UNDERSTANDING HOW HOUSEHOLD CAR OWNERSHIP CHANGES OVER TIME

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ABSTRACT

The PhD study presented in this thesis sets out to address the question: How and why does household car ownership change over time? This question is justified on the basis that the study of car ownership has traditionally been dominated by *cross-sectional*, *quantitative* analyses. It is argued that complementary *qualitative*, *longitudinal* methods have the potential to generate explanatory insights into the underlying process through which household car ownership states arise and change over time.

Accordingly, the study employed a novel flexible two stage research design. Stage one involved 15 in-depth retrospective biographical interviews with members of zero, one and two car owning households. An inductive thematic analysis led to the development of a new dynamic framework for understanding the general process of household car ownership change. Car ownership changes are triggered by *life events* which alter roles/relationships, spatial contexts and lifestyle preferences. Life events lead to *travel behaviour adaptation* and *consideration* of whether the current car ownership state is satisfactory. This can create a latent *propensity to change car ownership* state. Given the 'costs' and effort involved in taking action, households tend to *resist* changes to their car ownership state. In some cases, action may be prompted by another external *stimulus* such as the receipt of a maintenance bill, or the opportunity to acquire a car from a trusted friend or family member.

The dynamic framework was tested in a neighbourhood survey involving a self-completion questionnaire and follow-up telephone call to establish a wider set of accounts of car ownership *level* changes. The life event driven nature of car ownership level changes is confirmed and it is found that car ownership level changes are also strongly dependent on life stage. Younger households have a tendency to *increas*e car ownership level from zero to one or more cars as they move towards middle age. Vehicle relinquishments are more likely to occur in older age following retirement in association with health and income constraints. Over 70 percent of car ownership level changes recorded by the survey were associated with either a change in working circumstances, cohabitation, an adult joining or leaving the household, residential relocation, child birth or offspring reaching driving age. The thesis provides specific insights into the circumstances when such events are associated with a change in car ownership level.

The findings of the study support the proposition that transport policies and interventions concerned with changing the number and type of vehicles owned should consider life events as significant opportunities for change.

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Chapter 1: Introduction

This thesis presents a study addressing how and why household car ownership changes over time.

1.1 Why embark on a study of household car ownership?

While acknowledging the many benefits of the car to society, in recent years there has been a policy emphasis on encouraging behaviour change away from low occupancy car use. At the time of the study's inception (October 2007) a consultation document on future transport strategy from the incumbent UK Government, noted that "since two thirds of trips and over half of car journeys in the UK are less than five miles long, measures to change travel behaviour and reduce the need to travel in urban areas could bring significant benefits" (Department for Transport, 2007a p.12). However, in examining future policy goals it also recognised that "transport behaviours are amongst the most challenging to change…we know that car use presents a significant challenge…[and that there] is a belief that all car journeys are 'necessary' and a perception that viable alternatives to the car simply do not exist" (Department for Transport, 2008 p.6)[1].

The policy objective to rationalise some aspects of car use is set against an expectation that private car ownership at the aggregate level in the UK will continue to rise over the next 25 to 30 years (Department for Transport, 2004). This presents something of a paradox as it is arguably self-evident that private car *ownership* is an important determinant of car *use*. This claim is partially evidenced by the National Travel Survey (NTS) which showed that in 2006, households with a car on average undertook 41 per cent more trips and travelled two and half times further overall than households without a car (Department for Transport, 2006 pp.33-34).

[1] This policy framework has since changed following the change of government in May 2010. Nevertheless, consistent with past policy goals, the latest government white paper on local transport retains a similar intention to deliver a "shift in [car use] behaviour" (Department for Transport, 2011a p.7).

It is therefore reasonable to suggest that the point at which a household actions a car ownership change, and in particular, changes car ownership level, represents a possible transition point in travel behaviour. With this in mind, it is useful from a *policy* perspective to understand the process through which household car ownership changes over time.

1.2 Overview of the study

An *academic* rationale for a study of how household car ownership changes over time was developed following a literature review (presented in chapter two). This review synthesizes what is more broadly known about spatial and temporal variations in car ownership. Following consideration of remaining knowledge gaps, the primary research for the study is framed in chapter three by the following two overarching research questions:

Research Questions:

1. How and why does household car ownership change over time? and
2. To what extent is there potential for household car ownership to change?

The primary research was also guided by the following five, more specific objectives:

Objectives:

1. To *describe* how and to *explain* why household car ownership changes over time;
2. To examine the extent to which the present car ownership state meets (or exceeds) the household's desires;
3. To explore how households expect to change car ownership in the future;
4. To identify how residential location influences household car ownership and preferences towards car ownership over time; and
5. To provide policy relevant insights concerning the propensity for household car ownership states to change.

In response to these questions and objectives, a flexible research design, involving two stages of primary research, was developed. Stage one involved undertaking 15 in-depth, retrospective interviews to elicit accurate accounts of how household car ownership states had changed over time, in relation to wider changes in the household's circumstances. Stage two involved a survey of one

inner-urban and one outer-urban neighbourhood, to explore the wider prevalence of the findings from stage one and to more fully address objective four, to explore the influence of differing residential locations on the process of car ownership change.

1.3 A note on terminology

For readability, the terms *car* and *vehicle* are used interchangeably throughout the thesis. These terms encompass all motor vehicles other than motorcycles including cars, vans and pickup-trucks. The term *car ownership* refers to the cars that a household has arranged permanent and (usually) sole access to including privately owned cars, company and long term lease cars.

1.4 Structure of the thesis

The thesis is now presented in seven chapters which are summarised below. The order of the chapters accurately reflects the sequence of research tasks that were undertaken through the study. The thesis is also accompanied by a set of appendices which are referred to throughout.

Chapter 2: Literature Review

Before turning attention to the academic literature, the next chapter begins with a contextual review of the historic trend of increasing car ownership in the UK, presenting secondary data from the Department for Transport's statistics archive. The trend is broadly explained in terms of the macro scale factors (changing pricing signals, land use patterns and changing social practices) that have encouraged the process of motorisation across the population. This trend is then examined in further detail with recourse to two academic bodies of work which explore the variation in car ownership with land use patterns and social psychological factors.

Noting that aggregate trends arise from individual *household* car ownership changes, the review then examines in further detail what is known about *household* car ownership and how it changes over time. Lastly, having observed that the study of car ownership has relied predominantly on *quantitative* modelling, the chapter concludes with an overview of how these modelling techniques have been developed over the years and considers the strengths and weaknesses of this quantitative approach.

Chapter 3: Research Design

Such epistemological issues are dealt with in further detail in the research design. This begins by summarising the knowledge gaps identified following the literature review. It is argued that there remains a need for *longitudinal*, *qualitative* approaches to understand how car ownership *changes* at the disaggregate *household* level to complement the predominant cross-sectional, quantitative approaches that have been applied elsewhere. The overarching research question for the study - *how and why does household car ownership change over time?* – is academically justified in relation to this argument.

The chapter then presents the conceptual framework for the study which derived from the few theories of relevance to the dynamics of household car ownership and was supported by findings from the literature review. In contrast to other studies in the field, this conceives of household car ownership states as the outcome of a continual process of adjustment over the life course, rather than as static, equilibrium states. With reference to the concept of *stress* (Miller, 2005), the mediating subjective concept of *car access imbalance* (imbalance between the present car ownership state and a desirable alternative state) is defined in the framework to represent this process of adjustment.

Given the lack of an agreed structured theory which could be tested deductively, it is argued that the study required an *inductive*, *flexible* research design employing two stages of primary research. A flexible approach allowed a second stage to be designed following an understanding of the substantial findings from stage one. The stage one methodology involving the 15 *qualitative* in-depth retrospective interviews is then described and justified.

Chapter 4: Part One Results: In-depth Interviews

Chapter four presents a data driven thematic analysis (Braun and Clarke, 2006) of the 15 in-depth interviews. It begins by discussing the process of entering car ownership for the first time; identified from the literature as a key moment following which longer term car based lifestyles may become entrenched (Simma and Axhausen, 2007). Then, using empirical evidence from the interviews and with further recourse to the literature, the initial conceptual framework is developed inductively to provide a more detailed depiction of the *process* of car ownership change over time. This conceives of car ownership changes as being driven by *life events* which, through sub-processes of travel behaviour *adaptation* and *consideration* of the current car ownership position, leads to a lessening or

heightening of a *propensity* to change car ownership state. The chapter also offers empirical insights into the wider influences arising from the social and built environments on the process of car ownership change: firstly noting the *opportunistic* passing of vehicles between social and family networks; and secondly describing the process through which lifestyle preferences of relevance to residential location choice may form, based on positive and/or negative life experiences.

Chapter 5: Part Two Methodology: Neighbourhood Survey

The options for a suitable follow up study are considered in chapter five. Having achieved considerable depth of insight, albeit on a limited sample through the stage one study, a decision to undertake a survey of one inner-urban and one outer-urban neighbourhood in Bristol is justified. The survey aimed to examine the broader applicability of the findings from stage one and to also explore in further detail, the influence of differing residential locations on household car ownership outcomes; one of the five starting objectives for the study.

Although stage two employed a *survey method*, consistent with the argument developed in the research design, the objective was to achieve a broader range of *qualitative* accounts of household car ownership *level* change in addition to generating some complementary quantitative data. In contrast to the stage one study, the scope of the survey was intentionally limited to exploring car ownership *level* changes only. To generate reliable qualitative data, the survey involved both a self-completion questionnaire and a follow-up telephone call. This was administered to a relatively small sample of 248 households (approximately 125 households per neighbourhood) and a 'drop-and-collect' method of survey administration was employed. This achieved the necessary high response rate of 74 per cent or 184 returns.

Chapter 6: How Car Ownership States Have Arisen

The results of the survey are then presented in two chapters. The first of which presents a predominantly *qualitative* analysis of the accounts of household car ownership level changes captured by the survey. This includes an analysis of how the aggregate car ownership levels in either neighbourhood had changed since the 2001 census, based on detailed insights about changes at the household level. The chapter then describes the differing pathways towards four car ownership states (zero, one, two and three or more cars owned) since household formation, and confirms a car ownership life cycle effect (Dargay and

Vythoulkas, 1999). 14 reasons for car ownership level change are also identified inductively from the survey. These reasons are consistent with the notion that the process of car ownership level change is driven by life events, as suggested by the interview analysis. Lastly, to complement the qualitative analyses, the chapter concludes with an overview of the results of four multivariate regression models. These were used to identify broadly applicable factors across the neighbourhoods associated with change and non-change in household car ownership levels.

Chapter 7: The Potential for Household Car Ownership Change

In keeping with the study's starting objectives, chapter seven explores how stable current household car ownership states are across the survey neighbourhoods and examines the related issue of households' expectations for future car ownership change. The majority of households are found to be satisfied with their current car ownership level and expect to maintain this position in the future. Nevertheless, as postulated in the conceptual framework, the survey detects an important minority of households that are not in *equilibrium* with their current car ownership position. The chapter explores this issue and the reasons for expecting to change car ownership level in the future.

The relationship between residential location and car ownership is also examined. It is observed that as expected, residents of the outer-urban neighbourhood were more reliant on their vehicles and less multi-modal than residents of the inner-urban neighbourhood. However, this lower level of car *use* in the inner urban neighbourhood had not translated into lower car *ownership* rates overall. The chapter also presents a quantitative and qualitative analysis of the *perceived* influence of the residential location choice on household car ownership needs.

Chapter 8: Discussion and Conclusions

The final chapter of the thesis draws together the key findings from the literature review and the two stages of the primary research, with explicit reference to the five objectives for the study. This includes a discussion of the implications for policy interventions concerned with motivating changes in car ownership; either in terms of reducing car ownership levels in urban areas or encouraging households to purchase cleaner vehicles. This chapter also presents a critical review of the two methodologies and makes recommendations for further research. It is concluded that the study supports the proposition that transport policies and

interventions concerned with changing the number and type of vehicles owned should consider *life events* as significant opportunities for change.

Chapter 2: Literature Review

2.1 Introduction

This chapter presents a review of the contemporary understanding of car ownership. The chapter opens with a description of the national trend towards increasing car ownership in Great Britain. This trend is then explained, firstly in terms of the historic development of the automobile and secondly through discussions of the macro scale factors (changing pricing signals, land use patterns and changing social practices) that have acted to encourage the process of motorisation.

Variations in car ownership at the *aggregate* population level are then explored in separate sections dedicated to the influence of land use patterns and social psychological factors. This leads into a review of what is known about how and why car ownership changes at the *disaggregate* household level. The chapter concludes with an overview of how quantitative modelling techniques have been used and developed in the study of car ownership and considers the strengths and weaknesses of this approach.

2.2 Car ownership trends in Great Britain

The number of privately owned vehicles in Great Britain (England, Scotland and Wales) increased from 2.4 million vehicles in 1950 to just over 30.3 million vehicles in 2010 (Department for Transport, 2010 table TSGB 9.1). Figure 2-1 demonstrates that the trend has reflected a more or less linear increase and on average, approximately 473,000 additional vehicles were registered for use every year over this period.

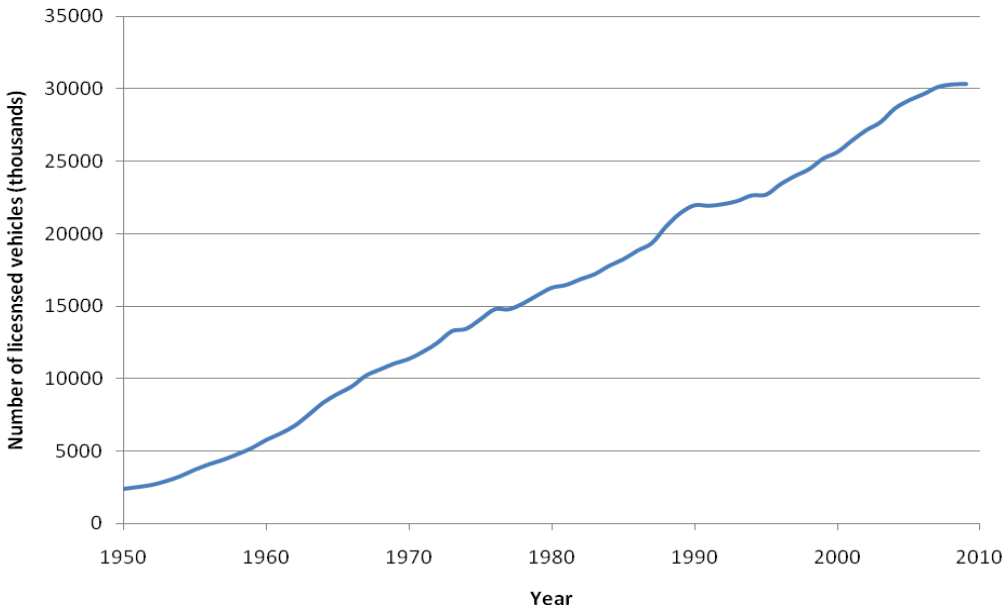


Figure 2-1: Privately owned vehicles in Great Britain: 1950-2010

(source: Department for Transport, 2010 table TSGB 9.1)

The rapid spread of car ownership across the population since the early 1970s is apparent in Figure 2-2. While the population increased by just over 10 per cent from 54.4 million people in 1971 to 60 million people in 2009, the number of vehicles owned per thousand population more than doubled, from 219 vehicles per thousand population in 1971 to 506 vehicles per thousand population in 2009 (Department for Transport, 2010 table TSGB 9.1, Office for National Statistics, 2010c table 1.2).

A timely observation is that this long term trend of increasing car ownership appears to have very recently reversed, undoubtedly as a result of the “credit crunch” and subsequent recession which occured in the UK and many other economies around the world. Perhaps significantly, the number of vehicles per thousand population declined slightly (by around three vehicles per thousand population) although the absolute number of vehicles in Great Britain continued to rise. It remains to be seen however, whether the impact of the recent recession appears as a temporary blip in the otherwise upward trend in private car ownership, as has been the case with past recessions, or indeed whether a downward pressure on private car ownership is maintained over the longer term.

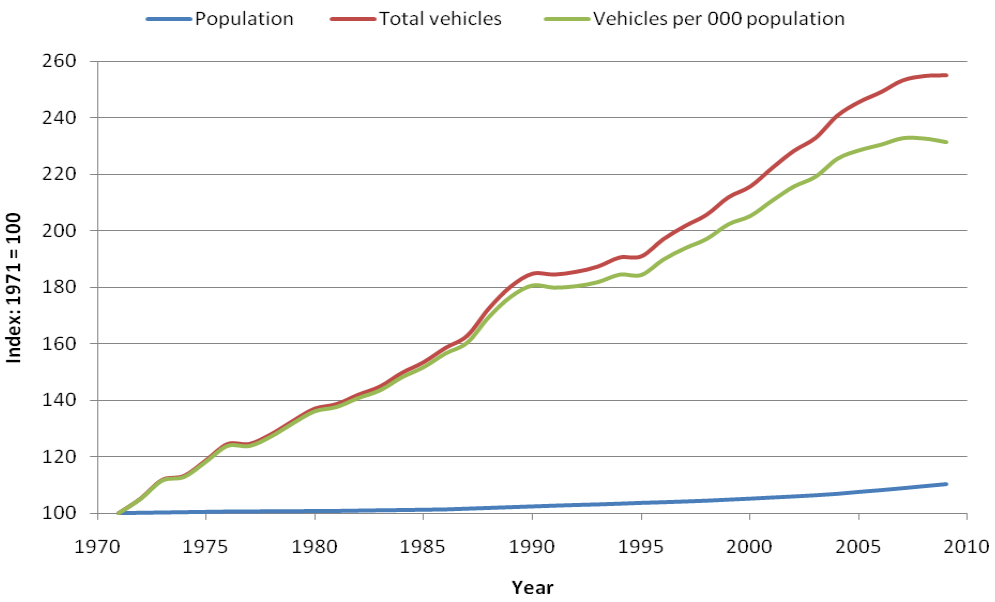


Figure 2-2: Vehicle ownership and population trends in Great Britain
(sources: Department for Transport, 2010 table TSGB 9.1, Office for National Statistics, 2010c table 1.2)

2.2.1 Increasing car ownership and the changing cost of transport

In macro-economic terms, the rapid increase in private car ownership has been facilitated by significant reductions in vehicle purchase costs, which have also translated into reductions in the overall cost of running a vehicle. These reductions in the cost of motoring have been accompanied by subsequent increases in the cost of public transport and have occurred over a period of long term increases in disposable income (Figure 2-3). Between 1987 and 2009 disposable incomes (in the UK) increased by 67 per cent in *real terms* (Office for National Statistics, 2010a figure 1). Motoring costs overall rose by 87 per cent, compared to a rise in the Retail Price Index (RPI, a measure of inflation) of 110 per cent (Department for Transport, 2010 Table TSGB0120). Thus the overall cost of motoring was *relatively less expensive* in 2009 than it was in 1987.

A closer inspection of motoring costs reveals that the marginal car running costs (tax, insurance and maintenance) actually increased over and above the rate of inflation between 1987 and 2009. However, vehicle *purchase* costs reduced by nine per cent over this period; a significant *relative* reduction given the rise in the prices of other goods (Department for Transport, 2010 Table TSGB0120). In relation to this, it is notable that a recent analysis carried out on behalf of the RAC foundation (Leibling, 2009) found that in fact, *new* vehicle purchase costs have remained constant over the 10 year period to 2009. The downward trend in

purchase costs has been driven by cost reductions in the *used* car market. Nevertheless, it is clear that vehicle purchase cost reductions overall have opened up the opportunity to enter car ownership to an increasing proportion of the population.

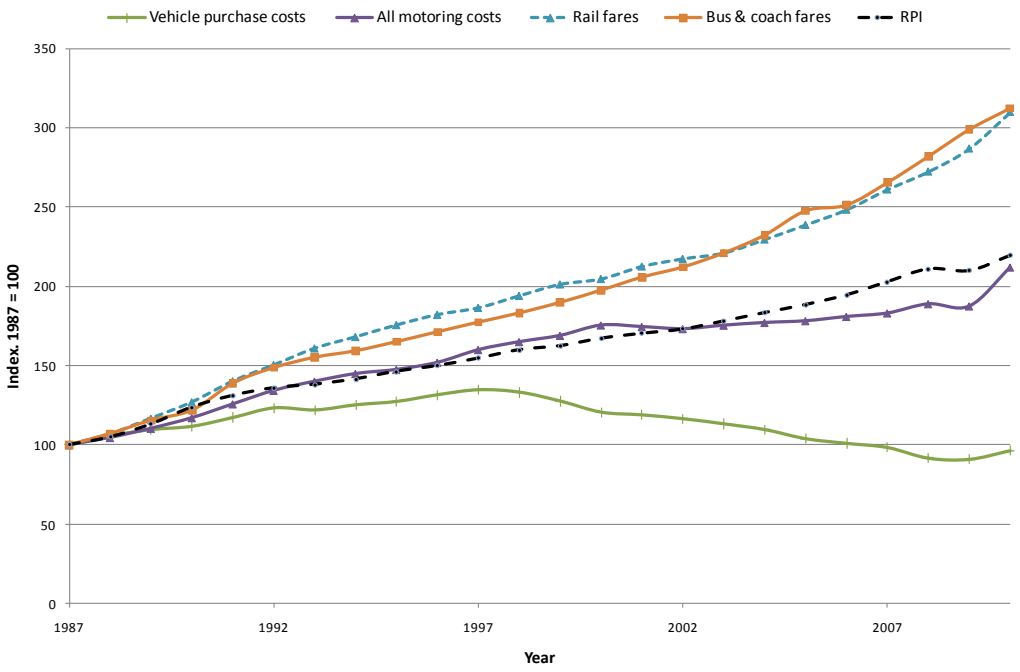


Figure 2-3: Vehicle ownership and trends in transport costs: 1987 – 2010

(source: Department for Transport, 2010 Table TSGB0120)

2.2.2 National trends in household car ownership

In terms of the changing composition of vehicle ownership across households, the early increases in private car ownership overall inevitably tended to reflect non-car owning households becoming single car owning households. Since the early 1970s however, the proportion of single car owning households has remained fairly constant at around 44 per cent of households in Great Britain (Department for Transport, 2010 table nts0205). More recently, the proportion of multi-vehicle households has continued to increase and in 2009 stood at nearly a third, 32 per cent of households (Figure 2-4). Indeed, there are now more multi-vehicle households than there are non-car owning households in Great Britain. Nevertheless it is notable that at one quarter of all households, non-car owning households still represent a significant minority, and their specific needs in a highly motorised society should be of great importance to transport policy makers.

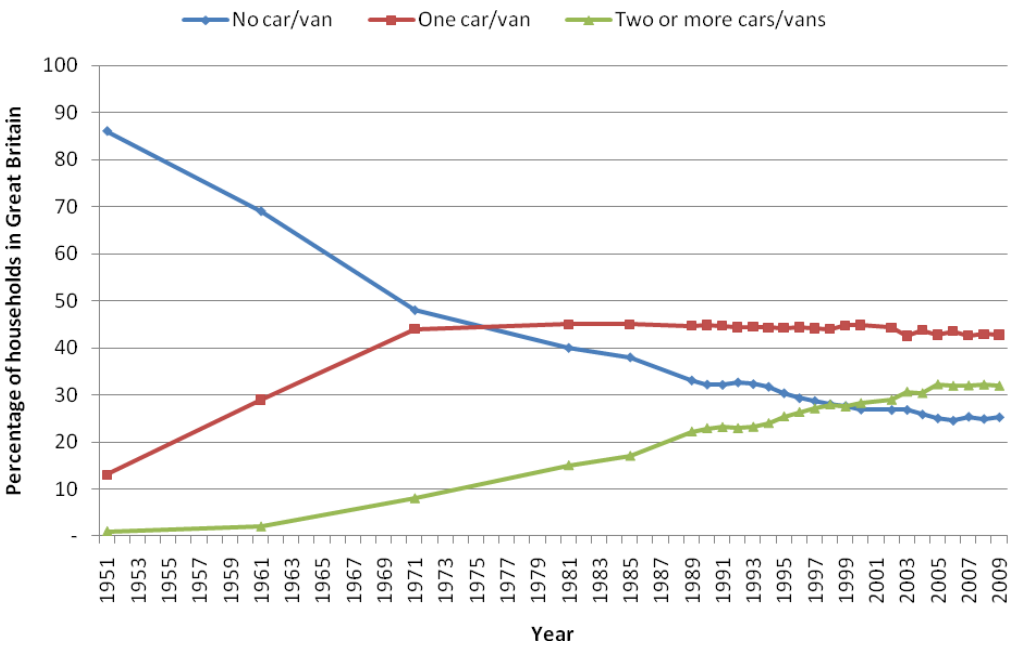
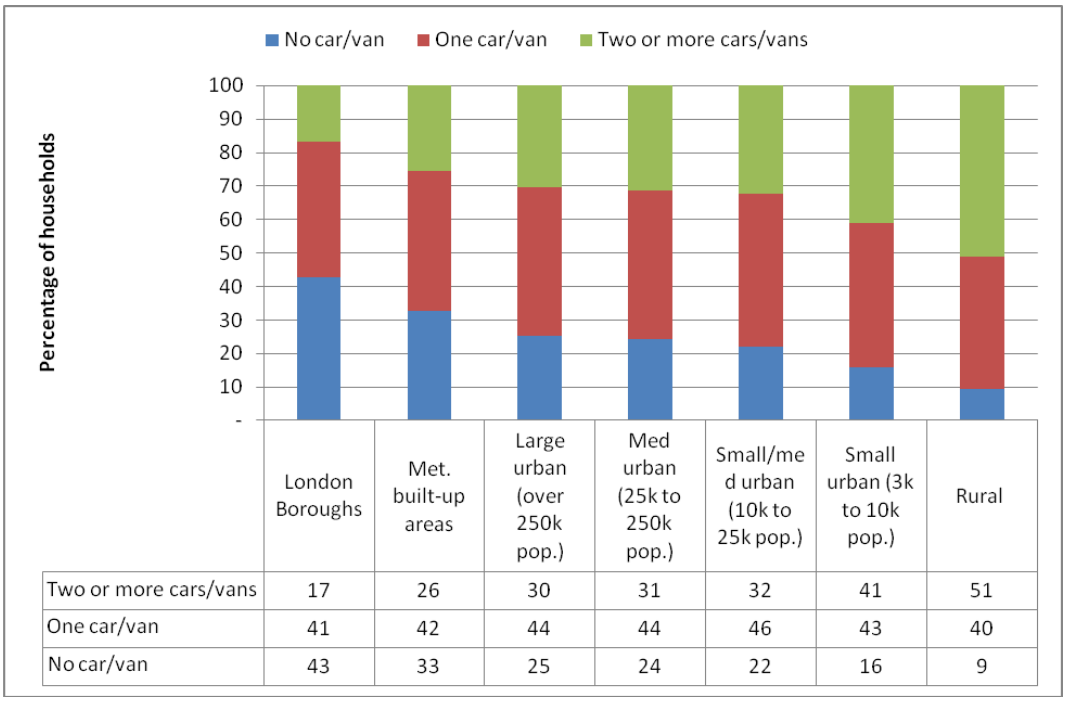


Figure 2-4: Changing household car ownership over time in Great Britain

(source: Department for Transport, 2010 table nts0205)

The intuitive and well documented relationship between land use patterns and private car ownership is also reflected in the national statistics. People living in higher density areas (e.g. cities) have greater opportunities to reach destinations by non-car based modes than people living in lower density areas (e.g. rural areas). It follows that there tends to be a diminished demand for private cars in higher density areas and indeed this is demonstrated by the national car ownership statistics when disaggregated by area type as in Figure 2-5 (this relationship is discussed further in section 2.3). The proportion of non-car owning households reduces with increasing rurality. The proportion of multi-vehicle owning households increases with increasing rurality. The variation in the proportion of single vehicle households between different area types is less striking however (Department for Transport, 2010 table nts9902).



	London Boroughs	Met. built-up areas	Large urban (over 250k pop.)	Med urban (25k to 250k pop.)	Small/med urban (10k to 25k pop.)	Small urban (3k to 10k pop.)	Rural
Two or more cars/vans	17	26	30	31	32	41	51
One car/van	41	42	44	44	46	43	40
No car/van	43	33	25	24	22	16	9

Figure 2-5: Household vehicle ownership by area type: 2008

(source: Department for Transport, 2010 table nts9902)

A comparison to past data reveals that the contrast in private car ownership between area types has become greater over time. Although London represents a unique context in Great Britain in terms of its transport geography (being a large, densely populated city with a very comprehensive public transport network), it is particularly notable that the proportion of non-car owning households actually increased in London between 1995 and 2008 which, over a period of increasing prosperity, bucked the national trend (Department for Transport, 2010 table nts9902).

2.2.3 National trends in driving licence availability

To make use of a private car as a driver requires a driving licence. Understanding changing patterns of licence availability is therefore of relevance to understanding vehicle ownership trends. The male population has historically had higher licence availability than the female population in Great Britain, though this gap is closing over time (Figure 2-6).

When disaggregated by age (Figure 2-7), it is apparent that a smaller proportion of 17-29 years olds had driving licences in 2009 than the same age cohort had in 1995/7 (Department for Transport, 2010 table nts0201). Chatterjee and Dudley (2008 p.42) attribute this fall amongst young adults to “the growth in higher education, increased motoring costs, improved public transport, police targeting

of young drivers and the introduction in 1996 of a theory component of the driving test". It also appears that the proportion of male licence holders has been declining slightly over time, for all cohorts up to the age of 49.

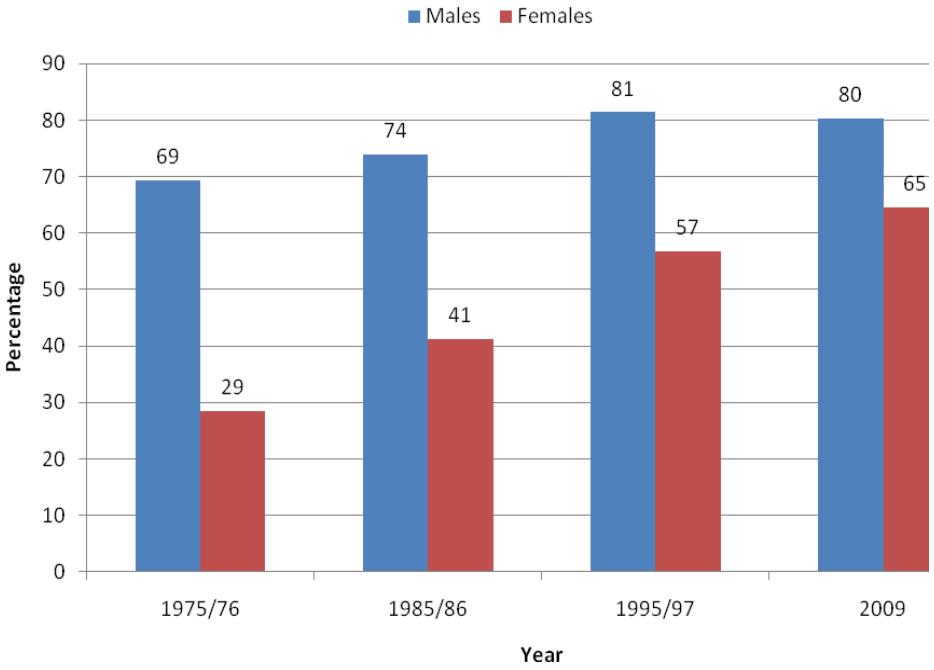


Figure 2-6: Licence holding, by gender in Great Britain

(source: Department for Transport, 2010 table nts0201)

Image redacted for copyright reasons

Figure 2-7: Licence holding, by age in Great Britain

(source: Department for Transport, 2010 table nts0201)

2.2.4 A brief history of the automobile

Given the significance of these national trends, it is worth at this point briefly summarising Dennis and Urry's (2009) account of the events in history and macro scale processes through which the "'System' of automobility" (Urry, 2004) became established in many industrialised societies around the world. As Dennis and Urry (2009) suggest, the rapid increase in private car ownership from an almost zero base in 1900 to the point where there were more vehicles than households in Great Britain in 1999, may well define the twentieth century as the 'century of the car' amongst other things.

Motor vehicles first started being developed in earnest in Europe and the USA in the late nineteenth century, with now well known industry names such as Peugeot and Benz competing to build the most reliable and fastest vehicles. Engineers at this time were experimenting with different forms of propulsion including steam and electric, as well as petroleum based internal combustion engines and in 1895 these differing technologies were pitted against each other in a race between Paris and Bordeaux. Dennis and Urry suggest that this race turned out to be a key turning point in automobile development as the petroleum based vehicles proved to be faster and more reliable than the other forms of propulsion. Consequently, the race result, coupled with the emergence of cheap oil, an abundant energy-dense fuel that also offered longer ranges than the alternatives, were important factors in the further development and ultimate adoption of petroleum based internal combustion engines across the industry.

It was the Americans, through Henry Ford, that fully established large scale 'assembly line' production of motor vehicles, bringing the Model T Ford, and the opportunity for personal transport to the masses. This reduced the cost of motor vehicles and private vehicle ownership rose sharply from 8,000 to 500,000 vehicles in the USA between 1900 and 1910. Production line assembly was subsequently adopted by European manufacturers and the sharing of parts between manufacturers became commonplace, ensuring that petroleum based technologies were finally economically "locked in" across the industry.

As private car ownership increased, road networks were developed and construction of the inter-urban motorway network in the UK, built solely for motor vehicles, began in the late 1950s (notably sometime later than other European nations including Italy and Germany which had constructed autobahns in the 1930s (Chatterjee and Dudley, 2008)). Simultaneously, the existing public transport systems began to be scaled down in towns and cities in order to make

way for the increasing number of privately owned motor vehicles. In 1963 the Beeching Report on the rail network was published (Beeching, 1963). This paved the way for the axing of a large number of rural and regional lines across Great Britain that were no longer deemed to be economically viable given the increasing competition from the private car.

The increasing availability of personalised transport and the development of a road network to accommodate private cars also acted to encourage the dispersal of land use patterns. With a privately owned car, people could live further away from work, shops, leisure and other centres of activity, and still be able to reach them in good time. The development of land that had been inaccessible became economically viable leading to suburban neighbourhoods, out of town shopping complexes and so on. The private car did not just replace public transport journeys but created new journeys that had not previously been possible. This generated a social pressure for people to acquire cars in order for them to feel able to participate in the greater range of activities that were made available through private car ownership. Indeed Dennis and Urry (2009 p.40) suggest that much "'social life' could not be undertaken without the flexibilities of the car and its 24 hour availability."

2.2.5 Changing transport policy on car ownership and use

It is also of relevance to briefly summarise how government policy has evolved in the UK in response to the benefits and challenges arising from mass motorisation. Through the period of rapid motorisation, from the 1950s to the early 1990s, UK transport policy arguably accommodated and encouraged the wide spread adoption of car ownership and use across society. This was initially demonstrated through the national policy to rapidly develop a motorway network from the late 1950s to the early 1970s and through local policies to remodel towns and cities to make way for the car through road building and reducing public transport provision. The positive encouragement of car ownership and use continued and even heightened into the 1980s, with Margaret Thatcher's government heralding the 'Great Car Economy' (Chatterjee and Dudley, 2008). In 1989, the 'Roads for Prosperity' policy (Department of Transport, 1989), a programme to deliver 500 new road schemes, was announced in response to predictions that road traffic would continue to grow at a considerable rate.

The programme was to be short lived however. In the early 1990s there was growing recognition that it would not be possible to build enough road capacity to

accommodate predicted increases in demand for car travel (Goodwin et al, 1991). This was supported by an influential study by the Standing Advisory Committee on Trunk Road Appraisal (SACTRA) which argued that new roads encourage development and stimulate movement, and could simply fill up with new, so called 'induced traffic' (The Standing Advisory Committee on Trunk Road Assessment, 1994). High profile and expensive public protests against environmentally damaging road schemes, such as the M3 expansion at Twyford Down (Wikipedia, 2009) and the A30 expansion in Devon (The Independent, 1996) also encouraged the scaling back of the 'Roads for Prosperity' programme.

By the mid 1990s then, the policy emphasis had shifted towards *managing* rather than *meeting* the demand for car *use.* The 1998 transport white paper, 'A New Deal for Transport' (Department for Transport, 1998) set out a framework aiming to "reduce the need to travel" and made mention of transport plans "which help to cut down on car use" (Department for Transport, 1998 p.8). The paper explicitly noted that "we do not want to restrict car *ownership* - with our vision for a prosperous Britain where prosperity is shared by all we expect more people to be able to afford a car." (Department for Transport, 1998 p.5, emphasis added).

Thus policy in the period since 1998 has sought to manage car *use*, without explicitly impinging on the *number* of cars owned. Specific interventions in this regard have included increasing fuel duty above the rate of inflation and encouraging the use of non-car modes through measures such as travel planning and improvements to local public transport, walking and cycling routes.

Whilst the *number* of cars owned has not been an explicit concern of central government policy, a range of measures have nevertheless been introduced to encourage the purchase of cleaner vehicles: For instance, changing vehicle excise duty to a graduated CO_2 emission based circulation tax in 2001 (Potter, 2008); and similarly changing company car taxation to a CO_2 based rating in 2002 (Potter and Parkhurst, 2005). This reduced business miles by over 300 million miles per year. In March 2009, a temporary vehicle scrappage scheme was introduced to both stimulate the automobile market in a recession and to incentivise the replacement of old vehicles with newer, cleaner models (Department for Business, Innovation and Skills, 2009). Over 370,000 new cars were purchased through this scheme in the period between May 2009 and March 2010 (Society of Motor Manufacturers and Traders, 2010). More recently, and at the time of writing, the policy of the current government has been to allocate

grants to subsidise the purchase of electric vehicles and the installation of recharging infrastructure (Department for Transport, 2011b).

2.2.6 Section summary

This discussion of the factors that have acted to encourage the wide spread adoption of private car ownership is now summarised in terms of a set of dynamic feedback relationships:

Reducing vehicle purchase costs and increasing disposable incomes have enabled a greater proportion of the population to purchase motor vehicles.

This has encouraged dispersal in land use and activity patterns in time and space; creating an increased instrumental need for cars to access employment and services.

As car based lifestyles become the social norm, there is an increasing social pressure for individuals to acquire their own cars in order to benefit from the perceived full range of opportunities available in a motorised society.

Whilst government policy initially sought to accommodate the wide spread adoption of car ownership and use, since the mid 1990s, policies have been introduced to manage car use and to encourage the purchase of cleaner vehicles in response to the growing challenges of congestion and energy scarcity.

The chapter now turns to the academic literature, to deepen understanding of these feedback relationships. Accordingly, the next section reviews in detail the relationship between car ownership and the form of the built environment. This is followed by a discussion of the social-psychological factors that influence car ownership.

2.3 Car ownership and the form of the built environment

As noted in the previous section, increasing car ownership (and use) has influenced patterns of land use development and created a cycle of cause and effect that has yielded a growing car dependency in society. In recent years, UK planning policy has sought to slow this cycle by adopting land use policies that aim to reduce urban sprawl, increase population densities and encourage mixed use developments, ideally around public transport nodes (Communities and Local Government, 2001, Communities and Local Government, 2006). It is anticipated that mixed land uses reduce journey distances, while higher population densities improve the economic viability of public transport, local amenities and services.

Such policies might therefore be expected to exert a downward pressure on car ownership.

Over the years, numerous studies have provided evidence to support the case that higher population densities and proximity to urban centres are associated with a reduction in per capita travel demand (see Stead and Marshall (2001) for a critical review). With regards to car ownership, a plot of 2001 census data (for England) clearly shows a pattern of increasing car ownership moving outwards from urban centres to rural areas (see Appendix A). Likewise, Dargay (2002) demonstrates that car ownership in rural areas is less sensitive to rises in motoring costs than is the case in urban areas, indicating that as expected, rural householders are more reliant on their cars than their urban counterparts.

2.3.1 Residential self-selection

While the presence of an association between form of the built environment and travel demand is not disputed, the degree to which the relationship is directly causal in the direction from built environment to car ownership, is a subject of some debate. Early studies are open to criticism for not having adequately controlled for socio-economic factors. Geographic clustering of particular socio-economic groups (with lower car ownership) is likely to account for some of the spatial variation for instance (Stead, 2001).

In more recent studies the effects of attitudinal residential self selection, whereby households might choose to live in areas that meet their pre-selected travel preferences have been explored (see Cao et al (2007b) for a review of such studies). For instance, car lovers may choose to live in spacious suburban areas, while car loathers may choose to live in inner city areas where alternatives are available. In recognising the possible effects of residential self selection on land use policies, Lyons (2003 p.8) notes that “the amount by which (car) travel is reduced is ultimately governed by the land users – the location choices of business, the location and travel choices of individuals and the spatial patterns of daily activities they choose or seek to maintain”. Similarly, Cao et al (2007a p.536) point out that the influence of the built environment on travel behaviour may be limited to a role of facilitation, which is constrained by the “sizeable share of households who favour suburban types of development”.

With this debate in mind, various quantitative modelling approaches have been employed in an effort to establish the strength and direction of the relationship

between built environment, attitudes, car ownership and car use (Van Acker and Witlox, 2010, Bhat and Guo, 2007, Cao et al, 2007, Naess, 2009).

Van Acker and Witlox (2010) test the hypothesis that the relationship between built environment and car use is *mediated* through car ownership. This they justify with reference to Ben-Akiva and Atheron's (1977) plausible theory that daily travel behaviours should be conceived in terms of a three tiered choice hierarchy relating to different time horizons (Figure 2-8). Employment location and residential location (built environment) are conceived as long range decisions which influence the medium range car ownership choice. The car ownership decision latterly influences short range (e.g. daily) travel choices:

Figure 2-8: Ben-Akiva and Atherton's choice hierarchy

source (Ben-Akiva and Atherton, 1977)

Van Acker and Witlox (2010) use cross-sectional data from a travel behaviour survey conducted in 2001 in Ghent (Belgium) to model car use as a function of car ownership, socio-economic and built environment factors. Structural equation modelling is employed to demonstrate that including car ownership as a mediating variable (which itself is dependent on built environment and socio-economic factors), rather than as a simple independent variable, improves the explanatory power of the model. The finding in their view, confirms the hypothesis that car ownership mediates the relationship between car use and the built environment. They conclude from this that land use policies seeking to influence

car use should also consider policies to moderate car ownership in order to be effective.

Bhat and Guo (2007) attempt to control for the effects of residential self-selection by jointly modelling the residential location choice and the car ownership choice using cross-sectional data from the 2000 San Francisco Bay area travel survey (developing one set of equations for the residential location choice and another set of equations for the car ownership choice). They demonstrate specific residential self-selection effects. For instance, that single occupancy households have a liking for high density living and also own fewer vehicles than other groups, while households with adults over 65 prefer lower density areas and have a preference for higher levels of car ownership relative to other groups. The extent to which the car ownership preference is *caused* by the residential location preference and/or the demographic grouping is not possible to establish from their analysis however. They conclude that while the built environment influences both residential location and car ownership decisions, household demographics have the stronger influence on car ownership. They also comment that income is the "dominant factor in residential sorting" (Bhat and Guo, 2007 p.524) noting that low income groups tend to be located in areas of high employment density and lower commute costs.

Cao et al (2007) employed both cross-sectional and quasi-panel[2] modelling approaches in an effort to tease out the strength of the direct relationship between built environment and car ownership. Two cross sectional (ordered response probit) car ownership models were estimated, one with and one without attitudinal factors reflecting preferences towards particular neighbourhood types. This exercise demonstrated that while car ownership did indeed increase with lower neighbourhood density and reduced mixed land uses, the inclusion of attitudinal factors significantly lessened the direct built environment relationship. This suggested that car ownership levels were predominantly influenced by attitudes rather than by the built environment.

A quasi-panel (static score) causal model was then constructed to analyse how car ownership *changed* following a move to a neighbourhood. This indicated that moving to a more spacious neighbourhood induced increases in car ownership even after attitudes were controlled for. This result in some ways contradicted

[2] quasi in the sense that survey respondents were asked to retrospectively provide car ownership data before and after a residential relocation.

the findings of the cross-sectional model. Nevertheless, interpreting the results of the two models together, the authors conclude that the built environment does exert a marginal influence on car ownership independently of attitude. However, they go on to comment that it would be beneficial to also explore the degree to which the built environment itself influences attitudes. This had not been possible to test using the available data.

Naess (2009) adopts an alternative position for his study on the Copenhagen metropolitan area in arguing that purely quantitative studies concerned with understanding self-selection may risk underestimating the strength of the relationship between built environment and travel behaviour. He suggests that "if households self-select into areas that meet their travel preferences, it seems self-evident that urban structure matters" (Naess, 2009 p.293). Indeed, using a mixed method approach Naess (2006) demonstrates that car ownership is higher in the peripheral areas of the Copenhagen metropolitan area, even after socio-economics and attitudes have been controlled for. Qualitative interviews undertaken during this study further revealed instances in which households were prompted to buy additional cars following a move to peripheral areas. Finally he counters other researchers by suggesting that car ownership and attitudes should not be controlled for in multivariate analyses concerned with built environment and travel behaviour, due to the two way nature of these relationships (Naess, 2009). Attitudes and car ownership influence built environment choice, but built environment also influences attitudes and car ownership. For instance, living in inner city areas with good public transport and some degree of congestion may act to weaken pro-car attitudes over time.

2.3.1.1 Summarising residential self selection

It is clear then that there are complex debates surrounding both the precise nature of the relationship between built environment and car ownership and the most appropriate methods to use to explore this relationship. Indeed, Mokhtarian and Cao (2008 p.225) suggest that "the more sophisticated the approach to treating self selection...the more difficult it becomes to answer questions about the absolute and relative magnitudes of the true impacts of the built environment on travel behaviour". Nevertheless, they recommend the use of longitudinal structural equation models as the best means of investigating causality - Structural equation models allow complex two way relationships to be explored, while longitudinal data allows for time precedence to be investigated; allowing for

instance an exploration of whether attitudes are changed *after* a relocation to a particular neighbourhood type. Naess (2009 p.299) however, offers a counter position in suggesting that "statistical analyses, even with longitudinal research designs, cannot themselves establish that causality exists". He suggests instead that "they can be used in an exploratory way, revealing patterns and relationships that might be a result of causal influences. And they may be used as (part of) the evidence for theoretically founded causal relationships."

Such epistemological issues are returned to later in the thesis in chapter three, which presents the research design for this study.

2.3.2 The effects of public transport

The nature of the public transport system is another feature of the built environment that influences the transport choices that people make. Alongside research into attitudinal residential self selection, a small number of other studies have investigated the specific relationship between public transport and car ownership.

Hass Klau (2007) and Crampton (2006) used the 2001 UK census data to perform a cross-sectional analysis of the relationship between car ownership and *proximity* to a public transport corridor (heavy rail, underground, tram or high quality bus). Their analysis demonstrated that "good public transport access reduces local car ownership, having controlled for population and socio-economic structure" (Crampton, 2006 p.9). Woldemanuel et al (2009) also reported that close proximity to underground or urban rail stations; close proximity to shops; a high level of satisfaction with public transport and increased level of difficulty of parking were all factors associated with reduced household car ownership. Neither study could control for the effects of attitudinal self-selection however, so the extent to which these relationship were directly causal could not be explored.

Cullinane (2002) investigated the relationship between *perceptions* of public transport and expectations about future car ownership using a cross sectional sample of university students in Hong Kong. Using a face-to-face survey, measuring *attitudes* to both public transport (rather than objective features of the public transport system) and future aspirations for car ownership, Cullinane established that having a *perception* that public transport was good and cheap was associated with a lower expectation to acquire cars. However, he also noted that "the problem lies in determining what level of public transport provision car ownership and use decisions are affected" (Cullinane, 2002 p.38).

The nature of the inter-relationship between car ownership, car use and public transport use has been demonstrably difficult to analyse using quantitative data. Kitamura ‘s (1989) panel analysis indicated that the tendency for an increase in car ownership level to lead to greater car use and lesser public transport use was stronger than the tendency for increasing public transport use to lead to less car use. On the other hand Thorgesen’s (2006) panel study conducted in Denmark provided evidence to suggest that making more frequent use of public transport was associated with an increased likelihood of relinquishing a car. A pragmatic interpretation of these two studies is that that there is a two way relationship between car ownership and public transport use. Acquiring a car does tend to reduce public transport use, but making more frequent use of public transport (if available and adequate) is also associated with increasing likelihood of relinquishing a car.

A further study by Goodwin (1993) used a panel survey of households in South Yorkshire (1981 to 1991) to test the impact of changing public transport service levels on public transport and car use. For specific policy reasons in the area, public transport service levels were improving at the beginning of the survey period and worsening towards the end of the survey period. Goodwin (1993 p.28) established that during the earlier period of improving public transport “car ownership increased less than another comparable area and less than in the later period of ‘worsening public transport’”. The implication being that changing the level of public transport provision influences the rate at which car ownership grows. This claim is supported by Lucas (2009 p.738) following a more recent analysis of the National Travel Survey. She reports that car ownership in the UK “has grown fastest in areas with the poorest public transit [transport] accessibility”.

2.4 Car ownership, social-psychology and behaviour theory

The preceding section on the complex relationship between the built environment, attitudes and car ownership demonstrated the importance of recognising the complexities of human decision making in travel behaviour research. Aggregate travel patterns and car ownership levels do not solely relate to the spatial distributions of activity centres and the nature of the transport links between them. They also depend on individual *preferences*. Accordingly, the chapter now turns to review what is known about the psychological factors that influence travel behaviour of relevance to car ownership and also car *use*.

Travel behaviour research has commonly used theories of behaviour arising from the field of micro-economics as a basis for explaining and predicting travel behaviour. Specifically, rational choice theory has been widely used in research and indeed is regularly operationalised in the models used in transport planning practice. Lucas and Levine (2009 p.14) summarise the key assumptions underlying rational choice theory as follows:

- "individuals make choices by calculating the best outcome for themselves based on cost/benefit calculations of different available courses of action" (this is often referred to as utility maximisation);
- "self interest is the main driver of these decisions";
- "the individual has all the relevant information with which to make a rational decision";
- "the individual is fully able to process this information in order to reach the optimal decision"; and
- "every such decision is made on the basis of cognitive deliberation".

A significant reason why rational choice theory has been historically dominant in the travel behaviour field is the ease with which it can be elegantly mathematically operationalised through discrete choice theory. This is discussed further in section 2.7 on car ownership models. However, recognising that people rarely make choices in entirely economically rational ways, as is assumed to be the case under traditional utility maximisation mode choice models, travel behaviour researchers have in recent years drawn on and adapted a number of alternative behaviour theories arising from the field of social psychology including for instance, Ajzen's (1991) theory of planned behaviour or Triandis' (1977) theory of interpersonal behaviour.

