is a significantly higher proportion than in any of the other SEG groups. This may be due to the inclusion of farm workers and armed forces personnel in the SEG4 category.

Table 6.3: Proportion of motorcycle commuters by socio economic group and journey distance

Workdist	% of SEG1	% of SEG2	% of SEG3	% of SEG4	% of Total
0-2Km	17%	19%	20%	26%	22%
3-4Km	15%	19%	20%	21%	20%
5-9Km	25%	27%	27%	24%	26%
10-19Km	22%	20%	18%	12%	17%
20-29Km	7%	6%	3%	2%	4%
30-39Km	2%	2%	1%	1%	1%
40Km+	6%	2%	1%	1%	2%
Home	4%	3%	3%	10%	5%
Not Stated	2%	2%	6%	2%	3%
outside GB	0%	0%	0%	0%	0%
Number of MC Users	651	1511	2344	2428	6934
% in each SEG Group	9%	22%	34%	35%	