A full review of behaviour theories of relevance to transport research is not required for the purposes of this discussion as good overviews are already provided elsewhere (Lucas and Le Vine, 2009, Parker et al, 2007, Lyons et al, 2008, Jackson, 2004). Nevertheless to summarise, such theories have allowed travel choices to be conceptualised and researched in terms of various social-psychological factors such as attitudes (e.g. 'I like cycling'), social norms (e.g. 'is it out of the ordinary or strange to cycle to work?'), perceived behavioural control (e.g. 'I think it is difficult to take the bus'), propensity for pro-social behaviour (e.g.

'I'd like to help reduce congestion by taking the bus') and habit; a mechanism whereby learnt travel behaviours are repeatedly performed with little or no cognition of the full range of choices available (Verplanken et al, 1997). This is in contrast to assuming solely selfish economic motives as is the case under utility maximisation frameworks.

2.4.1 Using behaviour theory to explain car use

Although studies utilising social psychological theories have tended to focus on car use behaviours rather than on car ownership behaviours per se, they have nonetheless yielded some relevant insights, which are now briefly reviewed.

The study by Thorgeson (2006) described previously operationalises concepts from the theory of planned behaviour. Through this he first establishes that attitudes, the perceived ability to use public transport and *car ownership* are strong determinants of public transport use. Amongst non-car owners, attitudes are found to influence behaviour, while conversely behaviour also influences attitudes. Of specific relevance to this review however, was the finding that car ownership encourages *habits* around car use to form which weakened this relationship between attitudes and behaviour.

Bamberg and Schmidt (2003) compare three behavioural theories – the norm activation model (Schwartz, 1977), the theory of planned behaviour and the theory of interpersonal behaviour – with respect to their ability to predict car use. They operationalise the theoretical constructs in a questionnaire survey of university students and test the relationships postulated in each theory using structural equation modelling. They report that the perceived ease with which cars enable travel is a strong predictor of car use and again confirm that car use is habitual. The study also suggests that 'role beliefs' - "the appropriateness of one's behaviour for one's perceived social role" (Bamberg and Schmidt, 2003 p.268) - are an important determinant of car use.

Steg (2004) uses Dittmar's theoretical model of the psychology of material possessions (Dittmar, 1992) to argue that cars perform symbolic-affective functions (an expression of self and status) in addition to their instrumental transportation functions. Her study revealed that people do distinguish between the instrumental and symbolic-affective roles fulfilled by cars; that symbolic-affective functions were most highly valued amongst young, male and lower income groups; and that even highly functional commuter travel was influenced by symbolic-affective motives to a greater extent than might be expected.

In relation to attitudes to cars relative to other modes, Anable (2005) performs a cluster analysis and identifies six attitudinally uniform population segments ranging from die hard drivers through to reluctant (public transport) riders. She finds that these attitude segments cut across socio-economic groupings and that "the same behaviour can take place for different reasons and that the same attitudes (e.g. positive attitudes to the environment) can lead to different behaviour (e.g. a reduction or no reduction in car use)" (Anable, 2005 p.77). The study relates differences between attitudes and behaviour to the concept of perceived behavioural control. Individuals may want to use the bus but perceive it to be much harder than using the car (which may or may not be objectively the case).

Along similar lines Goodwin (1995) discusses the complex concept of car dependence, noting that "people differ" and that transport policy should not seek to target some notional "average driver" (Goodwin, 1995 p.1). He suggests that there are both car dependent people (those that are behaviourally locked into car use) and car dependent trips (those for which there is no realistic alternative). Interventions concerned with reducing the number of car dependent *trips* must seek to change the spatial distribution of and the nature of the transport links between activity centres. Conversely interventions concerned with addressing car dependent *people* must seek to alter attitudes towards the use of alternative transport modes.

2.4.2 The psychology of car ownership

The proceeding section has outlined how behaviour theories arising from the field of social psychology have been used mainly in research concerned with car *use* rather than car *ownership* per se. The review now turns to a further body of literature dedicated to the extent to which *ownership* of a car fulfils deeper psychological needs, in addition to carrying out its instrumental transportation function (Urry, 2004, Gärling and Loukopoulos, 2008, Wright and Egan, 2000, Diekstra and Kroon, 1997, Macintyre et al, 1998, Sheller, 2004).

Wright and Egan (2000) make reference to Maslow's scale of human needs (Maslow, 1954) (Figure 2-9) and suggest that the "car satisfies needs on all [hierarchical] levels" by providing "warmth, shelter and security", a "social environment", a "status symbol" and a "means of [personal] expression" (Wright and Egan, 2000 p.289).

Image redacted for copyright reasons

Figure 2-9: Maslow's scale of human needs

(source: Maslow, 1954; image source: Askert, 2011)

Diekstra and Kroon (1997) argue that the car reinforces our ability for personalised mobility, further noting that cars evoke feelings of power, and that acceleration and speed stimulate pleasurable physiological responses. Sheller (2004 p.236) posits that cars evoke "automotive emotions" that "go beyond any economic calculation of costs and benefits".

As noted before, Urry (2004) suggests that worldwide, societies have become increasingly locked into a self perpetuating "system of automobility" and on a similar theme Dupuy writes that acquiring a driving licence and a car allows individuals to benefit from the "size of the club" that is already using and taking part in Urry's so called system (Dupuy, 1999 cited in Hiscock et al, 2002 p.132).

Finally MacIntyre et al (1998, 2001) reported tentative evidence to suggest that owning a car was an indicator of good health, even after social class and income were controlled for, although income was found to be a stronger predictor. Hiscock et al (2002 p.120) followed this finding up by examining the extent to which cars provide protection, autonomy and prestige, positing (though not proving) that such psycho-social attributes could "potentially be health promoting". They argue that given the high value associated with "choice and convenience" in today's society (Hiscock et al, 2002 p.133), the car out performs public transport by quite some distance.

2.4.3 Section summary

The literature on built environment and social psychological factors reviewed in this and the preceding section demonstrates that car ownership arises as a result of both instrumental need (for cars to meet daily travel obligations) and affective desire (for cars as an enjoyable possession). It has also been suggested that instrumental need and affective desire for cars may vary according to residential location, the choice of which may reflect a preference towards a more or less car based lifestyle.

2.5 Changing car ownership at the household level

The discussion so far has been predominantly (though not solely) concerned with exploring macro scale factors that influence aggregate car ownership levels: politics and pricing signals, the form of the built environment and social-psychological factors. It is however self evident that aggregate car ownership levels at a given point in time are the result of many *households* making changes to their car ownership level over time. Accordingly, the review now moves on to focus more specifically on *household* car ownership and how it changes over time in terms of the following themes:

- the household car ownership life cycle profile;
- underlying 'churn' in household car ownership;
- the importance of life events and lifestyle choices;
- car ownership inertia at the household level; and
- the relationship between household car ownership and car use.

2.5.1 The household car ownership life cycle profile

By constructing a pseudo-panel data set from the UK Family Expenditure Survey, Dargay and Vythoulkas (1999) analysed how household car ownership changes over time and revealed a typical *life cycle* profile: car ownership tends to increase as the head of the household reaches the age of 50, after which it declines. This mirrors household income profiles which also tend to increase as the head of the household reaches the age of 50 and thereafter decline. The household size was found to peak and fall a little earlier than car ownership and income, when the head of the household is around 45 years old: this was said to reflect a time *lag* between offspring leaving home and a reduction in household car ownership, implying that adaptation to a change in household structure takes time.

Dargay and Vythoulkas' (1999) analysis also revealed a generational effect, with successive generations each having on average, a higher level of car ownership than the last. This is indicative of a growing societal dependence on the car and is not unexpected given the higher disposable incomes and lower motoring costs available to successive generations as noted earlier.

2.5.2 Underlying churn in household car ownership

Several researchers have independently analysed a number of European panel data sets to confirm that the familiar gradual monotonic rise in car ownership at the aggregate level consistently masks a much larger number of changes occurring at the household level (Kitamura, 1989, Goodwin, 1993, Goodwin, 1988, Dargay and Hanly, 2007). This is a travel behaviour example of what has been termed *asymmetric churn*, whereby a small net change in a behaviour overall results from a larger (and potentially unrecognised) number of increases and decreases in the behaviour at the *individual* level cancelling each other out (Chatterjee, 2001).

In a British context, Dargay and Hanly's analysis of the British Household Panel Survey (BHPS) (Dargay and Hanly, 2007) revealed that a very small net increase in car ownership at the aggregate level between two consecutive years (0.2 per cent) resulted from nearly 16 per cent of households changing car ownership overall: 8.2 per cent of households increased car ownership, while a smaller, yet significant 7.6 per cent of households reduced car ownership[3].

The largest proportion of car ownership changes were found to be between one and two cars (in either direction) and these changes also reflected an asymmetric churn in the positive direction: 4.2 per cent of households changed up from one to two cars, while 3.8 per cent of households changed down from two to one cars. Only 1.9 per cent of households gave up car ownership altogether.

The circumstances under which households reduce car ownership are specifically reported in Goodwin (1988) and Dargay et al (2003). Both studies find that reductions are more common amongst households with high car ownership. Dargay et al (2003) also note that a third of reductions are transitory, lasting for only one year. Consistent with the findings reported in section 2.3.2, Goodwin's

[3] The figure of 0.2 per cent correctly refers to the change in the aggregate car ownership level and not the difference between the proportion of households changing car ownership level which is 0.6 per cent. Some households may have changed by more than one car over a period of one year.

study (Goodwin, 1988) suggested that building up a high level of public transport use was a precondition to giving up the car altogether, and that this was more likely in areas with an already good level of public transport provision.

2.5.3 The importance of life events and lifestyle choices

The analysis of the BHPS (Dargay and Hanly, 2007) confirms that a significant number of household car ownership changes are associated with wider *life events*. For instance, a little more than a third (33.8 per cent) of households experiencing a *reduction* in the number of adults, also *reduced* car ownership, while 30.5 per cent of households experiencing an *increase* in the number of adults, also *increased* car ownership. Around a quarter of households changed car ownership between two consecutive years in association with a house or a job move. Unemployment and retirement were found to be associated with reductions in car ownership. Mohammadian and Miller (2003) similarly report that an increase in the number of jobs in the household is associated with acquiring additional cars, while increases or decreases in household size are associated with acquisitions or disposals respectively.

This finding that long term life changes are also associated with car ownership changes is consistent with Ben-Akiva and Atherton's (1977) choice hierarchy that was introduced in section 2.3.1. Indeed this framework has been developed over the intervening years, first by Salomon (1983) who reconceived it in terms of *lifestyle* choices (long range), mobility choices (medium range) and activity and travel choices (short range). Salomon conceptualised the lifestyle as the longest term choices relating to family formation, type of employment to pursue and preferences towards leisure. He further recognised that there was a two-way relationship between the shortest and longest range decisions i.e. daily activity preferences could also influence longer-term lifestyle decisions (Figure 2-10).

Building on Salomon's work, Lanzendorf (2003) subsequently put forward a fully *longitudinal*, mobility biography approach for capturing and interpreting changing travel behaviour over an individual's life course in terms of what he calls their lifestyle, accessibility and mobility domains. Studies of car ownership carried out using this *longitudinal* approach confirm that changing car ownership is associated with changing income, moving house or changes in household structure (Prillwitz et al, 2006, Lanzendorf, 2006, Beige and Axhausen, 2006, Yamamoto, 2008).

Image redacted for copyright reasons

Figure 2-10: An extended choice hierarchy
Source (Salomon, 1983)

Krizek and Waddell (2002 p.119) also emphasised the importance of the concept of lifestyle in travel behaviour research noting that “the possibility that short term and long term choices are mutually informed is too often ignored”. They use cluster analysis to search for common groupings of households that have shared long and short term decision characteristics relating to travel behaviour, activity participation, *vehicle ownership* and residential location. Their identification of nine lifestyle groupings along these dimensions demonstrates that long and short term decisions are indeed mutually linked.

2.5.4 Car ownership inertia at the household level

Whilst it has been shown that the proportion of households changing car ownership level between two consecutive years is higher than might be expected (16 per cent according to the BHPS (Dargay and Hanly, 2007)) given the much smaller net increase at the aggregate level, the great majority of households maintain their car ownership level year on year (84 per cent according to the

BHPS (Dargay and Hanly, 2007)). This stability in car ownership at the household level implies the existence of *state dependence*. State dependence refers to the degree to which a present state (in this case the present household car ownership level) is influenced by a past state (in this case the household car ownership level at a previous point in time).

Several studies, based on panel data, have confirmed that household car ownership is highly state dependent (after taking into account changes in explanatory variables and unobserved heterogeneity) (Simma and Axhausen, 2007, Thorgersen, 2006, Hanly and Dargay, 2000). It seems that once an individual or household has acquired their first car, they are very likely to continue owning a car in future years. This is perhaps to be expected given that the purchase of a car often requires a significant one off capital expenditure (in exchange for a relatively cheap marginal cost per car trip) and this decision in itself represents a personal (longer term) commitment to car use (Simma and Axhausen, 2007, Scheiner and Holz-Rau, 2007).

Simma and Axhausen (2007) further point out that even large changes in personal circumstances are unlikely to motivate car owners to *relinquish* their vehicles. This does not contradict the finding that household car ownership changes are associated with wider life events, but emphasises the fact that car ownership reductions are very much the exception rather than the norm. This finding leads them to suggest that the following two questions are of particular relevance to understanding the demand for and dynamics of household car ownership:

- “when was the first car bought and what were the circumstances?” and
- “how often does it happen that a car owner again gives up this form of mobility?” (Simma and Axhausen, 2007 p.30)

In addition to confirming car ownership state dependence, other investigations have demonstrated the presence of *inertia* i.e. households resist changes to their car ownership state. This is revealed through studies of the dynamic relationship between income and car ownership which show that household car ownership takes time to respond to a change in income; reaffirming that individuals take time to adapt to a change in circumstances (Dargay, 2001, Goodwin and Mogridge, 1981).

Returning to the issue of household motoring expenditure (discussed in section 2.2.1), Brög's (1982) comparison of perceived motoring costs to actual motoring costs confirmed that motoring costs are generally underestimated, that certain costs are not counted within the motoring budget (for example parking fees), while others may not even be acknowledged (depreciation for instance). Although there is a lack of up to date academic literature in this area, a more recent RAC report (RAC, 2004) supports these general findings.

Furthermore, a review of evidence concerning public attitudes to transport reported that the cost of car use may not be "a decisive influence on travel choices" (Lyons et al, 2008 p.24). It is suggested that this may be due to an acceptance that car travel is a necessary (unavoidable) part of everyday life (once a pattern of car use has been established) and thus motoring costs are an inevitable expense that must be borne. The review further reports a perception amongst the public that "the more the car was used, the better value it represented" (Lyons et al, 2008 p.28).

The suggestion then, that the large capital expense required to buy a car, itself encourages car use has implications for policy. It has been hypothesised that shifting the burden of cost from car ownership to car use could help to rationalise car use. Indeed, a growing number of car clubs are seeking to exploit this. Their members benefit from an alternative model of car access (a concept which is developed further in chapter three), which replaces the large capital expenditure required to purchase a car, with a higher marginal cost per car trip (Duncan, 2011).

2.5.5 The relationship between household car ownership and car use

By investigating the relationship between household income and household car ownership, Dargay (2001) provides some evidence to support the premise that the acquisition of a car leads to some extent, to a pattern of car use becoming entrenched: car dependence grows over time (Goodwin, 1995).

The study firstly confirms the expectation that car ownership tends to increase with household income and tends to fall in response to a reduction in income. Crucially, however, the car ownership response to an increase in income is revealed to be twice that of an equal fall in income. Thus car ownership has an *asymmetric* response to changes in income, implying that households prefer to maintain their car ownership level, even if their income is reduced to a prior, non-car owning level. This suggests that purchasing a car allows a set of mobility

patterns to be acquired, which once established are difficult to relinquish (noting also the non-instrumental attachment to and association with an attained level of ownership as discussed in section 2.4.2).

The notion that car ownership might generate car use is also suggested, though not proved, by cross-sectional data from the UK National Travel Survey. As noted in the thesis introduction (section 1.1), in 2006, people in households with a car undertook 41 per cent more trips and travelled two and a half times further overall than those without a car (Department for Transport, 2006 pp.33-34). However, this does not necessarily imply that car ownership generates travel. These households may simply use a car in order to accommodate a pre-existing travel demand. To directly explore how travel behaviour changes following a change in car ownership level requires longitudinal data, of which there is surprisingly little.

Goodwin's (1995) analysis of four panel data sets from the UK, the Netherlands, the USA and Norway indicated that as expected, relinquishing a car reduced the number of car driver trips by between seven and 47 per cent; while acquiring a car increased the number of car driver trips by between seven and 51 per cent. He also observed, albeit from cross-sectional data, that the number of miles driven per week increased with length of licence ownership; supporting the notion that car dependency grows over time. As an illustration of complexity however, following a *cross sectional* analysis of Dutch panel data, Kitamura (1989 p.172) suggests that car ownership "is at best *marginally* associated with the *number* of person trips made by household members over a one-week period" (emphasis added). His longitudinal analysis of the panel data revealed that increasing car ownership was associated with a *shift* in trips from public transport to car use, rather than altering the number of trips made overall. Thus, Goodwin (1995) and Kitamura's (1989) findings together would suggest that while car ownership does indeed encourage car use in place of other modes, it may not necessarily increase the total *number* of trips made by the household.

2.5.6 Section summary

At this point it is appropriate to draw together some key observations from the literature concerning household car ownership churn, inertia and the importance of life events:

- buying (or having access to) the first car, encourages lifestyles and norms based around the car to form;

- as car based lifestyles and norms form, households become resistant to change, contributing to inertia (and state dependence) in household car ownership levels;

- although the majority of households maintain car ownership levels from one year to the next, a higher than might be expected number of households do change their car ownership level: the gradual increase in aggregate car ownership levels results from a much larger churn (gross change) at the household level;

- household car ownership changes are often associated with key life events, although adaptation to a new set of circumstances takes time; and

- this lends weight to the claim that key life events present opportunities for reassessment of lifestyles or indeed may mark a change in lifestyle (for instance the birth of the first child). Such life events may lead to longer term behavioural (including and induced by car ownership) change (Bamberg et al, 2003, Fujii and Kitamura, 2003, Stanbridge, 2006, Goodwin, 2008).

While these tendencies have been *suggested* by the studies reviewed so far, it is arguable that there remains a need for evidence based explanation of how and why household car ownership changes over time. This argument will be returned to in detail in the research design presented in chapter three.

2.6 Number of cars and vehicle type choices

The preceding discussion reviewed what is known about how the household car ownership *state* changes over time and why. The review now turns to the point of car ownership change; firstly exploring the timing of and differing types of car ownership *transaction* (acquiring, relinquishing and replacing cars); then reviewing the important transition to and from *multiple* car ownership; this is followed by an overview of vehicle *type* choices. Lastly, the section concludes with a discussion of the specific case of non-car ownership.

2.6.1 Car ownership transaction types

From a retrospective survey of 1,700 randomly selected households in Toronto, Roorda et al (2000) reveal that in a twelve month period a household is most likely to *do nothing* with respect to their car ownership position, second most likely to *replace* a vehicle, third most likely to *acquire* an additional vehicle and least likely to *relinquish* a vehicle. Analyses of the data also confirmed several

intuitive, but notable relationships (Mohammadian and Miller, 2003, Roorda et al, 2009): that the likelihood of replacing or buying a vehicle increases with income, that the likelihood of replacing or disposing of a vehicle increases with the number of vehicles owned and that owning many vehicles decreases the likelihood of buying a further vehicle. Households with more valuable vehicle fleets were also less likely to undertake a transaction potentially reflecting the fact that newer, more reliable vehicles remain useful.

In terms of the *timing* of car ownership transactions, the data revealed that in a Canadian context, vehicles were held by households for an average of 5.5 years (Roorda et al, 2009). Intuitively, a recent vehicle replacement reduced the likelihood of a further replacement or acquisition. While if a household had acquired a vehicle some years ago, the likelihood of disposing of a vehicle or buying a new vehicle increased (Mohammadian and Miller, 2003).

Roorda (2000 p.73) also noted the important finding that as "the number of drivers in the household, exceeds the number of vehicles, the pressure to buy vehicles increases dramatically, and the pressure to dispose of held vehicles without replacing them decreases dramatically" (also confirmed in Mohammadian and Miller (2003) and Roorda et al (2009)). A more detailed analysis of this data, using simulated household activity schedules, confirmed that the pressure to acquire additional vehicles increased with the number of within household conflicts over access to the vehicle fleet (Roorda et al, 2009).

Lastly, Roorda et al (2009) demonstrated the extent to which car ownership transactions differ in terms of gains and losses to the household. For instance, the mode choice utility[4] of *gaining* an additional car was found to be highest for zero car households, second highest for one car households and the lowest for two car households. In the opposite direction, the mode choice utility loss after *relinquishing* a car was found to be higher for one car households losing their only car, than for two car households losing the second car. This demonstrates the intuitive notion that the first car is more useful to the household than subsequent cars. A further important finding was that the utility gained by buying a first car was two times less than the utility lost when losing a first car; again indicating that the acquisition of a first car leads to a growing degree of car dependency.

[4] Mode choice utility is the utility of the choice set of modes available to all members of the household which changes with fewer or more owned cars.

2.6.2 The transition to multiple car ownership

While the proportion of households in Great Britain with access to one car has remained relatively stable since the 1970s, the proportion of households with two or more cars has steadily increased and in 2009 stood at 32 per cent (Department for Transport, 2010 table nts0205). It is notable that as a result of reductions in household size over time, the absolute number of households with one car continued to increase from approximately 10 million to 11 million households between 1991 and 2005, while the absolute number of households with two or more cars increased at a faster rate; from approximately five million to eight million households (Office for National Statistics, 2004b, Department for Transport, 2007b). The increase in multi-car households has therefore made a significant contribution to the overall increase in car ownership at the aggregate level.

It has also been demonstrated that the move between one and two cars in either direction makes up the greatest proportion of households changing car ownership between two consecutive years (Dargay and Hanly, 2007). It is therefore of relevance to understand what motivates a household to move between one and two cars and vice-versa. However, as noted by Rouwendal and Pommer (2003 p.1), up to date literature pertaining specifically to the motivations for multiple or second car ownership appears to be “scarce”.

Hensher and Le Plastier’s (1985) earlier quantitative study indicated that multiple car ownership was associated with an increasing number of drivers in the household, company car acquisition and life stage. Dix et al (1981) partly qualitative study offered some deeper insights into the life stage relationship. They found that while in some circumstances second cars were exploited by two workers to increase household income, the birth of the first child may constrain employment opportunities for one worker, reducing household income and the need (or desire) for a second car. A reduction in demand for second cars was also noted for retiring couples.

Consistent with the earlier discussion on dynamic effects (car ownership inertia, lags and leads), second car ownership changes were further found to occur sometime in advance of, or following transitions between life stages (e.g. having a child or retiring). It was suggested that households may not relinquish a second car until tax or insurance is ‘used up’.

With respect to defining what might constitute a 'second car' within the household's vehicle fleet, the study noted that "in most households, there was a natural sense of hierarchy within the stock of cars…First cars…were always either the biggest, newest or smartest and often all three" (Dix et al, 1981 p.185). And in terms of car usage patterns, the 'first' car would most likely be chosen for use on occasions when both cars were available. Indeed, second cars were found to be "used substantially less on average than the first and only cars" (Dix et al, 1981 p.191). This hierarchical use of cars is confirmed more recently by Vovsha and Petersen (2007) and Rouwendal and Pommer (2003). National Travel Survey data also reveals that in a two car household, the 'first' car typically travels 14,000 miles in a year, while the 'second' car travels just 6,000 miles (Department for Transport, 2005).

A number of studies have focused specifically on how multi-vehicle households use the different types of vehicle in their fleet (Golob et al, 1996, Kurani et al, 1996, Mannering, 1983). Golob et al (1996 p.103) find that older vehicles are used less frequently than newer ones; that if the principal driver of a vehicle is male then it is used more than if the principal driver is female; and that increasing operating costs shift usage towards the more efficient vehicles. This substitution effect according to operating costs is also confirmed by Mannering (1983). Kurani et al (1996) investigate the market potential for shorter range electric vehicles, which they suggest should be viewed as being complementary to rather than competing with the market for longer range petrol alternatives. They argue that shorter range vehicles may provide adequate alternatives to some types of 'second' car which are only ever used for short trips.

Finally and importantly, Dix et al (1981 p.191) observe that reliable second household cars may be acquired cheaply and used relatively infrequently (yielding a "latent-pool" of would be second cars). This leads them to suggest that "second car ownership and usage decisions may well be especially sensitive to policy factors". Consistent with this argument, Roorda (2009) revealed that the utility loss associated with a two car household relinquishing the second car was three times higher than the utility gain associated with a one car household acquiring a second car. This is further evidence in support of the notion that households adapt to their level of car availability and as patterns of use become entrenched, households tend to resist a future reduction in car ownership level. This suggests that, if reducing the demand for second cars were deemed to be a

desirable policy outcome, it may be more effective to target policy measures on *potential* second car owners, rather than on *existing* second car owners.

2.6.3 Vehicle type choice

There is a further body of predominantly quantitative studies that have specifically explored factors associated with vehicle *type* choices. The up to date literature, undertaken in an albeit American setting, confirms the expected socio-demographic relationships (Choo and Mokhtarian, 2004, Cao et al, 2006, Adjemian et al, 2010); that ownership of luxury and sports cars is associated with higher incomes; that multi-purpose vehicles (MPVs, otherwise known as minivans) are associated with larger households; and that younger household heads prefer smaller cars, while older drivers opt for luxury and saloon cars. With respect to the number of vehicles owned, pickup trucks, coupes (sports styling), and large saloon cars are found to be associated with households with more vehicles; indicating that multi-vehicle households choose specific vehicle types to serve specific purposes.

Choo and Mokhtarian (2004) specifically investigate the relationship between attitudes and vehicle type choice. They report a mixture of both intuitive and counter-intuitive results. For instance that driving a luxury car is both associated with individuals pursuing a status seeking lifestyle, and also with individuals with a disliking for travel - the luxury car compensates for the unpleasant experience of travel. A preference for high density, urban living is associated with both ownership of compact cars (which are easier to manoeuvre) and ownership of a Sports Utility Vehicles (as higher income households may also live within high density areas). They note the counter-intuitive implications for policy; that high density living and travel demand measures that worsen conditions for car drivers may not promote the ownership of more fuel efficient vehicles amongst some population groups.

Cao et al (2006) explore the relationship between neighbourhood design and vehicle type choice. They confirm that higher density neighbourhoods are associated with the ownership of smaller cars, while more spacious suburban neighbourhoods are associated with the ownership of light duty trucks (MPVs, pickups and so on). More pertinently, they reveal that the relationship remains after controlling for attitudes, indicating that the built environment exerts an influence on vehicle type choices, independently of the geographic clustering of like minded individuals. As a cross-sectional study, they are unable to explore the

mechanism through which the built environment influences vehicle type choice. But recognise that residential relocations and vehicle ownership decisions are likely to be associated with a complex range of factors including for instance changes in life stage and income which should also be explored.

Adjemian (2010 p.674) reports that households display a tendency to “choose a car that is favoured by their neighbours”. Owing to data limitations, the study is unable to establish the extent to which this is due to social influence or is instead reflecting households with similar tastes in cars also choosing to live in the same neighbourhoods.

2.6.3.1 Market research into car ownership choices

The literature review presented in this chapter has focused predominantly on studies arising from the field of transport research. There is however, a corresponding body of *market research* into how consumers make car ownership choices. A brief review revealed that such market research is *supportive* of the transport studies reviewed so far.

A survey by Tesco Insurance, for instance, supports the notion of a relationship between vehicle brand preferences and geographic location (Motor Trader, 2008). Vauxhalls are found to be more prevalent in Scotland, while German manufacturers are favoured in London. Tesco suggest that proximity to a vehicle manufacturing plant is an influencing factor in some cases, given that employees may be offered favourable rates on new or lease cars. A further survey by Tesco Insurance highlights the *temporal* relationship between vehicle type and life-stage. Porches are reported as the ‘mid-life’ crisis car of choice; Fiats and Peugeots are found to be favoured by younger people, while Volvos, Mercedes and Jaguars are purchased by older people (Tesco, 2008).

Market researchers have also conceptualised the *time dependent* nature of car ownership decision making, in order to inform the development of sophisticated marketing strategies. DDB Marketing suggest that consumers move through a process of unconscious preference formation with respect to car ownership (Wiltshire, 2009). This then develops into an active phase of consideration in the lead up to purchasing a car during which specific marketing literature is consulted. This they depict as a ‘funnelling’ process through which a wider knowledge of the automobile market is gathered during the subconscious phase. This then becomes focussed into a short list of models to potentially purchase during the conscious consideration phase (Figure 2-11).

Image redacted for copyright reasons

Figure 2-11: The new car buying process

(source: Wiltshire, 2009)

This conceptualisation is supported by Sambandam and Lord (1995) who suggest that consumers first form ‘consideration sets‘, containing a subset of vehicle manufacturers whose product offers are then evaluated prior to making a purchasing decision. The formation of such consideration sets is found to play “a substantial role in a consumer’s decision to switch or repurchase the same brand” (Sambandam and Lord, 1995 p.57). The authors recommend sales and marketing strategies that emphasise good after care or dissatisfaction with competitors, given that the inclusion of brands within the consideration set is strongly influenced by prior experience and satisfaction with previous vehicles.

Terech et al (2009) also investigate brand loyalty in the automobile market using a 1997 survey of new car buyers. Their analysis suggests that there are two categories of loyal purchasers: *Hard core loyals* who repurchased the same brand as their previous car and had *not* considered other options; and *soft core loyals* who repurchased the same brand as their previous car but *had* considered other brands. They suggest that automobile companies that fail to recognise the distinction could underestimate the importance of marketing to soft core loyals during the consideration phase of the purchasing process.

Lastly, Wilkes (1995) uses data from the US consumer expenditure survey to explore the extent to which *household life-cycle stage* influences level of household expenditure on a range of consumables, including cars. He discovers a “general inverted U pattern” (Wilkes, 1995 p.41) whereby expenditure increases following cohabitation and child birth and thereafter declines as the household

reaches older age. This is consistent with Dargay and Vythoulkas' (1999) discovery of a household car ownership lifecycle as reported previously in section 2.5.1.

Given that the findings of such academic and non academic market research were found to be consistent with those arising from the transport research field, a wider review of market research was not considered necessary. The central objective for the literature review was to establish the most significant gaps in the transport field's knowledge base relating to car ownership. This required a comprehensive coverage of the wide ranging body of transport studies into car ownership as reviewed in this chapter.

2.6.4 The case of non-car ownership

To conclude this discussion relating to decisions concerning number of cars and vehicle type, the chapter returns to the earlier observation that a significant minority, 25 per cent of households in Great Britain live without a car. Although non-car ownership is arguably a special case in a motorised society, the body of literature relating specifically to the issue of who lives *without* a car, why and how they are able to meet their mobility needs is quite small. This is recognised by Goodwin (2006 p.19) who, in an article relating specifically to ex-car owners, notes that "their attitudes, desires, needs and behaviour are vitally important and it is an extraordinary gap in transport science that we know so little about them."

The research that has been undertaken to date confirms that non-car ownership is prevalent amongst lower income and lower socio-economic groups, younger and older age groups (particularly retirees), women, single occupancy or single parent households, and residents of inner urban areas (George Street Research, 1999, Welsh Consumer Council, 2004, Melia et al, 2011, in press, Muller, 1999, Reutter and Reutter, 1996, Dudleston et al, 2005). It is important to recognise that these groups do retain a degree of reliance on the car. A study undertaken in Scotland (George Street Research, 1999) revealed that 65 per cent of non-car owners claimed to be at least occasional car passengers while 35 per cent of non-car owners reported being frequent car passengers.

Studies have also tended to draw a useful distinction between people that are *voluntary* non-car owners and people that are *involuntary* non-car owners. Duddleston et al (2005) go further by conducting a segmentation analysis along attitudes to transport. They identify three groupings which they label: car sceptics (voluntary non-car owners), reluctant riders and car aspirers (both reflecting

involuntary non-car owners). Voluntary non-car owners (car sceptics) are typically younger, single, more environmentally aware and are more frequent cyclist than other non-car owners (Melia et al, 2011, in press, Muller, 1999, Dudleston et al, 2005). These individuals tend to focus on the positive aspects of non-car ownership, citing reduced stress levels, improved social lives, cost savings, no parking problems and better mental and physical health as key personal benefits (George Street Research, 1999).

Conversely, the involuntary non-car owners display evidence of social exclusion and are more likely to report the negative aspects of life without a car; citing inconvenience, lack of opportunity to take part in activities and having to rely upon infrequent public transport as particular frustrations (George Street Research, 1999, Welsh Consumer Council, 2004). Within this grouping, the reluctant (public transport) riders were identified as being unable to acquire a car due to financial or health constraints. This segment included retirees, people from lower socio-economic groups and those that are physically impaired. Car aspirers were more prevalent amongst the unemployed and lower socio-economic groups. They were not found to be motivated by environmental concerns, and aspired to own a car in order to have access to a greater range of destinations, rather than for reasons of status (Dudleston et al, 2005).

A further important observation is that non-car owners are not a static grouping in the population (Melia et al, 2011, in press, Muller, 1999). Indeed, in an investigation of the demand for car free housing, Melia et al (2011, in press) note that nearly half the voluntary non-car owners recorded in their survey sample had at some point owned a car. It is suggested that voluntary non-car ownership is possible in a particular set of circumstances centred around inner-urban living and that this position may not be maintained in the future if circumstances were to change (for instance, following having children and moving to the suburbs) (Melia et al, 2011, in press, Muller, 1999).

Accordingly researchers suggest that car-free living can be encouraged through the provision of attractive housing areas which enable access to local amenities and multi-directional public transport (Melia et al, 2011, in press, Muller, 1999, Reutter and Reutter, 1996). This typically requires land in urban centres which may be limited in availability. It is also noted that some provision for access to cars in designated car free developments, either through car clubs or limited residential parking, can act as an incentive to facilitate the transition to a longer-term non-car owning lifestyle.

2.6.5 Section summary

The key observations from this discussion of number of cars owned and vehicle type choices are summarised as follows:

- Car ownership transaction types differ in nature depending on the direction and increment of change: First cars are suggested to be more valuable to the household than second and subsequent cars. The benefits associated with *gaining* a car are found to be worth less than the disbenefits associated with *losing* a car; again indicating that car based lifestyles form over time as the number of cars in the household increases.
- Vehicle *type* choices are found to vary with life stage. Younger households tend to have smaller cars than older households. When surveyed by neighbourhood, households are also shown to share similar tastes in vehicles (e.g. residents of higher density neighbourhoods tend to own smaller cars).
- Lastly, there is limited research into the significant minority in the population that either choose not to own or are constrained from owning a car. This is not a static group in the population and households may periodically move into and out of car ownership depending on circumstances. It is observed that the conditions required to encourage and maintain voluntary non-car ownership are most easily provided in inner-urban locations.

2.7 Modelling and the study of car ownership

The preceding sections have provided an overview of the state of the knowledge relating to car ownership, and it is apparent that a great deal of which is owed to *quantitative* mathematical modelling techniques. Mathematical models are developed on the one hand to further understanding of behaviour, while on the other hand to provide predictions about how behaviour might change in the future. Given their importance to the study of car ownership, the review now moves on to address how car ownership models have been developed over time; how they have used and developed 'behavioural theories' or conceptual frameworks to further knowledge of household car ownership; and while recognising their valuable contribution to the field, discusses the role and limitations of modelling as a research method.

2.7.1 The development of car ownership models over time

Increasingly sophisticated car ownership models have evolved over a substantial period of time (since the 1930s according to (Whelan, 2007b)). The first and

simplest “aggregate time series” (De Jong et al, 2004 p.380) car ownership models were based on observations of the number of cars across a population at successive points in time. These were plotted and an S-shaped curve function fitted to the empirical data to enable forecasters to extrapolate the trend into the future. The use of S-shaped curves was justified with reference to theories of the diffusion of technology across populations. Such theories quite reasonably postulate that “the take up rate for new products is initially slow, then increases as the product becomes more established, and finally diminishes as the market comes closer to saturation” (De Jong et al, 2004 p.381). It is notable that these simple time series models were very influential in government decisions concerning the need for additional road capacity in the 1960s and 70s.

As more detailed socio-economic data about populations became available (providing indicators of income and household expenditure for example) the theoretical basis underpinning aggregate time series models could be improved to reflect simple economic relationships. For example, the function of the curve fitted to the car ownership time series data would reflect the observed relationship between changes in income across the population and car ownership (Mogridge, 1967) (rather than simply the shape of an expected trend over time). This represented an improvement in the sense that predictions about future car ownership levels in the population were based on some understanding of economic relationships (e.g. income elasticities, though not at this stage decision making processes) rather than on a simple extrapolation of a past trend.

In the 1970s, researchers in the field began to apply ‘discrete choice analysis’ (Lerman and Ben-Akiva, 1976), a statistical method emerging from the field of economics, to the development of ‘disaggregate’ models of travel demand, including models of household car ownership. This generation of models are disaggregate in the sense that they are derived from observations about the household rather than population averages.

Discrete choice models are often, though not always based on rational choice theory described earlier (section 2.4). At the time, the use of discrete choice techniques represented a significant step forward in car ownership modelling, as it was the first time a so called ‘behavioural theory’, in this case rational choice theory, (an albeit necessary simplification of human decision making, the validity of which is contested by some (Heggie, 1978, Gärling, 1998)) could be reflected in the structure of the mathematical formulae used in the model.

In its simplest form, a discrete choice household car ownership model (a vehicle holdings model) provides an estimate of the probability of a household owning one or more cars (the dependent variable). Ortuzar and Willumsen (1990 p.220) note that in a discrete choice framework:

"the probability of individuals choosing a given option is a function of their socio-economic characteristics and the relative attractiveness of the option"

However, more sophisticated discrete choice models also include characteristic variables that are not necessarily socio-economic in nature: for instance, attitudes, the effects of state dependence and so on as employed in many of the quantitative studies described earlier.

The probability of owning one or more cars in a utility based discrete choice model then varies according to the attractiveness of the household owning one or more cars, measured relative to the attractiveness of the household not owning one or more cars. Attractiveness is represented by the economic concept of 'utility'. Ortuzar and Willumsen (1990 p.220) note that:

"alternatives, per se, do not produce utility: this is derived from their characteristics (Lancaster, 1966) and those of the individual", and their preferences.

The *utility* of owning one or more vehicles is calculated as a linear combination of a set of explanatory variables which are selected by the modeller, given some (ideally evidence based) assumptions about the determinants of household car ownership. For example, Whelan (2007b p.210) sets out the utility of owning one or more cars as specified in the DfT's national car ownership model as follows:

$$U_{1+} = ASC_1 + b_1 LPA + (C_1 + C_{h1} D_h + C_{a1} D_a) Y + d_1 E + e_1 O + f_1 R$$

"Where: LPA is the number of driving licences per household; Y is household income; Dh is a vector of household type dummy variables; Da is a vector of area type dummy variables; E is the number of adults employed; O is an index of purchase costs; R is an index of vehicle use costs;...ASC is a vector of alternative specific constants; b, c, d, e, f...are parameter vectors to be estimated."

The *probability* (as opposed to utility) of a household choosing to own one or more cars is calculated by the model through a mathematical comparison of the utility of owning one or more cars to the utility of not owning one or more cars. Ortuzar and Willumsen (1990 p.220) notes that "for this a variety of mathematical

transformations exist which are typically characterised for having an S-shaped plot".

A detailed discussion of these transformations is not required here, but by way of an example, such functions (for a choice between two alternatives) must reflect intuitive probabilities. That is, if the utilities of two choices a and b say are equal, then the probability of choosing a over b will be 50 per cent. If the utility of choice a is substantially greater than the utility of choice b, then the probability of choosing choice a will be close to (but not greater than) one. And conversely if the utility of choice a is substantially less than choice b, then the probability of choosing choice a will be close to (but not less than) zero (Figure 2-12):

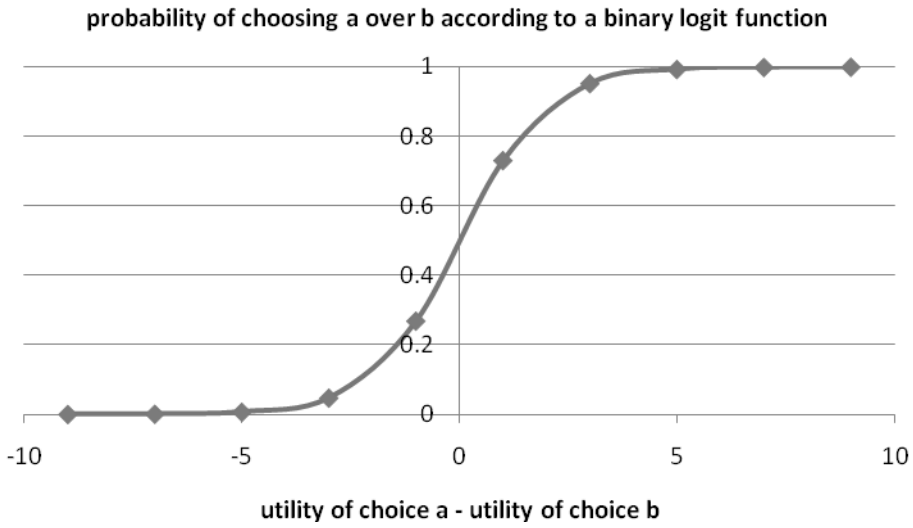


Figure 2-12: Shape of a binary logit function

It is up to the modeller to decide which variables to include in the utility functions for the available alternatives in the choice set, though this may be limited by data availability or by the extent to which a concept relating to utility can be measured quantitatively in a survey instrument. The coefficients for the model are then estimated statistically using a data set that includes information about the observed choices households have made (the number of vehicles owned in this case), the characteristics of the household (e.g. income, number of licence holders), and the factors affecting the attractiveness of car ownership (e.g. which might vary according to living in a rural or urban area) that are to be included in the utility functions.

The model specification may or may not provide a good match to the distribution of household car ownership levels as revealed by the data set. Through the process of model estimation (fitting the chosen utility and probability

transformation functions to an empirical data set) the modeller is provided with statistical information about which variables in the model are important in 'explaining' (in terms of mathematical relationships rather than real world decision making processes) car ownership choices and which variables are not.

The researcher interprets the statistical indicators about model fit to understand something about the most important determinants of household car ownership (i.e. how the mathematical relationships reflect a real world process or relationship). Indeed, this quantitative modelling approach forms the basis of many of the claims that have been set out in the preceding sections.

In addition to predicting observed car ownership behaviour, there is also a strong motivation to over time develop models of household car ownership choices that more accurately reflect real world decision making processes through their mathematical formulation (Hensher et al, 2008). Attention now turns to discuss the ways through which this is being approached.

As noted earlier, the first generation of discrete choice models tended to be based on rational choice theory and assumed that individuals made choices through a process of utility maximisation. These were estimated using cross-sectional, disaggregate data sets, which contain observations about households in a population at a single point in time. Such models are *static* since they contain no representation of change over time, (De Jong et al (2004 p.385) categorises them as "static disaggregate car ownership models"). A variety of static discrete choice model formulations exist some of which are based on rational choice theory, some of which are not. These are now reviewed.

2.7.1.1 Static disaggregate car ownership models

Ordered response choice models are for instance based on the hypothesis that "a single continuous variable represents the latent car ownership propensity of a household" (De Jong et al, 2004 p.386). Such models are structured around the reasonable assumption that household's move through car ownership levels (zero, one, two or more cars) in an ordered sequence. At a given point in time, a household has a propensity to add or remove a vehicle from their fleet; and the propensity to move into a particular car ownership state is assumed to be related to a range of factors, for example life stage or income. These factors are specified by the modeller.

Potoglou and Susilo (2008) however suggest that the relative weightings of the factors used to calculate the latent propensity variable is not supported by a behavioural theory and is instead derived from a purely mathematical process. This, they suggest is undesirable, drawing a comparison with *unordered response choice models* which do have a stronger theoretical underpinning, in being based on rational choice theory. Such models reflect a choice process through which households compare the utility of owning zero, one, two, or three or more cars and choose the outcome that offers them the highest utility. The choice process modelled is described as unordered as it is not assumed that the household need progress through successive car ownership states in sequence.

Indirect utility car ownership and use models jointly model car ownership and use. These models are 'indirect' in the sense that the utility associated with owning a car is assumed to derive from the ability to *use* a car. For instance, De Jong's (1997) utility maximising version of a joint car ownership and use model was based on "the idea that households compare combinations of car ownership and car use with each other and choose the combination that gives them the highest utility"[5] (De Jong et al, 2004 p.390).

A further refinement to static, disaggregate car ownership models was to model not only the *number* of cars in the vehicle fleet, but also the *type* of vehicles in the vehicle fleet. Vehicle type choice models use the same overall discrete choice modelling framework set out above, though many different model formulations (in terms of the variables included) have been developed and evaluated (Vovsha and Petersen, 2007, Spissu et al, 2009, Bhat and Sen, 2006, De Jong, 1996).

2.7.1.2 Dynamic disaggregate car ownership models

As noted before, static models, based on cross sectional data could by definition do nothing to represent or test the time dependent aspects of household car ownership decisions, even though the importance of time dependent processes (such as habit formation (Goodwin, 1977)) had already been recognised in theories about travel behaviour in general and car ownership specifically.

[5] the use of the word "idea" in this quote is notable, indicating (perhaps unintentionally) that this is an educated, and reasonable sounding assumption rather than an evidence based theory. While it would be wrong to claim that this is necessarily an invalid approach (all mathematical models must be based on a set of assumptions which simplify real world processes in a way that they can be reduced to a finite set of mathematical formulae), it would seem to indicate a requirement for a complementary, and alternative style of research approach which may be able to generate evidence to support or refute such starting points for modellers. This argument is returned to in chapter three.

This constraint was arguably imposed on the research community at the time by the limitations in data availability. However, since the late 1970s a growing number of car ownership modelling studies have been able to make use of panel data sets. Panel surveys collect information about the same households at repeated time intervals and hence are able to observe the process of change over time. Given the expensive nature of panel data surveys, a number of other studies have constructed and analysed so called 'pseudo-panel' data sets. These are panels constructed from successive cross sectional data sets which do not pertain to precisely the same sample of households.

Dynamic household vehicle holdings models estimated on panel data can be viewed as discrete choice[6] *discrete time-series* models (Ortuzar and Willumsen, 1990). These formulations use the same sorts of probability transformation functions that are specified in static discrete choice models but they also incorporate and test the strength of the influence on the current car ownership state of time dependent variables such as the car ownership state in a previous time period. While neither time nor the process of car ownership change tends to be represented in the model formulation as continuous variables, these models are dynamic in the sense that they estimate the probable number of cars owned through a sequence of fixed (discrete) points in time. Independent variables are incorporated to reflect the influence of what has happened before using observations about some aspect of car ownership from previous waves (years) in the panel. Other variables may be incorporated to reflect lags and leads (e.g. a delay in a car ownership change following a change in income).

Such (discrete choice, discrete time-series, vehicle holdings) models are not therefore 'fully dynamic' (Goodwin and Mogridge, 1981). As De Jong et al (2004 p.398) corroborate, Golounov et al (2001) "correctly" stated that "existing dynamic car ownership models...do not have a strong theoretical underpinning".

This lack of a theoretical basis has arguably begun to be addressed in the most recent advances in the dynamic modelling of car ownership, which has seen the development of 'vehicle transaction models'. These models take the current vehicle ownership state as the starting point and estimate how this is likely to change through transactions rather than a change in overall state. A vehicle transaction is typically defined as a vehicle acquisition, replacement or disposal.

[6] The term "discrete choice" is arguably misleading given the conceptual notion in dynamic models, that the most recent car ownership choice is in some way dependent on previous car ownership decisions.

Mohammidian and Miller (2003 p.99) suggest that transaction models offer a better prospect for reflecting real world behaviour noting that they:

"recognize fundamentally that the processes of buying and selling vehicles are different and are perceived differently by households. Transaction models have the potential to be more complex than holding models because there is more than one transaction path to arrive at a new holding level".

While vehicle *holdings* models estimate the probable number and / or type of vehicles owned at a point in time, vehicle *transaction* models either:

1. estimate the probability of a vehicle transaction occurring during a fixed time period; or
2. estimate the probable time until the next vehicle transaction occurs.

In the former case, "the decision to transact or not is modelled over a fixed discrete-time period" (Mohammadian and Miller, 2003 p.101) (usually one year between panel data points due to data availability), and the mathematics of discrete choice models is applied.

In the latter case, a branch of statistics known as hazard based duration modelling is employed to estimate the probable time until the next vehicle transaction and *time is handled in a continuous fashion*. De Jong et al (2004 p.400) note that a "hazard function gives the probability of exit from a state immediately after time t, given that the state is still occupied after time t" (hence the probability of a transaction occurring can be calculated for any given time t) and a 'hazard' in this context represents a vehicle transaction. By way of an illustrative example, De Jong et al (2004 p.399) describe the hazard function used in the Dutch Dynamic Vehicle Transactions Model. This they say "allows for a hazard [the probability of a vehicle transaction occurring] that increases or decreases over time with attributes of the person and household, attributes of the present car and attributes that vary [continuously] over time (e.g. fuel price index and a variable for quality of supply)".

Through the use of transaction models and panel surveys it has been possible to quantitatively test the influence of life events (for instance, moving house or a change in household structure) on the likelihood of a car ownership transaction occurring (Prillwitz et al, 2006, Yamamoto, 2008).

More recent developments have introduced a finer level of disaggregation and theory to the dynamic modelling of car ownership transactions. Recognising

that car ownership decisions often result from interactions between several members of the household, these emerging studies are attempting to reflect the influence of such intra-household interactions in their modelling frameworks (Roorda et al, 2009, Vovsha and Petersen, 2007, Hensher et al, 2008, Anggraini et al, 2008).

One example is the study by Roorda et al (2009) reported previously. They found that incorporating a finer measure of what they term *stress*, the number of intra-household conflicts over access to the vehicle fleet, led "to a significantly better model" compared to a model that used a coarser measure of stress, the ratio of the number of licence holders to the number of vehicles owned (Roorda et al, 2009 p.227).

2.7.2 The role of modelling in researching car ownership

This review confirms that car ownership models have indeed been refined and become more sophisticated over time. This process of development has been driven first by the availability of finer level, time-series data, second by advances in the probabilistic mathematical techniques (i.e. discrete choice analysis) available for representing choice making behaviour, third by advances in computing power (which is now enabling complex intra-household interactions to be surveyed and simulated on large scale data sets) and fourth by a desire to develop behaviourally accurate models that are sensitive to a wide range of policy measures (not just pricing signals for instance).

It has also been demonstrated that car ownership models vary in the extent to which they are underpinned by a behavioural theory. For instance, static discrete choice models often reflect some form of utility maximising behaviour, while some dynamic models have little formal theoretical basis and may quite validly set out to purely quantitatively test a hypothesis. For instance testing whether the previous car ownership state has an influence on the current car ownership state (Hanly and Dargay, 2000). While it is useful to know whether this is the case, quantitatively testing the hypothesis provides little or no insight into *why* it might be the case.

Indeed, Heggie (1978 p.541) offered an early critique of the then state of the art discrete choice models which were claiming to be "behaviourally sound". He argued that to "be behaviourally sound a model must demonstrate that its generalizations replicate the essential processes underlying that behaviour". He strongly claimed that assumptions underpinning some so called behavioural

models sometimes flew “in the face of what is known” (Heggie, 1978 p.542); citing that decision makers are often assumed to have complete knowledge of alternatives (which is intuitively known not to be the case) as an example.

More recently Gärling (1998 pp.3-4) succinctly noted that “in travel choice modelling a clear distinction is not always made between the statistical theory...and the substantial theory which must guide any modelling of a real-world process...behavioural assumptions are almost always made without reference to existing theories in the behavioural sciences”. He goes on to discuss the limitations of micro-economic theories of decision making (noted in section 2.4) which are often used in structuring discrete choice models.

On the other hand however, the extent to which models should even attempt to reflect actual behaviour is open to question. Some have suggested that the goal of a truly behavioural mathematical model is unobtainable. Following his discussion of how micro-economic theory of decision making could be improved Gärling himself (1998 p.13) notes that “far from anything as simple and elegant as micro-economic theory has been possible to suggest” and that “travel choice modellers [or indeed those that are evaluating such studies with a critical eye] may need to realise that quantitative behavioural theories may be unattainable” (Gärling, 1998 p.4).

Hopkin (1981 p.1) concluded that “the type of [car ownership] model that reproduces actual behaviour fully is likely to be too complex and data intensive to replace more conventional forecasting techniques, although some models might be feasible for particular population groups”. Town (1983 p.7) also concluded that “it is unlikely that such traits [social factors] could be incorporated directly into any form of mathematical model. More generally there is serious doubt about the practicality of developing models that represent in detail the various social factors that influence car ownership patterns”.

Nevertheless mathematical models should where possible be an accurate reflection of current knowledge. For example, a dynamic model that fails to represent the substantiated asymmetrical relationship between car ownership and income (discussed in section 2.5.5) would be implicitly wrong (even if it was consistent with the study’s own starting assumptions).

Some working within the modelling discipline advocate the use of complementary research approaches through which evidence based explanatory theories of the underlying process of car ownership change can be developed. In his analysis

of panel data, Yamamota (2008 p.42) recognises that “the statistical analysis used in this study cannot distinguish the causal relationship and the correlation” and suggests that “one way to overcome this limitation...is to obtain information on the reasons for each vehicle transaction...A qualitative survey might be useful for this purpose”. It is with this insight that this chapter now concludes. Issues of epistemology such as this are returned to in detail in the opening to chapter three which presents the research design for this study.

2.8 Chapter summary

This chapter began by explaining the process of motorisation in Great Britain in terms of a simple set of dynamic feedback relationships. It was demonstrated that the dispersal of land use patterns and a rebalancing of the transport network in favour of the private car occurred in response to a greater proportion of the population being able to afford cars of their own. The relationship between built environment and car ownership was shown to be complex however. Some quantitative studies suggest that preferences towards car based lifestyles may exert a stronger direct influence on car ownership than the built environment. Accordingly, studies that reveal the non-instrumental, affective motivations for car ownership were also presented.

The review moved on to explore what is known about how *household* car ownership changes *over time*, presenting evidence that households tend to resist changes to the car ownership level (car ownership is subject to state-dependence and inertia); and that car based lifestyles become entrenched following the acquisition of the first car. Other studies offered evidence that when car ownership level changes do occur they are often associated with wider life events such as employment changes or a change in household structure.

Observing through the review, that *quantitative* approaches have dominated the study of car ownership, the chapter concluded with a review of the modelling techniques that have been developed over the years. This section also offered some brief suggestions about the alternative types of qualitative research approach that might be appropriate for advancing understanding. This argument is now developed in chapter three which opens with a critical review of where further research into car ownership is now required in order to contribute to the body of knowledge reviewed here.

Chapter 3: Research Design

3.1 Introduction

This chapter presents and justifies both the two stage research design developed for the study and the specific methodology employed in the first stage of primary data generation and analysis.

The research design is set out under four sections. The first section on knowledge gaps advances the argument that *qualitative*, *longitudinal* methods are required to complement the quantitative, cross-sectional studies on car ownership that have been conducted elsewhere. The second section sets out the specific research questions and objectives that were defined for this study in relation to these knowledge gaps. The third section describes how a conceptual framework was developed, based on careful consideration of theory and the pertinent findings from the literature review. Lastly, the fourth section justifies why the research questions and conceptual framework implied the need for an inductive, flexible research design which comprised two stages of data generation and analysis.

Having set out the overall research design for the study, the chapter then moves on to describe the stage one methodology, which involved a small set of in-depth interviews. The stage two methodology is discussed later on in the thesis in chapter five. Consistent with the use of a *flexible* research design, options for the second stage of research are more naturally explored following the presentation of the stage one results in chapter four.

3.2 Knowledge gaps

The introduction to section 2.5 of the literature review "Changing car ownership at the household level" contained what constitutes the following two axioms:

Axioms about car ownership:

Aggregate car ownership states arise from individual households making changes to their car ownership state over time; and

In order to fully understand household car ownership states and how they arise, it is necessary to explore how and why household car ownership changes *over time*.

Taking a holistic view of the literature reviewed in the previous chapter and in particular as emphasised in the concluding section on the role of modelling, it is argued here that the two following epistemological statements[7] about the study of car ownership also hold:

Epistemological observations about the study of car ownership:

The study of car ownership has typically relied upon *quantitative* analyses; and

Car ownership research has often been limited to the analysis of *cross-sectional* data sets.

These two axioms and the two epistemological observations about the study of car ownership that followed provided the starting point for developing a research design for this study. The *household* constituted the unit of interest and there was recognition of a need to take a *longitudinal, qualitative* approach to deepen understanding of how car ownership changes over time. The study would be *complementary* to the mainly cross-sectional, quantitative analyses that had been undertaken elsewhere.

A rationale for the use of a flexible, exploratory, research design which required a *qualitative* methodology in the first stage of the primary research is developed later in this chapter from section 3.5. Attention here now turns to making a case for the need for *longitudinal* research into household car ownership.

3.2.1 The requirement for longitudinal research

Several summarising statements about how household car ownership changes over time were offered at the end of section 2.5, based upon evidence available in the literature. These were:

- buying (or having access to) the first car, encourages lifestyles and norms based around the car to form;

- as car based lifestyles and norms form, households become resistant to change, contributing to inertia (and state dependence) in household car ownership levels;

- although the majority of households maintain car ownership levels from one year to the next, a higher than might be expected number of households do change their car ownership level: the gradual increase in aggregate car

[7] Relating to how knowledge about car ownership has typically been generated.

ownership levels results from a much larger churn (gross change) at the household level;

- household car ownership changes are often associated with key life events, although adaptation to a new set of circumstances takes time; and

- this lends weight to the claim that key life events present opportunities for reassessment of life styles or indeed may mark a change in lifestyle (for instance the birth of the first child). Such life events may lead to longer term behavioural (including and induced by car ownership) change (Bamberg et al, 2003, Fujii and Kitamura, 2003, Stanbridge, 2006, Goodwin, 2008).

These statements are consistent with the suggestion that a requirement for a change in car ownership emerges *over time*. The decision to acquire, relinquish or to replace a car should not be viewed as a discrete, isolated judgement. A full explanation of a household car ownership change therefore requires an understanding of what also preceded and followed that change. This suggests a research focus on the *process* through which household car ownership changes over time. As Dey (1993 pp.37-38) notes, "the idea of process is bound up with the idea of change, and the circumstances, conditions, actions and mechanisms through which change comes about". Accordingly, studies concerned with understanding the *process* of car ownership change, must implicitly require a *longitudinal* research approach.

The limitations of cross-sectional data analysis were also observed repeatedly throughout the literature review. For instance, in the discussions of residential self-section (in section 2.3.1), it was noted that is not possible to explore *time precedence* using cross-sectional approaches. An understanding of time precedence is required in order to establish whether for example, the desire for a car-oriented lifestyle precedes the decision to move to a low density suburban neighbourhood. Or alternatively, whether moving to a low density suburban neighbourhood precedes a greater need for and a developing preference towards a more car oriented lifestyle.

Similarly, the cross sectional studies reviewed in section 2.3.2 revealed an association between lower car ownership levels and living in proximity to high quality public transport (Crampton, 2006). However, it could be that a preference for a less car oriented lifestyle precedes the move to an area of higher quality public transport. A cross-sectional analysis can establish the *association* between

public transport quality and car ownership, but not necessarily a *causal* relationship. Lastly, cross-sectional comparisons (reviewed in section 2.5.5) revealed that households with a car undertake more trips and travel further overall than households without a car (Department for Transport, 2006 pp.33-34). In this case it is not possible to establish the extent to which the car owning households had a higher pre-existing travel demand before acquiring a car than the non-car owning households. Moreover, cross-sectional data reveals little about the pathway of evolution towards current patterns of car use that occur following the acquisition of a first car.

Such limitations of cross-sectional approaches have been recognised by many working within the transport research field. In discussing issues of cause and effect, Mokhtarian and Cao (2008 p.205) suggest that (with an emphasis on quantitative analysis) four types of evidence are required to "robustly infer causality". These they identify as: "association (a statistically significant relationship), non-spuriousness (a relationship that cannot be attributed to another variable), time precedence (cause precedes effect), and causal mechanism (a logical explanation for why the alleged cause should produce the observed effect)". They suggest that longitudinal studies "offer substantial improvement over cross sectional designs" in this respect.

Moreover, as Chatterjee (2011) explores, a further issue with cross-sectional studies is that they may lead to observed behaviour being associated with *current circumstance* when the behaviour is actually more strongly influenced by *past experience*. This is the motivation behind exploring the strength of influence of time-dependent factors such as car ownership state dependence as reviewed in section 2.5.4.

Others working in the field (Dargay and Vythoulkas, 1999, Goodwin, 1998) offer a critique of the assumption made in cross-sectional studies, that individuals have reached *equilibrium* (stable) behavioural states. The problem with this assumption is best illustrated with recourse to an example: consider a cross-sectional cohort comparison of the car ownership states of couples *with* children, to those of couples of the same age *without* children. Arguably, some behavioural adjustments to the event 'having children' (including possible car ownership changes) may take some time, potentially years to take place and it would be unknown how far through this process of adjustment the couples *with* children are. Indeed, it has been suggested that in practice, true equilibrium behavioural states may never be reached (Dargay and Vythoulkas, 1999, Goodwin, 1998). A

cross-sectional comparison of the two cohorts, assuming that both groups had reached equilibrium states, would therefore risk under-estimating the longer term influence of the event 'having children'. Furthermore, a cross-sectional study would reveal no insights into the *process* of evolution towards the two alternative states (have children, do not have children). There may be unobserved characteristics of these different pathways, which have an important influence on eventual car ownership outcomes.

3.3 Research questions and objectives

It is suggested that these arguments provide a clear rationale for the use of a longitudinal research design to further understanding of household car ownership. The intention for this study was then to focus on the *household* and to explore the *process through which household car ownership changes over time*.

Accordingly, the parent research question for the study was stated as follows:

Research Question 1:

How and why does household car ownership change over time?

Given also that the initiation of this study had been motivated by a desire to provide policy recommendations concerning the potential for car ownership to change and if deemed appropriate, for car ownership changes to be prompted in response to specific policy measures, the following second research question was also defined:

Research Question 2:

To what extent is there potential for household car ownership to change?

The study was also guided by the following five, more specific objectives:

1. To *describe* how and to *explain* why household car ownership changes over time;
2. To examine the extent to which the present car ownership state meets (or exceeds) the household's desires;
3. To explore how households expect to change car ownership in the future;
4. To identify how residential location influences household car ownership and preferences towards car ownership over time; and

5. To provide policy relevant insights concerning the propensity for household car ownership states to change.

Objective one constitutes a re-statement of research question one. It makes it explicit that the research question required a research method that would first generate systematic *descriptions* of *how* car ownership changes over time. Such descriptions would provide the basis for explaining *why* such changes have occurred.

Consistent with the argument for longitudinal research into household car ownership, objectives two and three were included to guide the generation of insights into how *stable* the current car ownership position is; and how the current state is expected to change in the future. These factors would be understood in the context of past car ownership changes. Addressing objectives two and three, together with objective five would also provide answers to research question two in exploring the *potential* for household car ownership to change.

Objective four related to both research questions and was included to reflect the intention to provide some longitudinal insights into the specific relationship between residential location and household car ownership described in the preceding chapter (section 2.3.1). Exploring the complex, but important contextual relationship between built environment and car ownership was not intended to be a single or central focus for the study however and hence the influence of residential location was not explicitly defined in the two research questions.

It is also notable that the research questions and objectives referred to household car ownership *states* at the general level. This was intentional in order to provide a framework that would enable an exploration of both car ownership level changes, as well as vehicle replacements. Nevertheless car ownership *level* changes were at the outset considered to be of more interest in terms of understanding changes in travel behaviour, given that they reflect a more significant change in the transport resources available to the household.

3.4 The conceptual framework

Having established the specific research questions and objectives to be addressed through the study, a conceptual framework was constructed following consideration of the pertinent concepts emerging from the literature review and a

more focussed analytical review of the suitability of theories of relevance to car ownership. A conceptual framework is defined by Maxwell (1996 p.25) as “the system of concepts, assumptions, expectations, beliefs and theories that supports and informs your research”. Developing a preliminary conceptual framework as part of the research design is recommended as a means of providing a basis for the selection and design of an appropriate set of methods (Clifton and Handy, 2001).

3.4.1 The applicability of existing theories and frameworks

It was clearly important that the conceptual framework should recognise the time dependent nature of household car ownership change. Accordingly non-dynamic frameworks such as those underpinning static discrete choice models reviewed in section 2.7.1 were not considered to be appropriate for use in this study.

A broader search of literature relating to the dynamics of travel behaviour change also revealed relatively little in the way of agreed theoretical starting points. The transtheoretical model of behavioural change, a theory developed by researchers in the psychology and health fields, (DiClemente and Prochaska, 1982, cited in Beatty et al, 2002), has been used by some to gauge the extent to which individuals may be willing to change travel behaviour (Beatty et al, 2002, Jones, 2008). This theory outlines five stages through which a process of behavioural change may take place:

1. Precontemplation;
2. Contemplation;
3. Preparation;
4. Action; and
5. Maintenance.

However, the transtheoretical model was not felt to offer a suitable framework through which concepts such as changing lifestyle preferences and the occurrence of life events over time impinge on the process of household car ownership change. These were identified as being important factors to consider in the literature review (section 2.5). Moreover, as a highly structured theory, it was felt that it may constrain thinking and limit the extent to which the research questions could be explored and addressed.

3.4.2 Adapting the mobility biography framework

Attention therefore returned to the work of Lanzendorf which was first introduced in chapter two (section 2.5.3). Lanzendorf (2003) puts forward a theoretical framework of 'mobility biographies' which he designs with the specific intention to investigate how travel behaviours change over time. Drawing on the work of Salomon (1983), and using *aspects* of the *life course theoretical framework* (discussed in section 3.4.2.1) Lanzendorf defines three life domains through which time-lined data of relevance to understanding travel behaviour can be generated and analysed. These are:

1. the lifestyle domain (family formation, employment type, leisure preferences and so on);

2. the accessibility domain (relative spatial locations of home, work place and other activity centres); and

3. the mobility domain (car availability, public transport season ticket purchases, a record of actual travel patterns).

3.4.2.1 What is the life course approach?

The life course approach refers to an established theoretical framework in the social sciences that provides a set of premises and methodologies for understanding social systems, individual behaviour, and individual and social *change* from the point of view the 'life course'. Pioneers of life course research, Giele and Elder (1998 p.22) define the life course as:

"a sequence of socially defined events and roles that the individual enacts over time. It differs from the concept of life cycle in allowing for many diverse events and roles that do not necessarily proceed in a given sequence but that constitute the sum total of the person's actual experience over time. The life course concept also allows for the encoding of historical events and social interaction outside the person as well as age related biological and psychological states of the organism."

Thus a life course approach allows the researcher to interrogate in some detail how a present condition has arisen in relation to past events. Accordingly, applying *aspects* of this approach through the mobility biography theoretical framework offered an attractive starting point from which to develop a conceptual basis for the research design. First, it was compatible with the intention to investigate how the current household car ownership state had emerged over

time, in relation to past events, changing circumstances and wider decisions made by the household. Second, it provided a means of probing wider contextual factors in an orderly fashion and in doing so would enable the researcher to consider both the household unit (a primary concern of objectives one to three) and local contextual factors (a primary concern of objective four), whilst giving due consideration to the crucial time dimension.

3.4.2.2 Theories relating to the dynamics of household car ownership

The theoretical underpinnings of studies relating specifically to the dynamics of car ownership were then revisited to ascertain how the mobility biography framework may be adapted for the specific study of household car ownership change. As suggested by De Jong et al (2004 p.398) (in section 2.7.1.2), Golounov et al (2001) had "correctly" stated that "existing dynamic car ownership models...do not have a strong theoretical underpinning".

Nevertheless, some early studies did offer some important conceptual insights. Goodwin and Mogridge (1981) noted that while static car ownership models (derived from cross sectional data) may be adept at explaining observed car ownership states, they provided little insight into the *process* through which car ownership states arise (which may weaken their ability to make accurate forecasts). They offered a useful diagrammatic representation (Figure 3-1) of the key observations that firstly, populations take time to adapt their car ownership levels to a change in circumstance (in the illustrated case increasing income over time) and secondly, that populations tend to resist reductions in car ownership level:

Image redacted for copyright reasons

Figure 3-1: Dynamic car ownership response to changing income
reproduced from (Goodwin and Mogridge, 1981)

Related studies emerging from the Oxford Transport Studies Unit (Bradley, 1985, Goodwin et al, 1987) put forward a further conceptual model for representing the "phases of habit" formation which may occur as a person moves through the life course (Figure 3-2). This provides useful insight into the processes that may explain such time lags between circumstance change and behavioural adaptation:

Image redacted for copyright reasons

Figure 3-2: Representation of phases of habit
reproduced from (Bradley, 1985)

Five behavioural processes are represented in this model: first, habit formation. Bradley (1985 p.54) posits that during habit formation "a household or individual adjusts to circumstances by gaining experience with certain alternatives within a

limited range until a pattern which satisfies the priorities of the members is set". Second, entrenchment: during this phase, this pattern of behaviour is established as the "norm". Third, divergence: If the household's wider circumstances change over time, the established (as yet unchanging) pattern of behaviour may diverge from one or several alternative, more "optimal" patterns of behaviour. Fourth, dissonance: if such a divergence occurs (between circumstances and established patterns of behaviour), the household may attempt to "consciously or unconsciously…rationalise the continued habitual behaviour".

Lastly, the model reflects how a major life event may trigger the household to adjust their pattern of behaviour to adapt to the new circumstances. Importantly, Bradley (1985 p.54) notes that "these [behavioural] changes [in this case, a car ownership change] may be just as rational in the period before the shock as afterwards: it is perceptions, priorities or constraints which have changed."

With these insights in mind, a rationale for structuring the conceptual framework was developed, through the identification of four key components (highlighted in bold below and also depicted in Figure 3-3). The decision to use a **mobility biography** framework flowed from the need to consider change over **time**. Events and changes in a household's circumstances which may be captured through the mobility biography framework are related to changes in the household's **car ownership state**. A further mediating concept, labelled the household's **car access imbalance** (developed in section 3.4.3) was also identified to capture the subtle notion that while a household's car ownership state may change at discrete points in time (the day that the household acquires, relinquishes or replaces a vehicle), the extent to which the current car ownership state meets the household's desires may fluctuate in a more continuous fashion over time. This reflected the finding in the literature review that there is a *process* leading up to and following the point of car ownership change.

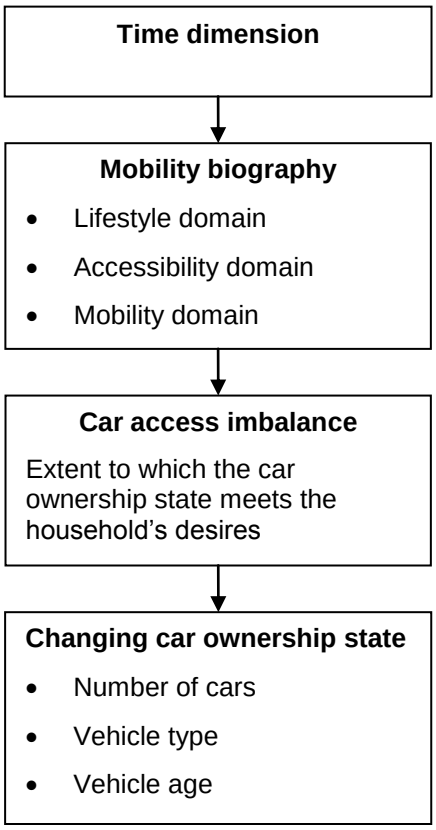


Figure 3-3: Components used to develop the conceptual framework

3.4.3 The concept of car access imbalance

The concept of car access imbalance was defined as follows:

Car access imbalance:

the *subjective* assessment of the extent to which the present car ownership state meets or exceeds the household's *desires*.

Drawing on the literature, desire was considered to arise from both the *instrumental need* for access to cars and from the *affective desire* for cars as a material good following Steg (2004) (as depicted in Figure 3-4).

As Oakil et al (2011) note, a change in *instrumental need* for cars may arise from a change in household circumstances, triggered by an event such as child birth or an employment change; this may require a higher degree of access to cars. Increased *affective desire* for cars may arise from a change in resources e.g. increased income prompting a greater desire for a 'better' car. Affective desire may also arise from social constructs such as social norms or indeed 'role beliefs' (which may change as an individual moves through the life course) as discussed in chapter two (section 2.4).

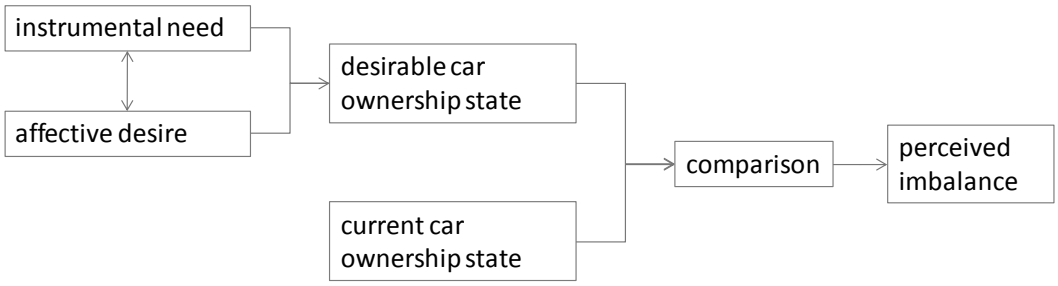


Figure 3-4: The concept of car access imbalance

3.4.3.1 Parallels with the concept of stress

Returning to the literature, the concept of car access imbalance was identified as being aligned with the concept of *stress*. This was developed by Rossi (1955) in the 1950s in his research into why families move. Working within the travel behaviour field, Miller (2005 p.183) explains that "stress arises when one's current state deviates from some alternative desired / expected / optimal state. The larger this deviation, it is hypothesized, the more likely one is to act in some way that attempts to reduce that stress." He also posits that "in many situations, people do not make continuous marginal adjustments to their state so as to maintain themselves at their "optimal"...state".

This is of relevance to understanding the process through which household car ownership changes. It is clearly not possible for households to make *marginal* adjustments to their car *ownership* state. A household can opt to own zero, one or two or more cars, but cannot (at least under current typical models of ownership) make a marginal adjustment to their car ownership level, to own 1.4 cars say. Similarly, a household cannot make a marginal adjustment to change the type of car that they own.

This inability to make marginal adjustments to car ownership states relates to the concepts of state dependence and inertia discussed in chapter two (section 2.5.4). Miller (2005 p.183) notes that it is "reasonable to hypothesize that people will tend to remain in their current [car ownership] state when stress is low, and will only actively seek to change this [car ownership] state when stress exceeds some threshold value." That is, only when the level of stress, or as postulated here a car access imbalance, becomes too large, will the household be tipped into an active search for an alternative, preferred state (if resources allow).

3.4.3.2 Magnitude and direction

It follows from this discussion that the concept of car access imbalance has *magnitude*. The household subjectively assesses the *extent* to which the present car ownership state meets or exceeds their collective desires. The terminology was also developed further to recognise *directionality*:

A car access surplus: arises when the household feels that they have too many cars or one or more cars of a type that is considered to be excessive for their needs. For instance a second car that is no longer used on a regular basis or a car that is now too large given that offspring have left home. A car access surplus may lead to a pressure to *reduce* car ownership level or to replace a large car with a smaller one.

A car access deficit: arises when the household feels that they have too few cars or cars that are of the wrong type. This might arise for instance when two adults are attempting to share access to a single household car, or when a young male decides that he would like a newer car (perhaps with a bigger engine) instead of the old car that he bought when he first passed his driving test. A car access deficit may lead to a pressure to *increase* car ownership level or to replace a small car with a larger one.

Notwithstanding this discussion of car access imbalances reflecting a process surrounding car ownership changes, it was also recognised that a change in car ownership may be imposed by a constraint which may relate to for instance reduced income or deteriorating health. In the case of an enforced vehicle relinquishment it was considered that a car access imbalance may *follow* rather than lead the change in car ownership.

3.4.3.3 The challenge of operationalising car access imbalance

Through the preceding discussions it is apparent that car access imbalance is a complex mediating concept which whilst of significance, is challenging to operationalise. First, it is a *subjective* concept that depends on both instrumental need and affective desire for cars. Second, at the household level, a car access imbalance reflects a consensual position formed by potentially *several members of the household* (discussed in the next section). Nevertheless, the notion that a household car ownership state may not represent an equilibrium position for the household at a given point in time was clearly an important concept for the study. And whilst recognising the complexity involved, it was considered that the primary

research should seek to reasonably *explore* whether imbalances could be observed empirically and if so to provide some further insights into how they might arise.

3.4.4 Individuals and household units

It was noted in section 3.2 that the 'household' was considered to form the observational unit for the study. This is supported by Heggie (1979 p.56) who notes that:

"Car ownership and use should not be characterised as an attribute of the individual, but as a pre-disposition felt by a household group faced with certain needs, a given pattern of land use and specific endogenous and exogenous constraints." (This is also mentioned in Clifton and Handy (2001 p.9)).

However, the household unit is in itself a somewhat complex and dynamic concept which requires careful definition, given the potential implications for household car ownership changes. Individuals organise themselves into household units, which may involve residing alone, or cohabiting with others. Cohabitation opens up opportunities to share resources, including cars, between household members.

Household units are transient and have shorter life-times than their constituent members. For instance partnerships form and dissolve; offspring are born and leave home. Nevertheless, at a single point in time, it is possible to conceive of a household unit which has an observable car ownership state. In their study of car ownership in Toronto, Roorda et al (2000 p.70) use the concept of a Decision Making Unit (DMU) which they define as the "set of persons within a household that make vehicle ownership decisions together. It is assumed that a household may consist of one or more DMUs and that a DMU may comprise one or more persons. For example, a household that consists of four students who act independently of each other would be assumed to comprise four separate DMUs."

With respect to exploring car ownership changes amongst a household, this definition of car ownership Decision Making Units was considered appropriate for use in the primary research phases of the study.

3.4.5 Introducing the conceptual framework

The conceptual framework, which draws together the key conceptual components of the time dimension, the mobility biography, car access imbalances and the changing car ownership state, is now introduced. To aid understanding and to demonstrate how changing circumstances over time may be associated with a change in car ownership, a simple hypothetical example is first presented, before introducing the *generalised* conceptual framework developed for the study.

3.4.5.1 A hypothetical example

Consider a young adult male, residing at his parental home and walking to work on a daily basis. He decides to move out, into his own home (marked by the events, moving house and forming a new household) and selects a residential location which requires him to now take the bus to work. Following the move, he finds the bus journey in comparison to the previous walk to work to be somewhat inconvenient. This prompts him to consider whether acquiring a car of his own might offer a better alternative – a car access deficit begins to arise. After a period of continued irritation with the bus journey to work (the car access deficit grows larger), he makes the decision to acquire a car of his own. Following the acquisition of the car he not only finds it much easier to get to work, but also finds the car to be more convenient for many other journeys. Accordingly his travel patterns and lifestyle preferences adjust to the new availability of the car.

This hypothetical example is now illustrated on a timeline based generalised conceptual framework which underpinned the initial stages of primary research (Figure 3-5):

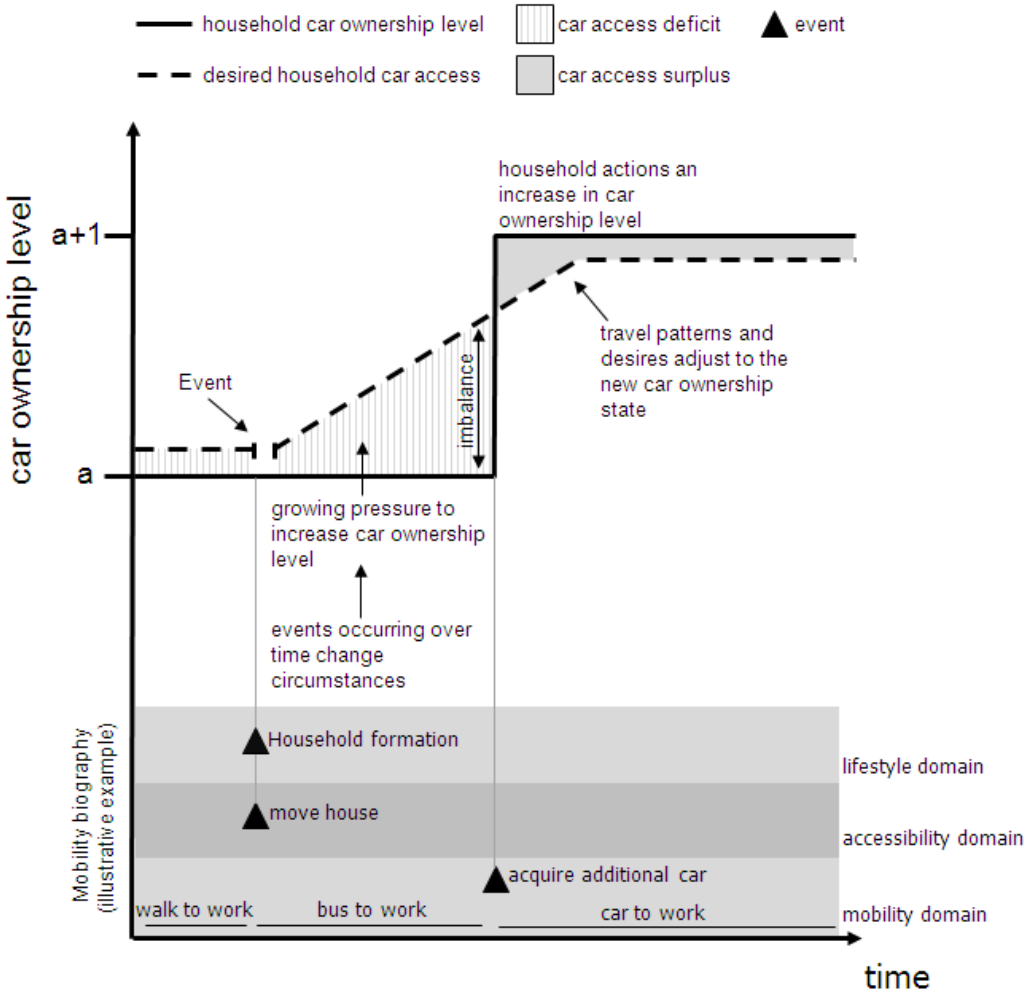


Figure 3-5: The conceptual framework

The framework is summarised as follows:

- Households make changes to their car ownership state over the course of time – car ownership states arise through a dynamic process.

- Life events may act as a trigger for changes in car ownership, but adaptation to a change in circumstances takes time. There are leads and lags - car ownership changes may occur in anticipation of or following such events.

- A household's current (and future) car ownership state is related to its past car ownership state(s) (the solid line in Figure 3-5). There is state and path dependency.

- While the household's car ownership state changes at discrete points in time, the extent to which the present car ownership state meets or exceeds the household's *desires* fluctuates in a continuous fashion i.e. not in integer

steps. This changing level of car access imbalance is represented by the dotted line and shaded areas in Figure 3-5.

Thus the upper section of the conceptual framework depicts the changing car ownership state and the fluctuating level of car access imbalance over time. The lower section of the diagram (which in this case also illustrates the hypothetical example) depicts events and behavioural changes occurring in the three mobility biography domains which may be associated with a change in car ownership.

With these theoretical and hypothetical considerations in mind, establishing what gives rise to a car access imbalance, how this related to events and changing circumstances (captured through the household's mobility biography) and the conditions under which an imbalance translates into a car ownership change, were important questions to be addressed through the research.

3.4.6 Situating the household unit in a wider context

The conceptual framework presented in Figure 3-5 relates only to the household unit, which may comprise one or more individuals. As identified in chapter two, householders and the process through which car ownership states change are subject to wider influences. For simplicity these were conceptualised in terms of influences arising from the built and social environments in an adaptation of a social-ecological[8] model presented in the Transportation Research Board's (2005) study of active travel and the built environment (Figure 3-6).

[8] Social-ecological models emerged from the field of psychology and were initially proposed by Urie Bronfenbrenner (1994). He conceptualised external influences on individual human behaviour as a series of nested layers with the individual at the centre.

Image redacted for copyright reasons

Figure 3-6: Situating the household in a wider context

(adaptation of Transportation Research Board, 2005 Figure ES-1)

3.5 Setting a framework for a flexible research design

The preceding discussion made the case that there are at present no formalised and agreed theories to reflect the process of household car ownership change. Instead, a conceptual framework was developed based on the key findings from the review of the car ownership literature and using aspects of the mobility biography theoretical framework proposed by Lanzendorf (2003). This was used to inform the design of a suitable set of research methods. Although it has not so far been made explicit, the preceding discussion on the role of theory in this study implied that the research strategy to be followed leant towards an *inductive* and *exploratory* approach, which required a flexible research design.

3.5.1 Inductive versus deductive approaches

In a *deductive* (confirmatory) approach, a social scientist starts with a theory about the world, constructs a set of hypotheses relating to the theory and subjects the hypotheses to empirical tests. In a purely *inductive* (exploratory) approach, as Bryman (2004 p.9) notes, “theory is the outcome of the research”. A researcher first makes observations about some phenomenon, with no preconceptions about how that phenomenon operates and generates a theory based on those observations. In reality research strategies are neither purely deductive nor purely inductive. Deductive approaches usually involve an element of induction through which a starting theory may be refined following new findings emerging from the data. While in inductive approaches, at least a loose set of concepts about the phenomenon of interest must first be established as a starting

point for the research; as was the case in this study - a conceptual framework informed by a literature review was constructed and used as a starting point to be explored and developed through the research process.

3.5.2 Flexible versus fixed research designs

A further useful distinction can be drawn between *fixed* (or non-emergent) and *flexible* (emergent) research designs. In a *fixed* research design a set of methods and analyses are tightly pre-specified and then carried out (Robson, 2002). A *flexible* research design on the other hand is less structured and is allowed to evolve over the course of the study in accordance with the findings emerging from the data (Robson, 2002, Maykut and Morehouse, 1994).

Indeed, parallels may be drawn between the fixed-flexible dichotomy and the deductive-inductive dichotomy. Fixed designs may tend towards a deductive approach given that a clear theory is required in order to develop a highly structured set of methods (Robson, 2002). Flexible designs, as employed here, may tend to involve an inductive approach given that an inductive approach requires the researcher to respond to emerging findings.

At this stage it is useful to summarise the rationale behind the research design that has been developed in this chapter so far:

- A review of pertinent knowledge gaps revealed a need to deepen understanding of and more widely explore the *time dependent* processes through which household car ownership states arise and change. Consideration of the reviewed literature suggested that there was a need for *longitudinal*, *qualitative* depth studies to complement the larger body of quantitative research (section 3.2);

- It was established that there were at present no agreed formal theories relating specifically to the process of car ownership change (section 3.4). The research strategy would therefore require an inductive, exploration of a high level conceptual framework.

- This implied that a flexible research design should be employed which would evolve in accordance with emerging findings.

Following the decision to adopt an exploratory approach requiring a flexible design, a research design working document was started, to firstly set out an overall framework for the entire study and secondly to assess and record

changes to the research design in a controlled manner as new findings emerged. From the outset it was envisaged that there would be two stages to the study:

Stage one: An initial depth exploration of how household car ownership states have arisen over time for a small sample of households; and

Stage two: Following an analysis of the stage one data, a suitable follow up study would be designed to improve the trustworthiness[9] of the findings emerging from stage one. The exact nature of the follow up study was unknown at the outset but it was envisaged that this would involve a decision between continuing a depth approach using a small sample (the composition of which was also unknown) or following a breadth approach on a larger sample to examine the broader applicability of the findings.

The overall research approach for the PhD is summarised in Figure 3-7:

[9] Trustworthiness in the context of flexible research designs refers to the extent to which the findings are *valid* (unbiased). It does not imply a necessary requirement to achieve a degree of generalisability (Robson, 2002).

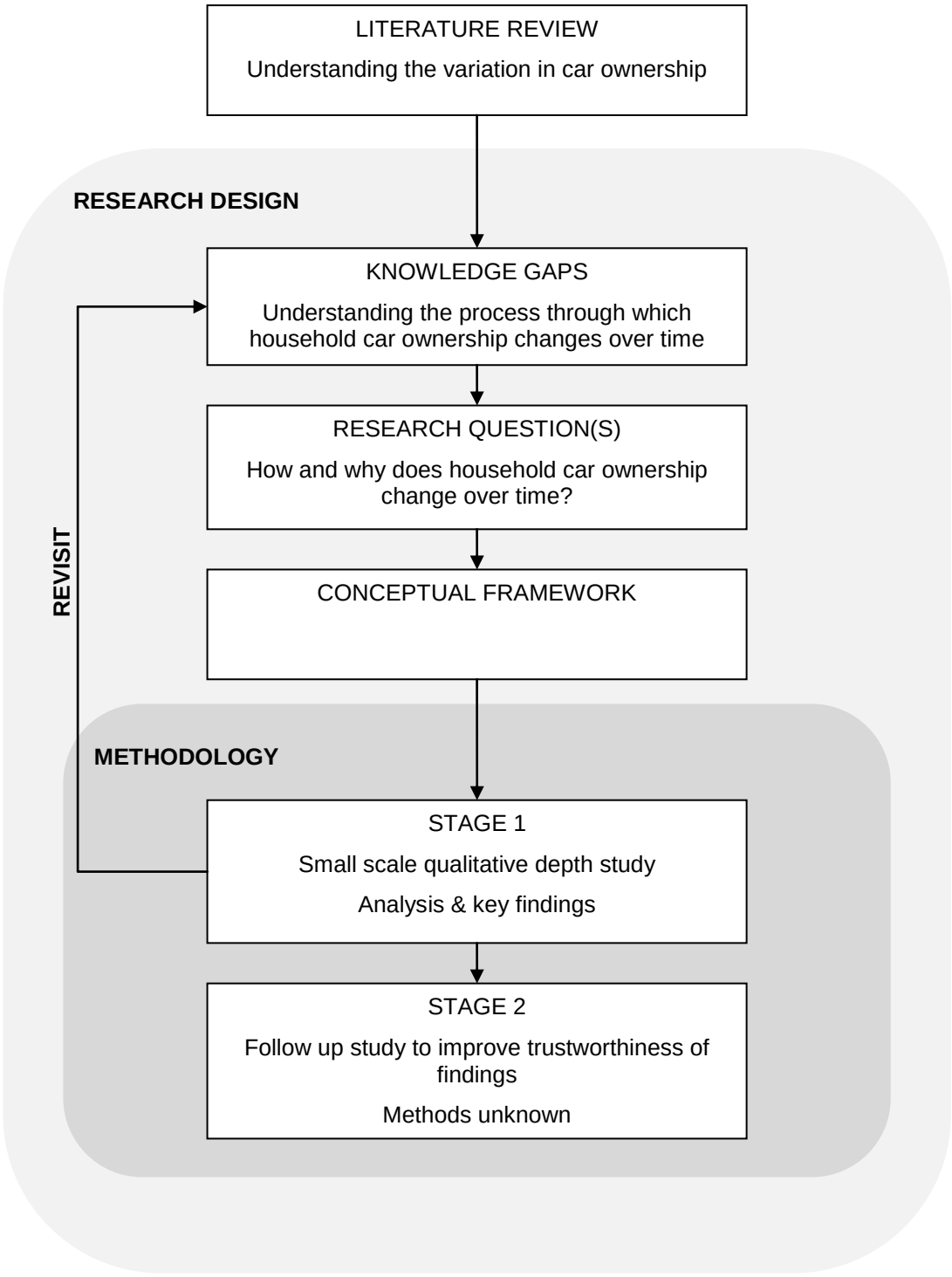


Figure 3-7: The research design

3.6 Part 1 methodology: In depth interviews

The chapter now moves on to offer a detailed rationale for the selection of qualitative in depth interviews as the stage one methodology. Detailed options for stage two are set out and evaluated in chapter five. Consistent with the use of a

flexible design, these are more naturally explored following discussions of the stage one analysis (presented in chapter four).

3.6.1 An overview of quantitative and qualitative research approaches

The preceding sections built the argument that given the lack of suitable pre-existing theoretical frameworks, the study required an inductive, exploratory approach; it followed therefore that a flexible research design should be adopted. The research methods literature also suggests that there is a further tendency for inductive, exploratory research to involve *qualitative* methods since qualitative methods enable the flexibility that is required in order to openly explore a tentative conceptual starting point. Likewise there is a tendency for deductive, confirmatory research to involve quantitative methods as these are well suited to testing more highly defined theories and hypotheses (Bryman, 2004, Robson, 2002).

Drawing a distinction between quantitative and qualitative research opens a complex debate as the two approaches are often viewed to be aligned with differing (some argue opposing) ontological and epistemological perspectives. Nevertheless, a pragmatic case for the use of a qualitative strategy in stage one of the study is made here in relation to understanding the most suitable approach to addressing the research questions.

Whilst not wishing to trivialise the debate surrounding quantitative and qualitative approaches to research, as a starting point, Bryman (2004 pp.19-20) offers the following useful and simple definitions for the types of data and analyses that are associated with each:

“Quantitative research can be construed as a research strategy that emphasizes quantification in the collection and analysis of data...By contrast, qualitative research can be construed as a research strategy that usually emphasizes words rather than quantification in the collection and analysis of data.”

Qualitative data may be defined more broadly in terms of what it is not i.e. it is anything that is not quantifiable (or has not been quantified) and may include for example, sound recordings or pictures as well as words.

3.6.1.1 Arguments in favour of complementary qualitative research

As was noted in section 3.2, an observation following the literature review was that the transport studies field and in this case the study of car ownership has traditionally been dominated by quantitative research (Gunnar Roe, 2000).

However, in recent years there has been a growing advocacy from those working within the field for the greater use of qualitative methods to complement (rather than to substitute for) quantitative studies (Clifton and Handy, 2001). Proponents suggest that, in contrast to quantitative approaches, qualitative research methods are better suited at providing explanation, and answering 'why' questions by "focussing on a small number of cases explored in depth...and generating a comprehensive account" (Clifton and Handy, 2001 p.13). Grosvener (1997 p.6) argues for the use of qualitative research to "put the flesh on the bones of the statistics". Mehndriatta and Picado (2003 p.305) suggest that exploratory, qualitative research is "invaluable" in "establishing the rules of process" through which individuals arrive at decisions relating to travel behaviour. Lastly, Goodwin (1989 p.131) notes that qualitative techniques may give "an understanding of possible cause and effect processes".

Thus it is suggested here that in combination with a *longitudinal* research design, *qualitative* data capturing a respondent's own account of how past car ownership changes came to be, would meet the four data requirements suggested by Mokhtarian and Cao (2008 p.205) relating to issues of cause and effect: that is evidence of association, non-spuriousness, time precedence and causal mechanism. Through a qualitative method, respondents would have the opportunity to reflect on and explain which influences were associated with car ownership changes and which were not.

Indeed, as far back as 1981, Goodwin and Mogridge (1981) recommended that the development of fully dynamic car ownership models would be aided by qualitative depth studies of household car ownership acquisitions. Smaller scale, depth studies have the potential to provide complementary accounts of the 'real world' household decision making processes which may help to inform the structure of new dynamic models and to uncover the most significant factors to be considered. However, the literature review has revealed that comparatively few such depth studies have been completed in the intervening years (Lanzendorf, 2006, Hopkin, 1981, Town, 1983, Dix et al, 1983).

These arguments all offered support for the use of a qualitative approach in addressing the overarching research question:

How and why does household car ownership change over time?

While the "how" component was concerned with providing *descriptions* of the ways through which car ownership states have emerged over time, the "why"

component was concerned with providing *explanation*. What are the processes through which these car ownership pathways are formed and how do they operate?

3.6.2 Weighing up alternative methods: Selecting in-depth interviews

The intended outcome of stage one of the study was then to generate a set of *qualitative* accounts of how household car ownership states arise and change over time for a carefully selected sample of households (see section 3.6.4 for a discussion of the sampling strategy). This limited the range of research methods that could be considered for use.

Firstly, the longitudinal nature of the research question implied making a choice between using a panel style approach (to capture new car ownership changes as they occur over time) and relying on retrospective recall (to capture car ownership changes that have happened in the past).

Panel approaches involve questioning the same participants at regular intervals over a given period of time (Lanzendorf, 2003). In this way it is possible to capture how their circumstances and views change over time. A panel approach appeared impractical for the stage one depth study and was quickly ruled out. First, the entire study was to be completed in three and a half years, leaving little time for the design of suitable survey instruments, recruitment and the repeat questioning of participants. Indeed, the initial stage of the research was intended to be completed in a timely fashion, leaving enough room in the work programme for a follow up study to be designed and carried out. Second there was the risk of attrition, with participants becoming unavailable for later waves. Third, the literature indicated that household car ownership is highly state dependent (Hanly and Dargay, 2000) and changes over the medium term (up to five years (Roorda et al, 2009)). Questioning a small sample of people repeatedly over a relatively short period of time ran the real risk of capturing few car ownership changes.

A method whereby participants retrospectively recalled how their *current* car ownership position had arisen in relation to *past* changes therefore seemed more suitable. This would also allow a longer period of a household's history to be captured than would have been possible through a panel. Attention then turned to the selection of an appropriate research instrument – a questionnaire, focus group or in-depth interview.

Use of a household questionnaire, either self completion or interviewer led, was quickly ruled out given that questionnaires are not well suited to eliciting open

ended qualitative responses. The richness of the retrospective information demanded from participants was also considered to be challenging to elicit in a questionnaire format and the reliability of such data would be called into question. Furthermore questionnaires are implicitly highly structured leaving no room for exploration and this was a key aim for the first stage of the research.

Focus groups, which are facilitated discussions undertaken in a group setting (typically with eight or more participants), also appeared unsuitable. Although focus groups provide an opportunity to explore group dynamics, understanding group influence outside of the household unit was not a requirement for the first stage of the study. This was focused on understanding how the *household* car ownership state had changed over time in detail. Discussing car ownership changes with a group of participants from several different households had the potential to generate a confusing mix of accounts, none of which would have been sufficiently detailed to offer useful insights.

Consideration then turned to the suitability of in-depth interviews with one or more household members. In-depth interviews may be positioned on a spectrum ranging from fully-structured to unstructured. Robson (2002 p.270) explains that fully structured interviews have "predetermined questions with fixed wording, usually in a pre-set order" while in an unstructured interview "the interviewer has a general area of interest...but lets the conversation develop within this area. It can be completely informal". In between these two extremes, a semi-structured interview allows the researcher to ask respondents questions about specific themes, but the order of the questions can be modified during the interview, and there is room to deviate from a loosely structured interview guide. If an area of interest emerges spontaneously during the discussion, then this can be followed up 'on the hoof'.

3.6.2.1 Issues of retrospective recall

A further benefit of using in depth interviews is that, as Lanzendorf (2003) suggests, they offer the potential to improve the validity of retrospective data in comparison to self-completion formats. Interviewer led formats allow respondents to be guided through the generation of a chronological account of their car ownership history which would otherwise be cognitively challenging in a self completion format. Areas of uncertainty can also be recognised and revisited during the interview or at least recorded as such. Techniques such as event-history calendars (of which mobility biographies are a form) can be employed to

improve the recall and sequencing of events. Through gentle prompting by an interviewer (Parry et al, 1999) the collocation of events in time has been shown to aid the generation of reliable chronological accounts (Belli, 1998). It is also suggested here that car ownership changes themselves constitute an *event* as well as a significant change in household resources. This increases the likelihood of successful recall. It was considered therefore that the construction of a mobility biography during an interview would offer a suitable means of generating reliable accounts of past car ownership changes.

With these considerations in mind it was deemed that the most appropriate method for the first stage of primary data generation would be *to undertake a set of semi-structured in-depth interviews with a range of specific household types*.

3.6.3 Designing the interview guide

The interviews were semi-structured in the sense that participants were asked about common themes relating to their car ownership history, current car ownership state and future desires, but there was room to deviate from a loosely structured interview guide.

The interview procedure and moderator guide (included as Appendix B) were developed iteratively through a process of piloting with volunteers recruited from within the university faculty. As recommended by Robson (2002), the interview was designed to start with an easy warm up section to ease the participant and researcher into the interview. Similarly, following the main body of the interview, the intention was to close with some straightforward questions which could lead into an informal discussion about points of interest that may have arisen. Robson suggests that interesting material can often emerge after the 'formal' interview has taken place and it is useful to record this if possible.

With respect to eliciting an accurate chronology of a household's car ownership history and the surrounding events, it became apparent that a small amount of pre-interview preparation to aid an orderly recall would be beneficial. This took the form of a brief pre-interview letter (also included as Appendix B) which gently prompted each participant to note down a chronology of their owned or company cars relative to job and house moves in a table provided on the back of the letter, prior to the interview.

The interview itself was designed to take around one hour and contained the following five sections:

Section one: An introductory section to elicit a simple, non-deliberative description of the current household car ownership state to ease the participant and researcher into the interview. This was followed by a brief discussion of typical patterns of car use for the household.

Section two: This involved the development of a mobility biography (focusing on car ownership history and associated events) using visual recording techniques to generate a chart (similar to the conceptual framework illustrated in Figure 3-5) for each participant. The researcher tended to work backwards through the respondent's car ownership history which they had prepared before the interview (i.e. starting with the most recent car ownership change), and then moved onto probe for the timing of important events in the households life[10]. Lastly the respondent was asked to broadly describe the general travel patterns for members of the household for clearly defined periods of time (for instance between two residential relocations or following child birth).

As well as generating an important document for later analysis, the drawing of the mobility biography provided the researcher with a visual reference point to guide a wider discussion of the household's history and past car ownership decisions. The discussion surrounding this task also formed a valuable part of the interview in providing explanatory insights into the reasons for particular car ownership changes. An example of a mobility biography timeline is included as Appendix C.

Section three: This constituted a more focussed discussion of the circumstances surrounding and the factors considered during either the most recent car ownership transaction or alternatively the most interesting car ownership transitions. Car ownership *level* changes were considered to reflect a greater change in the household's mobility resources in comparison to vehicle replacements and were prioritised accordingly.

Section four: This was followed by a deliberative assessment of satisfaction with the current car ownership state (operationalising the concept of current car access imbalance), which led the participant into considering their expectations for changing car ownership state in the future. Following some discussion, each participant was asked to mark where they were on a scale ranging from "I hadn't considered changing car ownership at all" through to "I'm actively seeking to change car ownership".

[10] The researcher deviated from this approach if the respondent felt more comfortable working forwards through time.

Section five: The final section constituted a stated adaptation experiment (Lee-Gosselin, 2003 p.335) in which the participant was asked to consider how they would expect to manage if one of the household cars were not available for two months[11]. To guide their thought process, a circular chart of alternative options (travel modes or lifestyle adaptations) was provided. The participant was then asked to distribute 10 tokens across the options to indicate and explain how car trips would otherwise be managed. This explored the level of household 'dependency' on the lost car. For instance, a highly car dependent participant had the option of allocating all 10 tokens on 'arrange a hire car'. This section related to research question two and was included to specifically examine the potential for car ownership *reductions* amongst the participants. An example of a completed stated adaptation chart is included in Appendix C.

The researcher then led a more conversational, relaxed discussion (still recorded) as the material was gathered together, drawing the interview to a close. All of the interviews were recorded and fully transcribed.

3.6.4 Sampling strategy and recruitment

3.6.4.1 Urban versus rural locations

With respect to the sampling strategy, an early decision was taken to focus the study on *urban* households only. Although understanding the influence of differing residential locations on car ownership change was identified as an objective, it was decided not to draw comparisons between rural and urban households. The particular transport circumstances of rural and urban households were not considered to be necessarily comparable whereas they would be across households drawn from *within either* an urban or a rural setting. The decision to focus on urban households was considered to be justifiable for three main reasons[12].

Firstly, 73 per cent of the population in England live in urban areas (Office for National Statistics, 2009). Researching households in an urban setting offered the potential for the findings to be relevant to this predominant urban population. Secondly, the well documented negative consequences of car ownership and use

[11] The temporary two month period was selected because it was felt that constraining the participants to consider the permanent loss of access to a car would have been unrealistic, as many of them would be able to afford to replace the car.

[12] It is recognised that an equally strong, but different case can be made for researching car ownership in the rural context.

are arguably more acute in urban areas than they are in rural areas owing to the greater population and vehicle densities. Indeed, it has long been argued in contemporary transport policy that reducing the reliance on the private car in urban settings would be of benefit to society. This again supported the policy relevance of the research in an urban setting, an important motivation of the researcher. And thirdly, from a policy perspective there is arguably greater potential for the provision and use of non-car based modes in urban settings given the shorter distances between activity centres and the wider availability of public transport systems.

3.6.4.2 Sampling from a single urban location

A further research design decision was taken to recruit study participants from a *single* urban area as opposed to recruiting from several urban areas across the UK. An important consideration for the initial exploratory stage of research was the need to control the variability in household circumstances. The in-depth interviews would involve a comparatively small sample and it was considered that drawing the sample from a *single* urban location would minimise the potential variance in transport availability outside of the household. This offered a degree of control when drawing comparisons between households. Moreover, while generalisability was not an objective of the first stage of the research (as is discussed further in section 3.6.4.5), it was considered that the findings from a study located in a single urban location would nevertheless have some relevance to other urban areas in the UK. Following the deregulation of local bus services in the 1980s, many UK towns and cities (outside London) have faced similar challenges in arranging adequate public transport networks and as a result suffer from the consequences of high levels of car ownership and use.

Lastly, a further advantage of situating the study in a single location was that it allowed a concentrated local network of contacts to be built up. This became an important factor in recruiting for both stages of primary research. As is revealed in section 3.6.4.6, local word of mouth snowballing was the most effective of several strategies employed in recruiting for the in-depth interviews. Similarly, local proximity also enabled the successful use of a necessary ‘drop and collect’ (Walker, 1976) process of survey administration during the follow-up stage of primary research. This strategy is discussed in detail in chapter five.

3.6.4.3 Situating the study in the city of Bristol

Attention then turned to whether the city of Bristol, the residential location and work place of the researcher, offered a convenient yet suitable setting for the study. Bristol is the seventh of eight core cities in England which are identified as being "the economically most important areas in England outside London" (Core Cities, 2011). It has a population of 433,100 and covers an area of 110 km^2 (Bristol City Council, 2011d). Of the eight core cities, Bristol has the highest rate of car ownership with 71 per cent of households having access to at least one car according to the 2001 census. This compares to an average of 58 per cent of households having access to at least one car across the other seven core cities (Office for National Statistics, 2004a).

Bristol also has a somewhat limited (mainly bus based) public transport system compared to other major cities, though a significant programme of bus network improvements has begun. Consequently satisfaction with the local public transport network has traditionally been relatively low, but is improving. According to the Bristol quality of life survey, 57 per cent of respondents reported being satisfied with the bus service compared with 63 per cent across the other core cities (Bristol City Council, 2010). Nevertheless, a comparatively high proportion of Bristol residents were able to walk to work in 2001 – 15.6 per cent compared to 10 per cent nationally (Bristol City Council, 2011a). And cycling to work is showing significant increases in the city from seven per cent of survey respondents in 2007 to nine per cent of respondents in 2009 (Bristol City Council, 2010). This has occurred in the period since the city was granted cycling city status in 2008 (Bristol City Council, 2011c).

Recognising the specific transport challenges facing the city, the city council website (Bristol City Council, 2011b) at the time of the study reported that:

"Every weekday, half a million vehicles cross into and out of the city centre. The average speed in the centre has fallen to just 11 mph at peak times and the number of road casualties is worryingly, showing signs of increasing. Air quality fails to meet national standards throughout much of central Bristol and surrounding areas. It is clear that Bristol has some important transport challenges."

Thus Bristol is an important UK city, which suffers particularly from the effects of high car ownership and use, coupled with a somewhat limited but improving public transport system. Understanding what gives rise to high car ownership in

Bristol would clearly have particular relevance locally, but the implications of the findings were also considered to apply to other urban areas in the UK. Lastly, there were the practical, but nonetheless important logistical considerations of recruitment and administration of the primary research instruments. For these reasons, Bristol was considered to offer both a suitable and practical location in which to situate the research.

3.6.4.4 Households versus individuals

Consideration was then given to whether the interviews should involve all adult members from each household decision making unit together (rather than a single individual) having recognised in the conceptual framework that car ownership is an attribute of the household unit, rather than of individuals. Grosvenor (1997 p.8) also suggests that household interviews "can explore such issues as the collective use made of the household car (or cars) and the knock-on effects of one individual's choice on the choices and behaviour of other household members."

Considering the title and objectives of this study, it seemed appropriate that where possible, all adult household decision makers would be recruited in preference to selecting a single household member. However, given expected difficulties in recruiting and arranging interviews with more than one household member, opportunities to interview suitable single household members were also deemed to be a nevertheless adequate alternative.

In relation to planning the number of households to recruit for stage one of the study, it was recognised that in flexible research approaches such as this, it is not always possible to pre-specify a precise sample size. However, it was appropriate to at least work towards an estimated range and this was informed by reference to relevant research methods literature.

Robson (2002 p.199) suggests that researchers should carry on adding to their sample until they reach a notional saturation point, after which each additional case reveals fewer new and valuable insights. Grosvenor (1997 p.9) notes that the sample should "embrace the range of attitude groups" and that "contrasts [between cases] need to be strong in order to interpret the data accurately". Mehndriatta and Picado (2003 p.308) emphasise that it is "futile to seek representativeness", but that the researcher should seek "exemplary situations" while avoiding unique cases. They suggest that a typical sample size ranges between 10 and 20 cases.

Accordingly, a target sample size of between 15 and 20 interviews was selected as a starting point, given the need to analyse this data before designing suitable follow up work.

3.6.4.5 Stratifying the sample

It was important in this exploratory stage of research to carefully identify a small purposive sample, in which participants had been carefully selected for inclusion, based on the possibility that each participant will expand the variability of the sample (Maykut and Morehouse, 1994). An earlier car use study by Dix et al (1983 p.253) opted to stratify a sample of 58 households for in depth interview according to three dimensions:

1. Household car availability (one car and more than one car);
2. Household location (inner urban, intermediate urban and outer urban); and
3. Household composition (which was split into eight sub-categories).

This three-dimensional stratification strategy also appeared suitable for this study as it aligned well with the objectives to explore how alternative car ownership states have arisen (stratum one), the influence of residential location on car ownership preferences (stratum two) and how households at different life stages reflect on their car ownership state (stratum three, household composition may loosely proxy life stage). However, a sample size of at least 48 households would have been required in order to capture one household per category.

For this reason it was decided that an initial 16 household target sample should be primarily stratified according to household car ownership state (the main phenomenon to be explored through stage one). The preferred sample composition according to household car ownership state is outlined in Table 3-1:

Table 3-1: Target sample composition for stage one interviews

Current car ownership state	Number of households in sample
1 car, stable	approximately 6
2 car, stable	approximately 6
1 car, recently changed up from 0 cars	at least 1
0 car, recently changed down from 1 car	at least 1
1 car, recently changed down from 2 cars	at least 1
2 cars, recently changed up from 1 car	at least 1
Total:	approximately 16

The rationale for selecting both stable households and households that had recently changed car ownership level, was to provide an opportunity to gain depth insights into households that were at differing stages in the process of car ownership change. Participants that had recently changed car ownership level may recall details that would otherwise be lost over the passage of time. They would also be able to talk in terms of their current perspective rather than providing a retrospective account which inevitably reflects a somewhat post-rationalised view of a past circumstance.

Before attempting to recruit participants it was predicted that 'stable' one and two car owning households would be more prevalent and easier to contact than recent car ownership level changers. It was felt that the chances of successful recruitment would therefore be higher for these categories. Participants in these categories would also have experienced at least changes between zero and one car and between one and two cars. And there was a good chance that (older participants at least) would also have experienced one or more vehicle replacements.

Given expected challenges with recruitment, a realistic view was taken that stable one and two car households would form the largest grouping within the sample (with equal numbers in each category). This would nevertheless be satisfactory given the range of potential car ownership changes that would have been experienced by participants in these groups. Efforts would also be made to recruit *at least* one household in the recent change categories (one to zero cars and vice versa, and one to two cars and vice versa).

Households that had *never* owned a car were considered to represent a unique case. With reference to the conceptual framework (section 3.4), it could be hypothesised that such households were managing a so called 'car access deficit' over the longer term. Whilst recognising the value of understanding how this group had met their mobility needs over time (compared to car owning households), it was felt that to examine their circumstances in detail would require a specifically tailored research design. The interview guide had been designed to explore how car ownership *changes* had occurred in relation to wider changes in the household's circumstances. It was not an appropriate means of examining the experiences of households that were yet to acquire a car. Indeed, a case could be made for a dedicated study into non-car owning households. For this reason, a scoping decision was taken to *exclude* households that had never owned a car from the sample. Nevertheless, efforts were made to recruit ex-car owning households, as the motivations for acquiring and then giving up cars could be explored using the same interview guide. This would offer some albeit limited insights into the experiences of non-car owning households compared to those of car owning households.

The following categories relating to local area within Bristol and household structure were also defined:

Local area:

1. Inner urban i.e. the city centre could be realistically reached by walking or a short cycle ride;
2. Outer urban i.e. On the boundary of the city; and
3. Intermediate urban – the midpoint between these two extremes.

Household structure:

The following broad categories were considered to reflect a range of household structures and within these categories it was envisaged that a range of differing life stages would be recruited:

1. Single household units;
2. Couples, no children; and
3. Families with children.

While efforts, through filtering were made to recruit a reasonably balanced spread across these two dimensions, there were no planned intentions to target a specific number of households from within each category.

3.6.4.6 Recruitment strategy

A £20 incentive was arranged in recognition that participants would be required to give up at least an hour of their time. Given the need to recruit potential participants quickly, several recruitment avenues were explored, which together constituted a snowballing or opportunistic recruitment strategy:

1. A household flyer drop (to target the three specified local area types);
2. Leaving flyers at used car retailers (to target recent car ownership changers);
3. A posting on the Gumtree car sales website (again to target recent car ownership changers);
4. Opportunistic word of mouth snowballing through acquaintances and earlier participants; and
5. A posting on the Institute of Physics intranet (arranged via an acquaintance).

The number of households recruited through each of these avenues is outlined in Table 3-2

Table 3-2: Stage one recruitment strategies

Recruitment strategy	**Number of households recruited**
Household flyer drop (120 households, 40 per local area type)	2
Used car retailer flyer drop (two retailers)	0
Posting on the Gumtree car sales website	1
Word of mouth snowballing	9
Posting on the Institute of Physics intranet	3
Total	15

Although it was unavoidable that participants recruited via any of these means were to some extent self selected, the intention of using a mixed method approach to recruitment was to mitigate against introducing a strong selection bias from any single population group.

Moreover, given the small size of the stage one sample, it was never an intention to attempt to achieve a representative sample from any particular group from which generalizations could be drawn. As noted by Maykut and Morehouse (1994 p.56), the aim of qualitative research is to gain "deep understanding of some phenomenon", acknowledging the "complexity that characterises human and social phenomena…and the limits of generalizability." Accordingly, the intention for this stage of the research was to identify pertinent themes that could be investigated further in the subsequent stage of the study.

The recruited sample is compared against the preferred sample composition in Table 3-3.

Table 3-3: Actual sample composition compared to preferred sample composition

Current car ownership state	Households in sample	
	Achieved	**Preferred**
1 car, stable	11*	approx. 6
2 car, stable	3*	approx. 6
1 car, recently changed up from 0 cars	0**	at least 1
0 car, recently changed down from 1 car	1***	at least 1
1 car, recently changed down from 2 cars	0*	at least 1
2 cars, recently changed up from 1 car	0****	at least 1
Total:	15	approx. 16

*six of the one car households had also experienced second car ownership

** All of the households had experienced a move from 0 to 1 car

*** Two of the one car households had also experienced a move from 1 to 0 car during their time as university students

**** This transition had been experienced by all of the two car households and six of the one car households (nine in total)

Although fewer than anticipated two car households were recruited, six of the one car households had also experienced second car ownership. As had been anticipated, recruiting recent car ownership level changers proved challenging and it was not possible to recruit households that had either recently acquired a second car or had recently relinquished a second car. These transitions were however covered within the sample of stable households. Similarly, at this stage

it had only possible to recruit one household that had recently relinquished their first and only vehicle (although two other interviewees had experienced medium term first vehicle relinquishments, albeit during their time as university students). This limited insights into motivations for giving up car ownership altogether to three, specific cases (two of which had been temporary relinquishments). Nevertheless, it was felt that analysis should commence on the achieved sample given that a decision could be taken later as to whether it would be beneficial to conduct further depth interviews on particular household types.

It is also notable that couples from five of the households (couples or family household structures) agreed to be interviewed together, and so 20 individuals in total participated in the first set of interviews.

3.6.5 Ethical and health and safety considerations

Careful consideration was given to the ethical implications of carrying out in-depth interviews, particularly given that these were designed to elicit personal biographical information from participants.

First and foremost, it was important that participants understood the nature of the study prior to agreeing to take part. To ensure that informed consent was granted before the interview began the researcher introduced himself, outlined the nature of the research topic, what the interview itself entailed and how the information would be used. The participants were also informed that they did not have to answer every question and that they could close the interview down or withdraw from the study at any stage. This information was then presented to the participants on a consent form (included in Appendix B) which they were asked to read and sign to confirm that they understood and were happy to take part.

It was recognised that the biographical nature of the interview also posed a risk of triggering emotional recall. For instance a car ownership change may have been associated with a relationship breakdown or a death in the family. With this in mind, the researcher was prepared to steer the discussion away from sensitive issues if they were not relevant to the core topic. The researcher was also prepared to remind the participant at any point that they were not obliged to discuss negative experiences if they felt uncomfortable doing so. In the unlikely event that emotional upset became severe, the researcher would seek to put the participant in contact with a friend, relative or appropriate counselling service.

Given that the interviews were to take place at the participants' convenience (for example at their home place, in the evening) and that the researcher would be working alone, it was necessary to employ a buddying system. The researcher arranged to contact a colleague before each interview began and then again on leaving the place of interview. The buddy was also given details of the location of the interview and expected contact times. In the unlikely event that the researcher failed to contact the buddy after a specified time, they would be in a position to attempt to contact the researcher, and as a last resort would contact the police.

3.6.6 Analysing the interviews

A thematic analysis was used to reduce the data with a view to ultimately constructing a concise interpretative narrative of the findings and to set up the second stage of the research. The approach was guided by Braun and Clarke's (2006) informative paper: "Using thematic analysis in psychology", which advances a six stage process:

1. Familiarising the researcher with the data;
2. Generating initial codes;
3. Searching for themes;
4. Reviewing themes;
5. Defining and naming themes; and
6. Writing up.

The researcher initially familiarised himself with the data through a lengthy process of full transcription. This involved three stages: Typing up, validating against the audio and final formatting. On completion, four written documents were then available for each interview:

1. A full transcript;
2. A mobility biography chart;
3. A propensity to change car ownership scale; and
4. A stated adaptation "How would you manage if you lost access to one of your cars" chart.

Examples of a mobility biography timeline, propensity to change car ownership scale and a stated adaptation chart are included as Appendix C.

Following transcription, a list of initial thematic codes was generated. This list was both deductively informed by the literature review, conceptual framework (and indeed the structure of the interview itself) and inductively informed through initial thoughts about the contents of the interviews.

Each printed transcript was then reviewed, and coded by hand. Additional codes emerged inductively throughout this process. The transcripts were then imported into NVIVO 8, a software package for managing qualitative analysis, and the transcripts were coded electronically. Finally, each code was printed out and an iterative process of further data reduction and interpretation commenced. Amongst other things, this included writing a one page summary of the key points from each interview, a description of the pathway towards the current car ownership state for each participant (included as Appendix D), and tabulating life events that appeared to be associated with the key car ownership transitions revealed in the interviews.

Throughout this process, it was borne in mind that, as Braun and Clarke (2006 p.93) note, the final "write up needs to do more than just provide data. Extracts need to be embedded within an analytical narrative that compellingly illustrates the story you are telling about your data and your analytic narrative needs to go beyond description of the data and make an argument in relation to your research question." Accordingly, the process of data reduction and interpretation was carried out with constant reference to the objectives. In particular, the first round of analysis asked the following two pertinent questions of the interview data:

Taking a view of the participating households as a whole, how (descriptive) and why (explanatory) has their car ownership state changed over time? And

What appear to be the most pertinent areas to follow up in the next stage of the research?

In the next chapter, the thesis moves on to present the analysis of the stage one in-depth interviews.

3.7 Chapter summary

This chapter began by making a case for the need for *longitudinal* research into the process through which household car ownership changes. It established that there were no formal theories relating specifically to the dynamic process of car ownership change and a new conceptual framework was therefore developed. This conceives of household car ownership states emerging as the outcome of a

continual process of adjustment over the life course, rather than as reflecting static, equilibrium states. With reference to the concept of stress (Miller, 2005), the mediating subjective concept of *car access imbalance* (imbalance between the present car ownership state and a desirable alternative state) was defined in the framework to represent this process of adjustment.

Given the lack of an agreed theoretical starting point that could be tested deductively, it followed that the research strategy required an inductive exploration of this new conceptual framework. Consistent with this line of argument, the chapter then offered a rationale for the use of 15 *qualitative* in-depth, retrospective interviews in the first of two stages of primary research and provided an overview of the interview format, sampling strategy and thematic approach to analysis.

Chapter 4: Part One Results: In-depth Interviews

4.1 Introduction

The thesis now presents a thematic analysis of the in-depth interviews. The analysis begins with a discussion of the process of entering car ownership for the first time; identified in the literature as a key moment following which car based lifestyles may become entrenched (Simma and Axhausen, 2007). It then offers a detailed explanation of the process through which car ownership subsequently changes as households move through the life course, based on evidence from the interviews.

The chapter moves on to provide a wider discussion of the contextual factors arising from the built and social environments of the current time that impinge on the process of car ownership change. Consistent with the study's objectives, the chapter then discusses the extent to which car ownership states are meeting the household's desires and explores participants' views on how they expect to change their car ownership position in the future (with reference to the concept of car access imbalance). Lastly, the chapter concludes with a summary of the key findings from the interview analysis. The implications of the findings for the remainder of the study are discussed later in the thesis, in chapter five.

Where quotes are included in the chapter, the participants are referred to by an identifier which reflects the interview number and the participant's gender (M for male and F for female). The identifiers, together with a characteristic description of the interviewees, are provided in Table 4-1:

Table 4-1: Characteristics of the interviewees

Household				Interviewee		
ID	**Structure**	**Area type**	**No. of cars / vans**	**ID / Gender**	**Age**	**Profession**
1	Couple	Outer urban	2	1F	28	Researcher
2	Family	Inner urban	1*	2F	Early 30s	Researcher
3	Single	Intermediate urban	1	3M	25	Researcher
4	Family	Inner urban	1*	4F	Late 30s	Researcher
				4M	Early 40s	Product Designer
5	Family	Intermediate urban	1*	5F	Early 40s	Researcher
6	Couple	Outer urban	2	6F	23	Teacher Trainee
				6M	27	IT Consultant
7	Family	Inner urban	1	7F	43	Secretarial Services
8	Family	Intermediate urban	1*	8F	53	Finance Officer
9	Couple	Outer urban	2	9M	39	Project Manager
10	Couple	Intermediate urban	1	10M	29	Researcher
11	Couple	Inner urban	1*	11M	49	System's Analyst
12	Family	Inner urban	1*	12M	40	Programme Manager
13	Family	Outer urban	1	13M	Early 40s	Database Specialist
				13F	Early 40s	Secretary
14	Couple	Inner urban	1 (Van)	14M	27	Publishing Editor
				14F	28	Accountant
15	Family	Inner urban	0	15M	Early 40s	Professor
				15F	Early 40s	Senior Lecturer
Notes: * indicates had also experienced second car ownership						

A summary of each household's car ownership history is also included as Appendix D.

It is first noted that the sample is not representative of the wider population. It is clearly biased towards middle class individuals in higher professions that are of a relatively young age. This was partly a consequence of the success or otherwise of the recruitment strategies reported in section 3.6.4.6. Snowballing through the

researcher's own networks was more successful than attempts to recruit via a household flyer drop and other forms of advertising. Nevertheless, given that generalisability was not an objective of this phase of the study, and the intention was to design a suitable follow-up study (which could include targeting a wider sample), analysis commenced with due consideration of the limitations of the sample composition.

4.2 The process of entering car ownership for the first time

The literature review makes reference to several studies suggesting that car ownership is highly state dependent and stable (Simma and Axhausen, 2007, Thorgersen, 2006, Hanly and Dargay, 2000) – that is, once a household or individual has acquired a car, they are very likely to continue owning a car into the future. Indeed, while the 15 interviews do not constitute a representative sample, the notion of state dependence did appear to be demonstrated by the participants' car ownership profiles - of the 15 households interviewed, only two had experienced moving back out of car ownership for a prolonged period of time.

Recognising the concept of car ownership state dependence suggests then that, in understanding long term car ownership states and changes at the household level, it is important to investigate the point at which an individual enters car ownership for the first time (Simma and Axhausen, 2007). This can be considered to be a two to three stage process:

- Stage one: acquiring a driving license;
- Stage two: an intermediate stage at which an individual may experience access as driver to cars through their social or family networks; and
- Stage three: acquiring the first 'own' car.

While these events were not a central focus of the interviews, the participants were asked to reflect on both their motivations for taking their driving test and the reasons why they acquired their first car. These are briefly discussed in the sections below.

4.2.1 License acquisition

When asked to reflect upon their motivations for undertaking driving lessons when they did, many of the participants had difficulty articulating specific reasons,

noting for example that it is *"just what you do"* (7F). Other responses reinforced the notion that passing your driving test when you reach driving age (17) is a social norm in the UK and indeed is seen as something of a rite of passage:

"Everybody says the sort of coming of age thing don't they but it's true. It's a freedom thing isn't it. It's growing up."

3M

"It's just everyone did it. It was just 17th birthday everyone had driving lessons. Grandparents said yeah you know we'll pay for them as a 17th birthday present so yeah, just did it. Didn't even think."

1F

Such family support for driving tuition at 17 was common place, either through paying for driving lessons, allowing participants to practice in family cars, or both. Conversely, a participant (4F) that had waited until her mid twenties to undertake lessons, reflected on the fact that she had passed her driving test comparatively late in life, partly because neither of her parents drive - evidence to suggest that family norms play a key role in encouraging (or not) young adults to enter car ownership.

Some participants recognised that passing the driving test at an early opportunity, provided a valuable 'option' to drive (driving being an important life skill to acquire) later on in life, whether or not there would be a car immediately available to use. Others noted that they saw their late teens as an ideal opportunity to take lessons, given their time availability and parental support:

"…well I didn't have a car to inherit at the time but everybody had always said to me how much hassle it [the driving test] was and it's great to get it out of the way and then you've got the choice to have one [a car] or not."

6F

In some cases, predominantly, though not solely, those living in rural locations, there appeared to be a greater (possibly perceived) instrumental need to pass the driving test (or the motorcycle Compulsory Basic Training) in comparison to those living in urban locations. This was associated with a mutually beneficial ability to gain transport independence from parents:

"I lived rurally so it was the only sort of freedom you had...my mum and dad I suppose had to ferry us around where ever we wanted to go."

14F

Her partner, who had waited until his mid twenties before taking his driving test, responded:

"…it was really rural wasn't it so it was a drive anywhere else. I think when I was 17 I still didn't need to drive because all my friends lived two minutes walk away."

14M

In relation to this last comment, those that postponed passing their driving test until some point in their twenties implied that they felt less instrumental need to drive in the medium term. An ability to meet their needs using other transport modes, income constraints, and the lack of potential for accessing a car as a driver were cited as reasons for discontinuing driving lessons in their earlier years:

"…I was about 19 I think [when he started having lessons] and I only started that because my little sister was starting and I think I was still living at home. Then I left home, came to Bristol and just stopped them. And to be honest I didn't have any desire. Some of my friends could drive and I just saw it as a bit of a waste of money. "

12M

In this example, the influence of the participant's younger sister starting driving lessons also illustrates the sorts of social pressures that may encourage people to start driving.

Reasons for returning to driving lessons in their twenties included an increased instrumental need to drive (typically associated with entering the labour market), the ready availability of a car to drive upon passing, an increase in income or social pressure from new dependents:

"The real motivation was thinking, I didn't really need a car when I was a student, but now I'm going to be looking for work. I probably do need to be able to drive."

4M

4.2.2 Acquiring the first own car

A summary of the primary (though not sole) motivations for acquiring the first car, as elicited from the participants is provided in Table 4-2:

Table 4-2: Primary motivations for the first car acquisition

Primary motivation	Occurrence
Access to the labour market	1F (company car), 5F (company car), 2F, 4F, 4M, *6F,12M.*
Opportunism[1]	14F, 6F
Desire for independence	10M, 6M, 13M
Family norms[2]	9M, 3M, 7F (safety)
Household formation	11M (marriage, moving house)
Household dissolution	12M
Moving in with a car owning partner[3]	13F, 8F, 14M
Urban form or rurality	*3M,11M,5F*

1. A car is handed down from parents
2. A car is purchased by parents on reaching driving age
3. These occurrences did not trigger a car ownership transaction

Italics: A secondary motivation for the listed individuals

The individual first car acquisitions are described and categorised in Appendix D.

4.2.2.1 Access to the labour market

Several participants perceived a need for their first car to access the labour market, or were directly encouraged to acquire cars by their employers – either through the provision of company vehicles or through an employer expectation that you would have a car available to use. One female participant (2F) commented on how she felt the need to buy a "*smart*", new car "*because there was a kind of expectation that you weren't going to turn up in a camper van or on a skateboard*".

4.2.2.2 Family norms

As noted in the discussion on license acquisition, many families actively encouraged their offspring to take on lessons, with some parents purchasing cars for their offspring when they passed their driving tests.

4.2.2.3 Opportunism

Two of the participants, 14F and 6F, had acquired their first, albeit old cars (in their early twenties) opportunistically (some years after passing their driving test) from a family member who had upgraded their own vehicle. Both commented that they would otherwise not have acquired a car at this stage in their lives, mainly due to income constraints (both were students at the time). However, one female participant in her early twenties (14F) who was undertaking a teacher training qualification, had been advised by friends that having access to a car would make travelling to school placements a lot easier. She clearly also had an instrumental motive for requiring a car.

Such opportunistic acquisitions are discussed more generally in section 4.4.

4.2.2.4 Desire for independence

Two male participants (3M and 6M), that had not acquired cars from their parents, bought cars for themselves as soon as they could reasonably afford to do so after passing their tests. They both commented that this was motivated by a desire for independence, which appeared to have been amplified by a lack of other adequate transport modes at their parental home.

A third male participant, 13M, lost access to a car as driver as a young adult, for a period of two years after his parents moved away from Bristol. It was apparent that his emerging need for a car as he got older was partly the result of social influence, and / or role beliefs having seen his friends move into car ownership:

"A friend of mine he got a car. He got a yellow Escort. He used to drive us around everywhere. There used to be three or four of us good friends and we used to spend a lot of time together and things. And he'd always drive to start off with. And then the other guy he got a car as well and it sort of I dunno. They had the independence and everything and I was still on the bus and stuff. So it just seemed like the thing to do I suppose even though I probably didn't particularly need one."

13M

4.2.2.5 Household formation and dissolution

In one case (11M), the first car acquisition was associated with the setting up of a marital home (selecting a particular rural *lifestyle* package which required a commute to work). In another case (12M), a search for a first car was prompted

following the dissolution of a household which resulted in a loss of access to a former partner's car.

Three of the participants (13F, 8F, 14M) first experienced permanent household access to a car after moving in with a car owning partner. However, these events did not prompt a car ownership transaction.

4.3 The process of car ownership change over time

Having reviewed the motivations for acquiring driving licenses and the first car, the thematic analysis was then advanced to understand how and why households change car ownership over time. Careful consideration of the interview transcripts in relation to the conceptual framework presented in chapter three led to the inductive development of a more detailed 'systems' style framework (also informed by Bradley (1985)) for understanding the process of car ownership change. While this emerged as an outcome of the analysis, the framework is presented from the outset of this section of the chapter (Figure 4-1). This is to provide the reader with an overview of the process, before moving into a more detailed discussion of each component:

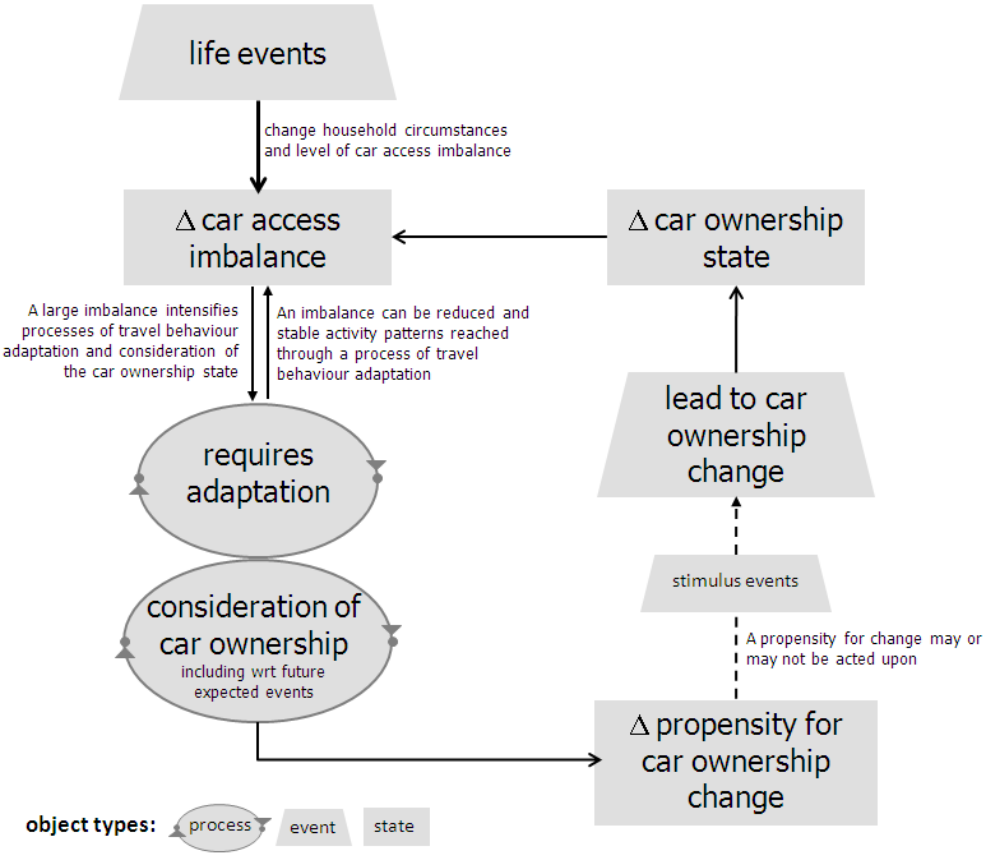


Figure 4-1: A framework depicting the process of car ownership change

The framework is summarised as follows:

- Life events, planned or unplanned, occur over the life course which change a household's resources, constraints and activity patterns. For instance a residential relocation, a change in employment location, child birth and so on.
- Through a process of adaptation to the new circumstances, households attempt to establish a set of satisfactory routine patterns of behaviour – finding the most comfortable means of travelling to work on a daily basis for instance. With respect to establishing satisfactory routine *travel* patterns, household car availability is an important factor that influences how a household is able to adapt;
- In some cases a satisfactory set of routine travel patterns may not be immediately established. For instance "my journey to work is taking too long by bus, but my partner has a greater need for our only car". Consistent with the original conceptual framework, an assessment of the extent to which the current car availability meets or exceeds the household's desires is labelled a 'car access imbalance' in the framework;
- If the level of dissatisfaction persists, then a process of consideration with respect to the household car ownership state intensifies;
- Through consideration, households reach a view on how they might like to change their car ownership state to better meet their requirements. For instance "a second car would really make life easier" or "an estate car would better suit our needs" – consideration creates a 'propensity for car ownership change';
- The propensity to change car ownership may not be acted upon immediately. In some cases, smaller stimulus events such as the receipt of an insurance reminder may prompt the household into making a car ownership change;
- Making a car ownership change, changes the extent to which the current car availability meets or exceeds the household's desires – reducing the car access imbalance. In the case of a car ownership level change, the household then adapts new routine travel patterns according to the change in car availability.

The framework is intended to be sufficiently high level and flexible so as to be consistent with a range of differing circumstances, including both car ownership level changes and vehicle replacements. For instance, a car access imbalance

could arise as a result of a vehicle becoming unreliable, leading to consideration and so on.

It is also important to emphasise that the framework need not be viewed as a linear sequence, necessarily starting with a life event and ending with a car ownership change. For instance, a household may predict a future life event and make a car ownership change prior to the event occurring. Such car ownership changes might be viewed as having been initiated by the process of consideration, rather than the occurrence of a life event.

This framework is now used to structure a more expansive narrative of the key findings from the interviews relating to the process of car ownership change.

4.3.1 Life events occur over the life course

It is recognised that daily travel behaviours change over the life course (Lanzendorf, 2003, Dix et al, 1983, Jones et al, 1983). Life is dynamic, circumstances are continuously changing, *life events* (planned or unplanned) occur and it has been suggested that in practice, a snapshot of a situation may not necessarily be viewed as representing a true equilibrium state, even for apparently stable situations (Dargay and Vythoulkas, 1999, Goodwin, 2009).

To clarify a point of terminology here, Miller (2005 p.177) draws a useful distinction between long run and short run decision making, noting that "the key difference between these two types of activities is that one [a short run decision] occurs within a fixed set of resources and other constraints (a current number of household cars, a current job, a contracted child-care arrangement etc.), while the other [a long run decision] involves actions that change those resources or constraints." This discussion draws the same distinction, but adopts the more general term 'life event' throughout, rather than 'long run decision'. This is in recognition of the fact that changes to the household's resources need not be the consequence of a conscious decision; unplanned events such as a redundancy or a vehicle write-off might also occur. Similarly, the notion of 'long run' is not considered necessary given that for instance, employment circumstances may themselves be volatile and not necessarily persist for any *longer* than car ownership states.

Indeed, it was apparent from the interviews, that life events had a significant impact on car ownership outcomes. The specific life events that could be retrospectively associated with car ownership level changes across the sample are briefly described in Box 4-1. Individual car ownership level changes are

categorised on a case by case basis in the car ownership histories presented as Appendix D.

Box 4-1: Life events associated with car ownership level changes

Reaching driving age: As described in section 4.2, reaching driving age was associated with the immediate acquisition of a first own car for some participants. Some individuals had cars bestowed upon them as a result of *family norms*. Others were motivated by a strong desire for *independence* and purchased their own cars.

Entering the labour market: marking a change in life stage which often imposed greater space and time constraints across the working day. Specific journey requirements were met by the acquisition of a first car, funded by an increase in income.

A change in the employment and/or home location: This prompted both increases and decreases in household car ownership level, depending particularly on the options available for reaching the work place from home. In one case (8F), an increase in working hours (and not necessarily a change in location) resulted in further conflicts over access to the only car, prompting the acquisition of a second car.

The formation of a new household: As discussed in section 4.2, marriage and moving to a rural location were associated with the purchase of a first car in one case (11M). Two couples (14F/M, 8F) had also relinquished second cars having realised that they were able to manage with one car between them after a period of cohabitation.

The dissolution of a household: Conversely, other participants were required to purchase their own cars after the breakdown of a relationship meant that they were no longer able to share a car with a partner.

Child birth: prompted the relinquishment of the second car in two cases (2F,12M) as the female partner gave up work to bring up the children.

While these events clearly had influenced later car ownership changes, there were often significant time lags before a change occurred (Dargay, 2001, Goodwin and Mogridge, 1981). Indeed such lags were often consciously recognised by the interviewees. For instance, one male participant in his early forties (4M), who presently lives with a wife and two year old child described how:

"We had a period of about three years where we didn't really need two cars. I mean there were occasions where we needed two, like maybe at Christmas or something…It seemed easier just to have two cars and run them but you know if we'd actually looked at the kind of economics of it..."

4M

This quote also provides evidence of the existence of *a car access surplus* which is discussed further in section 4.5. Nevertheless, these significant time lags imply the presence of further processes, described in the framework as *adaptation* and *consideration* that act between life events and the point of car ownership change.

4.3.2 Adaptation: establishing satisfactory patterns of behaviour

The assertion that people must *adapt* to a new set of circumstances, which may emerge over a period of time (life is continuously changing), or alternatively may arise instantaneously following an unpredictable event (redundancy, death, unplanned child birth) is also self-evident and intuitive. A number of studies and social psychological theories put forward the reasonable hypothesis that human adaptation involves a process of *trial and error* through which the potential ways of organising daily life, including how, where and when to travel, are learnt and compared (Dargay and Vythoulkas, 1999, Parker et al, 2007, Fried et al, 1977 cited by Goodwin, 2009, Campbell, 1963 cited by Jackson, 2004). The following quotes provide evidence for such a trial and error process of adaptation following a change in circumstance.

A female participant (5F) explains how she gradually started cycling, rather than driving to work after returning from maternity leave:

"I used to drive to [work] then... I can't quite remember when I started cycling. It wasn't like I suddenly stopped driving and started cycling. I would sort of go through periods where the weather was nice I would cycle. It was either at the end of that period [before leaving to go on maternity leave] or the start of the period when I came back to [work following maternity leave], I started cycling more."

5F

Another female interviewee (15F) described the process of adaptation that had occurred in the nine months subsequent to a decision not to replace a written-off first and only car and to therefore live without a car:

"And now we're used to not having a car...We did go 'let's do this, oh we can't, we can't get there'. Now we go, 'let's do this, how are we going to get there?'".

15F

If people adapt patterns of travel behaviour via a process of trial and error, logically it follows that the *perceived* set of travel options available for them to try out will influence the routine travel patterns that are eventually established. The set of travel options that members of a household are able to try out is governed by a complex range of subjective and objective factors arising from the built and social environments including:

- The household's own transport resources (cars, vans, motorcycles, bicycles, public transport season tickets and so on);
- The household structure and how individuals within households organise who has access to which mobility resources and when;
- Household members' actual and perceived ability to use the household's own transport resources – for instance, having a driving license influences an individual's *actual* ability to drive a car. Whether the individual feels confident driving influences their *perceived* ability to drive a car.
- Household members' *perceived* ability to access the transport resources owned by others - for example through taking lifts or borrowing cars.
- The form of the built environment (including public transport availability) in which household members' live and work which governs the transport options that are available outside of the home.
- And lastly by household members' perceived ability to navigate the built environment using the transport modes that they consider to be available to them.

A household member's preferences towards, and understanding of their ability to use alternative modes is influenced by the extent to which they have experimented with alternative forms of transport through the process of adaptation - a routine car driver may have little or no experience or knowledge of local public transport availability. Preferences towards alternative modes are also affected by experience as well as being subject to social influence - within a family it may be considered more normal to use a car in comparison to cycling for instance.

A detailed exploration of the factors influencing routine travel behaviours, such as attitudes, habits, social norms, perceived behavioural control, was outside the scope of the interviews, although these are covered elsewhere in the literature as reported in chapter two, section 2.4.1 (Thorgersen, 2006, Bamberg and Schmidt, 2003, Anable, 2005). However the interviews did illustrate that the establishment or non-establishment of satisfactory routine travel patterns had knock-on consequences for later car ownership decisions.

4.3.2.1 An illustrative example

This process of adaptation is now demonstrated by a thorough analysis of a single case from the interviews. Couple 13 described how they successfully adapted around an existing single car, following a move from Bristol city centre to the outer suburbs. Having established that parking in the city centre would be expensive, the male partner explained:

"When we first moved here we used to get the bus together [to work in Bristol city centre]....Not for very long, only for a few months. Oh it was awful...And that was one of the things that got me into cycling. The buses being so bad...And I suppose I must have got the bike out and thought: 'Oh this has got to be better than doing the bus hasn't it...?'

Living in close proximity to the fully segregated Bristol to Bath cycle path into the city centre ensured that the cycle ride was amenable, although the process of transition from bus to bicycle was gradual:

"I started off doing it just one or two days a week...And then I'd do the bus the other days and built up".

They later discovered that the male partner could use a train service to get into the city, by taking a lift to a nearby station with his wife on her way to work:

"But we never thought of getting the train did we...We didn't do that until fairly recently really."

The adaptation (behavioural change) appeared to be continuing, even though the family had lived in their present location for more than 10 years. This also supports the suggestion that completely stable travel routines are rarely, if ever, reached.

Later on in the interview, the couple described how they had considered at one point buying a second car as the male partner had nearly been knocked off his bike on the way to work.

The female partner recalls how:

"...we did consider either another car or a motorbike, but then decided that a motorbike wasn't really any safer than the push bike".

The husband responds:

"and you don't get the fitness thing which is you know, half of what I like about being out in the fresh air on a push bike."

This example neatly demonstrates how the availability and propensity to use alternative means of mobility, which may emerge as an adaptation response to a change in circumstances, can act to suppress the subsequent desire for an additional car. In this case the suppression resulted from a combination of a developing positive attitude towards cycling for one individual in the household, living in close proximity to a fully segregated cycle path to the city centre, predictable congestion in Bristol city centre, and a perception of a poor public transport connection - a conclusion that was reached by the participants following attempts to use the bus service to the city centre.

Conversely, other participants in the sample described how they were prompted to change their car ownership state after finding it difficult to establish a satisfactory set of travel patterns following a change in circumstances. For instance a female participant (8F) noted that weekend working, which resulted in repeated conflicts over access to the first and only car, was the *"final straw"* in her household's decision to acquire a second car. Another male participant (12M) described how attempts to carry baby equipment on holiday was instrumental in the household's decision to sell two sports cars in favour of a single estate car. This decision was also influenced by a change in working patterns and a reduction in income as the female partner stopped working for a period after child birth.

4.3.3 Consideration: developing a propensity for car ownership change

Household car ownership change is inevitable since cars are a durable (long lasting), but nevertheless depreciating asset – they wear out and periodically need replacing. The interviews suggested that people are aware of this and, even if a satisfactory pattern of behaviour can be established with the current set of mobility tools, they will have spent some time *considering* how they might expect to change their car ownership state in the future. This might constitute reflecting on the type of vehicle that they would like to own, or considering how they might

expect to respond to a potential future event (e.g. the birth of a child, acquiring a new job or moving home).

The interviews suggested that there is an ongoing process of consideration with respect to the household car ownership state that fluctuates over time. It seems reasonable to suggest that consideration is ongoing as car owners are frequently faced with fuel, maintenance, tax and insurance bills as a reminder of their car ownership state. Nevertheless, the level of priority afforded to contemplating a car ownership change varies according to the household's circumstance. For instance, in some circumstances there may be a significant lag following a change before consideration of car ownership status resumes. The car ownership state becomes low priority while the new circumstances are established. One female participant (8F) describes such a situation, having split up with her husband of 18 years and moved house with her daughter some 18 months prior to the interview:

"...suddenly I'm on my own again after 18 years, and it's like oh my God so I kind of spent time on all of that. And then, now things have calmed down [12 months after the move], I was thinking, mmm maybe I could make some money. Sell that car for three, four grand, buy something cheap, run-around for like two grand and may be make some profit."

8F

In other circumstances, people may be weighing up their car ownership options pending an expected change. For instance, a male interviewee (3M), aged 25 explains how:

"In the next year I'm going to be getting a job which is hopefully going to be paying me a bit more than I get now. And there's definitely a sort of an expectation that you don't want to be turning up at work in this absolute heap if you are using it to go to work. So I think at the end of the year, if I've still got it and it's still going I probably will change it but for now it's absolutely fine."

3M

And similarly, another male interviewee (10M), 29 explains:

"I will be looking to get another car but it really depends on the job that I get next. So I am thinking about getting another car but I don't know exactly how long I'll have until I get it."

10M

These examples support the notion that people ‘store up’ a propensity to change car ownership. In some cases this propensity to change is never acted upon (as indicated by the dotted line in Figure 4-1) and indeed diminishes as the household adapts to ongoing changes in circumstance. In other cases a propensity to change is released at some point in the future, often following some other stimulus event, as discussed further below (Goodwin, 2008, Hopkin, 1981). It is also reasonable to propose that some form of albeit loose criteria for the next car ownership change (relating to vehicle type or budget) may be developed as a result of the process of consideration.

At the opposite end of the spectrum, a so called shock event may prompt a household to take immediate action with respect to their car ownership state, with little opportunity for planning, effectively compressing the adaptation and consideration phases of the cycle. A male interviewee (11M), living in a rural location at the time, with few transport alternatives (hence there were no alternatives available for trial and error adaptation), describes such a circumstance:

“then I got made redundant and then I had to get another job which was in Bury St Edmonds so I got a car just for that. That purpose alone you know...It was oh my God I’ve got to drive 35 miles in the opposite direction [to his wife whom he had previously car shared with], I need a [second] car this weekend.”

11M

4.3.4 Inertia and trigger events as signals to act

The discussion so far has demonstrated that often a life event followed by a period of adaptation and consideration may create a ‘stored up’ propensity to change car ownership. The accounts of car ownership change provided by the interviews indicated that typically a series of one or more smaller stimulus events are subsequently required to prompt a household into taking action. In agreement with the literature, the interviews support the case that people are resistant to change (Goodwin and Mogridge, 1981); that car ownership changes are subject to inertia (Dargay, 2002, Goodwin and Mogridge, 1981, Dargay, 2007); and that trigger events may be viewed as signals to act which are required to overcome the inertia.

A number of reasons for inertia (i.e. not acting on a desirable car ownership change) were apparent from the interviews. Namely:

Sticking with what you know: familiarity or risk aversion as described by a female interviewee (8F) in her fifties: *"I know it's a reliable, good car, so do I trade that in for, although I may get something cheaper to run, but I won't know it's history, I won't know how reliable it's gonna be, so I don't really know what to do. So I'll just stick with what I've got."*

Depreciation of the car asset and assessing the costs and benefits of a change: a couple in their late thirties / early forties (4F) described why they delayed selling one of their two cars when they formed a household together: *"how much would you get for it...you know is it worth selling it or would you just keep it? Because at least we've got it, because we won't get much money for it anyway, so you might as well just have it."*

Apathy: Changing cars may not be a priority and there may be no desire to spend time thinking about it as described by a female interviewee (2F): *"So the idea was to get a four door car and sell the two door car. But we never quite got around to selling. This makes us sound so awful. We never quite got around to selling the SEAT."*

Lack of or not seeking information about alternative options: a couple (15M, 15F) described how an insurance write-off settlement brought previously unrealised depreciation costs to their attention. This was a factor in them subsequently deciding not to replace the car: *"And then it was like we got 1,400 quid [pounds] on the insurance on it. And we were thinking OK, we've just lost 3,600 quid over 4 years. OK that's fine, that's depreciation, but it's 800 quid a year on depreciation. Plus the AA [Automobile Association], plus the insurance, plus everything else we spent on it."*

The search costs associated with buying or selling a car: one female interviewee (5F) described her conundrum on what to do with her existing car when she acquires a newer (temporarily second) car from her parents: *"What am I going to do with the old car anyway? You know, I've got to go to the effort now of finding some way of getting rid of it."*

Indecision, maintaining equity in the household or personal attachment to a car: a couple (4F, 4M) described how when they got together, having realised that they only needed one car, they had a dilemma as to whose car they should sell first: male - *"We did have this discussion about oh well actually I want to keep hold of mine, let's sell yours. No you sell yours";* female: *"Yeah because we'd*

both kind of come into it with our own cars, which had whatever value attached to them for ourselves, so you kind of didn't want to give that up".

It was possible to retrospectively identify a number of types of events that appeared to be associated with prompting a household to take action, overcoming the inertia and releasing the stored up propensity to change. For instance, such signals to act included:

Financial signals: such as insurance renewal notices or the receipt of a large maintenance quote. These appeared to be significant in households relinquishing underutilised cars or replacing old cars. One male participant (12M) noted: *"The insurance was sky high, it was 900 to 1000 quid..."* Interviewer: *"When did you start thinking oh perhaps we should [change the car]?"* Interviewee: *"After the second time we had to renew the insurance. When it was like, 'this is crazy'".*

Incentive schemes offered by employers: for example, a female participant (8F) described how her husband's firm had offered favourable terms at the local Vauxhall dealership. This prompted them to buy the second car they had craved for some time: *"They were offering employees the opportunity to buy brand new cars at a reduced rate. And we were then, you know we had been thinking about a new car, and because this offer came along we said 'well really it's an offer we can't really turn down' so off we trotted."*

A vehicle catastrophe (for example write-off, engine blow, vehicle theft): a write-off event had changed the course of a car ownership pathway in one case (15M, 15F), prompting the household to trial living without a car.

Opportunism: in several cases, households had acquired or relinquished cars when opportunities had arisen for car ownership transactions (somewhat randomly), generally through family or social networks.

4.4 Situating the process within a wider context

This finding that several (eight out of 15) of the interviewees described situations in which they had acquired or relinquished cars opportunistically through social or family networks serves as an important reminder that the process through which households change car ownership over time is subject to wider contextual influences. These were conceptualised in the research design (in an ecological model, see section 3.4.6) in terms of influences arising from the social and built environments. Accordingly, the chapter now offers a discussion of these influences in sections dedicated to:

- The vehicle pool, social networks and opportunism; and
- Residential self selection, lifestyles and the built environment.

4.4.1 The vehicle pool, social networks and opportunism

Consistent with the literature review, which highlighted the extent to which the UK is now a highly motorised society, the interviews reinforced the sense that there is now a large pool of highly accessible second hand vehicles which are being freely exchanged between households. Even the income constrained participants, (notwithstanding the fact that these were mainly students from higher socio-economic groups, though without parental financial support) had been able to acquire and successfully run cheap vehicles for a sustained period of time.

Moreover, some individuals seemed to have a greater potential to acquire cars from friends and family networks than others. They were more connected into the privately owned vehicle pool through their social contacts and this had clearly influenced their car ownership trajectories. Such 'car connected' participants had been able to acquire cars through their social networks earlier in their lives than was perhaps instrumentally necessary. Indeed, without prompting, participant 14F reflected on the fact that she had benefited from a "pool" of vehicles that were available through her family network:

"Even the cars that my sister has had in between the ones that have come to us. All of her cars have sort have come from aunties and uncles. There just seems to have been a pool of cars in our family."

14F

Other less 'car connected' individuals had delayed acquiring cars until such time as they could afford to buy their own.

4.4.1.1 Trust

One possible motivation for seeking to acquire cars from family or acquaintances appeared to be the issue of trust. A second hand car transaction may consume a significant amount of a household's budget and so ensuring the purchase is reliable is generally a key consideration. This was explicitly mentioned (without prompting) by three of the participants:

"Well one of the things that stopped me getting a car through this whole period, was actually the fact that I hate buying second hand cars, because...It's a

notoriously untrustworthy profession. So one of the main criteria was that it was somebody that I knew and effectively I bought it off his dad. And they're close family friends..and I knew the car's history and I knew there was nothing wrong with it. So that was a major point in my buying that. If it was a second hand car for that price off somebody else, I wouldn't have gone for it because I wouldn't have trusted it."

3M

"If you're spending a couple of thousand pounds on a car second hand you need to be able to trust the person you're buying it from. And if it's family you know what the car is like. You know you're not going to get duped I suppose"

14M

"I felt that I probably needed a car, but I didn't really want one. And it happened that my uncle,...a car mechanic, had his own garage. So it was very easy as well, to get provided with cheap good, cos he'd check everything out for you...So it was very easy for me to get a car."

5F

4.4.1.2 Lending and borrowing cars

As well as revealing a prevalence of opportunistic car transactions (a notion that had not been anticipated), the interviews also highlighted that cars may be temporarily loaned out (effectively shared) amongst social and family networks: Participant 2F had leant her underutilised second car to friends, participant 14F had benefited from long term car loans from her parents, participant 9M had borrowed his sister's second car for a period of time. The stated adaptation experiment ("how would you cope if you had one fewer car for two months", reviewed later in section 4.5.5) also revealed that households recognised the option to borrow what might be considered to be underutilised cars from friends or family (noted by participants 3M, 13F/M, 9M and 15F/M).

It was also demonstrated that living in close proximity to friends and family was a pre-condition to being able to borrow cars. Indeed, participant 14M explained that, having only just moved to Bristol:

"We have [got the option of borrowing cars] but they're all in other bits of the country. There would be where we'd be going because we don't know anybody around here. At least if we were visiting my family the cars we could drive would be there." 14M

4.4.2 Residential self selection, lifestyles and the built environment

The literature review had also demonstrated the complexity of the inter-relationship between residential location choice and car ownership outcomes (section 2.3). Though not a *central* focus of enquiry, in specifying the research design, one of the five objectives for the study was to identify how residential location influences household car ownership and preferences towards car ownership *over time*. Accordingly, the interviews included some discussion[13] (and subsequent analysis) of where respondents have lived and the associated implications for daily travel and car ownership outcomes.

It was apparent that the level of consideration given to transport when moving, varied across the sample, from not being considered at all through to being one of the most important factors (as confirmed by Standbridge (2007)). This depended on the reasons for and the circumstances surrounding the move. For example, at one end of the spectrum, participants 15F/M actively sought to buy a house in a location in which they could walk to work. At the opposite end of the spectrum, participant 10M found himself living in a very remote area while completing a work placement for his degree. With little opportunity to consider the consequences for travel, he was required to buy a car. In the middle of the spectrum, participant 8F made trade-offs between various attributes of the property, including the travel implications, and accepted a reasonable compromise; ensuring that the next affordable property was within a reasonable distance of both an offspring's existing school and the parent's place of work.

Accepting that residential self-selection happens to a greater or lesser extent, the interviews further suggested that the choice of where to live and hence the form of the built environment, could have unplanned consequences for car ownership outcomes. For instance, having moved to within walking distance of work, some *nine years* later, participants 15F/M chose to relinquish their only car, which was no longer frequently used after it was written off. This had <u>not</u> been an intention for the move and demonstrates the significant time lags that can exist between a life event and a car ownership change. Similarly, participant 10M decided not to replace a scrapped car having moved to Luton, a densely populated area that was well served by public transport.

[13] Which either emerged naturally during the interview or through prompting at appropriate points.

The interviews further revealed examples of people actively placing locational constraints on where they would choose to work or send their children to school. Participant 13M noted that:

"It is a condition of where I work...I tend to work in range of where I can cycle."

and added

"...one of the major decisions [relating to school choice] was well do you actually want to get in the car every morning for the next six or seven years when you could walk 200 yards."

In some cases, examples of self-selection could be related to the development of particular *lifestyle* preferences (Salomon, 1983, Krizek and Waddell, 2002) over time, based on life experience. Participants 15F/M chose to live within walking distance of work in order to avoid the unpleasant commute they had experienced previously. Participants 4F/M noted that they developed a preference for the current city centre lifestyle following a period living in Paris. Participant 5F noted that, while living in their present city centre location had not been a particularly important consideration at the time of their move, making sure that the household were not reliant solely on cars would now be a significant factor if they were to relocate in the future.

With these insights in mind, the relationship between residential location, travel behaviour and car ownership was conceived as a feedback *process* which acts over time (Figure 4-2). The residential location (the form of the built environment) influences the available travel choices and the travel behaviours that are performed. This reinforces preferences towards particular lifestyles and travel behaviours over time. These preferences may subsequently be realised, through residential self-selection at the next relocation event:

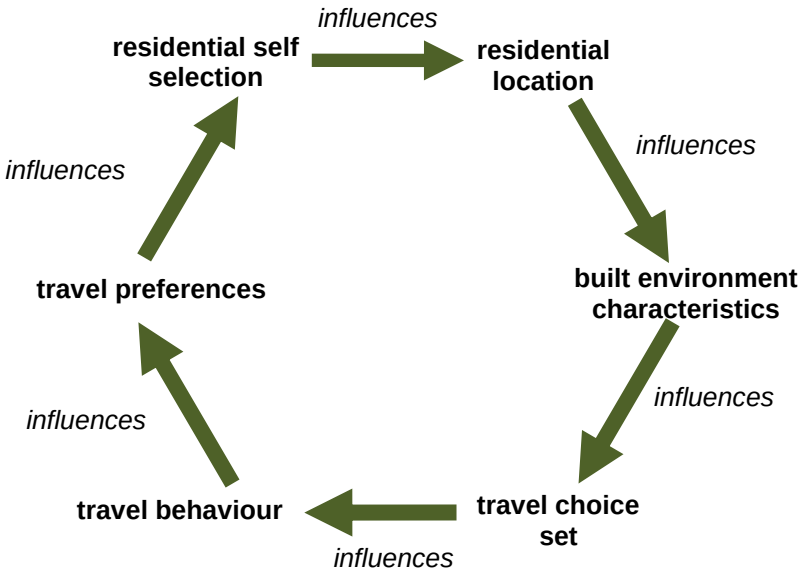


Figure 4-2: Residential self selection as a feedback process

4.5 Investigating stability in current car ownership states

The conceptual framework developed for the study introduced the mediating concept of car access imbalance to reflect the notion that there is a *continual* process in the lead up to and following a *discrete* car ownership change. This was suggested to be related to the extent to which the present car ownership state meets or exceeds the household's desires. Accordingly, the interview transcripts were explored to establish evidence for how such car access imbalances might arise.

4.5.1 Evidence for how car access surpluses arise

Examples of what might constitute a car access surplus were possible to *retrospectively* identify from the interviews in cases where the household had at some point decided to reduce the number of cars that they own[14]. In the case of second car ownership, participants recalled how they had realised that they rarely used both cars on the same day:

"Because I used to have a consultancy job where I had to do a lot of travelling and I had a car allowance, so I had my own car. And then I suppose we realised

[14]Given the retrospective nature of the interviews, where possible, the accounts were interpreted to detect whether a car access imbalance was indeed present at the time, or whether the participant was instead describing a post rationalised view of a past circumstance. For instance, respondents may be able to explain that a relinquished car was surplus to requirements at the time, only with the benefit of hindsight.

after I'd done the job for about four years that we had never used a car on the same day. And so we decided to move down to one car."

2F

As noted earlier, participant 4M recalled how, following moving in with his car owning partner:

"We had a period of about three years where we didn't really need two cars"

4M

This couple went on to describe how their *desire* to retain two cars (leading to *inertia*) was initially driven by wanting to retain some individual independence and maintaining equity in the relationship; even though the two cars were not necessarily *needed*:

"We did have this discussion about oh well actually I want to keep hold of mine, let's sell yours. No you sell yours";

4M

"Yeah because we'd both kind of come into it with our own cars, which had whatever value attached to them for ourselves, so you kind of didn't want to give that up".

4F

Their account suggested that the desire for two cars lessened over time and this was exaggerated by ongoing maintenance costs and parking difficulties at their home in central Bristol - a car access surplus increased over time as the couple adjusted to cohabitation. The male partner explained:

"I think there was also just a general feeling that two cars is excessive really, we just didn't need it".

4M

It was argued in chapter two (section 2.6.1) that giving up car ownership all together is a much bigger lifestyle choice than relinquishing the second car. However, one ex-car owning household had similarly recognised that they rarely used their only car sometime before they relinquished it:

"We used to say we have a car that sits on the street for six days out of every seven at the most frequent use."

15F

This quote indicates that a feeling that the household had too many cars for their desires (a car access surplus) did exist prior to the relinquishment, as opposed to having been identified during the interview with the benefit of hindsight. In this case, the realisation was heightened when the car was written off, and the household calculated the annual running costs, ultimately motivating the household to attempt to continue living without a car.

4.5.2 Evidence for how car access deficits arise

There was evidence of how a car access deficit may arise when there are more license holders than cars in a household, and there are competing demands amongst license holders for access to the household car(s) – that is, there are too few cars to service the household's needs and consequent desires.

Participant (8F), noted earlier as having described weekend working as the "*final straw*" in her decision to acquire a second car, expressed the complex negotiation required between her and her husband to organise use of the single household car when her working patterns changed.

"…I often had to work on a Saturday because of the shifts we had to cover the weekends which meant, if he wanted the car on the weekend, he'd have to drive me there, drop me there, come home and then come back at 11 or four or whatever time it was to pick me up. So it was like, this is getting silly, we need another car. And I was earning more, so I was like we can afford another car."

8F

Another female participant (7F) described how her and her ex partner shared their only car according to who would be looking after their daughter, following the dissolution of their household. Being income constrained at the time, she initially acquired a bicycle for use when she did not have access to a car (her ex partner had use of a motorcycle) – an adaptation response to losing permanent access to the car. However, she explained how car sharing became *"irritating"* and the conflict was eventually resolved when her mother-in-law donated her underutilised London car to her (an example of an opportunistic acquisition arising from her family network).

The interviews also revealed examples of an implied car access deficit occurring as a result of the existing household car being of the wrong *type*. One (non-income constrained) female participant (2F) described how, as a result of increasing pressure to drive for work, she bought herself a brand new car as her

husband's existing car, which though available for use during the day, was old and large and consequently uncomfortable to drive:

"Because I knew that, having a car was to do my consultancy work really and I didn't want to be driving this tank of a car up and down the motorway all the time. Which is why I bought a small car to drive."

2F

4.5.2.1 Strategies to reduce car access deficits

In addition to the possibility of changing the car ownership state, or indeed adjusting routine travel behaviours through adaptation, the interviews demonstrated that ongoing *negotiations* within cohabiting households with one car could act to suppress car access deficits. Participant (2F) neatly articulated the ongoing process of negotiation between her and her partner:

"So I do think that a car is always available to me but that's only because we discuss who needs the car and when. It's not because there is literally always a car available to me."

2F

Similarly participant 12M, describes how the household's transport needs are met through a combination of being a keen cyclist and negotiating who in the household has access to the only car and when:

"...it's usually me that sways and I have to get on my bike or just choose to do the trip at another time... if I've arranged a mountain bike trip and I've got other people and I've got to pick them up and we're going on Saturday then you know I have prime use and [his wife] will have to sway"

12M

4.5.3 Current level of car ownership stability and future prospects

Towards the end of the interviews, participants were invited to deliberate on how satisfied they were with their current car ownership state (exploring current level of stability) and to consider what they expected to be their next car ownership change. Their responses are summarised in Table 4-3.

Table 4-3: The next expected car ownership change

ID	Household structure	No. of vehs	Process of car ownership change category	Next expected change
1	Couple	2	Planning for an expected event	Replacement
2	Family	1	In a stable position	Replacement
3	Single	1	Planning for an expected event	Replacement
4	Family	1	In a stable position	Replacement
5	Family	1	Undertaking a car ownership change	Temporarily acquiring a second car but will sell the existing car
6	Couple	2	A propensity for car ownership change	Replacement
7	Family	1	In a stable position	No plans
8	Family	1	In a stable position	Replacement
9	Couple	2	A propensity for car ownership change	Replacement
10	Couple	1	Planning for an expected event	Replacement
11	Couple	1	In a stable position	Replacement
12	Family	1	In a stable position	Replacement
13	Family	1	In a stable position	Replacement
14	Couple	1 (Van)	Planning for an expected event	Expect to acquire a second car
15	Family	0	Adapting to a change in car availability	May one day re-acquire a car

In keeping with the argument developed throughout this thesis, concerning car ownership change as an outcome of a process, the expectations for the next car ownership change were viewed in the context of the household's past circumstances, current situation and future plans. As such the households have also been classified according to their position in an overall process of car ownership change. Through these categories it was possible to explore in further detail *why* the next change was expected and the extent to which the household was 'in balance' with their current situation. It is these categories, rather than the specific intention to replace or increase car ownership, which are now discussed:

Planning for an expected event: Four households (1F, 3M, 10M and 14F/M) were expecting a significant change in their lives, in that they would definitely be

experiencing a job change and potentially a home relocation in the next 12 months. This led to an expectation that the household would upgrade a car or acquire an additional car when the household member(s) had settled into a new job and had enough money to acquire a newer car. It was notable that these participants were all at a relatively early life stage which may have been a contributory factor to their less stable circumstances.

Adapting to a change in car availability: Household 15F/M had relinquished their only car nine months before the interview and appeared to be in the process of *adapting* to that change. They speculated on how long they may live without the car which implied that they were in a transitional state, managing a car access deficit.

"I don't have a date in my head that I'd say we're going to have a car then. I have been thinking over the last few weeks about whether or not we need to think about getting a car. I can't say why"

15F

Her husband responded:

"You said it the other day. Should we think about getting a car. And we thought we need to do the garden. We can do the garden or we can rent a car. You know what we can rent a car. We can't rent a garden"

15M

They also noted that they were not committed to a car free lifestyle and would consider getting another one, particularly if they changed jobs or moved from their current central location.

In a stable position, but contemplating the future: Seven households, typically at a mid-life stage, appeared to be in a stable position with respect to their current car ownership state (2F, 7F, 8F, 11M, 12M, 13M/F, 4F/M). Participant 7F reported having no thoughts about future car ownership changes at all while the others expected to *replace* a vehicle at the appropriate moment in the maintenance cycle. Household 13M/F had considered in the longer term acquiring a second car when their daughters reach driving age, and explained that "we'll have to see what happens when we get to that point".

A propensity for car ownership change: Two households (6F/M, 9M) had well developed intentions to replace ageing cars in the short term as they were becoming unreliable and expensive to maintain. They reported an expectation to

make the change when the next maintenance bill was received or if a suitable opportunity to buy another car arose – evidence for the need for smaller stimulus events to prompt households into taking action.

Undertaking a car ownership change: Household 5F was actively in the process of receiving a second car which was being handed down from her parents – an example of opportunism and the passing of cars through family networks. She expected to sell her existing car, returning to a one car household "when the next round of expenditure comes up", a further example of how inertia acts to hold back instantaneous changes.

4.5.4 A comment on functional need versus affective desire

It is recognised that functional necessity for cars has emerged as a stronger theme throughout the analysis presented in this chapter than symbolic-affective motivations for car ownership. Although several themes relating to the symbolic affective value of cars did emerge during the process of coding the transcripts, these themes were not central to the process of change framework presented in Figure 4-1 which subsequently became the focus of enquiry.

This is partly a result of the nature of the interview guide and indeed the overall approach to analysis, which focussed mainly on understanding car ownership *level* changes in terms of wider, typically functional changes in the household's circumstances: For instance, changing jobs, moving house, changes in household structure and so on. It was clear from the interview analysis (and indeed as is also suggest by the literature (Dargay and Hanly, 2007, Mohammadian and Miller 2003)) that these structural, if functional changes in the household circumstances were strongly associated with car ownership level changes.

Furthermore, as noted previously (in section 3.6.4.5), the retrospective nature of the interviews also meant that participants were presenting a *current* view of a *past* circumstance. This introduces a number of inevitable biases, including *post-rationalisation* and *self-justification* which could further bias participants' explanations for past car ownership changes towards functional need. Post-rationalisation occurs when participants present a past vehicle acquisition or relinquishment as a logical outcome, given a particular chain of events, even if this outcome could not necessarily be foreseen at the time. Similarly, self justification could lead to participants presenting a *need* for a car to serve a specific functional purpose, as this offers a more rational explanation for a car

ownership change in retrospect (whether or not it was necessarily needed at the time), than a *desire* for a car as a material good. There is also the issue of time recall. Participants are more likely to remember the functional impact of significant life events rather than their subjective thoughts and feelings at the time. This could lead to the underweighting of subjective factors in the participants' accounts of past changes. Attempts were nevertheless made to mitigate for this by including a deliberative discussion of the current car ownership circumstance and views on likely future outcomes.

Lastly, it is notable that discussions of symbolic-affective factors during the interviews tended to relate to vehicle *type* choices. For example in discussions of the decision to acquire sporty cars, which were enjoyable to drive and in some cases impressive to friends. However, as set out in the research design (chapter three), car ownership level changes were of greater concern to the researcher than vehicle type choices. Thus vehicle type choices were not analysed to the same level of detail. Indeed, although outside the scope of the developing thesis, an avenue for further analysis would be to revisit the interview transcripts with a specific focus on symbolic-affective factors and vehicle type choices.

4.5.5 Stated adaptation to life with one fewer car

Finally in this chapter, a brief comment on the stated adaptation experiment is offered. This posed the scenario:

"Your household loses access to one car for two months. How would you manage the journeys that are normally completed using that car?"

The experiment was introduced to test the extent to which there may be potential for car ownership reductions; considered to be of relevance to transport policy in urban areas. The temporary two month period was selected because it was felt that constraining the participants to consider the permanent loss of access to a car would have been unrealistic, as many of them would be able to afford to replace the car. Nevertheless, two months remained a significant period of time during which they would be required to adapt.

The respondents were asked to consider how they might expect to manage the scenario by either allocating former car trips to alternative modes or by making alternative arrangements (for example using the internet, or stopping certain activities).

In general, the participants seemed comfortable that they could cope (at least for the two month period) without arranging full time access to another car. It also appeared that the temporary nature of the car loss scenario influenced the participant responses. For example, respondents were inclined to deliberate that they would be able to postpone specific leisure activities that required the car and make adequate alternative arrangements in the shorter term. Only one participant (9M) felt that he would need to arrange a full time replacement car. As a 'car connected' individual he reported that his sister had "*a spare car sat there doing nothing*" which he would borrow.

Although the discussions elicited during this section of the interview proved informative in developing the analysis outlined in the preceding sections, the specific findings relating to expected change in modal usage were not considered to be directly relevant to the developing thesis. For completeness, a more detailed discussion of how respondents expected to adapt using alternative modes is provided as Appendix E.

4.6 Chapter summary

The interview analysis presented in this chapter served to demonstrate the quite complex process through which household car ownership changes over time. Through an inductive thematic analysis and with recourse to the literature, a framework for understanding the key elements in this process emerged (Figure 4-1). The key overall findings from the analysis are summarised here:

- The interviews suggested that car ownership level changes are driven by *life events*. Life events mark a distinct change in the household's circumstance.
- The interviews provided *empirical* evidence for the complex mediating concept of '*car access imbalance'* introduced *theoretically* in the research design. Imbalances between an existing car ownership state, and a desirable alternative were found to arise as circumstances change over time in response to life events.
- The interviews illustrated how efforts to reduce imbalances, without first changing car ownership state, were made through a process of *adaptation* to the new circumstances. In some cases, individuals within households had developed a new propensity to use alternative modes (bicycles or adequate public transport) through this process of adaptation. This had acted to suppress the subsequent need for an additional car. In other cases, following an unsatisfactory period of *adaptation* and through *consideration* of the car

ownership state, a latent *propensity* to change car ownership state had developed.

- Households were however, demonstrably resistant to change - car ownership was found to be subject to *inertia*. This contributed to time lags (of up to several years) between a propensity to change car ownership state emerging and the household taking action. It was revealed that further stimulus events (such as the receipt of an insurance renewal) may be required to prompt the household into taking action.
- The extent to which this process of car ownership change is subject to wider influences was also visible from the interviews. In particular, there was an unanticipated prevalence of *opportunistic* car ownership transactions occurring through family and social networks (both acquisitions and relinquishments). This was suggested to be an indication of the high level of motorisation now present across some sections of society.
- Lastly, exploring the influence of residential location on car ownership change revealed that some interviewees had developed particular lifestyle preferences over time based on past experience. These lifestyle preferences were realised at a subsequent residential relocation event - for instance, moving to within walking distance of work in order to avoid a previously experienced commute by car. In some cases this was a key factor in influencing a later, not necessarily foreseen, change in car ownership level.

This framework for understanding the process of car ownership change appeared compatible with the differing accounts of car ownership change that were elicited through the interviews[15]. However, owing to the limited sample size and composition, the framework's wider applicability had not been tested. In the next chapter, the thesis presents the options considered for and sets out the methodology used in the follow up to this stage one study.

[15] The reader is encouraged to review the individual car ownership histories presented as Appendix D. These accounts have been structured to illustrate how they relate to the concepts and processes presented in this chapter.

Chapter 5: Part Two Methodology: Neighbourhood Survey

5.1 Introduction

The thesis now returns to the research design and presents the stage two methodology. The chapter begins by comparing the options of broadening or deepening the findings presented in the concluding summary of chapter four. The selection of a *broader* survey of two neighbourhoods in Bristol is justified and the overall approach to the survey ('drop and collect' self completion questionnaire and follow-up telephone call) is described. The chapter then sets out the criteria through which the two survey neighbourhoods were selected. This leads into a discussion of the design of the two parts of the survey instrument (questionnaire and telephone call). Reflections on the process of survey administration and a detailed summary of the survey response rate are then provided. The chapter concludes with an overview of the approach to analysis and offers a summary of the characteristics of the survey respondents.

5.2 Evaluating methodologies for the follow-up study

The interviews had revealed considerable depth of insight into the process through which household car ownership changes and indeed led to the emergence of an empirically evidenced framework describing how this process operates. From the complexity of the processes and concepts involved, a case could be made that further depth research would be valuable. On the other hand, the interview sample was recognisably limited in size and biased towards particular socio-economic groups. Designing a suitable follow up study involved making a trade-off between pursuing depth of understanding and pursuing breadth of understanding. The options considered in this regard are now discussed and the decision to pursue a broader *neighbourhood survey* is justified.

5.2.1 Opportunities for further depth investigation

A number of questions lending themselves to further *depth* exploration were posed by the findings from the interviews, including:

- What factors affect how households adapt their travel behaviours over time, according to changing circumstances (marked by life events) and the mobility resources available to them?

- How do individuals within households organise access to the vehicle fleet on a routine basis? How do *individual* needs and desires translate into car access imbalances at the *household* level?
- Under what circumstances do these processes of adaptation and intra-household negotiation translate into a propensity to change car ownership state?
- What factors influence how longer term lifestyle preferences (of relevance to the process of car ownership change) form? How and when are such preferences realised?

Consistent with the literature, the interviews had also served to highlight the extent to which car ownership transition types differed. For instance, relinquishing an only car has very different implications to relinquishing a second car. In particular, the interviews offered insights into how some *couples* had relinquished *second* cars after a period of cohabitation, though this process had taken a number of years in some cases; while other couples had always shared one car between them and had resisted the acquisition of a second car. Understanding in detail why some cohabiting couples require a second car while others do not, appeared to be an interesting area to follow up.

Accordingly attention turned to evaluating whether focussing on the transition to and from second car ownership offered a suitable way to address the questions posed above. Multiple car ownership was identified in chapter two (section 2.6.2) as a notably under-researched area (Rouwendal and Pommer, 2003), and the interviews had provided evidence to support the notion that second cars were in some cases more marginal than first cars. Hence, it appeared that the demand for second cars may be more susceptible to policy interventions geared towards reducing private car ownership (such as car clubs), than the demand for only cars.

It was envisaged that such a study would involve carrying out a series of more tightly structured interviews comparing current second car owning households, with one car owning households who may have a potential to acquire a second car. This implied placing a limitation on the sample to households with two or more cohabiting driving license holders, owning one or more vehicles.

While this approach appeared to offer some advantages in terms of controlling the scope of enquiry, there were a number of recognisable limitations. First and foremost, constraining the sample to household structures with two cohabiting

driving licence holders was felt to risk limiting the wider relevance of the findings. The proportion of single person households in Great Britain increased from 18 per cent in 1971 to 29 per cent in 2007 (Office for National Statistics, 2008). Understanding the potential for multiple car ownership was felt to be of little relevance to this increasingly important demographic.

Furthermore, the stage one study had specifically recognised the importance of understanding *heterogeneity* in household circumstance (household structure, lifestyle preferences, number of cars owned and how this state had arisen, level of stability in current circumstance and so on). It was felt that targeting a specific household type would severely limit the extent to which the potentially wide variety of circumstances leading to alternative car ownership states could be explored.

5.2.2 Opportunities for further breadth investigation

The second option was to broaden the study to explore the process of car ownership change across larger, *geographically clustered* samples of households from differing neighbourhood types. Indeed, a recognisable limitation of the in-depth interviews was the extent to which it had been possible to address objective four, to explore the influence of *residential location* on the process of car ownership change.

Moreover, with the limited size and composition of the sample of interviews conducted up to this point, it was not possible to know whether the framework depicting a *life event* driven process of car ownership level change would be applicable across broader sections of the population. Testing for the wider applicability of this framework was therefore attractive in terms of improving the trustworthiness of the overall findings from the study.

Using geographically clustered samples of households and not necessarily limiting the sample to particular household structures / specific car ownership states would also address some of the issues highlighted with the depth approach; specifically, that the study should continue to recognise heterogeneity in household circumstance in order to broaden the relevance of the findings.

Careful consideration of these issues led to the final decision *to pursue a neighbourhood survey*. It was felt that a survey offered significant advantages over a depth study of a specific transition type, in terms of the potential to achieve well rounded results overall, that were also consistent with the full range of starting objectives. By conducting a survey it would be possible to combine the

depth of insight gained through the stage one interviews with an understanding of the broader applicability of the findings.

Nevertheless it was recognised that, depending on the size of the sample used in the survey, and the nature of the survey instrument itself, conducting a broader survey would be at the expense of the ability to probe some of the more complex emerging concepts to a greater or lesser extent. This issue is given further consideration in the section to follow.

5.3 Neighbourhood survey: The overall strategy

The overall strategy for the survey is now reviewed with reference to: defining the objectives that would underpin the survey, considering how the survey would be conducted and designing a suitable sampling strategy.

5.3.1 Survey objectives

Consistent with the study's starting objectives the following five objectives were defined to underpin the survey:

1. To describe how and to explain why *household* and *neighbourhood* car ownership *levels* change over time;
2. To examine the extent to which the present car ownership *level* meets (or exceeds) household desires;
3. To explore how households expect to change car ownership level in the future;
4. To examine the potential for households to permanently manage with one fewer car; and
5. To explore the (objective and perceived) influence of residential location on household car ownership levels.

In addressing objective one the intention for the survey was to generate a broader range of *qualitative* accounts of how the households' current car ownership *level* had arisen. A notable decision was taken to explicitly use the survey to generate accounts of car ownership *level* change. Vehicle replacements would not be explored. This was partly for reasons of managing the scope of the survey. In addition, as noted before, understanding how the *number* (as opposed to type) of cars available to the household changes was also considered to be of greatest significance for transport policy in congested urban areas. By using geographically clustered samples of households, the intention

was also to explore in some detail how the *aggregate* car ownership level in the selected neighbourhoods had come to be, given detailed information at the household level.

Objective two was included to examine the extent to which a cross section of households were currently in a stable car ownership position in terms of the *number* of cars owned. The intention for the survey was to investigate the prevalence of present 'car access imbalances' across the surveyed neighbourhoods.

Objectives three and four were concerned with ascertaining the potential for future car ownership change as this was considered to be of particular relevance to policy. Objective four, testing the extent to which households felt able to *permanently* manage with one fewer car, was included to specifically explore the level of redundancy in the privately owned vehicle fleet across the selected neighbourhoods. Given parking constraints in congested urban areas, reducing the demand for private car ownership is arguably a desirable outcome in some circumstances and it was deemed informative to establish the extent to which this might be possible. The permanence of the relinquishment was an important feature of the scenario to be posed. Based on experience gained during the in-depth interviews[16], it was deemed necessary to force respondents to carefully consider the longer term implications of having one fewer car available to them, as opposed to considering whether they could manage on a more temporary basis.

Finally, objective five was concerned with exploring the influence of the residential location on household car ownership. The survey would be designed to examine both *objective* indicators of the influence of differing residential locations as well as the respondents' subjective views on whether residential location had influenced their car ownership needs.

5.3.2 Survey administration and sampling strategy

Notwithstanding the decision to adopt a survey approach, the question over the degree to which depth should be compromised in favour of breadth remained. The research design set out in chapter three made a strong case for the need for *longitudinal*, *qualitative* research to deepen understanding of the *process* of household car ownership change over time. This rationale had not changed.

[16] the temporary nature of the scenario posed in the interviews appeared to encourage respondents to reach the conclusion that they could easily manage on a temporary basis.

Indeed, the interviews had not generated structured hypotheses that could easily be quantitatively tested. The intention for the survey was to generate a wider range of qualitative accounts of car ownership change, supported by quantitative data from which more general observations about car ownership in the survey neighbourhoods could be made. A further consideration was that the dynamic components represented in the process of car ownership change framework (such as the process of adaptation to establish satisfactory routine travel patterns) were recognisably challenging to operationalise. A survey approach imposed a greater degree of structure than had been the case in the in-depth interviews and some simplification of concepts would be required.

It followed that the design of the survey instrument (the balance of qualitative and quantitative data generated), how it would be administered (interviewer led or self completion) and the size of the sample, were issues that had to be jointly and carefully addressed. Interviewer led approaches would be more resource intensive to administer, but would enable greater depth of exploration on a smaller sample. At the opposite end of the spectrum, a mail back self completion questionnaire would be less resource intensive for the researcher to administer, would limit the depth of exploration, but could target a wider sample of households (as illustrated in Table 5-1):

Table 5-1: Relationship between differing survey approaches and sample size

Survey approach	Depth versus breadth	Sample size implications
Structured interview	depth at the expense of breadth	smallest sample size
Interviewer led questionnaire	the middle ground	medium sized sample
Mail back self completion questionnaire	breadth at the expense of depth	largest sample size

A further important observation from the interviews was the challenge involved in eliciting reliable retrospective accounts of a household's car ownership history. This had been possible to address in the in-depth interviews by issuing a pre-interview form to be filled in by the participants and by carefully guiding respondents through a mobility biography, which enabled recall mistakes to be corrected during the interview.

Indeed, through a somewhat lengthy process of piloting differing styles of self-completion questionnaire, it became apparent that reliable household car

ownership histories could not be effectively elicited through self completion alone. Trial respondents reported completion fatigue, and confusion when confronted with tables to collect retrospective event history data. While others in the field have made use of self-completion event history formats, these have also been resource intensive (taking up to 90 minutes to complete) and were required in order to generate structured data for use in later quantitative duration modelling (Beige and Axhausen, 2006). This was not an intention for this survey.

This led to the conclusion that without simplifying the underlying survey objectives further, a standalone self completion questionnaire would not be effective. Furthermore, over simplifying was felt to risk compromising the underlying rationale for the research design. Therefore retaining the requirement to elicit reliable, retrospective qualitative accounts of household car ownership level changes (as set out in survey objective one) implied involving an interviewer led component of some form in the survey design.

Accordingly, two options were considered for administering a survey involving an interviewer led component:

1. Issue a short, easy to complete self-completion questionnaire that would invite respondents to suggest a convenient time to take part in a structured interviewer led discussion (which may be face to face or via a telephone call); or
2. Issue a lengthier stand alone self-completion questionnaire that would invite respondents to suggest a convenient time to take part in a shorter follow-up telephone call.

Option one was considered to pose some risks relating to the overall response rate. The self-completion element would not in itself satisfy the five survey objectives and there were no guarantees that a large enough sample of households would offer availability for the follow-up interview. By comparison, option two was considered to offer a better compromise as the questionnaire would itself stand-alone in the event that fewer than anticipated participants were available for a follow-up telephone call. It was therefore decided *that the survey would employ a stand alone questionnaire which would be followed up by a short telephone call.*

5.3.2.1 'Drop and collect' survey administration

The logistically related issues of survey administration and the sampling strategy were then considered. This ultimately led to *the selection of a 'drop and collect' method of survey administration to achieve full coverage of two neighbourhoods (one inner urban and one outer urban), containing 125 households each.*

Dealing with the issue of survey administration first, use of an internet questionnaire seemed inappropriate, given the need to target geographically clustered households. An impersonal mail back method involving a relatively long questionnaire was also considered unlikely to encourage many households to participate, risking an unsatisfactory response rate.

By contrast, the 'drop and collect' method (Walker, 1976) appeared to offer a much more suitable alternative. 'Drop and collect' requires the researcher to deliver the questionnaire *in person* to each household and offer a time to collect the questionnaire *in person* some days later. This means that participants can fill in the questionnaire in their own time, rather than at the door step. Personal contact also provides an opportunity for the researcher to introduce themselves, explain the nature and purpose of the research, explain what is required to take part and removes the need for the respondent themselves to return the questionnaire. Using personal contact in this way is a means of boosting response rates and seemed to offer significant benefits in this instance, given the relative complexity of the survey.

Accordingly a four stage 'drop and collect' process of survey administration was designed with a view towards maximising the response rate:

Stage one: A post card (included in Appendix F) would be delivered to each household pre-warning them that a researcher would be calling in the next few days to ask if they would be willing to take part in a transport survey.

Stage two: Households would be called upon during weekday evenings of the following week to ask if they would be willing to complete the stand alone questionnaire. The researcher would explain that he would collect the questionnaire one week later. Households would be called upon up to three times and if there was still no contact on the third visit, a questionnaire would be delivered with a cover letter and mail back envelope.

Stage three: The researcher would return to the households one week later to collect the completed questionnaire. If the questionnaire had not yet been

completed then the researcher would either explain in person that he would come back in two days time or would deliver a cover letter containing the same information.

Stage four: The follow-up telephone call would then be conducted at a convenient time for the household as specified on the questionnaire.

5.4 Selecting two survey neighbourhoods

As noted previously, the decision to include an interviewer led component in the survey and to pursue a 'drop and collect' process of survey administration was not taken in isolation from considerations concerning the sampling strategy. Clearly the resources required to conduct such a survey had implications for the number of households that could be contacted by a single researcher. Indeed the decision to pursue a 'drop and collect' method was taken in conjunction with the decision to also achieve full coverage of two neighbourhoods in Bristol.

Based on a PhD study of a similar scale (Jones, 2008), it was anticipated that it would be manageable to target 250 households in total. It also seemed appropriate to identify geographically clustered households using census geography, specifically output area boundaries, which typically contain 125 households each (Office for National Statistics, 2007). This meant that the survey could either target all households located in two output areas or could sample a smaller number of households from several output areas.

Returning to the issue of depth versus breadth, the use of 'drop and collect' seemed naturally aligned with achieving a high response rate from a smaller number of neighbourhoods[17]. This also appeared to meet the research objectives for the survey, in combining considerable depth of understanding of how car ownership levels had arisen at the *neighbourhood* level, with breadth of understanding at the *household* level.

5.4.1 Defining a neighbourhood selection criteria

The aim of the neighbourhood selection process was to identify two neighbourhoods that housed a similar demographic, but varied in their locational characteristics in a controlled way. To reiterate, one of the objectives of the

[17] By contrast a mail back questionnaire could target a larger number of households from several neighbourhoods, but the response rate would be lower.

survey was to explore the influence of differing residential locations on the process of car ownership change.

It was found from the literature review that aggregate car ownership levels tend to be lower in city centre locations than in suburban locations (see section 2.2.2). Varying the residential location from inner urban to outer urban offered a pragmatic means of exploring the extent to which differing urban locations impact on household car ownership changes. The following neighbourhood selection criteria were therefore defined:

- One neighbourhood should be located within close proximity to the city centre, with easy access to city centre amenities by walking, cycling or public transport (and thus could be expected to be less 'car dependent' in nature); and
- One neighbourhood should be located on the outskirts of the city boundaries and be outer urban in nature (and thus could be expected to be more 'car dependent' in nature).
- A further desirable criterion was for the two neighbourhoods to be located along a shared transport corridor. This would provide a degree of control over access to common transport infrastructure (which serves common destinations) outside of the home, while varying the geographic characteristics from inner urban to outer urban.
- Lastly, in order to explore the influence of residential location choice on car ownership change, the residential location choice (inner urban versus outer urban) would be the single varying factor. In an ideal scenario, 'all else', in terms of the demographic composition of the two neighbourhoods, would be more or less equal.

5.4.2 Identifying neighbourhoods that met the criteria

The 2001 census (Census Dissemination Unit, 2011) provided a readily available data set for analysing the demographic composition of output areas, although a recognised but unavoidable weakness was that nine years had passed since the data had been collected. The census provides an Area Classification system (Office for National Statistics, 2010b) which constitutes a hierarchical set of categories describing shared lifestyle characteristics of the population at the neighbourhood level.

5.4.2.1 Situating the survey in the city of Bristol

A rationale for situating the *overall* study in the city of Bristol was developed in the research design (section 3.6.4.3). Given the research focus on urban areas, and that Bristol was considered to share similar characteristics to the other major cities in England, it was not considered necessary or indeed practical (given the logistical issues associated with using a 'drop and collect' method of survey administration) to seek census output areas outside of the Greater Bristol urban area. Moreover, using the census area classification system to identify survey neighbourhoods meant that the sample would share similar characteristics to the wider population of urban output areas in Great Britain of the same class[18].

Accordingly, the population characteristics of Bristol output areas were explored by firstly analysing the proportion of output areas in each census lifestyle category (Table 5-2) and secondly visually inspecting the geographic distribution of output areas in each census category using a coloured coded thematic map[19] (Figure 5-1).

Table 5-2: Census classification of output areas in Greater Bristol

Census category	**Number of output areas**	**Proportion of output areas**
Blue Collar Communities	427	12.82%
City Living	384	11.53%
Constrained by Circumstances	369	11.08%
Countryside	262	7.87%
Multicultural	156	4.68%
Prospering Suburbs	713	21.40%
Typical Traits	1020	30.62%
Total	**3331**	**100%**
source: (Census Dissemination Unit, 2011 Census 2001 table KS014a)		

[18] The extent to which the survey sample is representative of a wider population and the implications for the ability to make specific statistical generalisations is given further consideration in section 5.8.2.1.

[19] developed using the MapInfo GIS software suite.

Image redacted for copyright reasons

Figure 5-1: Census classification of output areas in Greater Bristol

(source: Census Dissemination Unit, 2011 Census 2001 table KS014a)

Given that 'Typical Traits' emerged as the predominant category, the thematic map was visually inspected to identify a pair of 'Typical Traits' output areas that met the selection criteria outlined in section 5.4.1. The following two output areas were initially identified as offering a good match in terms of their geographic location relative to the city centre (Table 5-3):

Table 5-3: Candidate output areas for use as survey neighbourhoods

Output Area Code	Ward	Area type
00HBNQ0003	Bishopston	Inner urban
00HDNX0027	Bradley Stoke	Outer urban

The locations of the two output areas are shown on a map of Bristol in Figure 5-2. Both output areas are located in proximity (and connected by public transport) to the A38, a main corridor into the city centre. The Bishopston output area is situated approximately 1.5 miles from the city centre and also benefits from proximity to a wide range of local shops, bars and restaurants along the A38 Gloucester Road, approximately a five minute walk away. The Bradley Stoke output area was developed in the late 1980s and is situated in close proximity to the M4 and M5 interchange on the outskirts of the city (approximately seven

miles from the city centre). While Bradley Stoke had few, if any local amenities when it was first constructed, it is now quite self contained with a range of supermarkets and a local shopping / leisure centre having been developed, within walking distance of the selected output area.

Image redacted for copyright reasons

Figure 5-2: Locations of the survey neighbourhoods

The differing built environment characteristics of the two survey neighbourhoods are demonstrated in the photographs on the pages to follow. Bishopston is higher density, has a grid like street layout with mainly on street parking and contains terraced houses built at the turn of the twentieth century. Bradley Stoke has modern terraced housing, and a more spacious suburban street layout including some dedicated parking areas.

Figure 5-3: Photographs of the Bishopston candidate neighbourhood

Figure 5-4: Photographs of the Bradley Stoke candidate neighbourhood

5.4.2.2 Characteristics of the neighbourhood populations in 2001

The output areas, herein referred to as Bishopston (inner urban) and Bradley Stoke (outer urban), were then compared against a range of other socio-demographic indicators available from the 2001 census (Census Dissemination Unit, 2011 Key Statistics tables). The main findings from which are as follows:

Housing stock: The majority of houses (around 90 per cent) are classed as terraced or semi-detached in both areas.

Tenure: Around 52 per cent of households owned their own homes with a mortgage in both Bradley Stoke and Bishopston. There were more rental properties in Bradley Stoke in 2001 (32 per cent of households compared to 15 per cent in Bishopston). This was balanced by their being more households owning their homes outright in Bishopston (27 per cent of households compared to 8 per cent in Bradley Stoke).

Household composition: Around 50 to 55 per cent of households in both areas contained couples (either married or otherwise). There were more single occupancy households in Bradley Stoke (26 per cent of all households in the area compared to 17 per cent of all households in Bishopston).

Age: Bishopston had an older population in 2001 with a greater proportion being over 45 (25 per cent compared to seven per cent in Bradley Stoke). This was balanced by a greater proportion of the Bradley Stoke population being between 20 and 30 (32 per cent compared to 15 per cent in Bishopston).

Educational Attainment: A greater proportion of households had a higher level educational qualification in Bishopston with 48 per cent of households having a first degree (or higher) compared to 22 per cent in Bradley Stoke.

Socio-economic classification: Close to 45 per cent of households in both areas were classified as lower to higher managerial professionals. The main difference appeared to be the presence of a student population in Bishopston constituting 20 per cent of households in the area which was not present in Bradley Stoke. This was balanced by there having been more individuals in intermediate or semi-routine occupations in Bradley Stoke (29 per cent of households) than in Bishopston (11 per cent of households).

Car ownership levels: There were slightly more 'no car' households in Bishopston (17 per cent of all households) than in Bradley Stoke (12 per cent of all households). The proportion of households owning one or two cars were

similar in both areas (approximately 80 per cent). In line with expectations, the outer-urban neighbourhood, Bradley Stoke had a slightly higher car ownership rate (1.31 cars per household) than Bishopston (1.27 cars per household) overall.

Travel to work: Similarly, a higher proportion, 73 per cent of households used a car to travel to work (either as passenger or driver) in Bradley Stoke compared to 54 per cent of households in Bishopston. This was balanced by there being more adults walking or cycling to work in Bishopston.

Although the populations of the two neighbourhoods were not precisely the same, they shared enough *core* features for them to be both classified, beneath the 'Typical Traits' category as 'young families in terraced homes' in the 2001 census. Furthermore they displayed the expected travel behaviour characteristics in that both car ownership and use (for work) were comparatively higher in the outer-urban area. Given that these output areas also provided a good match with the locational selection criteria set out in section 5.4.1, they were considered suitable for use in the neighbourhood survey.

5.5 Designing the survey instrument

The self-completion questionnaire and a moderator guide for the follow-up telephone calls were carefully designed to address the five survey objectives set out in section 5.3.1.

5.5.1 Questionnaire content

A copy of the final questionnaire is included as Appendix F. It contained six sections.

Section one: the current vehicle ownership state: An introductory section entitled "About the cars available to your household" sought to generate quantitative measurements relating to the household's car ownership state, and level of access to other mobility resources (following (Simma and Axhausen, 2007)). The following concepts were operationalised (Table 5-4):

Table 5-4: Operationalising car ownership, car access imbalance and car use

Concept	Operationalised as	Question
Current car ownership state	Number of vehicles owned (worded as per the 2001 census for compatibility)	1
	Type of vehicles owned	2
	Duration of vehicle ownership	2
	Company car status	2
Car use	Self reported frequency of use of each vehicle for maintenance (work), subsistence (shopping) and discretionary (leisure) trips following Krizek (2002)	3
Car access imbalance	Assessment of the extent to which the number of cars owned meets or exceeds the household's desires	4
	Level of awareness of whether the number of cars owned meets or exceeds the household's desires	5
Access to other mobility resources	Number of motorcycles owned	6
	Ownership of public transport season ticket	7
	Regular use of a push bicycle	8

Sections two and three: The household's past car ownership changes: Section two, "Thinking about past car ownership changes" and the early part of section three, "The number of cars that you own and where you live" (questions 9 to 25) were designed to generate a *partial* account of the *household's* (and not the individual respondent's) car ownership history. The car ownership history was intentionally partial to reduce the recall burden on the respondent. It had earlier been observed that a complete, reliable car ownership history and how it related to other changes in circumstances would be extremely challenging to generate through a self completion format.

Accordingly, the questionnaire was designed to reveal whether the number of cars owned by the household at the time of the survey was different to the number of cars owned at the point of household formation. Household formation was defined as the point at which adults in the household began residing together or on their own in the case of single occupancy or single parent households. The questionnaire also generated a qualitative account of the *most recent* car

ownership level change. The most recent, rather than all car ownership level changes was selected again to reduce the recall burden.

As such, questions were structured to carefully guide the respondent through recall of car ownership changes around the following ‘anchor points’ in a household’s history (as depicted in Figure 5-5):

- the point of household formation (question 9);
- the point at which the *most recent* car ownership level change occurred (question 11) followed by a qualitative description and explanation of that change (questions 12 to 16); and
- the point at which the household moved to the neighbourhood which may have occurred before household formation (question 18). This was followed by a set of questions to understand whether a car ownership level change occurred within 12 months of the move to the neighbourhood (questions 20 to 26). These questions were included to establish whether moving to the neighbourhood was associated with a change in car ownership level.

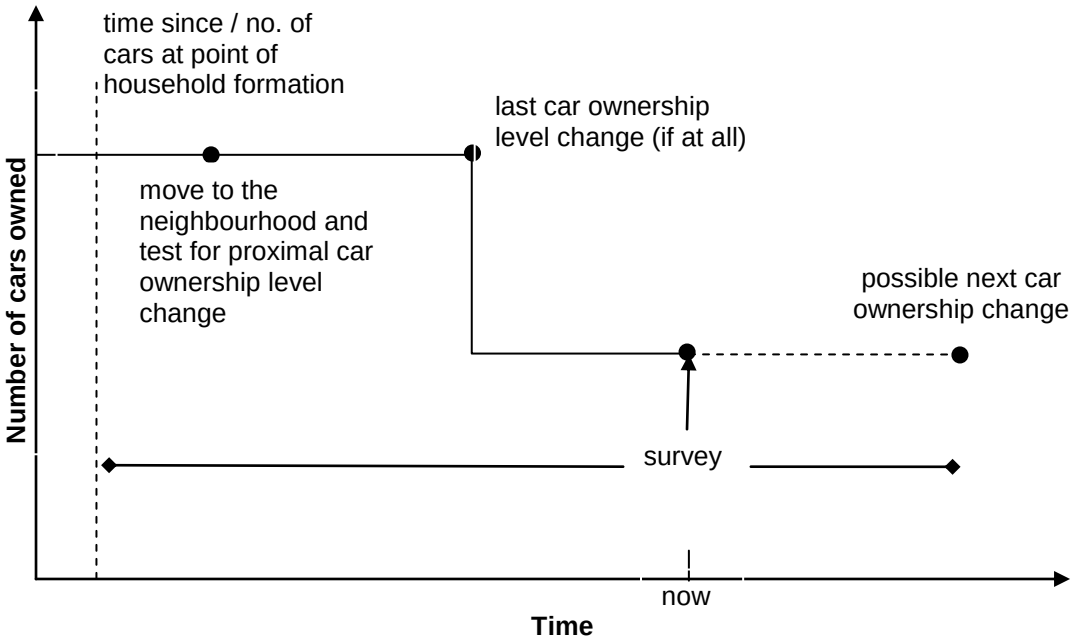


Figure 5-5: Anchor points used to generate a household car ownership history

Open ended questions were included (questions 16 and 25) to allow the respondent to provide a qualitative explanation of why they made a particular car ownership level change. These questions were not expected to generate a great deal of insight however, with the intention to mitigate for this through the follow up

telephone call. The preceding questions (15 and 24) asked whether the respondent felt that the car ownership level change was in any way related to one or more specific *life events*. This was an important finding from the in depth interviews and these questions were included as a prompt to get the respondent thinking more deeply about the car ownership level change, before they moved on to complete the open ended question.

The respondent's perception of **the influence of the residential location on car ownership needs**[20] was measured quantitatively by level of agreement with the statement "Living in [neighbourhood] has an influence on the number of cars my household needs" (question 26). The interview analysis had further suggested that households varied in the extent to which they had prioritised transport issues when choosing to move to their current home (and this had consequences for future car ownership outcomes). Accordingly Question 27 measured the respondent's agreement with the statement "Travel issues (getting to work / shops / parking) were an important consideration when choosing to move to [neighbourhood]". A six point scale was employed in both questions to allow respondents to indicate agreement, disagreement, a neutral response or 'no opinion'. The responses to these questions were to be clarified qualitatively in the follow-up telephone calls.

Section four: The next expected car ownership change: Section four was intended to generate a qualitative account of the respondent's next expected car ownership change (whether this would be a vehicle replacement or an increase or decrease in car ownership level). This followed a similar format to the preceding sections on past car ownership changes. A five point scale was also included for the respondent to indicate the level of *consideration* afforded to the next car ownership change (ranging from one 'not really considered it yet' to five 'seriously considering it now'). This was a means of exploring the extent to which households were *re-considering* their car ownership position, identified as an element in the process of car ownership change framework put forward following the interview analysis.

Section five: Ability to permanently manage with one fewer car: The respondent's assessment of the frequency with which all members of the household use all transport modes was recorded in question 34. This provided a

[20] The word 'needs' was used in the questionnaire as this was felt to be more easily comprehended than the word desires.

measure of the level of household car use relative to the use of other modes i.e. measuring how the household had *adapted* to their current situation. Differing patterns of *adaptation* had emerged from the interviews as being of relevance to understanding the household's current car ownership state and the household's potential for a future car ownership level change.

The respondent was then asked to state whether they felt their household could permanently manage with one fewer car (a stated adaptation test). A four point scale was employed here (ranging from no problem to impossible) as it was judged that a neutral response to this question would be incompatible with the permanence of the car ownership reduction described (either being possible to a greater or lesser extent, or impossible). Question 36 then gauged how the household's modal usage would most likely change following a car ownership reduction, with three response options available for each mode: 'no change', 'use a little more' and 'use a lot more'.

Section six: Demographic questions. The questionnaire concluded with a set of standard demographic questions about the household. These were designed to be compatible where possible with national data sets such as the census, National Travel Survey and the British Household Panel Survey to enable comparisons to be drawn between the sample population and the national population during the analysis phase.

It was also desirable that variables present in typical car ownership models were included in the questionnaire so that the relationships revealed by car ownership models could be explored using the survey data. The following list of relevant variables was compiled and included in the questionnaire by reviewing documentation relating to the DfT's national car ownership model (Whelan, 2007b, Whelan, 2007a, Department for Transport, 2009), and De Jong et al (2004) comprehensive review of car ownership models:

- The household's income;
- The household's structure including age, gender and occupation of all household members and the number of employed adults;
- The number of driving license holders; and
- Presence of a company car.

5.5.2 Questionnaire design considerations

The questionnaire was carefully designed and consistently formatted in accordance with Dillman's (2000) guidelines. An initial challenge was found to be accommodating the range of household circumstances that were likely to be encountered (shared housing, single occupancy, families and couples) across the two neighbourhoods. This resulted in a need for a great deal of conditional explanation in early versions of the questionnaire. For instance, the phrase 'if you live in a shared house, please answer for yourself' was repeated throughout. A decision was therefore taken to create a separate questionnaire for single occupancy and shared households (knowing that household composition could be identified on delivery) which removed the need for a great deal of conditional explanation.

A further significant challenge, which quickly became apparent through piloting, was the miscomprehension of skip instructions. Skip instructions were an important and unavoidable feature of the questionnaire design as quite complex branching was required in order to accommodate (ideally) all possible household circumstances and car ownership trajectories. The skip instructions were significantly improved through the use of visually striking arrows to direct respondents to the next relevant question and by using for example '(if yes or no)' at the start of the first question of a sub branch to reinforce the fact that this is a filtered question.

Having established a final set of questions, the questionnaire was then iteratively refined through a process of talk out loud piloting with 'expert' research colleagues recruited from within the university, as well as non-researchers recruited amongst friends and family. Errors were logged and corrected before the next talk out loud session commenced. This process proved to be an invaluable means of improving the questionnaire.

5.5.3 The follow up telephone calls

The follow up telephone calls took the form of interviewer led questions with the intention being to build qualitative explanation around several of the more complex concepts used within the self completion questionnaire. Accordingly, the interviewer led questions (included in Appendix F) were designed to:

- Validate and where necessary correct the responses on the self completion questionnaire;

- Generate a qualitative description of the household's car ownership history and to explain why particular car ownership level changes had occurred. In contrast to the self completion questionnaire, the telephone calls enabled the researcher to probe respondents about particular aspects of specific car ownership changes.
- Generate a qualitative description and explanation of the household's expectations for the next car ownership change;
- Generate a qualitative description of how the household uses cars and other mobility resources on a day to day basis; and
- Generate qualitative insights into whether and, if so, how the residential location was felt to impact on the household's car ownership needs.

5.5.4 Ethical considerations and incentives

As with the stage one study, careful consideration was given to the ethical implications of carrying out the neighbourhood survey. Any issues concerning the biographical nature of the questions used in the follow-up telephone calls were dealt with in accordance with the strategy set out for the in-depth interviews (in section 3.6.5). The cover sheet of the questionnaire was designed as a consent form; providing contact details for the researcher and including a signature box for respondents to confirm that they understood the nature of the research and were happy to take part.

While administering the door-to-door survey, the researcher wore a photo identification badge at all times to ensure it was clear the researcher worked for a local university. The researcher also employed a 'buddying' system, informing a colleague of the time and location of each survey day, and letting them know of his safe return. All collected data was secured under lock and key and anonymised at the point of data entry.

Finally, a £10 supermarket voucher was arranged for each participant in recognition of the time required to fill in the questionnaire and to take part in the telephone interview. This was given to respondents on collection of a fully completed questionnaire. The voucher was also employed as a means of boosting the response rate which was important in order to get full coverage from each neighbourhood. Similarly, a £350 prize draw was also arranged to encourage participation in the follow-up telephone calls.

5.6 Conducting the survey

The survey was conducted over seven tranches, each covering a two week period. The first week involved the postcard drop and questionnaire delivery. The second week required questionnaire collection and an attempt to complete as many follow up telephone calls as possible, while respondents remained highly aware of their involvement with the study. The tranche dates are set out in Table 5-5:

Table 5-5: Survey dates

Bishopston: 120 households			
Tranche	**Number of households**	**Postcard drop and questionnaire deliveries (week commencing)**	**Questionnaire collection (week commencing)**
1 (pilot)	21	Sunday 18th April 2010	Sunday 25th April 2010
2	40	Sunday 16th May 2010	Monday 24th May 2010
3	41	Sunday 6th June 2010	Monday 14th June 2010
7	18	Sunday 5th September 2010	Monday 13th September 2010
Bradley Stoke: 128 households			
Tranche	**Number of households**	**Postcard drop and questionnaire deliveries (week commencing)**	**Questionnaire collection (week commencing)**
4	40	Sunday 20th June 2010	Monday 28th June 2010
5	42	Sunday 4th July 2010	Monday 12th July 2010
6	46	Sunday 18th July 2010	Monday 26th July 2010

5.6.1.1 The pilot tranche

A first tranche of 21 households in Bishopston was planned as a means of piloting the process of survey administration, as well as the questionnaire itself. With no prior experience of this style of survey administration, it was not possible to estimate how much time and effort would be required to cover a 20 household tranche, from questionnaire delivery through to completion of the follow-up telephone calls. It was clearly important to gauge time requirements prior to carefully planning subsequent tranches.

Furthermore, as an inexperienced door to door 'market researcher', establishing how to effectively present oneself at the doorstep when delivering questionnaires, represented an early and steep learning curve. Nevertheless, through a process of trial and error, a successful doorstep strategy was adopted which became better rehearsed over time. The postcard drop pre-warning householders of the

researcher's visit was clearly a valuable 'ice breaker', although a substantial number of households reported not having noticed the flyer. Collecting the questionnaires in person also provided an unanticipated and valuable opportunity to quickly validate the questionnaire with the respondent at the doorstep.

Following the pilot tranche several minor changes were made to the questionnaire document itself (though content remained the same). Most significantly from the point of view of administration, a box to indicate the collection date and time was added to the front cover. With hindsight, this was a somewhat obvious oversight.

5.6.1.2 The follow-up telephone calls

The pilot tranche also provided a valuable opportunity to refine the approach to the follow-up telephone calls. A template was prepared for recording responses in favour of using audio recording and transcribing the interviewer led questions. It quickly became apparent that fully transcribing phone calls would be unmanageable for a single researcher also conducting the door-to-door survey and was in some ways unnecessary. The intention was to capture a 'factual' (though interviewer interpreted) account of the household's experience of car ownership level changes, and not the respondent's exact narrative, in contrast to the in-depth interviews undertaken in stage one.

Through a process of trial and error, it was established that a telephone discussion would typically take around five to 10 minutes with each respondent, with a further 10 minutes or so required to write up the responses. Given that the telephone calls had originally been advertised as taking 15 minutes, the questionnaire was subsequently altered to indicate five to 10 minutes in an effort to boost participation rates.

With recourse to the PhD work programme and taking cognisance of the resources required to complete the 21 household pilot tranche, a further five tranches of approximately 40 households each were planned to be completed by the end of July 2010. To avoid the predominant summer holiday period (August), the remaining 18 households in Bishopston (effectively the second half of the pilot tranche) were surveyed in September 2010.

5.7 The survey response rate

The 'drop and collect' approach to survey administration achieved a 74 per cent response rate overall, with 184 questionnaires being returned out of the 248 households sampled across the two neighbourhoods.

129 households agreed to take part in the follow-up telephone calls. However, four households remained not contactable after several attempts and 125 follow-up calls were completed in all. This reflected 68 per cent of the respondents and 50 per cent of the overall sample.

The survey response rate for Bishopston, broken down by method of questionnaire delivery and receipt is presented in Table 5-6:

Table 5-6: Bishopston response rate

Bishopston questionnaire response rate	**80%**
Number of households sampled:	**120**
Questionnaires delivered in person	96
Questionnaires delivered through the letter box with a postage paid envelope (as not in after two or more house calls)	15
Unoccupied households	2
Refusals in person	7
Number of questionnaires received:	**96**
Questionnaires delivered in person and collected in person	76
Questionnaires delivered in person, but received by mail (as not in on collection dates, so provided with a reminder and postage paid envelope)	12
Questionnaires delivered through the letter box with a postage paid envelope and received by mail	8
Number of non-responses:	**24**
Questionnaires delivered in person, but not received by mail (having not been in on collection dates, so provided with a reminder and postage paid envelope)	8
Questionnaire delivered with a postage paid envelope but not received by mail	7
Unoccupied households	2
Refusals in person	7
Telephone interviews:	
Number of follow-up telephone calls agreed	72
Number of follow-up telephone calls completed	71

The survey response rate for Bradley Stoke, broken down by method of questionnaire delivery and receipt is presented in Table 5-7:

Table 5-7: Bradley Stoke response rate

Bradley Stoke questionnaire response rate	**69%**
Number of households sampled:	**128**
Questionnaires delivered in person	90
Questionnaires delivered through the letter box with a postage paid envelope (as not in after two or more house calls)	24
Unoccupied households	0
Refusals in person	14
Number of questionnaires received:	**88**
Questionnaires delivered in person and collected in person	86
Questionnaires delivered in person, but received by mail (as not in on collection dates, so provided with a reminder and postage paid envelope)	1
Questionnaires delivered with a postage paid envelope and received by mail	1
Number of non-responses:	**40**
Questionnaires delivered in person, but not received by mail (having not been in on collection dates, so provided with a reminder and postage paid envelope)	3
Questionnaire delivered with a postage paid envelope but not received by mail	23
Refusals in person	14
Telephone interviews:	
Number of follow up telephone calls agreed	57
Number of follow up telephone calls completed	54

Comparing the response rates from the two neighbourhoods it was apparent that a higher response rate was achieved in both parts of the survey in Bishopston. This could be attributed to the demographic differences identified before - being younger and lower educational attainment have been attributed to lower response rates in previous travel surveys (Bricka, 2009). Not being able to contact a household in person also appeared to be associated with a reduction in the likelihood of receiving a response, particularly in Bradley Stoke where only two questionnaires were received by post.

5.8 Analysing the survey

The analysis was structured to answer each of the five survey objectives and entailed the use of both qualitative and quantitative data. It is important at this point to remind the reader that the main objective for the survey was to generate a wider set of qualitative accounts of car ownership level changes in order to broaden the earlier findings from the in-depth interviews. It was not an intention to generate highly structured quantitative data for use in a modelling framework. Nevertheless, the quantitative data generated by the survey was used to make more general claims about the survey data (using statistical inference, see section 5.8.2.1) to complement the qualitative findings.

5.8.1 Qualitative analyses

The qualitative data was of a very different form to that generated by the in-depth interviews, in reflecting a wider range of accounts of car ownership level change, at the expense of depth. The self-completion open responses tended to be fairly brief (supporting the need for follow-up telephone calls) and were fully transcribed. The responses to the telephone calls had also been recorded in the researcher's and not the respondent's own words. Hence quotes tend not to be used in the reporting of qualitative analyses in the two results chapters that follow.

Qualitative analyses in relation to the survey research questions typically involved an iterative process of data reduction. Given that there were now 184 cases to explore, the relevant data would first be reduced into a single summary table to enable the researcher to more easily scan the entire data set. This would typically be reduced further by means of a data led thematic analysis to establish a manageable number of categories to which households could be assigned and analysed further.

5.8.2 Quantitative analyses

The quantitative survey data was entered into and managed using the statistical software package SPSS version 17. The majority of the quantitative analyses took the form of bi-variate tests of association between two variables. Typically, the following three statistical tests were employed:

Cross tabulations and chi-square tests of association were used to explore the relationship between two categorical variables; for instance, the relationship between number of cars owned and neighbourhood of residence.

Mann-Whitney tests were used to explore whether the variation between *two* sample means was significant (given that the assumptions underlying an independent t-test tended to be violated). For instance, when comparing the mean frequency of car use reported by residents of Bishopston and Bradley Stoke.

Kruskal-Wallis tests were used to establish whether the variation between *more than two* sample means was statistically significant. For instance when comparing the mean frequency of car use for one, two and three or more car households.

5.8.2.1 Interpreting statistical significance

The decision to sample 100 per cent of households from two census output areas (one inner-urban and one outer-urban) in Bristol constituted a 'purposive' sampling strategy. The use of a non-random sample such as this had implications for the interpretation of the bivariate statistical tests which are used and reported in the two chapters that follow.

For the reasons set out in section 5.4, the two output areas were intentionally selected to contain a similar demographic composition overall. This demographic was categorised in the 2001 census as 'young families in terraced homes'. Thus in using statistical tests it can be assumed that the 184 survey responses are representative of households located in output areas classified as 'young families in terraced homes' in Greater Bristol (of which there were 216 output areas).

Thus the reporting of statistical significance in the chapters that follows only implies a statistically significant variation within the population of households located in areas classified as 'young families in terraced homes' in Greater Bristol.

To take an illustrative example, say it is discovered that a greater proportion of two or more car owners reported ownership of 'too many' cars compared to the other car ownership categories; and this contributed to a statistically significant chi-square test. The result is interpreted as follows: a household *located in an area classified as 'young families in terraced homes' in Greater Bristol* is more likely to report ownership of 'too many' cars if they own two or more cars than if they own one or fewer cars. This general claim applies only to the population defined in italics and cannot be reliably extended to a wider population.

This is however a conservative assumption relating specifically to the interpretation of statistical tests. As noted in section 5.4.2, Bristol was considered to share similar characteristics to other major cities in England and the census classification system also applies nationally. Thus *qualitative* findings drawn from the survey sample could be considered to apply to households located in other urban neighbourhoods in England classified as 'young families in terraced homes'.

5.8.3 Sub-groupings within the sample

The sampling strategy and design of the questionnaire ensured that there were also a number of natural sub-groupings of households (sharing one or more common attributes) within the overall sample. Three sub-groupings in particular were used to explore whether membership of a subgroup was associated with an underlying variation in car ownership and / or other variables of relevance to the study. These sub-groupings were number of cars owned, neighbourhood of residence, and household structure.

5.8.3.1 Number of cars owned

The number of cars owned and how this had changed over the life-time of the household unit was central to the research. Households were categorised as owning zero, one, two or three or more cars. The influence of other factors (e.g. neighbourhood) on the number of cars owned (and how this has changed over time) was explored through the analysis; as was the influence of the number of cars owned on other factors such as the next expected car ownership change.

5.8.3.2 Neighbourhood of residence

Living in either an inner urban neighbourhood (Bishopston) or an outer urban neighbourhood (Bradley Stoke) offers differing opportunities for travel. For instance, Bishopston residents had greater access to the city centre while Bradley Stoke residents had greater access to the motorway network. Accordingly, the nature of the relationship between neighbourhood of residence and the process of car ownership change and other related travel behaviour variables (for instance level of car use) was explored.

5.8.3.3 Household structure

Household structure was considered to offer a useful proxy for both life stage (a time dependent variable), some commonality of life-trajectory (e.g. partnership

formation or dissolution, having children or not) and some commonality of activity patterns which may have an influence on daily travel behaviours and longer term car ownership needs. For instance, having young children within the household is associated with certain common obligations: schooling, health care, after school activities and so on. A three tiered hierarchical schema (running from a coarser to a finer level of categorisation) was used to categorise the surveyed households according to:

1. Whether the household had one or two or more household heads;
2. Household structure (couple, parents with children, single parents with children, single occupancy, shared housing, other); and
3. Life stage (see Appendix G for these life stage categories);

Whether household structure was associated with particular car ownership or related transport needs was also explored.

Further details on aspects of specific quantitative and qualitative analyses are reported throughout the two results chapters.

5.9 Characteristics of the survey respondents

A summary of the characteristics of the survey respondents, by neighbourhood is provided in Table 5-8 overleaf. More detailed cross tabulations and where appropriate, chi-square tests of association are provided in Appendix H, tables H-1 to H-4. Comparing the demographic composition of the two survey neighbourhoods, it is apparent that:

- Bishopston residents reported higher incomes and higher levels of educational attainment than their Bradley Stoke counterparts;
- Bishopston households were older on average than Bradley Stoke households. The average age of the oldest householder in Bishopston was 48 compared to 39 in Bradley Stoke.
- Compared to the Bishopston population, the Bradley Stoke population included a larger proportion of (younger) single occupancy households, single parents and couples. This was countered by Bishopston including proportionately more households with both parents with children. Bishopston also housed a larger post 60 population than Bradley Stoke.

Table 5-8: Summary of the survey respondents

		Bishopston	Bradley Stoke	Total
Respondent gender	Male	34 (35.4%)	38 (43.2%)	72 (39.1%)
	Female	62 (64.6%)	50 (56.8%)	112 (60.9%)
	Total	**96 (100%)**	**88 (100%)**	**184 (100%)**
Age of the oldest householder	Average age (SD)	48 (15.6)	39 (12.4)	44 (14.8)
	N	**89**	**80**	**169**
Car ownership	0 car	12 (12.5%)	7 (8.0%)	19 (10.3%)
	1 car	50 (52.1%)	54 (61.4%)	104 (56.5%)
	2 cars	28 (29.2%)	21 (23.9%)	49 (26.6%)
	3+ cars	6 (6.3%)	6 (6.8%)	12 (6.5%)
	Total	**96 (100%)**	**88 (100%)**	**184 (100%)**
Household structure	Single occupancy	15 (15.6%)	23 (26.1%)	38 (20.7%)
	Shared housing	9 (9.2%)	1 (1.1%)	10 (5.4%)
	Single parent with children	6 (6.3%)	13 (14.8%)	19 (10.3%)
	Couple	16 (16.7%)	22 (25.0%)	38 (20.7%)
	Parents with children	46 (47.9%)	27 (30.7 %)	73 (39.7%)
	Other	4 (4.2%)	2 (2.3%)	6 (3.3%)
	Total	**96 (100%)**	**88 (100%)**	**184 (100%)**
Highest level of educational attainment	Compulsory	2 (2.1%)	5 (6.0%)	7 (3.9%)
	GCSE	2 (2.1%)	10 (11.9%)	12 (6.7%)
	'A' Level	7 (7.4%)	7 (8.3%)	14 (7.8%)
	Vocational	4 (4.2%)	23 (27.4%)	27 (15.1%)
	Degree	32 (33.7%)	18 (23.5%)	50 (27.9%)
	Post graduate	44 (46.3%)	17 (28.6%)	61 (34.1%)
	Other	4 (4.2%)	4 (4.8%)	8 (4.5%)
	Total	**95 (100%)**	**84 (100%)**	**179 (100%)**
Income	<£15,000	11 (11.8%)	6 (7.1%)	17 (10%)
	£15,001-£30,000	20 (21.5%)	23 (27.1%)	43 (24%)
	£30,001-£50,000	17 (18.3%)	32 (37.6%)	49 (28%)
	£50,001-£70,000	16 (17.2%)	9 (10.6%)	25 (14%)
	> £70,001	18 (19.4%)	1 (1.2%)	19 (11%)
	Don't know or didn't say	11 (11.9%)	14 (16.5%)	25 (14%)
	Total	**93 (100%)**	**85 (100%)**	**178 (100%)**

Notes: Not all categories sum to 184 responses due to missing values in the data set

These demographic differences between the two neighbourhoods were not unexpected, in being consistent with those identified during the analysis of the 2001 census undertaken as part of the neighbourhood selection process (reported in section 5.4.2).

A further notable observation is that the survey revealed *high* car ownership rates overall in both neighbourhoods relative to the national population. In particular, non-car owning households represented just 10 per cent of the sample (19 households), compared to 25 per cent at the national level (Department for Transport, 2010 table nts0205). Indeed, further analysis (reported in detail in section 6.4.2) revealed that there were only six instances of transitions from one to zero car ownership. This limited the breadth of insight into this important car ownership transition and the strength of any corresponding conclusions that could be drawn.

5.10 Chapter summary

This chapter has outlined the rationale for and method used in undertaking a survey of two neighbourhoods in Bristol. The survey was designed to meet five objectives (defined in section 5.3.1), in testing for the broader applicability of the findings from the interview analysis. It was reported that the survey achieved a 74 percent response rate overall through the successful use of a 'drop and collect' method of survey administration. The thesis now moves on to present the results of the survey in the two chapters that follow. These results chapters are structured to provide one section in answer to each of the five survey objectives.

Chapter 6: How Car Ownership States Have Arisen

6.1 Introduction

This chapter presents the first of two sections of survey analysis and relates specifically to survey objective one. Namely: to describe how and to explain why *household* and *neighbourhood* car ownership *levels* change over time.

The chapter begins with an analysis of the aggregate composition of the vehicle fleets in both neighbourhoods at the time of the survey. An estimation of how the aggregate car ownership position has changed in each neighbourhood since the 2001 census is then provided given an understanding of underlying changes at the household level.

In offering detailed insights into how household car ownership levels have arisen over time, the chapter moves on to present a qualitative analysis of 12 pathways towards four alternative household car ownership states (zero, one, two and three or more cars). Following this 14 common reasons for changing car ownership level are identified. Lastly, to complement the qualitative analysis, the chapter concludes with an overview of the results of four multivariate regression models concerned with identifying factors associated with change and non-change in household car ownership levels across the survey neighbourhoods.

Where necessary, supporting statistics and tables are included in Appendix H in the order in which the analysis is presented in the text.

6.2 Composition of the surveyed vehicle fleet

In order to understand how vehicle ownership states in either neighbourhood had arisen over time, it was first necessary to establish what vehicle ownership states were captured by the survey and how these were distributed across the sample.

The survey recorded a total of 241 privately owned vehicles across 184 households – an average of 1.31 vehicles per household (Table 6-1). This average was found to be the same across the two survey neighbourhoods:

Table 6-1: Vehicle counts by neighbourhood

Neighbourhood	No. of vehicles	No. of households	Vehicles per household
Bishopston	126	96	1.31
Bradley Stoke	115	88	1.31
Sample	241	184	1.31

The composition of household vehicle ownership states across the sample, measured with respect to the *number* of vehicles owned is presented in Table 6-2. The biggest share, over half of the sample, reported owning one car; A third (33 per cent) of the sample reported owning two or more vehicles; A tenth of the sample reported not owning a vehicle:

Table 6-2: Household car ownership in the survey neighbourhoods

No. of cars	Bishopston Households		Bradley Stoke Households		Total Sample	
	No. of households	Percentage	No. of households	Percentage	No. of households	Percentage
Zero	12	12.5%	7	8.0%	19	10.3%
One	50	52.1%	54	61.4%	104	56.5%
Two	28	29.2%	21	23.9%	49	26.6%
Three or more	6	6.3%	6	6.8%	12	6.5%
Total	96	100.0%	88	100.0%	184	100.0%
Chi-square test: $\chi^2 = 2.126$, df=3, p=0.547						

While there appeared to be some differences in the distribution of car owning states between the two neighbourhoods, the variation was not statistically significant according to a chi-square test ($\chi^2 = 2.126$, df=3, p=0.547). Overall this demonstrated that **the composition of the vehicle fleets in the two neighbourhoods, in terms of the aggregate number of cars owned and the distribution of zero, one, two and three or more car owning households, was broadly the same**. It suggested that the potential tendency for Bishopston residents to have lower levels of car ownership than Bradley Stoke residents, owing to the closer proximity to the city centre, had been countered by the higher incomes available to Bishopston residents.

6.3 How neighbourhood car ownership levels have arisen

The survey had been designed to be comparable with the 2001 census and as such it was possible to explore how the *aggregate* car ownership levels in both neighbourhoods had changed since 2001. The detailed car ownership histories generated by the survey also enabled an investigation of how car ownership changes at the aggregate *neighbourhood* level, related to underlying changes occurring at the *household* level.

The car ownership rates for 2001 and 2010 are compared for Bishopston and Bradley Stoke in Table 6-3 and Table 6-4 respectively. It is acknowledged that while the wording of the question on car ownership in the survey (question 1) was exactly the same as the 2001 census, the method of survey administration was not. Consequently, the 2010 survey achieved a lower number of responses than the 2001 census which is required to be returned by law:

Table 6-3: Bishopston: Comparison of car ownership levels: 2001 to 2010

Category	Bishopston 2001		Bishopston 2010	
	No. of households	Percentage of households	No. of households	Percentage of households
Total	**130**	**100%**	**96**	**100%**
No car households	22	16.92%	12	12.50%
One car households	60	46.15%	50	52.08%
Two car households	43	33.08%	28	29.17%
Three car households	5	3.85%	5	5.21%
Four or more car households	0	0.00%	1	1.04%
Total cars in the area:	165	0.00%	126	
Average no. cars per household	1.27		1.31	
Notes: 2001 data extracted from 2001 census, table KS17 (Census Dissemination Unit, 2011)				

Table 6-4: Bradley Stoke: Comparison of car ownership levels: 2001 to 2010

Category	Bradley Stoke 2001		Bradley Stoke 2010	
	No. of households	Percentage of households	No. of households	Percentage of households
Total	**126**	**100%**	**88**	**100%**
No car households	15	11.90%	7	8.0%
One car households	63	50.00%	54	61.4%
Two car households	42	33.33%	21	23.9%
Three car households	6	4.76%	5	5.7%
Four or more car households	0	0.00%	1	1.1%
Total cars in the area:	165	0.00%	115	100%
Average no. cars per household	1.31		1.31	
Notes: 2001 data extracted from 2001 census, table KS17 (Census Dissemination Unit, 2011)				

The average car ownership rate recorded in Bradley Stoke had not changed between 2001 and 2010; remaining at 1.31 cars per household on average. The average car ownership rate recorded in Bishopston was very slightly higher in the 2010 survey: increasing from 1.27 vehicles per household in 2001 to 1.31 vehicles per household in 2010. This equates to an additional four vehicles in total since the 2001 census across the 96 surveyed households in Bishopston.

It is recognised that a simple comparison such as this does not account for the possible effects of non-response bias, given the lower number of responses achieved in the 2010 survey. This could potentially reflect a lower number of responses from a particular grouping (single occupancy or non-car owning households for example). Therefore it is not possible to determine with confidence exactly how the aggregate car ownership level has changed[21]. Nevertheless, given the reasonably high response rate, this partial comparison would indicate that the aggregate car ownership levels in both neighbourhoods had *not* changed substantially between the 2001 census and the 2010 survey.

The composition of the populations in the two neighbourhoods, in terms of household structure (used as a proxy for life stage characteristics), also appeared to have remained relatively stable (Table 6-5 and Table 6-6). One slight change in both neighbourhoods appeared to be a slightly higher proportion of parents with children in 2010 than there was in 2001. This was countered by a slightly

[21] A more complete comparison will be possible when the 2011 census results become available.

lower proportion of couples. This either implied a move through the family life cycle (i.e. couples having children) for a small proportion of households in the two neighbourhoods or again was a possible consequence of a non-response bias amongst couples.

Table 6-5: Bishopston: Comparison of population composition: 2001 to 2010

Category	Proportion of households 2001	Proportion of households 2010
Both parents with children	39.2%	47.9%
Lone parents with children	9.2%	6.3%
Couples	22.3%	16.7%
Single Occupancy	16.9%	15.6%
Other	12.3%	13.6%
Notes: 2001 data extracted from 2001 census, table KS20 (Census Dissemination Unit, 2011)		

Table 6-6: Bradley Stoke: Comparison of population composition: 2001 to 2010

Category	Proportion of households 2001	Proportion of households 2010
Both parents with children	25.6%	30.7%
Lone parents with children	14.4%	14.8%
Couples	29.6%	25.0%
Single Occupancy	26.4	26.1%
Other	4.0%	3.4%
Notes: 2001 data extracted from 2001 census, table KS20 (Census Dissemination Unit, 2011)		

With respect to underlying household car ownership changes, longitudinal insights from the 2010 survey suggested that households moving into both neighbourhoods displayed a greater tendency to *increase* car ownership level than to reduce car ownership level following the move (Table 6-7):

Table 6-7: Car ownership changes following a move to either neighbourhood

	Bishopston		Bradley Stoke	
Households increasing car ownership	20	24%	11	15%
Households reducing car ownership	9	11%	7	10%
Households remaining unchanged	54	65%	54	75%
Total households	83	100%	72	100%

A more detailed analysis of when households moved into each neighbourhood and / or had changed car ownership level relative to the 2001 census is included

as Appendix I. In summary, this suggested that increases in car ownership level across the survey sample could be attributed to the car ownership life cycle effect observed by Dargay and Vythoulkas (1999), and reported earlier in section 2.5.1. Both neighbourhoods were characterised by young adult households moving in and subsequently acquiring first or second cars as they move through the car ownership life cycle. For example, first cars were acquired when starting the first job, second cars were required when working circumstances changed or as offspring reached driving age.

These empirical observations concerning aggregate and household level changes are now synthesized as follows:

- The finding that the composition of the populations in both neighbourhoods, in terms of life stage characteristics, had remained relatively stable since the 2001 census *implied* that households moving into Bishopston and Bradley Stoke tended to be at an earlier life stage than households moving out of Bishopston and Bradley Stoke. Population turnover acted to maintain a stable population composition in the neighbourhoods over time.
- The further finding that aggregate car ownership levels had remained relatively stable since 2001 also *implied* that some of the older households leaving the neighbourhood had *higher* car ownership levels at the time of the move than some of the younger households moving into the neighbourhood. This again could be attributed to the older households being further on in their car ownership life cycle than the younger households moving into the neighbourhood (Dargay and Vythoulkas, 1999).
- The process of population turnover then acted to suppress the extent to which car ownership increases at the household level following a move into either neighbourhood, translated into car ownership increases at the neighbourhood level.

These longitudinal observations provide some empirical insights into the general factors that influence change in car ownership at the neighbourhood level:

The characteristics of the neighbourhood (housing stock, geographic location, social environment) influences the life stage of the households moving into and out of the neighbourhood;

Amongst a complex array of factors, the life stage of households moving into the neighbourhood influences whether households have a tendency to increase (younger households) or decrease (older households) car ownership level over time;

Whether the population remains in the neighbourhood and ages over time or whether older households are replaced by younger ones (or vice-versa) influences the extent to which car ownership life cycle effects are cancelled out at the aggregate level.

6.4 How household car ownership levels have arisen

Having established an understanding of the composition of the vehicle fleet across the sample, and how car ownership rates had changed in either neighbourhood since the 2001 census, the next step was to develop a deeper understanding of how car ownership states had arisen at the disaggregate, household level.

This stage of analysis was concerned with *systematically describing* how household car ownership levels had arisen over time – an important aspect of survey objective one. It involved identifying the features of a set of *car ownership change pathways* through which household car ownership states had arisen over time. This section of analysis was important, as consistent with the developing thesis, it was necessary to understand how current car ownership states were related to past car ownership level changes or indeed non-change in the case of car ownership stability.

6.4.1 Identifying features of the car ownership pathways

The analysis proceeded by first grouping households by number of cars owned at the time of the survey; that is zero, one, two and three or more cars owned. Households were then categorised according to the form of their car ownership pathway since household formation: For example, moving from zero cars at the point of household formation to one car at the time of the survey, from one car at the point of household formation to one car at the time of the survey and so on. Through this, the following 12 car ownership pathways were identified (Table 6-8):

Table 6-8: Car ownership pathways since household formation

Pathways to:	Pathway type	No. of cases	Percentage
no cars	0 to 0 cars	13	7.1%
	0 to 1 to 0 cars	1	0.5%
	1 to 0 cars	5	2.7%
one car	0 to 1 car	21	11.4%
	1 to 1 car	57	31.0%
	2 to 1 car	22	12.0%
	1 to 2 to 1 car	4	2.2%
two cars	0 to 1 to 2 cars	3	1.6%
	1 to 2 cars	18	9.8%
	2 to 2 cars	26	14.1%
	2 to 1 to 2 cars	2	1.1%
three+ cars	x to 3+ cars	12	6.5%
Total		**184**	**100.0%**

The qualitative data from the open response questions and the follow-up telephone calls relating to past car ownership level changes, current modal usage patterns and future intentions were then summarised in a single table. This was sorted by pathway type and household structure, enabling the researcher to look across the data set to identify the common qualitative features of each pathway type. Grouping the sample by household structure was considered to provide an indicator of at least some common shared life-experiences over the life course for households across the sample e.g. Adapting to life as a couple, or single occupancy household; adapting to life with children.

A range of *quantitative* indicators relating to each pathway type were also extracted from the data set to establish whether there were any notable patterns within and across the pathway groupings; for instance, relating to household size, average age, income. These quantitative indicators are summarised in the tables included in Appendix H (table H-5 and table H-6).

The process of developing systematic descriptions for each pathway type proved insightful and yet challenging, given the variety of unique car ownership stories that were revealed by individual households. Nevertheless the key features of each pathway type are set out in the sections to follow. It is noted that the descriptions often make reference to specific *reasons* for undertaking a car

ownership level change. A separate analysis of the common reasons for car ownership level changes is subsequently presented in section 6.5.1.

6.4.2 Pathways towards non-car ownership

The survey recorded 19 non-car owning households and revealed examples of three pathways towards non-car ownership since household formation:

- Zero to zero cars: The household had never owned a car;
- One to zero cars: The household had one car at the point of formation but subsequently relinquished it; and
- Zero to one to zero cars: The household acquired a car after formation but subsequently relinquished it.

The number of occurrences within each pathway type, disaggregated by household structure is set out in Table 6-9:

Table 6-9: Pathways to non-car ownership, by household structure

Pathway type (No. of cars)		couple	parents with children	other	single occupancy	shared housing	single parent with children	Total
0 to 0	No. of households	1	1	0	4	4	3	13
	%age of pathway type	8%	8%	0%	31%	31%	23%	100%
0 to 1 to 0	No. of households	0	0	0	1	0	0	1
	%age of pathway type	0%	0%	0%	100%	0%	0%	100%
1 to 0	No. of households	0	1	0	4	0	0	5
	%age of pathway type	0%	20%	0%	80%	0%	0%	100%

On average, non-car owning households were characterised in the sample as having the smallest household sizes, the lowest number of license holders and the lowest incomes.

Zero to zero cars: The majority (13 out of 19 or 68 per cent) of non-car owning households had *never* owned a car (at least for the duration of the current household unit). This group was equally distributed across the two survey neighbourhoods. Two sub-groupings were identified within this pathway.

The first and largest grouping (nine out of 14 cases) were **younger adults (up to 35) that were yet to move into car ownership for the first time**. Seven of these reported an intention to enter car ownership at some point in the future (discussed further in section 7.3.4). Their responses in the follow-up telephone calls implied that their lower incomes (which related to health constraints in one case) had been a barrier to entering car ownership so far.

The second grouping comprised older **adults (over 35) that had never owned a car**. This included two single occupancy adults over 60, both residing in Bishopston that had brought up families without moving into car ownership. These individuals matched the profile of voluntary non-car owners (Melia et al, 2011, in press), presenting themselves as keen cyclists and advocates of car free living.

One to zero cars: There were five examples of households relinquishing an only vehicle; four of which were **single occupancy households that had moved out of car ownership in later life**, all residing in Bishopston. These relinquishments were related to the ageing process and were prompted by health reasons, separation from or death of a car owning husband, and in one case a vehicle write off prompted non replacement at the age of 70. As noted before, Bishopston had a slightly larger older population than Bradley Stoke, hence the greater prevalence of this pathway type in Bishopston.

In the fifth case a Bradley Stoke family had relinquished a car following the temporary loss of a license due to a speeding fine. The relinquishments in this pathway type were all arguably involuntary, being triggered by constraints imposed on the household in one way or another.

Zero to one to zero cars: This one case of a single occupancy male had intentionally moved to a central location (Bishopston), in order to avoid needing to run a car – a further example of a voluntary non-car owner who reported a dislike of driving and being ideologically oriented towards a car free lifestyle (Melia et al, 2011, in press).

6.4.3 Pathways towards owning one car

The surveyed captured 104 single car owning households and generated examples of four pathways towards ownership of one car:

- Zero to one car: The household acquired the first car after formation;

- One to one car: The household had a car at formation and this has remained to be the case;
- Two to one car: The household had two cars at formation but relinquished the second car after formation; and
- One to two to one car: The household had one car at formation and temporarily acquired a second car which was subsequently relinquished.

The number of occurrences within each pathway type, disaggregated by household structure is set out in Table 6-10:

Table 6-10: Pathways to single car ownership, by household structure

Pathway type (No. of cars)		couple	parents with children	other	single occupancy	shared housing	single parent with children	Total
0 to 1	No. of households	3	9	0	5	4	0	21
	%age of pathway type	14%	43%	0%	24%	19%	0%	100%
1 to 1	No. of households	8	15	2	20	2	10	57
	%age of pathway type	14%	26%	4%	35%	4%	17%	100%
2 to 1	No. of households	6	8	0	4	0	4	22
	%age of pathway type	27%	36%	0%	18%	0%	18%	100%
1 to 2 to 1	No. of households	2	2	0	0	0	0	4
	%age of pathway type	50%	50%	0%	0%	0%	0%	100%

In line with expectations, one car owning households were on average larger in size and included more license holders than non-car owning households. Conversely they were smaller in size and included less license holders than multi-vehicle households.

Zero to one car: The survey captured 21 instances of the acquisition of the first car in the household. This group was evenly distributed across differing household structures: couples, families and single occupancy households, **affirming that the single car owning state is suitable for a range of differing household circumstances**. In all cases the acquisition of the first car had occurred relatively early on in the household's history and was typically associated with another significant event; for example, child birth, a change in

working circumstances (including moving into the labour market for the first time) or a residential relocation. Three households commented that they had bought their first car when they had been financially able to.

One to one car: This group was similarly evenly distributed across differing household structures. Given that the survey was designed to focus on the reasons for the last car ownership level change rather than non-change, it was challenging to establish specific reasons for stability amongst these 57 one car owning households. With hindsight this was perhaps a weakness in the survey design.

Amongst cohabiting households, the pathway implied that one partner had owned a car before the couple moved in together. The non-acquisition of a second car amongst these couples (with or without children – 23 cases) appeared to be associated with cases of one partner not yet having a driving license, one partner being out of work, or one or both partners being willing and able to use non-car modes to get to work.

The single adult household structures, some of whom had previously lived with a partner, described having always had a car and needing a car to meet their work, child care or other lifestyle obligations. These were more prevalent in Bradley Stoke owing to the higher proportion of single adult households in this neighbourhood.

Two to one car: 14 out of these 22 second car relinquishments occurred amongst couples that already had a car each when they started living together. Relinquishments generally occurred following a distinct change in circumstances for the household meaning that one partner no longer needed a car of their own on a regular basis. In ten cases (the majority, eight of which resided in Bishopston), the relinquishment was found to be directly associated with the couple finding that they were able to manage with one car after moving in together. Other reasons included a health constraint in older age, a change in working circumstances, residential relocation or retirement (meaning a second car is no longer required).

Amongst single occupancy or single parent households, the relinquishment of a second car tended to be related to a change in household structure. That is an adult partner had left the household, taking their car with them.

One to two to one car: There were only four cases of temporary second car acquisitions amongst couples, each of which had a *unique* explanation. One case

related to a company car acquisition which was subsequently reversed. The second case reflected the family life cycle whereby adult offspring had reached driving age, acquired their own car and then left home, taking their car with them. In the remaining two cases the acquisition and relinquishment was related to a change in working circumstances following which both partners either did or did not require a car of their own.

6.4.4 Pathways towards owning two cars

The surveyed captured 49 two car owning households and revealed examples of three pathways towards owning two cars since household formation:

- Zero or one to two cars: The household had either zero or one car at household formation and had two cars at the time of the survey;
- Two to two cars: The household had two cars at household formation and this has remained to be the case; and
- Two to one to two cars: The household temporarily relinquished a second car before re-acquiring another second car.

The number of occurrences within each pathway type, disaggregated by household structure is set out in Table 6-11:

Table 6-11: Pathways to second car ownership, by household structure

Pathway type (No. of cars)		couple	parents with children	other	single occupancy	shared housing	single parent with children	Total
0 to 1 to 2	No. of households	1	2	0	0	0	0	3
	%age of pathway type	33%	67%	0%	0%	0%	0%	100%
1 to 2	No. of households	5	10	1	0	0	2	18
	%age of pathway type	28%	56%	6%	0%	0%	11%	100%
2 to 2	No. of households	11	14	1	0	0	0	26
	%age of pathway type	42%	54%	4%	0%	0%	0%	100%
2 to 1 to 2	No. of households	0	2	0	0	0	0	2
	%age of pathway type	0%	100%	0%	0%	0%	0%	100%

As expected second car ownership occurred amongst households with two or more adults of driving age i.e. Couples or both parents with children or single parent households with adult offspring.

Zero or one to two cars: There were only three cases of the 'zero to one to two' car pathway type, hence this category is combined with the 'one to two' car pathway type here. The low number of households in this grouping relates to the finding that most (45 out of 48) of the two car owning couples in the sample demographic (younger couples / families) had at least one car before moving in together.

The acquisition of a second car amongst couples (with or without children) after household formation generally occurred following a distinct change in circumstances for the household. While one adult had initially been able to meet their activity patterns without a car, a change in circumstances consequently led to both adults needing a car of their own. Four reasons were identified: birth of the first child, a change in working circumstances or a residential relocation (which required one adult to acquire a car in order to travel to work), and retirement (which meant the retired adult needed a car of their own while the other car was in use for work).

In one single parent household, an adult offspring acquired a second car on reaching driving age. In another case, leisure activities motivated a couple to acquire a camper van as a second vehicle.

Two to one to two cars: The relinquishment and subsequent re-acquisition of a second car occurred in just two cases (one retired couple with adult offspring and one young family), again following a distinct change in circumstances for the household. The relinquishments were triggered in one case by being able to manage with one car after moving in together (one adult was able to walk to work) and in another case a change in working circumstances (one adult giving up work) meaning they no longer needed a car of their own. Similarly the re-acquisitions were prompted by a change in working circumstances in one case (a car is required by both adults for work) and retirement in the other (a car is required by the retired adult to meet leisure commitments while the other car is used by another household member for work).

Two to two cars: There were 26 cases of stable two car owning households, evenly distributed between Bishopston and Bradley Stoke. Again, it was challenging to establish specific reasons for stability amongst these two car

owning households. Nevertheless there was evidence to indicate that both partners in the household were accustomed to having a car available to them as individuals and would typically each use their cars to get to work or other regular activities - 16 out of the 17 households that were available for follow up telephone call described how both partners used their cars on a regular basis. This is in contrast to the couples in the 'one to one' car pathway type who reported one partner being unable to drive and / or being willing and able to meet their daily obligations without a car.

6.4.5 Pathways towards owning three or more cars

The survey captured 12 instances of households owning three or more vehicles, evenly distributed between Bishopston and Bradley Stoke (Table 6-12).

Table 6-12: Pathways towards multiple car ownership, by household structure

Pathway type (No. of cars)		couple	parents with children	other	single occupancy	shared housing	single parent with children	Total
x to 3+	No. of households	1	9	2	0	0	0	12
	%age of pathway type	8%	75%	17%	0%	0%	0%	100%

Multiple vehicle ownership occurred predominantly in family households. Six cases related simply to families in which both household heads already had a car and subsequently offspring had reached driving age and acquired their own car. Five of these six households resided in Bradley Stoke while one household resided in Bishopston – tentative evidence to suggest that adult offspring were more likely to remain at home and acquire cars in Bradley Stoke than equivalent adult offspring residing in Bishopston; these may either have a greater tendency to leave home, or to stay at home and not acquire a car.

Four cases related to households in which both household heads already had a car of their own and an additional specialist vehicle was acquired for leisure use (camper vans, classic cars or sports car). These all resided in Bishopston which may indicate an effect of the higher incomes overall in this neighbourhood.

Two cases related to complicated household structures where four or more related adults were sharing a house, and several individuals had ownership of their own car.

6.4.6 Section summary

In distilling the key findings from the pathway analysis it was observed that a household's pathway type tended to relate to the household's life stage at the time of the survey. Indeed, the pathways could be associated with the typical car ownership life cycle pattern observed by Dargay and Vythoulkas (1999)[22] and reflected, in order of life stage:

- Young single adults that were yet to move into car ownership for the first time;
- A small number of longer term voluntary non-car owners who appeared content with this position;
- Couples or families with young children that had acquired first or second cars;
- Older families with adult offspring that had acquired their own vehicles (leading to multiple vehicle ownership);
- Older families that had lost vehicles when adult offspring had left home; and
- A small number of older households that had relinquished vehicles due to constraints (health and income) arising during the ageing process.

With respect to understanding the underlying process of car ownership change over time, the composition of pathway types across the sample (illustrated in Table 6-8) demonstrated a tension between notions of car ownership *as either a stable or unstable state*: 52 per cent, over half of the surveyed household had *not* changed car ownership level since household formation – evidence that household car ownership levels tend to reflect *stable* states. On the other hand 48 per cent of households, nearly half the sample, had experienced *at least* one car ownership level change – evidence that car ownership levels can also be *unstable*.

This tension was first revealed in the reviewed literature (sections 2.5.2 and 2.5.4). To reiterate, analysis of the BHPS for instance, demonstrated that 16 per cent of households change car ownership level between two consecutive years. However, 84 per cent of households, the majority, maintain their car ownership level from one year to the next (Dargay and Hanly, 2007). Furthermore, car ownership has been demonstrated to be state dependent i.e. the current car ownership level is strongly determined by past car ownership levels (Hanly and Dargay, 2000).

[22] This revealed that car ownership tends to increase as the head of the household reaches the age of 50, after which it declines.

In support of the developing thesis, it is suggested that this tension between household car ownership as either a stable or unstable state can be resolved by viewing car ownership level changes as the outcome of a continual process of change over time. That is to say that car ownership can change from a stable to an unstable state over time. In chapter seven, the prevalence of car access imbalances across the sample at a single point in time is explored. This reveals that one quarter of households, a significant minority, report feeling that they own too few or too many cars for their needs. Thus non-equilibrium car ownership states can and do arise over time. This supports the conception developed in chapter four, that there is a period in the lead up to and following a car ownership level change during which the household may not be 'in balance' with the current car ownership state. Nevertheless, the pathway analysis would also suggest that once the new car ownership state has been established, it is typical for that state to be maintained.

A further observation from the analysis of the car ownership pathways was that households often described specific *reasons* for undertaking changes in car ownership level. These reasons are now evaluated in the section to follow.

6.5 Understanding household car ownership level changes

The survey captured 109 car ownership level changes across 184 households. 96 households (52 per cent) reported never having made a car ownership level change so the 109 car ownership level changes occurred across 88 households (48 per cent of the sample).

The 109 level changes are categorised by car ownership transaction type in Table 6-13:

Table 6-13: Reported car ownership level changes by transaction type

Car ownership transaction type	Number of instances	Proportion of all recorded changes
0-1	25	22.9%
1-0	6	5.5%
1-2	29	26.6%
2-1	32	29.4%
2-3	11	10.1%
3-2	2	1.8%
3-4	1	0.9%
0-2	2	1.8%
1-3	1	0.9%
Total	**109**	**100.0%**

63.3 per cent of the recorded changes represented increases in car ownership, while only 36.7 per cent were reductions in car ownership. Changes between one and two cars in either direction made up the largest share of all recorded changes, at over half, 56 per cent of all changes. Changes between zero and one car also made up a significant proportion of all changes at just over one fifth (22.9 per cent). Conversely there were very few instances of only car relinquishments (six overall).

The first observation is that the composition of these changes is commensurate with the characteristics of the survey neighbourhoods - young families in terraced housing which, given their life stage, had a tendency to *increase* car ownership level. There are consequently fewer examples of vehicle relinquishments that may occur in later life than there were examples of vehicle acquisitions as younger households move into first or second car ownership. Secondly it **suggests greater volatility in second car ownership than first car ownership, as expected and as highlighted in the literature review** (Dargay and Hanly, 2007, Dix et al, 1981).

6.5.1 Reasons for car ownership level changes

The common reasons for undertaking a car ownership level change were identified through a qualitative coding exercise. This entailed reviewing the summary table of car ownership level changes prepared during the pathways analysis. From this an initial list of common reasons was generated inductively and refined further by identifying categories that would contain more than one level change across the sample. Each car ownership level change was then assigned to the most appropriate category.

The process of identifying the most suitable reason category for each car ownership level change was again challenging given that, consistent with the interview and pathway analysis, individual car ownership level changes were typically associated with several factors that had acted over time. Judgement was required to establish the most natural groupings across the sample. For example, household a49 acquired their first car when they had their first child and relocated from London where they had been able to live without a car. This level change was assigned to the ‘child birth’ category as this was found to be more prevalent across the sample than ‘relocating from London’. Nevertheless, the category definitions were intended to be general enough so that other common

factors could be discussed in the wider interpretative descriptions which are presented in the sections to follow.

The coding exercise generated 14 reasons for car ownership level change and these are listed, in order of category size in Table 6-14:

Table 6-14: Reasons for undertaking a car ownership level change

Reason for undertaking a car ownership level change	Number of instances	Proportion of all car ownership level changes
change in working circumstances	20	18.3%
able to manage with one car after moving in together	12	11.0%
a change in household structure	11	10.1%
residential relocation	10	9.2%
child birth	9	8.3%
company car acquisition or relinquishment	8	7.3%
offspring reaching driving age	8	7.3%
leisure	5	4.6%
bought a first car when financially able to	3	1.8%
retirement	3	2.8%
opportunism	2	2.8%
partner learns to drive for independence	2	1.8%
declining health in older age	2	1.8%
a change in public transport attractiveness	1	0.9%
other	5	4.6%
unknown	8	7.3%
Total	**109**	**100%**

It is also notable that the reasons tend to be instrumental in nature. It is acknowledged that there may also have been associated underlying factors such as a particular lifestyle preference or attitude that may not have been detected by the survey – desire for city centre living, environmental concern, or a liking for driving for instance. This was to some extent unavoidable given that use of a survey instrument limited the depth of insight that could be consistently achieved across the sample.

Nevertheless the reasons were consistent with the process of car ownership change framework emerging from the analysis of the in-depth interviews, in often representing *life events* which trigger a change in circumstance which in turn linked to a change in car ownership level. Indeed 82 per cent of respondents describing level changes in the questionnaire subjectively agreed that the level

change was associated with a life event. Each reason is now briefly described in the sub-sections to follow.

6.5.1.1 Change in working circumstances

Table 6-15: Car ownership level changes associated with a change in working circumstances

Car ownership level change type	Number of instances
0-1	8
1-0	1
1-2	8
2-1	3
Total	**20**

A large proportion of car ownership changes associated with a change in working circumstances related to **second car acquisitions** (Table 6-15). These not surprisingly occurred in households in which two adults lived as partners, with or without children. A change in working circumstances involved a change in the location of the work place (which may be fixed or variable) for one adult which meant that they were no longer able to travel to work by public transport or another non-car mode. In some cases a car was required for the new job to also service journeys during the working day.

Conversely **second car relinquishments** amongst two adult households occurred following one adult stopping work, or a change in work location meaning one adult was able to travel to work by public transport.

In most cases changes from **zero to one car** reflected the acquisition of the *first car*. As identified in the interview analysis, this often linked to the first job after leaving education or indeed another significant turning point in life such as a career change or returning to work after bringing up children.

The single case of a change from **one to zero cars** related to the single occupancy male household described before under the 'zero to one to zero' car pathway. He voluntarily gave up his car after his job location changed and he found himself able to commute by public transport.

6.5.1.2 Ability to manage with one car after moving in together

Table 6-16: Car ownership level changes associated with cohabitation

Car ownership level change type	Number of instances
2-1	12

As identified through the pathways analysis, there were 12 cases of **second car relinquishments** following two adults moving in together (Table 6-16). In all cases at some point after the move, the couple realised that they no longer required a car each. The length of time from the point of cohabitation to the relinquishment of the second car ranged from zero (an apparent simultaneous change) to eight years. The average time to relinquishment was three years. **This clearly demonstrates that car ownership adjustments to a new set of circumstances can take a significant length of time, often several years.**

There was qualitative evidence to suggest that a useful pre-condition to relinquishment was that at least one partner was already using an alternative mode to get to work for some part of the week prior to relinquishing the second car. Cohabitation meant that *both* partners still would retain access to a car for non-work activities. Consistent with the process of change framework developed from the in-depth interviews, some respondents also reported that the realisation of the ability to manage with one car had been prompted by a smaller 'trigger' such as maintenance costs, parking constraints or an opportunity arising to sell a car on.

6.5.1.3 A change in household structure

Table 6-17: Car ownership level changes associated with a change in household structure

Car ownership level change type	Number of instances
0-1	1
1-0	2
2-1	7
3-2	1
Total	**11**

These 11 instances (Table 6-17) simply related to a car becoming associated with, or leaving a household as a result of an adult joining or leaving the household respectively. For example: adult offspring leaving or returning home

with a car; a relationship breakdown with one partner leaving the household with their car; the death of a partner forcing the sale of a car; or a young adult leaving the family home, setting up a new household of their own and subsequently losing access to the previous household's cars.

6.5.1.4 Residential relocation

Table 6-18: Car ownership level changes associated with a residential relocation

Car ownership level change type	Number of instances
0-1	3
1-2	6
2-1	1
Total	**10**

Residential relocations tended to prompt increases in car ownership amongst the surveyed households (Table 6-18). Given that there were five cases in either neighbourhood, it was not possible to qualitatively establish any effect of moving to either an inner-urban or outer-urban location.

Second car acquisitions were prompted amongst households with two or more adults, one of which was no longer able to travel to work by a non-car mode following the move. Conversely, the **second car relinquishment** occurred after one adult was able to travel to work by public transport following the move (they had not been able to from their previous address). In all cases the car ownership change was prompted by a change in the relative location of work place and home and the nature of the transport link between the two, rather than the characteristics of the residential neighbourhood per se.

Two of the **first car acquisitions** occurred following young couples relocating from London to Bristol and experiencing a lower availability of public transport. The remaining first car acquisition related to a household relocating from Eastern Europe and acquiring the car shortly after the move.

Across these cases, the length of time between the move and the car ownership level change was observed to range between zero months (a simultaneous change) and nine months, and in all cases the car ownership change *followed* the move[23]. This would tentatively suggest that car ownership changes associated

[23] It was only possible to calculate durations for six out of the ten cases, owing to lack of specific dates in the unstructured qualitative data.

with residential relocations can be expected within one year of moving. However, the survey would not have necessarily captured the longer term effects of residential relocations that were apparent in the in-depth interviews – for instance the case of the household (15F/M) that had relinquished their only car, nearly *10 years* after moving to an inner urban location.

6.5.1.5 Child birth

Table 6-19: Car ownership level changes associated with child birth

Car ownership level change type	Number of instances
0-1	2
1-2	5
2-1	2
Total	**9**

The arrival of children in the family tended to be associated with increases in car ownership (Table 6-19). **Second car acquisitions** were prompted by the child carer requiring access to a car at home while the other car is in use during the working day. In one case a parent of a young couple deemed the household's current car to be inadequate for child care needs and donated his existing car to them – an example of cars being transferred through family networks (see section 6.5.1.9).

First car acquisitions were also prompted by the birth of the first child in two cases. One of these was also associated with a family relocating from London to Bristol. They similarly had not needed a car during their time living together in London.

On the other hand **second car relinquishments** were prompted by one partner giving up work to care for children. There was tentative qualitative evidence to suggest that the other partner being able to commute by non-car modes or working locally was a useful precondition to second car relinquishments following childbirth. In such cases the only car was then sometimes available for child care during the day.

In terms of the timing of change, five of the car ownership level changes occurred within 12 months of the birth of the first child, some of which had been actioned during pregnancy. A further two cases had occurred some years later (two years and five years). These longer lags appeared to relate to other longer term changes, for instance in one case an associated change in working patterns for

the female when she returned to work on a part-time basis (realising that the second car was no longer required)[24].

6.5.1.6 Company cars

Table 6-20: Car ownership level changes associated with company cars

Car ownership level change type	Number of instances
0-1	1
0-2	1
1-2	2
2-1	1
2-3	2
3-2	1
Total	**8**

Company cars tended to create temporary car ownership increases which were then reversed following a change in working circumstances (leading to the relinquishment of the company car) or the household selling a privately owned vehicle (Table 6-20). In some cases company cars led households to temporarily have access to more than two cars as they initially retained ownership of their existing vehicles.

6.5.1.7 Offspring reaching driving age

Table 6-21: Car ownership level changes associated with offspring reaching driving age

Car ownership level change type	Number of instances
1-2	2
1-3	1
2-3	4
3-4	1
Total	**8**

These cases all simply related to one or more offspring in the household reaching driving age and deciding that they needed independent transport of their own (Table 6-21). In some cases a specific instrumental need was reported – for

[24] It was possible to estimate these durations to the nearest 12 months based on the age of the eldest child (in years) for seven out of nine cases due to missing dates in the unstructured qualitative data.

example servicing a sailing hobby, or having independent transport to get to university or part time work.

Offspring reaching driving age was a common reason why households would own more than two cars. This tended to be a temporary state which was reversed when offspring left home, taking their cars with them.

6.5.1.8 Leisure

Table 6-22: Car ownership level changes associated with leisure

Car ownership level change type	Number of instances
1-2	1
2-3	4
Total	**5**

The four instances of **third car acquisitions** all related to classic or sports cars that were acquired to service a hobby of a male household head within two parent households with older children (Table 6-22). The **second vehicle acquisition** occurred when a young couple temporarily acquired a camper van to travel around Scandinavia.

6.5.1.9 Opportunism

Table 6-23: Car ownership level changes associated with opportunism

Car ownership level change type	Number of instances
0-1	2

In two cases, first (old) cars (with little value) were donated to young adults by family or friends even though these individuals were not actively seeking to acquire a car of their own at the time (Table 6-23). It is notable that there were seven other detected cases where a car ownership level change had involved a transaction between friends and family networks, but the presence of opportunism was apparently subordinate to other factors in these cases.

Given that the survey did not set out to explicitly measure the presence of opportunism in relation to the last car ownership level change, a number of other cases may also have gone undetected. Nevertheless it is clear that the presence of opportunism was less apparent in the survey data than it was from the in-depth interviews. This is undoubtedly a result of the differing nature of the two research

instruments. Through in-depth discussions the presence of opportunism had emerged naturally in relation to the acquisition of first own cars, and vehicle replacements. Neither of these transaction types were necessarily captured by the survey. Moreover, the survey had not been designed to explicitly capture detailed data relating to precisely who cars were acquired from and relinquished to.

6.5.1.10 Bought a first car when financially able to

Table 6-24: Car ownership level changes associated with disposable income

Car ownership level change type	Number of instances
0-1	3

Two respondents described how they acquired their **first cars** as young couples in the 1980s when they felt they could afford to (Table 6-24). One mentioned that high mortgage rates in the 1980s had prevented them buying a car previously, illustrating the influence of wider economic factors at the time. Both households had adequately managed prior to buying a car (one had a motorcycle) but they felt restricted in terms of leisure activities and caring for elderly relatives. It is notable that these respondents were further on in their life courses at the time of the survey and other specific reasons for acquiring a car may have faded from memory. Younger respondents in the sample, who have more recently acquired their first cars may have been more likely to report a specific instrumental reason such as an employment change.

The third case relates to a 34 year old single occupancy female who bought her own car in her early twenties when she felt she had the money to. She reported previously having been more interested in spending money on travelling and other leisure pursuits – indicating a change in priorities as she moved through her life course.

6.5.1.11 Retirement

Table 6-25: Car ownership level changes associated with retirement

Car ownership level change type	Number of instances
1-2	2
2-1	1
Total	**3**

Second car acquisitions following retirement were prompted when the retired adult found that they needed a car to service leisure activities (Table 6-25). They had previously been able to get to work by a non-car mode and the other car was still in use by the remaining working adult. This finding was somewhat counter intuitive, but indicated that in some cases a fixed work location which is accessible by non-car modes suppresses the need for an additional car.

Conversely the **second car relinquishment** was prompted following a realisation that the household could manage with one car between them with only one adult working (implying that both adults had previously required the car to get to work).

6.5.1.12 Female partner learns to drive for independence

Table 6-26: Car ownership level changes associated with a female partner learning to drive

Car ownership level change type	Number of instances
1-2	2

Two cases of female partners acquiring their own car in middle age were recorded (Table 6-26). These individuals belonged to a generation in which a lower proportion of females acquired driving licenses on reaching driving age. In one case a female partner was prompted to acquire her driving license during the 1980s (in middle age) when the household had an opportunity to buy a new car. The desire to acquire a driving license was partly motivated by a need to care for an ageing mother who lived in area of the city which was difficult to get to by bus.

In the second case one partner bought the car when they learnt to drive at the age of 40 to 50. They have since relinquished the second car owing to one partner becoming unemployed.

6.5.1.13 Declining health in older age

Table 6-27: Car ownership level changes associated with declining health in older age

Car ownership level change type	Number of instances
1-0	1
2-1	1
Total	**2**

These first and second car relinquishments were prompted by eye-sight issues which occurred in later life (60+) requiring the householder to give up driving (Table 6-27). These health reasons were also associated with the ageing process.

6.5.1.14 Other reasons

Several other unique reasons for car ownership level changes were reported including:

- A change from one to two cars being prompted by an increase in rail fares for a commute between Bristol and London. The household felt that a second car would offer a cheaper alternative.
- A change from zero to one car being prompted by it being easier to travel by car as a family than by public transport. This change had nonetheless occurred 10 years after having the first child.
- A change from one to zero cars being prompted by the temporary loss of a driving license due to a speeding conviction.
- A change from one to zero cars being prompted in later life after the vandalism of a car. This respondent decided not to replace the vehicle partly owing to the ageing process as she is now 70 and lives alone.
- A change from two to one cars after one household member passed his motorcycle test and replaced one car with a motorcycle.
- A change from two to three cars in a house shared by two Eastern European families. The third car was acquired for one adult to learn to drive in.

6.5.2 Section summary

The qualitative analysis of all car ownership level changes recorded by the survey revealed 14 common reasons for undertaking a car ownership level

change. The reasons support the process of car ownership change framework emerging from the in-depth interviews which posited that car ownership level changes occur as an adaptation response to *life events* occurring over the life course. Indeed, 70 percent of recorded level changes were found to be associated with: a change in working circumstances, cohabitation, an adult joining or leaving the household, residential relocation, child birth, offspring reaching driving age, retirement or a health constraint arising.

6.6 A quantitative analysis of household car ownership change

The preceding sections have systematically reviewed the wide range of qualitative explanations for household car ownership level change and also non-change. A quantitative, multi-variate analysis of factors associated with change and non-change in car ownership levels was also performed to complement these qualitative findings. This provided an opportunity to use statistical inference to make more general, broader claims about the survey data to support these non-generalisable qualitative findings.

6.6.1 Opting for binary logistic regression

The survey was structured to develop a car ownership trajectory from the point of household formation, defined as the point at which the household head(s) began cohabiting or living alone. This meant that the time period captured by the survey differed from household to household. In order to quantitatively investigate factors associated with experiencing a car ownership level change across the sample it was necessary to control for the variation in household duration.

Binary logistic regression modelling offered a suitable approach. Such models relate a binary dependent variable (a yes / no answer, for example in this instance the household has or has not experienced a car ownership level change) to a series of independent variables. Including household duration as an independent variable meant that the influence of other factors in the model on car ownership level change could be analysed, holding all else (including household duration) equal.

The applicability of hazard based duration models, which are suited to modelling systems which change over time, was also considered, but ruled out due to limitations in the quantitative data generated by the survey. Such models provide estimates of the probable time until the next vehicle transaction as a function of a set of independent variables, including indicators of the historic rate of vehicle transactions over time. Hazard models, when applied to household car ownership

transactions, therefore require structured data about the full car ownership history of each household since household formation i.e. precisely what vehicle transactions (acquisitions, relinquishments and replacements) have occurred and when. Given that a complete car ownership history was not available from the survey data, the use of hazard models was not appropriate. (To reiterate, the intention of the survey was to generate deeper insights into the last car ownership level change for the household and not to generate highly structured quantitative data about the household's car ownership history for a subsequent detailed modelling analysis).

Nevertheless the binary logistic modelling exercise offered a means of exploring factors associated with four different dependent variables relating to car ownership level change (highlighted in italics below):

- To explore what factors were associated with a household having experienced *at least one car ownership level change since household formation*;
- To explore what factors were associated with a household having experienced *a net increase in the number of cars owned since household formation*;
- To explore what factors were associated with a household having experienced *a net decrease in the number of cars owned since household formation*; and
- To explore what factors were associated with a household *not experiencing a net change in the number of cars owned since household formation*.

Accordingly four binary logistic regression models were specified and interpreted using the statistical software package SPSS version 17.0.

6.6.2 Selecting independent variables to include in the models

It was important to develop a model specification that both had satisfactory explanatory power and that produced results that could be meaningfully interpreted. Accordingly, the following independent (predictor) variables were selected for inclusion given a reasoned expectation that they could have an influence on the household's propensity to change car ownership level:

Duration of the household unit (in months): The longer a household had been established, the greater the chance of recording a car ownership level change in the survey. Duration of the household unit was included to enable the influence of

other factors on car ownership level change to be tested, *controlling for household duration* given that the duration of the household unit varied from household to household.

Number of cars owned at the point of household formation: This was included to explore whether particular car ownership states at the point of household formation were more stable than others, all else being equal.

Neighbourhood: This was included to explore whether living in Bradley Stoke or Bishopston was associated with a propensity to change car ownership level, all else being equal.

Household structure: A binary variable to indicate whether the household heads lived alone or with a partner, was included to test whether these differing circumstances and decision making structures had an influence on the propensity to change car ownership level. A binary variable to indicate whether the household had children at the time of the survey was also included given the impact of children on household activity patterns and hence potential implications for car ownership needs. Representing household structure in this way, rather than by household category (single occupancy, couple, parents with children and so on) was found to improve the explanatory power of a model.

Income: The strong relationship between income and car ownership is well known and indeed including income was found to improve the explanatory power of the models. It also enabled the influence of the other factors to be tested, controlling for income effects.

These variables had been generated in a structured manner across the sample through the questionnaire element of the survey. Consideration was given to whether other potentially insightful 'life event' variables could be extracted from the qualitative data. For instance, to explore whether experiencing a job change was a strong predictor of car ownership change. However, this was ruled out, given the less structured nature of the qualitative questions and data i.e. Not all households reported the same level of detail relating to specific life events. A job change may only have been reported if it related to a car ownership level change and not otherwise.

6.6.3 Interpreting model output

The SPSS output for each model was first interrogated to establish whether the overall model was statistically significant i.e. whether the specified independent

variables taken as a group were able to make statistically significant predictions about the dependent variable. Two tests were available: The Omnibus test, in this case a p-value of less than 0.05 indicated that the model was statistically significant; and the Hosmer and Lemeshow test, in this case a p-value greater than 0.05 indicated that the model was statistically significant. All four models were found to be statistically significant and the tests of significance are reported within the tables of results in the discussion sections that follow.

The model results were then interpreted to establish which of the independent variables had the strongest predictive power in each model. The 'Sig' column in the SPSS output, which reported the p-values of the independent variables was explored here. At the 95 per cent confidence level, a p-value of less than 0.05 indicated that the independent variable offered a statistically significant contribution to the model's predictive power. Statistically significant variables at the 95 per cent confidence level are shaded light grey in the results tables that follow. Dark grey is used to highlight weaker relationships - the variables that were significant at the 90 per cent confidence level.

The odds ratio (Exp(B) in the model results tables) indicated the direction and magnitude of the relationship. An odds ratio greater than one implied that a unit increase in the independent variable increased the odds of the outcome (in this case a change in car ownership level) occurring. An odds ratio of less than one implied that an increase in the independent variable decreased the odds of the outcome (in this case a change in car ownership level) occurring.

The results of the four models are now presented under separate sections.

6.6.4 Model 1: Experiencing at least one car ownership level change

The result of the model testing factors associated with *experiencing at least one car ownership level change since household formation* is set out in Table 6-28. 75 out of the 166 cases included in the model had experienced at least one car ownership level change.

Neighbourhood of residence is not found to offer a statistically significant contribution to the model, indicating that car ownership level changes were equally likely to have been reported in either neighbourhood. This suggests that comparatively, there was nothing particular to the conditions in either survey neighbourhood that would encourage more changes in car ownership level. Having offspring within the household was also not found to be a statistically

significant variable in the model, indicating that this was not a strong predictor of having experienced at least one car ownership level change.

The number of cars owned at the point of household formation does offer a statistically significant contribution to the model. Perhaps unsurprisingly, households with no vehicles at the point of formation were more likely to have experienced a change in car ownership level than households with one vehicle at the time of household formation. **This supports the notion that in a highly motorised society, there is a tendency for non-car owning households to enter car ownership over time**.

There is a weaker relationship (statistically significant at the 90 per cent confidence level) between household structure and experiencing a car ownership level change. Households with a single adult at the head of the household were less likely to have experienced a car ownership level change than cohabiting adults. **This implies that the number of cars required by two cohabiting adults is a more volatile state than the number of cars required by a single adult** as detected in the qualitative analysis (section 6.5.1.2).

The income relationship is also statistically significant in the model and is in line with expectations. Lower income households were less likely to have experienced a car ownership level change than households earning £50k - £70k. **This indicates that increasing disposable income is associated with an increased flexibility with respect to the number of cars owned at any point in time.**

Table 6-28: Regression model 1: at least one car ownership level change

Independent variable	Category	B	S.E.	Wald	df	Sig.	Exp(B)
Neighbourhood	Bishopston	0.148	0.443	0.111	1	0.738	1.160
	Bradley Stoke	(Reference category)					
Number of vehicles at the point of household formation	0 vehicles	2.089	0.608	11.814	1	0.001	8.077
	2 vehicles	0.173	0.461	0.142	1	0.707	1.189
	3+ vehicles	-22.358	40192.970	0.000	1	1.000	0.000
	1 vehicle	(Reference category)					
Duration of the household unit (months)	NA	0.008	0.002	14.543	1	0.000	1.008
Household structure	Single adult	-0.924	0.554	2.784	1	0.095	0.397
	Cohabiting adults	(Reference category)					
	Offspring in the household	-0.129	0.443	0.086	1	0.770	0.879
	No offspring in the household	(Reference category)					
Income	< £15k	-3.088	1.094	7.964	1	0.005	0.046
	£15k - £30k	-1.556	0.711	4.784	1	0.029	0.211
	£30k- £50k	-1.139	0.629	3.276	1	0.070	0.320
	£70k - £100k+	-0.457	0.764	0.358	1	0.549	0.633
	Unspecified	-0.039	0.709	0.003	1	0.956	0.962
	£50k - £70k	(Reference category)					
	Constant	-0.488	0.681	0.513	1	0.474	0.614

Tests of model significance:	
Number of level changers:	75
Number of included cases:	166
Omnibus test	$\chi^2 = 66.714$, df = 12, $p<0.05$
Hosmer & Lemeshow	$\chi^2 = 6.369$, df=8, p=0.606
Nagelkerke R Square	0.331 – 0.443
Predicted correct	Null model: 54.8% Specified model: 76.5%

6.6.5 Model 2: Experiencing a net increase in car ownership level

The result of the model testing factors associated with *experiencing a net increase in car ownership level since household formation* is set out in Table 6-29. 48 out of the 166 cases included in the model had experienced a net increase in car ownership level.

The table reveals the same pattern of statistical significance i.e. car ownership state at household formation and income offer a statistically significant contribution to the model. Neighbourhood of residence and presence of children in the household do not.

In line with expectations, households with no vehicles at the point of household formation were a great deal more likely to have experienced an increase in car ownership level than households with one vehicle. Conversely households with two vehicles at the point of household formation were less likely to have experienced an increase in car ownership than households with one vehicle. **This implies that there is a tendency for households to enter car ownership, but once two cars are owned, further increases in car ownership level are unlikely**.

Lower income households were less likely to have experienced a net increase in car ownership level than households earning £50k - £70k. **This confirms that achieving higher income is associated with also experiencing increases in car ownership level**.

Table 6-29: Regression model 2: a net increase in car ownership level

Independent variable	Category	B	S.E.	Wald	df	Sig.	Exp(B)
Neighbourhood	Bishopston	-0.070	0.586	0.014	1	0.905	0.932
	Bradley Stoke	(Reference category)					
Number of vehicles at the point of household formation	0 vehicles	3.855	1.052	13.431	1	0.000	47.228
	2 vehicles	-2.290	0.665	11.865	1	0.001	0.101
	3+ vehicles	-22.813	40192.970	0.000	1	1.000	0.000
	1 vehicle	(Reference category)					
Duration of the household unit (months)	NA	0.008	0.003	10.372	1	0.001	1.008
Household structure	Single adult	-1.304	0.790	2.721	1	0.099	0.271
	Cohabiting adults	(Reference category)					
	Offspring in the household	0.283	0.569	0.248	1	0.618	1.328
	No offspring in the household	(Reference category)					
Income	< £15k	-5.067	1.568	10.437	1	0.001	0.006
	£15k - £30k	-3.931	1.168	11.330	1	0.001	0.020
	£30k- £50k	-1.430	0.765	3.493	1	0.062	0.239
	£70k - £100k+	0.256	0.915	0.078	1	0.780	1.292
	Unspecified	-1.381	0.888	2.419	1	0.120	0.251
	£50k - £70k	(Reference category)					
	Constant	-0.458	0.829	0.306	1	0.580	0.632

Tests of model significance:	
Number of net increasers:	48
Number of included cases:	166
Omnibus test	$\chi^2 = 93.105$, df = 12, $p<0.05$
Hosmer & Lemeshow	$\chi^2 = 4.516$, df=8, p=0.808
Nagelkerke R Square	0.429 – 0.614
Predicted correct	Null model: 71.1% Specified model: 86.7%

The weaker relationship between household structure and car ownership increases is also apparent. **Single adult households were less likely to have experienced increases in car ownership than cohabiting households**. This could either be due to an effect of entering second car ownership amongst couples or may reflect the underlying life stage characteristics of the survey sample. For example, single adult households in the sample includes younger adults that are yet to move into car ownership for the first time, and some retired adults that have relinquished cars. Cohabiting households on the other hand are more likely to include households that are in mid-life, at or nearing the peak of their car ownership life cycle. The survey may have therefore captured a greater number of increases in car ownership level amongst cohabiting adults than amongst single adults.

6.6.6 Model 3: Experiencing a net decrease in car ownership level

The result of the model testing factors associated with experiencing *a net decrease in car ownership level since household formation* is set out in Table 6-30. Although the model specification was found to be statistically significant, the reliability of this model may be questionable, given the small number of households (only 19 out of 166) that had reported a net decrease in car ownership level since household formation. Indeed the comparative 'Null Model' (a model with no predictor variables) consequently had an already high prediction rate of 88.6 per cent owing to the low number of households experiencing a net decrease in car ownership since household formation.

The only statistically significant variable in this model is owning two vehicles at the point of household formation. **Second car owners were a great deal more likely to have reduced car ownership level than one car owners**. This supports the notion that in some cases the need for a second car is more marginal than the need for an only car.

Table 6-30: Regression model 3: a net decrease in car ownership level

Independent variable	Category	B	S.E.	Wald	df	Sig.	Exp(B)
Neighbourhood	Bishopston	0.513	0.764	0.452	1	0.502	1.671
	Bradley Stoke	(Reference category)					
Number of vehicles at the point of household formation	2 vehicles	3.418	0.951	12.929	1	0.000	30.506
	3+ vehicles	-16.832	40192.970	0.000	1	1.000	0.000
	1 vehicle	(Reference category)					
Duration of the household unit (months)	NA	0.002	0.003	0.537	1	0.464	1.002
Household structure	Single adult	1.022	0.934	1.198	1	0.274	2.780
	Cohabiting adults	(Reference category)					
	Offspring in the household	-0.616	0.677	0.829	1	0.363	0.540
	No offspring in the household	(Reference category)					
Income	< £15k	-0.237	1.613	0.022	1	0.883	0.789
	£15k - £30k	-0.105	0.969	0.012	1	0.914	0.901
	£30k- £50k	-0.981	0.975	1.013	1	0.314	0.375
	£70k - £100k+	-1.587	1.265	1.573	1	0.210	0.205
	Unspecified	1.007	0.881	1.306	1	0.253	2.738
	£50k - £70k	(Reference category)					
	Constant	-4.280	1.209	12.534	1	0.000	0.014

Tests of model significance:	
Number of net decreasers:	19
Number of included cases:	129
Omnibus test	$\chi^2 = 34.745$, df = 11, $p<0.05$
Hosmer & Lemeshow	$\chi^2 = 13.243$, df=8, p=0.104
Nagelkerke R Square	0.236 – 0.417
Predicted correct	Null model: 85.3% Specified model: 88.4%

6.6.7 Model 4: Experiencing no net change in car ownership level

Finally, the result of the model testing factors associated with stability, *not experiencing a net change in car ownership level since household formation* are set out in Table 6-31:

Table 6-31: Regression model 4: no net change in car ownership level

Independent variable	Category	B	S.E.	Wald	df	Sig.	Exp(B)
Neighbourhood	Bishopston	-0.228	0.444	0.264	1	0.607	0.796
	Bradley Stoke	(Reference category)					
Number of vehicles at the point of household formation	0 vehicles	-2.240	0.618	13.125	1	0.000	0.106
	2 vehicles	-0.148	0.458	0.104	1	0.747	0.863
	3+ vehicles	21.921	40192.970	0.000	1	1.000	3.311E9
	1 vehicle	(Reference category)					
Duration of the household unit (months)	NA	-0.005	0.002	8.053	1	0.005	0.995
Household structure	Single adult	0.703	0.568	1.533	1	0.216	2.020
	Cohabiting adults	(Reference category)					
	Offspring in the household	-.0109	0.435	0.063	1	0.802	0.897
	No offspring in the household	(Reference category)					
Income	< £15k	2.879	1.046	7.572	1	0.006	17.789
	£15k - £30k	2.192	0.747	8.606	1	0.003	8.951
	£30k- £50k	1.124	0.615	3.340	1	0.068	3.076
	£70k - £100k+	0.300	0.745	0.162	1	0.687	1.349
	Unspecified	0.145	0.680	0.045	1	0.831	1.156
	£50k - £70k	(Reference category)					
	Constant	0.555	0.674	0.679	1	0.410	1.742

Tests of model significance:	
Number of non-changers:	99
Number of included cases:	166
Omnibus test	$\chi^2 = 62.513$, df = 12, $p<0.05$
Hosmer & Lemeshow	$\chi^2 = 11.960$, df=8, p=0.153
Nagelkerke R Square	0.314 – 0.424
Predicted correct	Null model: 59.6% Specified model: 77.7%

Income and number of cars at the point of household formation were revealed as statistically significant predictors of car ownership stability in the model. **Non-car owners at the point of household formation were less likely to remain in this state than car owners - again illustrating that non-car ownership is unlikely to be maintained as people move through their lives**. Lower income groups were more likely to maintain a stable car ownership position than households earning £50-£70k. This supports the earlier finding that increasing disposable income is associated with an increased flexibility with respect to the number of cars owned.

6.7 Chapter summary

This chapter has presented analyses concerned with addressing the survey objective: to describe how and to explain why *household* and *neighbourhood* car ownership *levels* change over time.

At the neighbourhood level, the longitudinal nature of the survey data provided evidence of the process of population turnover that acted to maintain a stable population composition and aggregate car ownership level over time. The housing stock and location of the two survey neighbourhoods attracted young households that tended to increase car ownership following the move to the area. These increases in car ownership were cancelled out by older households with higher car ownership levels leaving the neighbourhood.

The survey captured 12 differing pathways towards four car ownership states (zero, one, two and three or more cars) over time. The car ownership pathways reflected the household car ownership life cycle observed by Dargay and Vythoulkas (1999) and included: young single adults that were yet to move into car ownership for the first time; couples or parents with young children that had acquired first or second cars; families with adult offspring that had acquired their own vehicles (leading to multiple vehicle ownership); or older households that had relinquished vehicles due to the ageing process.

A qualitative analysis also revealed 14 reasons for car ownership level change. These reasons supported the finding from the interview analysis that car ownership level changes are often an adaptation response to *life events* occurring over the life course. Evidence of significant lag times between the occurrence of life events and car ownership changes was also presented. In particular, the relinquishment of second cars amongst newly cohabiting couples was observed as having taken three years on average.

Lastly, a multi-variate statistical analysis confirmed that all else being equal, non-car owners were more likely to increase car ownership level than other car ownership states. Second car owners were more likely to decrease car ownership level than only car owners, confirming the more marginal nature of second cars. There was also weaker evidence to suggest that cohabitation leads to greater volatility in household car ownership levels than living as a single adult household head.

Chapter 7: The Potential for Household Car Ownership Change

7.1 Introduction

Having previously examined how household and neighbourhood car ownership levels have arisen, the thesis now moves on to present an analysis of the potential for household car ownership levels to change in the two survey neighbourhoods. The chapter is divided into four sections, each relating to the remaining four survey objectives (two to five) which were:

2. To examine the extent to which the present car ownership *level* meets (or exceeds) household desires;
3. To explore how households expect to change car ownership level in the future;
4. To examine the potential for households to permanently manage with one fewer car; and
5. To explore the (objective and perceived) influence of residential location on household car ownership levels.

The analysis reported in this chapter reveals that while car *use* is found to vary with residential location (car use increases with greater distance from the city centre), car *ownership* is not. This suggests that car use is more easily influenced through policy measures than car ownership. It may also reflect to some extent the policy emphasis on managing car use rather the number of cars owned per household, which has not been an objective for transport policy to date.

The results of a number of statistical tests are summarised throughout the chapter. Where necessary, supporting tables and statistics are included as Appendix J in the order in which the analysis is presented in the text.

7.2 Investigating stability in current car ownership states

This first section is concerned with addressing the survey objective: To examine the extent to which the present car ownership *level* meets (or exceeds) household desires.

The analyses to follow are predominantly cross-sectional and quantitative in nature, exploring the survey variables that were intended to measure the extent

to which the household is presently in a stable car ownership position. Two variables are explored under separate sections:

- Intensity of car use: This variable reflects the reported frequency with which the household's vehicle fleet is in use for differing journey purposes; and
- The respondent's subjective assessment of whether their household had too many, too few or just the right number of vehicles - a measure of the concept of car access imbalance.

Where appropriate, the key results from a related piece of analysis which explored the level of car use relative to other transport modes are also reported. This analysis is included in full as Appendix K.

7.2.1 Intensity of car use

Respondents were asked to indicate how often each of their vehicles was used for three different journey purposes: Shopping, work and leisure (question 3) following Krizek (2002). Their responses were coded on a scale from zero to five as follows:

5 – Most days or more, 4 – A few times a week, 3 – Once or twice a week, 2 – A few times a month, 1 – Less than that, 0 – Never.

These scores were then converted into a proportionate 'car use intensity' variable that could be compared across households with differing numbers of vehicles. The highest possible score for a single vehicle, across all three journey purposes was 15 (three journey purposes multiplied by five, the score for 'Most days or more'). The total 'car use intensity' variable (across all three journey purposes) was then calculated as follows:

$$Total\ car\ use\ intensity = \frac{\sum_{All\ vehicles} Car\ use\ frequency\ scores}{No.\ vehicles\ \times 15}$$

This variable was calculated to provide an indication of instrumental *pressure on*, or *redundancy in* the household's vehicle fleet. A total car use intensity close to one would indicate that all vehicles in the household's vehicle fleet are in use for all three journey purposes 'Most days or more'; an indication of pressure on the vehicle fleet. At the opposite extreme, a total car use intensity close to zero would indicate a redundancy in car availability; an indication that one or more vehicles in the fleet are rarely used. Car use intensities for each of the three journey purposes were also calculated in a similar way.

It should be noted that the car usage frequency scores have not been weighted and this analysis assumes equal distances between each category i.e. the distance between the 'Never' and 'Less than that' frequency categories is assumed to be the same as the distance between the 'Once or twice a week' and 'A few times a week' frequency categories. The car use intensity variable nevertheless provides a useful *indicator* (rather than an accurate measure) of the reported extent to which the household vehicle fleet was in use.

7.2.1.1 Intensity of car use by neighbourhood

The average car use intensities for the full sample and for the two survey neighbourhoods are reported in Table 7-1. To aid interpretation, the car use intensities across the sample ranged from 0.17 (a two vehicle household with an infrequently used camper van) to 1.0 (all vehicles reportedly in use 'Most days or more'):

Table 7-1: Average total car use intensity, by neighbourhood

Neighbourhood	Mean	N	SD
Bishopston	0.51	92	0.25
Bradley Stoke	0.68	86	0.24
Sample	0.59	178	0.26
Mann-Whitney test: U = 2058, r=-5.554, p<0.05			

Neighbourhood of residence was found to have a statistically significant influence on car use intensity. **Residents of the inner urban neighbourhood reported using their vehicles less frequently than residents of the outer urban neighbourhood.** This pattern was present across all three journey purposes (work, shopping and leisure - Table 7-2), although the higher car use intensities reported for leisure by residents of the outer urban neighbourhood were not found to be statistically significant. It is also notable that Bishopston residents reported using their cars equally frequently for leisure and work, while Bradley Stoke residents reported using their cars most intensively for work.

Table 7-2: Average car use intensity, by journey purpose, by neighbourhood

Neighbourhood	Journey purpose								
	Work			Shopping			Leisure		
	Mean	N	SD	Mean	N	SD	Mean	N	SD
Bishopston	0.55	94	0.38	0.44	93	0.26	0.55	93	0.28
Bradley Stoke	0.80	86	0.35	0.62	87	0.27	0.62	87	0.29
Sample	0.67	180	0.39	0.53	180	0.28	0.59	180	0.29
Mann-Whitney tests	U=2316 Z=-5.17 p<0.05			U=2492 Z=-4.55 p<0.05			U=3479 Z=-1.65 p=0.098		

This effect was also reflected in the modal share analysis (Appendix K). Bradley Stoke residents reported a 13 per cent higher car use modal share than Bishopston residents. This was counter-balanced by Bishopston residents on average reporting higher walking, cycling and public transport modal shares. **This suggests that there were greater opportunities and / or a greater propensity for residents of the inner urban neighbourhood (to adapt) to use non-car modes compared to residents of the outer urban neighbourhood**. However as reported in chapter six, this had *not* translated into lower car ownership rates overall in the inner-urban neighbourhood.

7.2.1.2 Intensity of car use by number of cars owned

In line with expectations, average car use intensity was found to decrease with the number of cars owned (Table 7-3) and a Kruskal-Wallis test indicated that the relationship was statistically significant ($\chi^2 = 6.431$, df=2, p=0.040).

The statistical significance appeared to be mainly due to three or more car owners having much lower car use intensities than households with fewer cars. This related to the three or more car group including a number of households that owned a leisure vehicle (a camper van, classic car or sports car) which was used relatively infrequently:

Table 7-3: Average total car use intensity, by number of vehicles owned

Number of vehicles	Mean	N	SD
One	0.68	104	0.16
Two	0.64	45	0.17
Three or more	0.56	10	0.17
Sample	0.66	159	0.17
Kruskal-Wallis test: $\chi^2 = 6.431$, df=2, p=0.040 excludes non-car owners as their zero car use intensity would bias the test of variance.			

7.2.1.3 Intensity of car use by household structure

The relationship between intensity of car use and household structure was complex, given the underlying relationship between number of cars owned and car use intensity (Table 7-4). Although the variation between household structures was not statistically significant, there were some notable patterns. Two car owning couples reported using their cars more frequently than two car owning parents with children. This could possibly be attributed to a difference in activity patterns. For instance, both partners working full time in couples may both frequently drive to work. This might compare to one partner working full time in households with children. In such cases, the partner undertaking child care responsibilities may require less frequent use of the second car.

It is also notable that households with a single adult household head had lower mean car use intensities, owing to the greater number of non-car owners amongst this group:

Table 7-4: Average total car use intensity, by household structure

Household structure	No. of household cars	Mean	N	SD
Couple	zero	0.00	1	.
	one	0.69	19	0.17
	two	0.70	16	0.22
	three	0.44	1	.
	All couples	**0.67**	**37**	**0.22**
Parents with children	zero	0.00	2	0.00
	one	0.67	34	0.14
	two	0.60	25	0.15
	three	0.61	8	0.16
	four	0.32	1	.
	All parents	**0.61**	**70**	**0.18**
Single parent with children	zero	0.00	3	0.00
	one	0.68	14	0.16
	two	0.68	2	0.02
	All single parents	**0.57**	**19**	**0.29**
Single occupancy	zero	0.00	9	0.00
	one	0.71	29	0.17
	All single occupancy	**0.54**	**38**	**0.34**
Shared housing	zero	0.00	4	0.00
	one	0.62	6	0.21
	All shared housing	**0.37**	**10**	**0.36**
Other	one	0.67	2	0.09
	two	0.60	2	0.14
	All other	**0.63**	**4**	**0.11**
Total	zero	0.00	19	0.00
	one	0.68	104	0.16
	two	0.64	45	0.17
	three	0.59	9	0.16
	four	0.32	1	.
	Sample	**0.59**	**178**	**0.26**
Kruskal-Wallis test: $\chi^2 = 4.830$, df=5, p=0.437				

7.2.2 Car access imbalance

To gain a measure of car access imbalance (the extent to which the current car ownership state meets or exceeds the household's desires), respondents were asked to indicate (on behalf of the household) whether they felt they had too few, too many or just the right number of vehicles for their needs[25] (question 4). A

[25] The word 'needs' was used in the questionnaire as this was felt to be more easily comprehended than the word desires.

caveat to this section of analysis is that this variable represented the *individual respondent's* assessment of the household's position, rather than a measure of the household's consensual view. It is possible that individuals from the same household would offer alternative assessments.

The majority of the sample, nearly three quarters of respondents, reported that they had just the right number of cars for their needs – **most people were satisfied with their current car ownership level**. However, this also implied that one quarter, a significant minority, felt that they had either too few or too many cars for their needs (Table 7-5):

Table 7-5: Car access imbalance by neighbourhood

Car access imbalance	Bishopston		Bradley Stoke		Sample	
	No. of households	%age	No. of households	%age	No. of households	%age
Too few vehicles	18	18.9%	15	17.0%	33	18.0%
Too many vehicles	13	13.7%	2	2.3%	15	8.2%
Just the right number of vehicles	64	67.4%	71	80.7%	135	73.8%
Total	95	100.0%	88	100.0%	183	100.0%
Chi-square test: $\chi^2 = 8.447$, df=2, p=0.015						

The results of *quantitative* tests undertaken to identify factors associated with presence of a car access imbalance are now reported (Table 7-6). *Qualitative* findings are reported later on in the chapter (in section 7.3.4) in conjunction with an analysis of future intentions. It is logical to present these findings together, given the close relationship between satisfaction with the current car ownership level and expectations for future car ownership changes.

Table 7-6: Factors associated with car access imbalance

Factor	Statistical test	Observation
Neighbourhood	Chi-square test: $\chi^2 = 8.447$, df=2, p=0.015	Reporting 'Too many cars' was more prevalent in Bishopston. Reporting 'Too few cars' was equally distributed between the two neighbourhoods.
No. of cars owned	Chi-square test: $\chi^2 = 74.260$, df=2, p<0.000	'Too few cars' was reported proportionately more by non-car owners. 'Too many cars' was reported proportionately more by two or more car owners.
Household structure	Chi-square test: $\chi^2 = 1.59$, df=2, p=0.452	No statistically significant relationship
Car use intensity	Kruskal-Wallis test: $\chi^2 = 11.129$, df=2, p=0.004	The 'Too many cars' group reported the lowest car use intensities (0.50). The 'Too few cars' group reported the highest car use intensities (0.73).
See Appendix J: Tables J-1 to J-4		

A first observation was that only household structure was not found to be a statistically significant factor. It was reported earlier that cohabiting adults may require a greater number of car ownership level changes in order to reach a stable car ownership position than single adult household structures. From this it follows that a greater proportion of cohabiting adults would be expected to report a car access imbalance when measured cross-sectionally, than single adult household structures. However, this was not found to be the case. This implies that the surveyed cohabiting households had already been through a period of car ownership volatility by the time of the survey. Indeed, the finding that car access imbalance was evenly distributed across the household structure categories would suggest **that households tend to organise themselves towards a satisfactory car ownership state according to their structure**.

7.2.2.1 Factors associated with reporting 'too many cars'

Eight percent of the sample, just 15 households reported owning *too many* cars for their needs. The cross tabulations and statistical tests indicated that reporting ownership of 'too many cars' was associated with:

- Living in the inner-urban neighbourhood: 13 out of the 15 households resided in Bishopston;
- Owning two or more cars: 12 out of the 15 households owned two or more cars;

- Already having a level of redundancy in the vehicle fleet: Respondents reporting ownership of too many cars had the lowest mean car use intensities, indicating that one or more cars in their fleet was used comparatively infrequently.

7.2.2.2 Factors associated with reporting 'too few cars'

A larger proportion of respondents, 18 per cent of the sample reported ownership of *too few* cars (33 households). These respondents were evenly distributed between the two neighbourhoods, **indicating that the reasons for having too few cars were not necessarily associated with residential location**. However, the observation that car owners in this group had higher than average car use intensities indicated that there was a 'pressure' on the household's vehicle fleet.

Indeed, a common attribute of respondents with too few cars was living in a household with fewer cars than adults of driving age. The majority, 80 per cent of non-car owners (15 cases) reported owning too few cars – **indicating that non-car ownership was recognised as a constraint by most non-car owners**. There were also 14 cases of one car owning couples (with or without children) who reported feeling constrained by having to manage with one car between them. There were similarly four cases of two or more car owning households in which there were three or more adults (typically adult offspring) that experienced conflicts over access to the vehicle fleet (explored further in section 7.3.4).

7.2.2.3 Awareness of car access imbalance

Respondents were then asked to report the extent to which they had *thought* about whether they had the right number of cars or vans for their needs. This question was included to test whether the idea of having too many or too few cars had occurred to respondents previously, without having been prompted by the questionnaire.

39 per cent of households reported not having thought about it. 61 per cent of households reported having given it some consideration before (Table 7-7):

Table 7-7: Awareness of car access imbalance

Awareness of car access imbalance	No. of households	%age
hadn't thought about it	72	39.1%
sometimes think about it	60	32.6%
very conscious about it	52	28.3%
Total	184	100.0%

The results of chi-square tests of association with awareness of car access imbalance are summarised in Table 7-8:

Table 7-8: Factors associated with awareness of car access imbalance

Factor	Chi-square test	Observation
Neighbourhood	$\chi^2 = 1.007$, df=2, p=0.604	No statistically significant relationship
No. of cars owned	$\chi^2 = 9.097$, df=4, p=0.059	No statistically significant relationship
Household structure	$\chi^2 = 20.896$, df=6, p=0.002	Cohabiting adults were more aware than single adults
Car access imbalance	$\chi^2 = 18.796$, df=2, p=0.001	Dissatisfied respondents were more aware than satisfied respondents
See Appendix J: Tables J-5 to J-8		

As might be expected, reporting a car access imbalance (too few or too many cars) was found to be associated with reporting being more aware of it i.e. respondents reporting feeling like they had too few or too many cars were more likely to report 'sometimes' thinking about it. **This supports the framework emerging from the in-depth interviews, which posited that the presence of a car access imbalance (an unsatisfactory state for the household) heightens the level of consideration with respect to the car ownership state**.

There was also a statistically significant relationship between consideration of a car access imbalance and household type. Proportionately more cohabiting adults reported having considered whether they had the right number of cars for their needs. Conversely, proportionately more single adult household structures had not considered whether they had too few or too many cars. **This implies that household structures with more than one adult decision maker are more conscious of whether they have the right number of cars than households with just one adult decision maker**.

A possible explanation is the observation that households with two adults have a greater number of realistic car owning states from which to choose (zero, one or

two cars) compared to households with one adult (zero or one car). Moreover, a negotiation is required in two adult households, to reach a consensus on which state is most suitable. These factors may act together to increase the general level of awareness of satisfaction with the car ownership state. This is consistent with the finding from the multi-variate analysis, that car ownership is less stable amongst cohabiting adults than amongst single adult household arrangements.

7.2.3 Section summary

This section has presented findings relating to the survey objective: to examine the extent to which the present car ownership *level* meets (or exceeds) household desires.

The survey revealed that residents of the inner urban neighbourhood report using their vehicles less frequently and were more multi-modal than residents of the outer urban neighbourhood. Reporting ownership of 'too many' cars occurred entirely amongst two or more car owners, predominantly residing in the inner-urban neighbourhood. This indicated that 'marginal' second cars were more prevalent in the inner-urban neighbourhood where there was an apparent greater potential for the use of non-car modes. Reporting ownership of too few cars was prevalent amongst non-car owners and amongst car owning households with fewer vehicles than adults of driving age.

The relationship between instrumental need for cars and the concept of car access imbalance was revealed to be as expected. Those reporting ownership of too many cars reported the lowest car use intensities, while those reporting ownership of too few cars reported the highest car use intensities.

The exploration of satisfaction with the current car ownership level is now deepened in the next section, in conjunction with an analysis of expectations for future car ownership changes.

7.3 Exploring prospects for future car ownership change

The chapter now moves on to address the survey objective: to explore how households expect to change car ownership level in the future.

Respondents were asked in the questionnaire to report whether they next expected to replace, relinquish or acquire an additional vehicle (question 30). The overall survey response is summarised in Table 7-9.

Table 7-9: Next expected car ownership change

Next car ownership change	No. of households	% of households
replacement	127	71.3%
increase	30	16.9%
decrease	8	4.5%
no change	13	7.3%
Total	178	100.0%

The results of quantitative tests undertaken to identify factors associated with the next expected change are summarised in Table 7-10. These are subsequently discussed in separate sections relating to car ownership stability; an expectation to increase car ownership level; and an expectation to decrease car ownership level.

Table 7-10: Factors associated with next expected car ownership change

Factor	Statistical test	Observation
Neighbourhood	Chi-square test: $\chi^2 = 8.275$, df=3, p=0.041	Reported relinquishments were more prevalent in the inner-urban neighbourhood.
No. of cars owned	NA as not all categories were applicable for non-car owners (e.g. decrease)	Relinquishments were reported entirely by two or more car owners.
Household structure	Chi-square test: $\chi^2 = 20.034$, df=3 p<0.000	Relinquishments were reported entirely by cohabiting adults. 'No change' was reported proportionately more by single adults.
Car use intensity	Kruskal-Wallis test: $\chi^2 = 15.158$, df=2, p=0.001	Relinquishers reported the lowest car use intensities (0.39). Increasers reported the highest car use intensities (0.71).
See Appendix J: Tables J-9 to J-12		

7.3.1 Expecting no change in car ownership level

Consistent with the analysis of car access imbalance, 79 per cent, **the majority of respondents, expected to maintain their current car ownership level at the next transaction** (Table 7-9).

7.3.1.1 Never change

A small proportion of respondents (13 households) reported that they had no expectation to ever change their car ownership state. Two of these appeared to

be incongruent responses from car owning households[26]. The remaining 11 cases were non-car owners that expected to maintain this position indefinitely. In contrast to the multi-variate analysis presented in chapter six, which confirmed that non-car owning households are very likely to enter car ownership over time, **this observation demonstrated that non-car ownership can also be a stable position for a minority**. From the reported cases, maintaining non-car ownership could be attributed to:

- Life stage: Some respondents had permanently moved out of car ownership as they moved into older age. In contrast, younger non-car owners in general expected to acquire a car at some point in the future (discussed further in section 7.3.4);
- Constraints i.e. health or income constraints (which also related to ageing in some cases), meant that there was a lack of an expectation to purchase a car in the future; and
- Attitude: Others reported a clear disliking for cars and driving in general and as such could be classed as car free choosers (Melia et al, 2011, in press).

The cross tabulations also indicated that the characteristics listed above were most likely to occur amongst single adult, non-car owning households (12 out of the 13 cases - see Appendix J Table J-11).

7.3.1.2 Vehicle replacements

A further 71 per cent of respondents (127 cases) expected their next transaction to be a vehicle replacement. The majority of those offering a qualitative explanation simply cited vehicle age as the main reason for undertaking the next replacement i.e. the vehicle becoming old, unreliable, expensive to maintain or unsafe.

7.3.2 Expecting to reduce car ownership level

Only eight respondents expected to next *relinquish* a vehicle. The cross tabulations and statistical tests indicated that reporting an expectation to relinquish a vehicle was associated with:

[26] One female was demonstrating strong feeling against her husband's decision to buy a sports car which she felt was unnecessary. The other was unavailable for follow-up telephone call.

- Living in the inner-urban neighbourhood: Seven out of the eight cases resided in Bishopston contributing to the statistical significance of the relationship between neighbourhood and the next expected car ownership change;
- Cohabitation and owning two or more cars: All of the respondents were couples or families that owned two or more cars; and
- A redundancy in the household's vehicle fleet. The comparatively lower car use intensities reported by these respondents indicated that one or more vehicles were already infrequently used.

7.3.3 Expecting to increase car ownership level

A larger proportion, 17 per cent of respondents, from 30 households, expected to *increase* car ownership level. The comparatively higher car use intensities reported by the car owning respondents indicated that these households might have a deficit in car availability. Indeed the qualitative responses confirmed that these households had fewer cars than there were adults of driving age (discussed further in section 7.3.4). In comparison to expected vehicle relinquishments, this response was not as strongly related to residential location. The cases were fairly evenly distributed between both neighbourhoods (see Appendix J Table J-9). There was similarly no strong association with household structure.

7.3.4 Car access imbalance and the next car ownership change

A cross tabulation confirmed the expected relationship between reporting a car access imbalance and the next expected car ownership change (Table 7-11). Reporting ownership of *too few* cars was associated with also reporting an expectation to *increase* car ownership level. Conversely reporting ownership of *too many* cars was associated with reporting an expectation to *decrease* car ownership level.

Table 7-11: Car access imbalance by next expected car ownership change

Next expected change		Too few vehicles	Too many vehicles	Just the right no. of vehicles	Total
Replacement	Count	10	6	111	127
	Expected Count	22.2	10.8	94.0	127.0
	% next car ownership change	7.9%	4.7%	87.4%	100.0%
	% age access imbalance	32.3%	40.0%	84.7%	71.8%
Increase	Count	15	1	14	30
	Expected Count	5.3	2.5	22.2	30.0
	% next car ownership change	50.0%	3.3%	46.7%	100.0%
	% age access imbalance	48.4%	6.7%	10.7%	16.9%
Decrease	Count	0	7	1	8
	Expected Count	1.4	.7	5.9	8.0
	% next car ownership change	0.0%	87.5%	12.5%	100.0%
	% age access imbalance	0.0%	46.7%	0.8%	4.5%
No change	Count	6	1	5	12
	Expected Count	2.1	1.0	8.9	12.0
	% next car ownership change	50.0%	8.3%	41.7%	100.0%
	% age access imbalance	19.4%	6.7%	3.8%	6.8%
Total	Count	31	15	131	177
	Expected Count	31.0	15.0	131.0	177.0
Chi-square test: χ^2 = 107.338, df=6, p<0.000; 5 cells (41.7%) have expected count less than 5					

Nevertheless, it was also apparent that not all respondents reporting a car access imbalance also expected to change car ownership level. Similarly, some respondents reported being satisfied with the current position, but expected to make a car ownership level change in the future in response to a *future expected event*. **This supported the proposition put forward in the process of change framework: that the presence of a car access imbalance is distinct from a propensity to change car ownership level**; **and that the difference is mediated through a process of *consideration* of the current and potential future situations**. For instance, a car access imbalance may exist as an assessment of 'I have too few cars'. Through consideration ('I have thought about

it'), this may or may not manifest itself as a propensity to change car ownership state ('I am / am not able and intend / do not intend to acquire a further car').

Further insights into the relationship between car access imbalance and future intentions were gained through an analysis of the qualitative data. Through this the following four groupings of households were identified:

- Those that were satisfied with the current car ownership level and had no intention to change car ownership level in the future;
- Those that were satisfied with the current car ownership level but expected this to change in the future;
- Those that were dissatisfied with the current car ownership level to some extent, but did not expect this to change in the future; and
- Those that were dissatisfied with the current car ownership level and expected this to change in the future.

7.3.4.1 Satisfied now and no intention to change car ownership level

The majority of respondents (116/177) were satisfied with the current car ownership position and did not expect this to change in the future. This is an important observation and is consistent with the existence of what has previously been observed statistically as car ownership state dependence (Hanly and Dargay, 2000).

7.3.4.2 Satisfied now but expect to change car ownership level in the future

This group (15 out of 177 respondents) were characterised by being satisfied with their current car ownership level, but expected this to change in association with an *expected future life event*.

Decreasing car ownership: One household of retirement age expected to relinquish the second car when the second partner also retired.

Increasing car ownership: There were nine cases of one car owning couples and families that had a *longer term* expectation to acquire a *second* car in association with an *expected future life event*. The following expected life events were identified: a change in working circumstances, child birth, or moving out of the city to be closer to better secondary schools, also requiring the household to run a second car. There were a further five cases of two car owning family households that were considering acquiring additional cars when offspring reached driving age.

7.3.4.3 Dissatisfied now but no intention to change car ownership level in the future

This group (23 out of 177 respondents) were characterised as being dissatisfied with their current car ownership position to some extent; but either did not consider it necessary or were unable to change car ownership level in the future. **This is consistent with the hypothesis put forward in the research design, that there may be a 'threshold' level of car access imbalance beyond which the household will seek to take action** (see section 3.4.3.1).

Too few cars and no intention to change: There were six examples of *non-car owners* that recognised the benefits of car ownership but did not intend to acquire a car; either due to specific constraints or owing to a preference for non-car ownership. These were all notably single females and included: two retirees that had relinquished cars in older age owing to health and / or income constraints; two retirees that had never owned a car; and one young female that was on long-term sick leave.

There were seven examples of *one car owning couples* that felt an occasional need for a second car. These respondents mentioned strategies or preferences to avoid second car ownership including: making a 'conscious' (respondent's words) effort to manage with one car; having replaced a second car with a motorbike; and occasionally hiring a car when the other car was in use elsewhere for the weekend. A further three respondents reported conflicts over access to *two* household cars arising from: the second car being stored in another city for work; or parents with adult offspring sharing two cars between three or more adults.

Too many cars and no intention to change: This group was characterised by expressing feelings of guilt relating to car ownership or a latent desire to relinquish one car. Obligations dictated that this was not a realistic possibility however. The group included two young single adult, one car owners that had a positive attitude towards the use of non-car modes, but expected to retain their car for specific work requirements. There were two examples of families with children that ran a second car for child care needs. Whilst recognising that this car was used relatively infrequently, it nevertheless remained useful. One young couple explained that they both needed a car for work, but were able to share one car for leisure activities. Another pre-retirement couple explained feeling 'guilty' about running two cars as they could in theory car share to work. They were considering relinquishing the second car in retirement.

7.3.4.4 Dissatisfied now and intend to change car ownership level in the future

This group (23 out of 177 respondents) were dissatisfied with their current car ownership position and this also translated into an intention to change car ownership level to better meet *existing* needs.

Too many cars and expecting to decrease car ownership: Seven cases. These *all* related to *two car owning couples or families that intended to relinquish underutilised second cars*. In all cases, *circumstances had already changed* in response to a specific life event and the second car was no longer required for a previous purpose. The specific life events identified included: a change in working circumstances, moving in together and being able to manage with one car, child birth (meaning a camper van would be sold) and the acquisition of a company car.

Too many cars and expecting to increase car ownership: This one counter intuitive case related to a respondent expecting her car owning partner to move into her house. They were already sharing access to both cars, and she felt that one car would be enough between them – hence reporting having ownership of too many cars. Nevertheless the next expected change for the household would be a car ownership increase, when her partner moves in.

Too few cars and expecting to increase car ownership: This category included seven young non-car owners that had an aspiration to acquire their first car. Reasons given for wanting a first car included, frustration with using public transport, wanting to keep the driving skill having just passed the driving test, needing a car more in future for work, and helping with child care. There was a further single example of a non-car owning older family (late 30s) who expected to re-acquire a car when a revoked license was returned.

There were also seven examples of one or two car owning couples or families that expected to acquire an additional car to better meet obligations relating to: employment (finding or getting to work more easily), child care or leisure pursuits.

The general characteristics of the households in each of these potential car ownership level change states are summarised in a matrix (Table 7-13) overleaf.

7.3.5 Level of consideration with respect to the next car ownership change

Respondents were also asked to indicate the extent to which they had considered making their next car ownership change on a scale of one to five; one

being ‘not really considered it yet’ and five being ‘seriously considering it now’. The mean consideration scores were then compared for various sub groupings within the sample. The tests of statistical significance are summarised in Table 7-12:

Table 7-12: Factors associated with level of consideration of the next car ownership change

Factor	Statistical test	Observation
Neighbourhood	Mann-Whitney test: U=3297.5, Z=-0.625, p=0.532	No relationship
No. of cars owned	Mann-Whitney test: U=314.5, Z=-2.508, p = 0.012	Non-car owners reported higher consideration scores than car owners
Household structure	Chi-square test: χ^2 = 5.481, df=5 p=0.360	No relationship
Car access imbalance	Chi-square test: χ^2 = 12.744, df=2, p=0.02	Reporting a car access imbalance was associated with higher consideration scores
Next expected car own change	Chi-square test: χ^2 = 7.3, df=2, p=0.026	Expecting to change car ownership level was associated with higher consideration scores
See Appendix J: Tables J-13 to J-16 and Table 7-14		

The statistical tests revealed that reporting comparatively higher consideration scores with respect to the next car ownership change was associated with:

- reporting a car access imbalance;
- reporting an intention to change car ownership level; and
- being a non-car owner that also has an aspiration to acquire their first car.

These findings all support the proposition put forward in the framework for car ownership change: **that dissatisfaction with the current car ownership state**

Table 7-13: Relating car access imbalance to the next expected car ownership change

	Level of car access imbalance		
Next expected car ownership change	**Too few vehicles [31 cases]**	**Just the right number of vehicles [131 cases]**	**Too many vehicles [15 cases]**
Relinquish a vehicle [8 cases]	No responses	1 case: **Planners** Current situation is satisfactory, but expect to relinquish a second car following a planned future life event.	7 cases: **Acting on a surplus** Two car owning couples and families: Circumstances have changed and a second car is no longer required for a previous purpose. It will be relinquished.
No change [12 cases]	6 cases: **Managing a deficit** Non-car owners that feel a car would be useful but do not intend to acquire one either due to constraints or a preference for non-car ownership.	5 cases: **Stability** Non-car owners that are satisfied with this position.	1 case: **Maintaining a surplus** Conflict within the household over whether a third sports car is required.
Replace a vehicle [127 cases]	10 cases: **Managing a deficit** Couples managing with one car or families with adult offspring sharing two cars between three. No intention to change but an additional car would sometimes be useful.	111 cases: **Stability** Car owners that are satisfied with the current position and expect to remain so.	6 cases: **Maintaining a surplus** One and two car owners. Positive attitude to alternative modes and would like to manage with fewer cars but obligations mean that this is unlikely.
Gain an additional vehicle [30 cases]	15 cases: **Acting on a deficit** Young adults (single, couples, families) that aspire to acquire the first car. Couples and families that require a second or third car for a specific purpose.	14 cases: **Planners** Car owning couples and families. The current situation is satisfactory, but expect to gain a second or third car following a planned future life event.	1 case A car owning partner is about to join the household involving an increase in the number of cars which is expected to be excessive.

heightens the level of consideration with respect to the next car ownership change.

It was also notable that respondents expecting a *decrease* in the number of vehicles owned reported *higher* consideration scores than those expecting to gain an additional vehicle (Table 7-14):

Table 7-14: Level of consideration by next expected car ownership change

Next car ownership change	Mean	N	SD
Replacement	2.31	127	1.37
Increase	2.93	30	1.39
Decrease	3.25	8	1.67
Sample	2.47	165	1.41
Kruskal-Wallis test: $\chi^2 = 7.3$, df=2, p=0.026			

As noted previously, relinquishments tended to be reported by households for which circumstances had either already changed or were certain to change (a change in working circumstances for instance). Conversely, the reasons for reporting an expected increase in car ownership were in some cases longer term aspirations (a young adult's desire for a first car for instance). **This suggests that relinquishments were only reported in the survey if the conditions for a relinquishment were (or were about to be) well established.** This would explain the higher consideration scores and the comparatively lower number of respondents in this group.

The *absence* of a relationship between level of consideration and both neighbourhood and household structure were equally important observations. Given that higher consideration scores were associated with dissatisfaction with the current car ownership position, this would suggest that over time, **households tend towards a satisfactory car ownership state according to their structure and residential location**.

7.3.6 Section summary

This section of analysis was concerned with the survey objective: to explore how households expect to change car ownership level in the future.

It established that the majority of respondents were satisfied with their current car ownership level and did not expect this to change at the next car ownership transaction, observed statistically as state dependence in previous studies. Only

eight households reported an intention to relinquish a vehicle. These were all two car owning households, the majority of which resided in the inner-urban neighbourhood – confirming the more marginal nature of second cars and suggesting a greater potential for such marginal second cars to arise in an inner-urban neighbourhood. A larger proportion, 17 per cent of households expected to increase car ownership. This related to either an aspiration amongst non-car owners to acquire the first car, couples sharing one car between them feeling a requirement for a second car, or multi-vehicle households with offspring approaching driving age.

Two aspects of the framework depicting the process of car ownership change which emerged from the interview analysis were also confirmed. Firstly, the survey provided empirical evidence for the presence of current car access imbalances and demonstrated that this is a distinct state from a propensity to change car ownership. Secondly, it was demonstrated that the level of consideration with respect to the household's car ownership state is indeed heightened as dissatisfaction with the car ownership state increases.

7.4 The potential to manage with one fewer car

The chapter now moves on to address the survey objective: to examine the potential for households to permanently manage with one fewer car.

Respondents were asked to indicate whether it would be possible for their household to permanently manage with one fewer car (question 35) and were given four response categories: permanently living with one fewer car would be: no problem, possible but sometimes inconvenient, possible but often inconvenient and impossible.

Just over half of the sample, 56.4 per cent of car owning households reported that it would in principle be possible to permanently manage with one fewer car to a greater or lesser extent (Table 7-15):

Table 7-15: Households reporting potential to manage with one fewer car

Managing with one fewer car would be:	No. of households	%age of households
No problem	16	9.7%
Possible but sometimes inconvenient	27	16.4%
Possible but often inconvenient	50	30.3%
Impossible	71	43.0%
Sample	164	99.4%

7.4.1 Factors associated with potential to manage with one fewer car

Factors associated with an ability to permanently manage with one fewer car were first explored quantitatively using cross tabulations and comparisons of means. The results are summarised in Table 7-16:

Table 7-16: Factors associated with potential to manage with one fewer car

Factor	Statistical test	Observation
Neighbourhood	Chi-square test: $\chi^2 = 3.332$, df=3, p=0.343	No relationship
No. of cars owned	Chi-square test: $\chi^2 = 7.663$, df=3, p=0.054	Multi-vehicle households were more likely to report a potential to manage with one fewer car
Household structure	Chi-square test: $\chi^2 = 3.622$, df=3, p=0.305	No relationship
Car access imbalance	Chi-square test: $\chi^2 = 31.731$, df=6, p<0.000	Respondents with 'too many' vehicles were more likely to report a potential to manage with one fewer car
Car use intensity	Kruskal-Wallis test: $\chi^2 = 8.797$, df=3, p=0.032	Respondents with a potential to manage with one fewer car reported lower car use intensities
See Appendix J: Tables J-17 to J-20 and Table 7-17		

7.4.1.1 Neighbourhood and household structure

Although proportionately more outer-urban residents reported that it would be *impossible* to manage with one fewer car (50 per cent compared to 36.9 per cent of inner-urban residents) a chi-square test revealed that the relationship was not statistically significant. Household structure was also confirmed to not have an association with potential to manage with one fewer car.

7.4.1.2 Number of cars owned

There was evidence of a weak association between number of cars owned and potential to permanently manage with one fewer car. Proportionately more households with two or more cars indicated that this scenario would be possible compared to households with one car - **Multi-vehicle households reported a greater potential to permanently manage with one fewer car than single vehicle households**.

7.4.1.3 Car use intensity

Ability to permanently manage with one fewer car was found to be intuitively related to car use intensity. Households reporting 'no problem' with permanently managing with one fewer car reported lower car use intensities on average than households reporting 'impossible' (excluding zero car owners from the analysis) (Table 7-17). **This suggests that households reporting 'no problem' already had a level of redundancy in their vehicle fleet**.

Table 7-17: Car use intensity by potential to manage with one fewer car

Managing with one fewer car would be:	Mean car use intensity	N	SD
No problem	0.52	15	0.22
Possible but sometimes inconvenient	0.66	26	0.18
Possible but often inconvenient	0.66	48	0.16
Impossible	0.70	69	0.14
Sample	0.66	158	0.17
Kruskal-Wallis test: $\chi^2 = 8.797$, df=3, p=0.032			

This pattern was also repeated in the modal share statistics (Figure 7-1). The car use modal share was 11 per cent higher amongst households reporting 'impossible' compared to households reporting 'no problem'. This was counter-balanced by higher walking, cycling and public transport modal shares amongst the 'no problem' category. The variation in modal shares was only statistically significant for car use according to Kruskal-Wallis tests ($p<0.05$, see Appendix J Table J-21).

These findings imply that **respondents in the 'no problem' category were already making greater use of alternative modes (they were more 'multi-modal') and therefore had a greater potential to adapt using alternative**

modes following the loss of a vehicle, than those in the 'impossible' category.

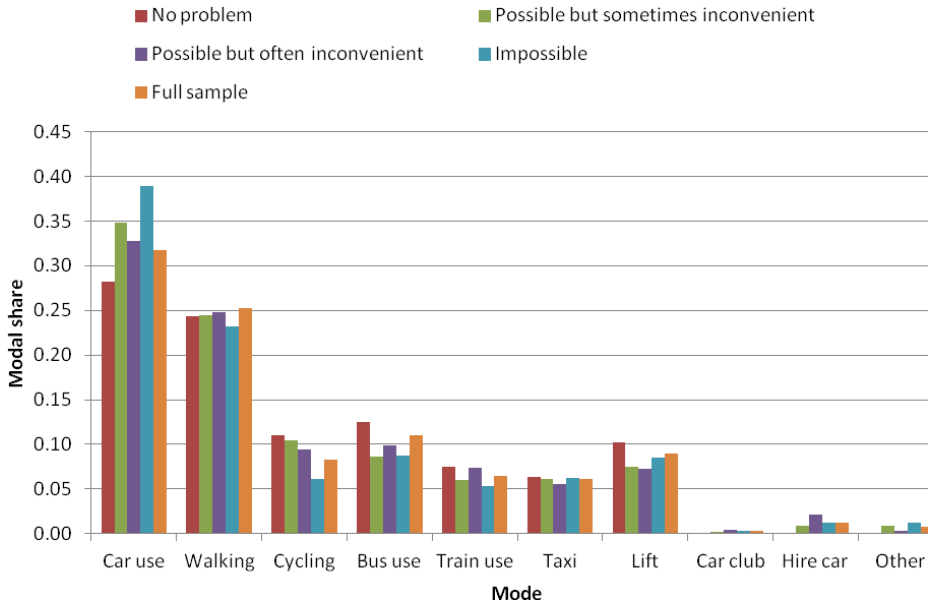


Figure 7-1: Modal share by potential to manage with one fewer car

7.4.2 Reasons for managing with one fewer car being 'no problem'

16 respondents, evenly distributed between the two survey neighbourhoods, reported that it would be 'no problem' to permanently manage with one fewer car. As these respondents appeared to represent the greatest unrealised potential for vehicle relinquishments, their qualitative responses were analysed. This revealed three underlying reasons for being able to permanently manage with one fewer vehicle:

1. Amongst two car owning households, a second vehicle was already no longer required and was about to be relinquished (five instances);
2. Amongst two or more car owners, specialist second or third vehicles (sports cars or camper vans) could be relinquished with no impact on routine travel patterns (two instances); and
3. Amongst one car owners, the household already managed or was in a position to manage work trips using alternative modes (walking, cycling or public transport). These respondents tended to report that relinquishing their car would impact upon leisure travel however (seven instances).

The remaining two 'no problem' responses appeared to be incongruent in that the qualitative description of their household circumstance was incompatible with a 'no problem' response (illustrating the weaknesses inherent in standalone closed

response questionnaires). For instance, one respondent reported that she would have to move house to be closer to work if she gave up her car.

It is also notable that categories two and three did not expect to relinquish cars. In such cases the respondent recognised that while one vehicle was not routinely needed, it was nevertheless still a *desirable* possession and hence would be retained. A further observation was that respondents reporting ownership of 'too many' vehicles, but with no intention to relinquish a vehicle tended to report that managing with one fewer vehicle would be 'sometimes inconvenient' rather than 'no problem'. This provided an indication of the somewhat marginal, but nevertheless necessary nature of one or more vehicles in their fleet.

7.4.3 Stated adaptation to the loss of one car

Respondents reporting an ability to permanently manage with one fewer car were then asked to indicate which modes would be used in place of the lost car (question 36). The change in usage of each mode could be rated as 'a lot more' (coded as 2), 'a little more' (coded as 1) or 'no change' (coded as 0).

A crude indicator of the expected relative change in use of each mode was calculated by dividing the score for each mode by the sum of the responses across all modes. A number of respondents indicated that relinquishing a vehicle would have no impact on their use of other modes. To ensure that the average proportionate modal shift across modes summed to one across the sample, an additional 'no change' modal share variable was created and set to one for these respondents.

The average patterns of adaptation for different subgroups within the sample are now presented.

7.4.3.1 Modal uptake and neighbourhood

The expected adaptation in travel behaviour reported by residents of Bishopston and Bradley Stoke were broadly similar (Figure 7-2). Bishopston residents reported that they would use the internet and car clubs more than Bradley Stoke residents following the relinquishment of a vehicle. Conversely, Bradley Stoke residents reported that they would use lifts more than Bishopston residents. Statistically significant differences between the two neighbourhoods were detected for the internet and car club options (see Appendix J Table J-22) both being higher in Bishopston (although both alternatives had low scores relative to other modes). This is unsurprising given that the Bishopston neighbourhood is in

close proximity to car club car parking spaces while the Bradley Stoke neighbourhood is not.

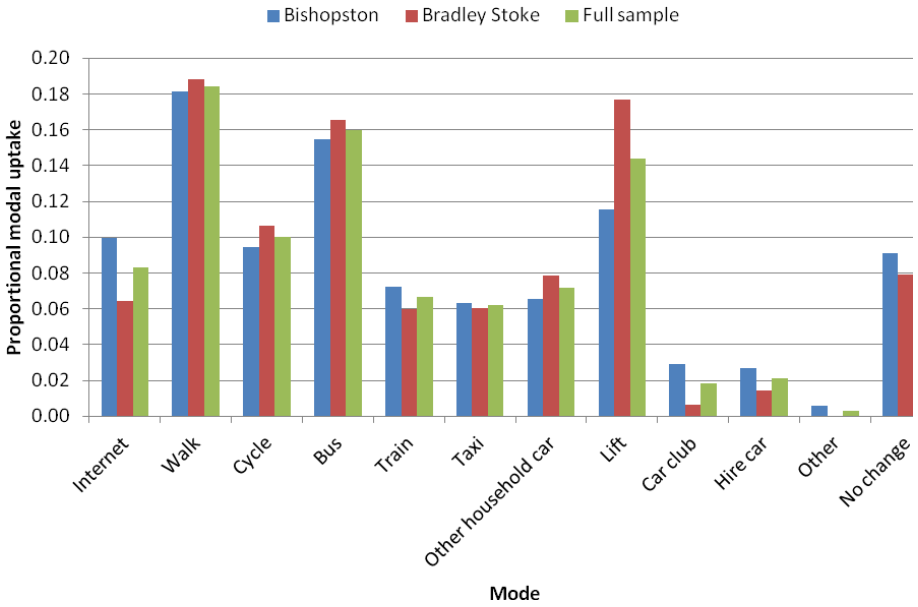


Figure 7-2: Change in modal use following a vehicle relinquishment by neighbourhood

7.4.3.2 Modal uptake and ability to manage with one fewer vehicle

There were some notable differences in the expected patterns of adaptation across the four response categories: managing with one fewer car would be: 'no problem', 'sometimes inconvenient', 'often inconvenient' and 'impossible'.

Those respondents reporting that it would be 'no problem' to relinquish a vehicle were most likely to indicate that this would not change their travel patterns at all. This again suggested that one or more vehicles were already not being used on a routine basis.

The 'sometimes inconvenient' category reported that they would take lifts and walk proportionately more than the other categories. This indicated that these respondents had a known source of lifts that they could call upon if needs be. The 'often inconvenient' category reported that they would use another household car proportionately more than the other categories.

Across the three 'difficulty' categories, Kruskal-Wallis tests indicated statistically significant differences for the 'no change' and taking lifts options ($p<0.05$ see Appendix J Table J-23).

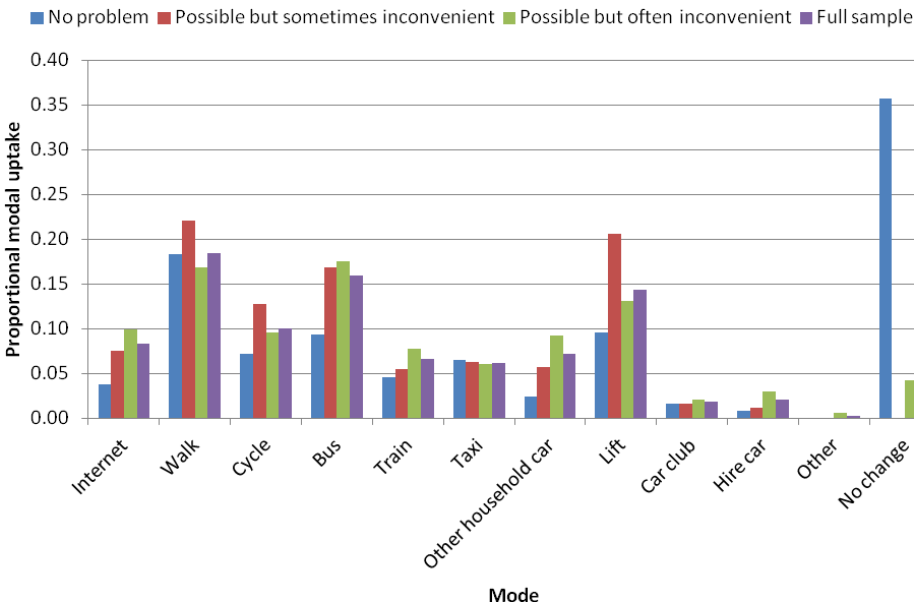


Figure 7-3: Change in modal use following a vehicle relinquishment by potential to manage with one fewer car

7.4.3.3 Modal uptake and number of cars owned

The expected patterns of adaptation when compared by number of cars owned were as expected:

- Three car owners were more likely to report that relinquishing a vehicle would not change their travel patterns, indicating that one or more vehicles was not being used routinely. In line with expectations they also reported being able to use another household car more so than the other car ownership categories.
- Two car owners reported a higher proportionate shift of trips to using the other household car relative to the other modal shift options available.
- One car owners were not able to use another household car and consequently reported shifting trips to bus, train and taxis to a greater extent than multiple car owners.

Across the different car ownership states, Kruskal-Wallis tests indicated statistically significant differences for the train, taxi and using another household car options ($p<0.05$ see Appendix J Table J-24).

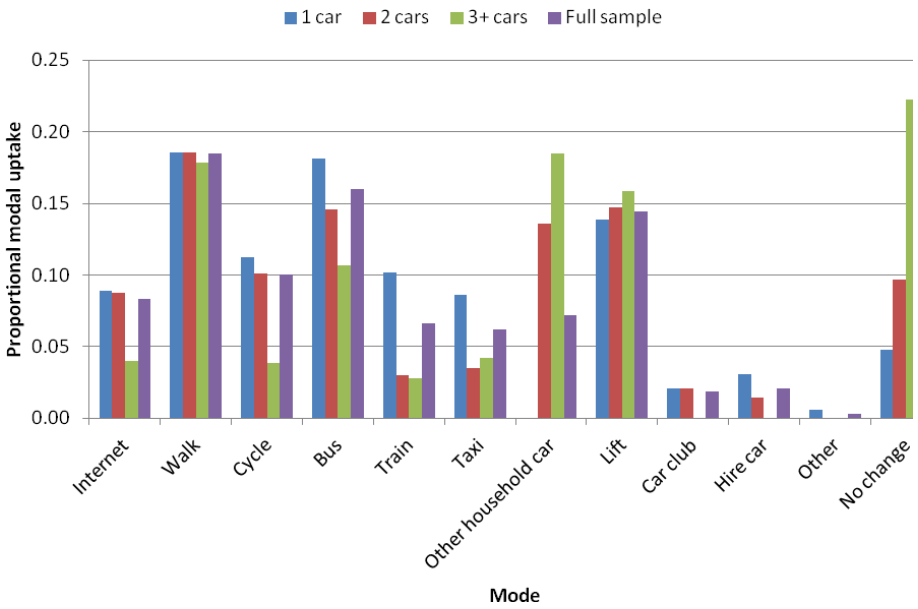


Figure 7-4: Change in modal use following a vehicle relinquishment by number of cars owned

7.4.4 Section summary

This section of analysis was concerned with addressing the survey objective: to examine the potential for households to permanently manage with one fewer car.

More than half of respondents felt that this scenario would be possible to a greater or lesser extent. Neighbourhood of residence was not a statistically significant factor although a larger proportion of respondents from the inner urban neighbourhood agreed that permanently managing with one fewer car would be possible.

10 per cent of car owning households reported that relinquishing a vehicle would be 'no problem', and would have little impact on their routine travel patterns. Their responses demonstrated that there was already a redundancy in their vehicle fleet (a leisure car or a second car that was no longer used for its original intended purpose for instance). Respondents reporting that it would be impossible on the other hand, were found to be less multi-modal, more reliant on their household cars and consequently felt less able to adapt than the other response categories.

7.5 The perceived influence of residential location

This final section of analysis is concerned with addressing the survey objective: to explore the (objective and perceived) influence of residential location on household car ownership levels.

While *objective* indicators of the influence of residential location have been reported as a common theme running through the preceding four sections, this section focuses specifically on:

- A *quantitative* analysis of the respondents' subjective agreement with the statement "living in [neighbourhood] has an influence on the number of cars my household needs" (questionnaire question 26);
- A *quantitative* analysis of the respondents' subjective agreement with the statement "Travel issues (e.g. getting to work / shops / parking) were an important consideration when choosing to move to [neighbourhood]" (questionnaire question 27); and
- A *qualitative* analysis of the respondents' views on these statements elicited during the follow up telephone calls.

7.5.1 Subjective assessment of residential location and the need for cars

Respondents were asked to indicate the extent to which they agreed or disagreed with the statement "Living in [neighbourhood] has an influence on the number of cars my household needs" (question 26).

- 40.8 per cent of the sample overall agreed with this statement;
- 25.5 per cent of the sample overall disagreed with this statement; and
- 33.7 per cent of the sample either had no opinion or neither agreed nor disagreed.

Responses were coded on a scale ranging from -2 (strongly disagree), through 0 (neither agree nor disagree) to +2 (strongly agree). The mean scores for level of agreement with this statement were calculated and compared for the following subgroups within the sample: Neighbourhood of residence, number of cars owned and household structure. Respondents offering no opinion were excluded from the analysis.

7.5.1.1 Neighbourhood

The mean scores across the sample indicated very slight agreement with the notion that residential location does have an influence on the number of cars that are needed (Table 7-18). Bishopston residents indicated marginally stronger agreement than Bradley Stoke residents. However, the difference was not found to be statistically significant according to a Mann-Whitney test ($p>0.05$).

Table 7-18: Perceived influence of residential location on number of cars owned, by neighbourhood

Neighbourhood	Mean	N	SD
Bishopston	0.16	88	1.30
Bradley Stoke	0.10	77	1.41
Sample	0.13	165	1.35
Mann-Whitney test: U= 3319, Z=-0.232, P=0.817			

7.5.1.2 Number of cars owned:

Level of agreement with the statement was found to vary according to number of cars owned at the time of the survey. Households with no cars indicated slight *disagreement* with the notion that residential location influenced the number of cars required, as did households with three or more cars. On the other hand, households with one or more car tended to *agree* with the statement. A Kruskal-Wallis test indicated that the variation between means was not statistically significant however ($p>0.05$). This finding is discussed further in section 7.5.1.2 in conjunction with an analysis of the extent to which households had thought about transport when moving to the neighbourhood.

Table 7-19: Perceived influence of residential location on number of cars owned, by number of cars owned

Number of cars owned	Mean	N	SD
Zero	-0.50	12	1.45
One	0.18	94	1.42
Two	0.25	48	1.18
Three or more	-0.09	11	1.30
Sample	0.13	165	1.35
Kruskal-Wallis test: $\chi^2 = 3.098$, df=3, p=0.377			

7.5.1.3 Household structure

The relationship between household structure and level of agreement with the statement was complex to interpret, given the underlying relationship with number of cars owned. It was notable however, that single occupancy households reported slight disagreement with the statement on average. The qualitative data indicated that such respondents were more likely to report 'having a car for lifestyle reasons regardless of where they live' (discussed further in

section 7.5.3). A Kruskal-Wallis test indicated that the variation between means across household structures was not statistically significant (p>0.05):

Table 7-20: Perceived influence of residential location on number of cars owned, by household structure

Household structure	No. of household cars	Mean	N	SD
Couple	one	0.17	18	1.34
	two	0.25	16	1.24
	three	-2.00	1	.
	Total	**0.14**	**35**	**1.31**
Parents with children	zero	0.00	1	.
	one	0.58	31	1.29
	two	0.29	28	1.15
	three	-0.14	7	1.35
	four	0.00	1	.
	Total	**0.37**	**68**	**1.22**
Other	one	1.00	1	.
	two	1.00	2	0.00
	three	1.00	1	.
	five	1.00	1	.
	Total	**1.00**	**5**	**0.00**
Single occupancy	zero	-0.57	7	1.51
	one	-0.48	27	1.45
	Total	**-0.50**	**34**	**1.44**
Single parent with children	zero	-0.50	2	2.12
	one	0.55	11	1.57
	two	-1.00	2	1.41
	Total	**0.20**	**15**	**1.61**
Shared housing	zero	-0.50	2	2.12
	one	0.33	6	1.37
	Total	**0.13**	**8**	**1.46**
Total	zero	-0.50	12	1.45
	one	0.18	94	1.42
	two	0.25	48	1.18
	three	-0.22	9	1.39
	four	0.00	1	.
	five	1.00	1	.
	Total	**0.13**	**165**	**1.35**
Kruskal-Wallis test (household structure categories only): $\chi^2 = 10.738$, df=5, p=0.057				

7.5.2 Subjective assessment of residential self selection

Respondents were also asked to indicate the extent to which they agreed or disagreed with the statement “Travel issues (e.g. getting to work / shops / parking) were an important consideration when choosing to move to [neighbourhood]”. This was included as a measure of residential self-selection with respect to preferences for particular travel behaviours.

- 59 per cent of the sample agreed with this statement;
- 18.6 per cent of the sample disagreed with this statement; and
- 22.4 per cent of the sample either offered no opinion or neither agreed nor disagreed with the statement.

As before, responses were recorded on a scale ranging from -2 (strongly disagree), through 0 (neither agree nor disagree) to +2 (strongly agree). The mean scores for level of agreement with this statement were then calculated and compared for the same subgroups within the sample: Neighbourhood of residence, household structure and number of cars owned. Respondents offering no opinion were excluded from the analyses.

7.5.2.1 Neighbourhood

The means for the two neighbourhoods indicated very slight agreement that respondents had thought about travel issues when choosing where to live (Table 7-21). A Mann-Whitney test indicated that there was no statistical difference between the sample means for the two neighbourhoods ($p>0.05$).

Table 7-21: Consideration of transport when moving to the neighbourhood, by neighbourhood

Neighbourhood	Mean	N	SD
Bishopston	0.52	91	1.26
Bradley Stoke	0.56	79	1.39
Total	0.54	170	1.32
Mann-Whitney test: U = 3441, Z = -0.5, p=0.617			

7.5.2.2 Household structure

No notable patterns were observed between household structure and level of thought about transport when moving (See Appendix J Table J-25).

7.5.2.3 Number of cars owned

A relationship was apparent between number of cars owned at the time of the survey and level of consideration about travel when moving (Table 7-22). Respondents with no cars more strongly agreed that they had considered transport when moving, than car owning households. Multi-car households had the lowest level of agreement with the statement. Across all four categories, the relationship was *not* found to be statistically significant according to a Kruskal-Wallis test ($p > 0.05$):

Table 7-22: Consideration of transport when moving to the neighbourhood, by number of cars owned

Number of cars	Mean	N	SD
Zero	1.13	16	1.09
One	0.50	96	1.34
Two	0.47	47	1.38
Three or more	0.27	11	1.10
Total	0.54	170	1.32
Kruskal-Wallis test: $\chi^2 = 4.994$, df=3, p=0.172			

However, a Mann-Whitney test indicated that there was a statistically significant relationship (U=870.5, r=-2.013, p=0.044), at a coarser level of categorisation; comparing non-car owners to car owning households (see Appendix J Table J-26).

It is notable that on the one hand non-car owners tended to disagree that where they live had an influence on the number of cars that they needed. While on the other hand they agreed (more strongly than car owners) that they had thought about travel considerations when choosing where to live.

This implies that the commitment (or constraint) to be a non-car owner came before neighbourhood choice for these respondents. Neighbourhoods that could facilitate a car-free life were sought thereafter. Non-car owners were more conscious of travel considerations than car owners when moving, but did not perceive that their neighbourhood subsequently influenced the number of cars that they needed i.e. they would not have a car regardless of where they lived, but nevertheless chose to live somewhere in which car free living was possible.

Conversely, multi-car owners less strongly agreed that they had considered transport when moving to the neighbourhood. Implying that ownership of many cars was associated with such households feeling able to live in any location. Indeed this was supported by insights from the qualitative follow-up telephone calls, which are now reported.

7.5.3 Qualitative insights

The follow up telephone calls provided an opportunity to ask respondents to explain why they felt where they live does or does not have an influence on the number of cars that they need. Common response categories were identified and their responses were coded according to nine themes (Table 7-23). In most cases, the category aligned with either agreement of disagreement with the notion that residential location does have an influence on the number of cars that are required:

Table 7-23: Reasons why residential location does / does not influence household car ownership

	Frequencies			
Category	**D**	**N**	**A**	**T**
Activity patterns govern how many cars I need	18	20	0	38
The co-location of work and home is an important factor	0	1	18	19
Car ownership preference precedes neighbourhood choice	4	6	4	14
Neighbourhood choice precedes car ownership needs	0	4	8	12
I would have a car for lifestyle reasons regardless of where I live	6	4	0	10
Public transport is inadequate relative to the car	0	1	7	8
Other	0	4	3	7
Where I live influences car use but not car ownership	1	0	5	6
I chose my neighbourhood for non-transport reasons	1	3	1	5
Total	**30**	**43**	**46**	**119**
Notes: D = Disagree, N = No opinion or Neither, A = Agree, T= Total				

Activity patterns govern how many cars I need: This category was associated with disagreement or indifference. These respondents felt that activity patterns associated with work, family or leisure commitments were the overriding factors for requiring one or more cars rather than where they live. This category also included respondents that had other constraints relating to health for instance, that had dictated their need for a car or conversely their non-ability to drive or to acquire a car.

The co-location of work and home is an important factor: This category was associated with agreement. These respondents recognised that the ability of one or more family members to get to work via non-car modes (or vice versa) has had an influence on the number of cars that they own now (or may need in the future). The co-location of work and home rather than living centrally per se was the important factor, though this seemed to be a more likely response from Bishopston residents, suggesting that co-location was more prevalent amongst residents living in an inner-urban area.

The car ownership preference precedes neighbourhood choice: Equally associated with disagreement and agreement. This category included both: respondents that had a commitment to being car free prior to choosing where to live, but then accepted the range of neighbourhood locations available to them given their commitment to non-car ownership; and respondents that commented that owning a car meant that they could feasibly live in any neighbourhood location.

In both cases the commitment to car or non-car ownership appeared to come *before* the decision on where to live, and the neighbourhood location choice subsequently was perceived to <u>not</u> be an influence on their continuing commitment to car or non-car ownership.

Neighbourhood choice precedes car ownership requirements. Associated with agreement**.** This category included respondents that had chosen a neighbourhood to live in for non-transport reasons (liking for the neighbourhood, or house price constraints for example) and this had subsequently had a recognisable influence on the number of cars required (whether anticipated or not) e.g. One respondent commented that they made a conscious trade off between buying a more expensive house in an inner urban area or a less expensive house further out of town and running a second car. Others commented that they had moved to their current house without considering car ownership requirements and then found that they could either manage without two cars or were required to buy a second car.

I would have a car for lifestyle reasons regardless of where I live. Associated with disagreement**.** This category included respondents that commented that having a car improved their wider lifestyle whether or not it was a necessity for non-discretionary trips such as work. Hence they would want to own a car regardless of where they lived. Single occupancy, car owning households

seemed more likely to give this response. A possible explanation is that they were unlikely to own a second car, but needed to keep an only car in order to derive the benefits of an independent car owning lifestyle regardless of where they live. Couples may feel more or less likely to be able to cope with or without a second car depending on where they live relative to work and/or other regular destinations.

Public transport is inadequate relative to the car. Associated with agreement. Some respondents commented that they felt public transport was inadequate relative to the car and hence owning a car was something of a necessity. This seemed to be a particularly prevalent response in Bradley Stoke. Several respondents noted that while the Bradley Stoke bus service was in some ways good in terms of frequency during the day, it only served a limited range of destinations. Other households had experienced living in London and felt that the public transport system was limited in Bristol in terms of the range of destinations served. They had consequently acquired a car on moving to Bristol.

Neighbourhood influences car use but not car ownership. Associated mainly with somewhat agree**.** This category included respondents that commented that where they live influenced how much they use their car, but not the number of cars that they needed. These respondents all felt that where they live meant that they were not that reliant on their cars (five of the six respondents lived in Bishopston), but there were nevertheless still enough trips that their car(s) were required to serve.

Chose neighbourhood for non-transport reasons. Associated with neither agree nor disagree. This category included respondents that described how they had chosen their neighbourhood according to non transport criteria e.g. Living in a nice area, being close to a good school (which had not been perceived to be a transport issue), house prices. These respondents did not strongly feel that this had influenced the number of cars needed by the household.

Outside of these categories, a number of other unique explanations were offered including:

- Having lived in the neighbourhood (Bradley Stoke) both with and without a car the respondent now realised that both are possible. He felt that running a car was therefore down to a personal choice rather than being predetermined by the characteristics of the neighbourhood;

- Another respondent noted that being a keen cyclist (a commitment to another transport mode) he would cycle to work regardless of where they lived in the city and hence they would never need to acquire a second car;
- One respondent commented that everyone in the street had at least one car parked in the street and they felt that it was only fair that they did too. An indication of how local social norms may influence a household's attitude towards car ownership; and
- In another case, parking constraints [in Bishopston] had been a reason for offspring not acquiring their own car.

7.5.4 Section summary

This final section of analysis was concerned with exploring the *perceived* influence of residential location on household car ownership levels.

The quantitative data revealed that residents of both neighbourhoods had similar perceptions of whether where they live has an influence on the number of cars required - both tending to slightly agree that residential location was an influential factor. The number of cars owned by the household was a stronger source of variation however. In particular, non-car owners and multi-car owners disagreed that where they live influenced the number of cars required, indicating that their commitment to non-car ownership or multi-car ownership preceded the decision on where to live. The average responses to the closed questions in the questionnaire also masked some considerable variation within the sample. The qualitative insights revealed the underlying complexity which governs the number of cars that are required by households.

7.6 Chapter summary

This chapter has examined the potential for household car ownership change across the two survey neighbourhoods. It confirmed the presence of state dependence; the majority (79 per cent) of surveyed households were content with their car ownership level and expected this to be maintained.

The chapter has also provided further evidence in support of the process of car ownership change framework emerging from the in-depth interviews. Future car ownership level changes could again be associated with *life events* that had either already taken place or were expected to happen. The presence of *current* car access imbalances, a challenging concept to operationalise in the survey, was nevertheless empirically evidenced: A car access imbalance may exist as an

assessment of ‘I have too few cars’, through consideration (‘I have thought about it’) this may or may not manifest itself as a propensity to change car ownership state (‘I am / am not able and intend / do not intend to acquire a further car’). The chapter also presented evidence that presence of a car access imbalance heightens the level of *consideration* with respect to the car ownership state, and that the imbalance needs to exceed some *threshold* level before the household actively considers changing car ownership. This was earlier hypothesised in the conceptual framework developed in the research design (section 3.4).

With respect to the influence of residential location on household car ownership change, it was observed that as expected, residents of the outer-urban neighbourhood were more reliant on their vehicles and less multi-modal than residents of the inner-urban neighbourhood. This had not translated into lower car ownership levels in the inner-urban neighbourhood however. The greatest potential for car ownership relinquishments was observed to be amongst *second* car owners residing in the *inner-urban* neighbourhood, again demonstrating the potentially more marginal nature of *second cars* for some households.

Chapter 8: Discussion and Conclusion

8.1 Introduction

Five objectives for the study were outlined in the research design presented in chapter three. These were:

1. To describe how and to explain why household car ownership changes over time;
2. To examine the extent to which the present car ownership state meets (or exceeds) the household's desires;
3. To explore how households expect to change car ownership in the future;
4. To identify how residential location influences household car ownership and preferences towards car ownership over time; and
5. To provide policy relevant insights concerning the propensity for household car ownership states to change.

These objectives have been addressed through a literature review, a small sample of in-depth interviews and a survey of two neighbourhoods in Bristol. In this concluding chapter, the thesis draws together the findings of each phase of the study, explicitly in relation to the study objectives. Accordingly, the first four sections of this chapter relate to the five starting objectives (as objectives two and three are dealt with in a single section). These are followed by some reflections on the research process and a discussion of opportunities for further research. The chapter and indeed the thesis concludes by summarising the key contributions to knowledge that have emerged from this study.

8.2 Objective 1: How household car ownership changes over time

Objective one was: to describe how and to explain why household car ownership changes over time. Accordingly this discussion begins by first reporting the key *descriptive* insights.

8.2.1 Descriptive insights

As noted in chapter two, Dargay and Vythoulkas (1999) observed a car ownership life cycle profile: car ownership tends to increase as the head of the household reaches the age of 50, after which it declines. This effect was

confirmed by the car ownership pathways that were generated by the neighbourhood survey.

There is a household car ownership life cycle profile

A household's car ownership pathway type was found to be associated with life stage and reflected, in order of life stage:

- Young single adults that were yet to move into car ownership for the first time;
- A small number of longer term voluntary non-car owners who appeared content with this position;
- Couples or families with young children that had acquired first or second cars;
- Older families with adult offspring that had acquired their own vehicles (leading to multiple vehicle ownership);
- Older families that had lost vehicles when adult offspring had left home; and
- A small number of older households that had relinquished vehicles due to constraints (health and income) arising during the ageing process.

It is recognised that these pathways reflect a somewhat standardised life cycle profile: single early adulthood, followed by cohabitation, child birth, children ageing and leaving home, retirement and old age. This is perhaps to be expected, given that the neighbourhoods surveyed were classified as "young families in terraced homes" in the 2001 census. Whilst it is not suggested that individual life courses follow a standard pathway, **the car ownership life cycle profile is nevertheless a useful means of understanding the *tendency* for household types to undertake a particular car ownership level change and when**. The car ownership life cycle does not *determine* how household car ownership changes over time, but it does indicate how household car ownership *tends* to change over time. Accordingly Figure 8-1 conceives of the car ownership life cycle in terms of the following six car ownership transition spaces (ordered chronologically):

1. Zero to one car: This transition space is occupied by young adults (single or cohabiting) that have a tendency to enter car ownership, confirmed by the observation that three quarters of households have access to one or more cars (Department for Transport, 2010). Few younger adults go on to relinquish only cars.

2. One to two cars (and vice versa): Second car ownership tends to occur amongst cohabiting adults (as opposed to amongst single occupancy households). Cohabitation of two independent car owning adults creates second car owning households, but the survey also demonstrated a tendency for a proportion of these households to relinquish second vehicles *three years* after cohabitation on average. Changes between one and two cars in either direction are also common for cohabiting adults in response to for instance child birth or changing employment status.
3. Two to three cars: Third car ownership occurs when offspring in family households reach driving age; or when cohabiting adults have enough disposable income and a desire to acquire a third leisure vehicle.
4. Three to two cars: Third cars are removed from family households when adult offspring leave home.
5. Two to one car (and vice versa): Couples approaching retirement have a tendency to relinquish second cars but also to acquire second cars to pursue leisure pursuits during their additional free time.
6. One to zero cars: More elderly, often single adults (household structures that have arisen following partnership dissolution or the death of a partner) have a tendency to relinquish only cars owing to health and / or income constraints.

It is recognised that the interview participants and the survey sample reflected a particular demographic (characterised in the census as 'young families in terrace homes'), with high rates of car ownership relative to the national population (only 10 per cent of the sample were non-car owners relative to 25 per cent at the national level (Department for Transport, 2010 table nts0205)). Thus the majority of the sample were clustered within transition space two and the survey offered only limited insights into other transition types.

As is discussed further in section 8.7, it would now be beneficial to conduct further research on a wider demographic to establish whether the descriptions of car ownership transition spaces offered above are more broadly applicable. In particular it would be useful to specifically target households that have undergone the transition from one to zero car. These were particularly under-represented in the sample (only five cases in all) and the life-cycle profile would suggest that this transition is more prevalent amongst older age groups.

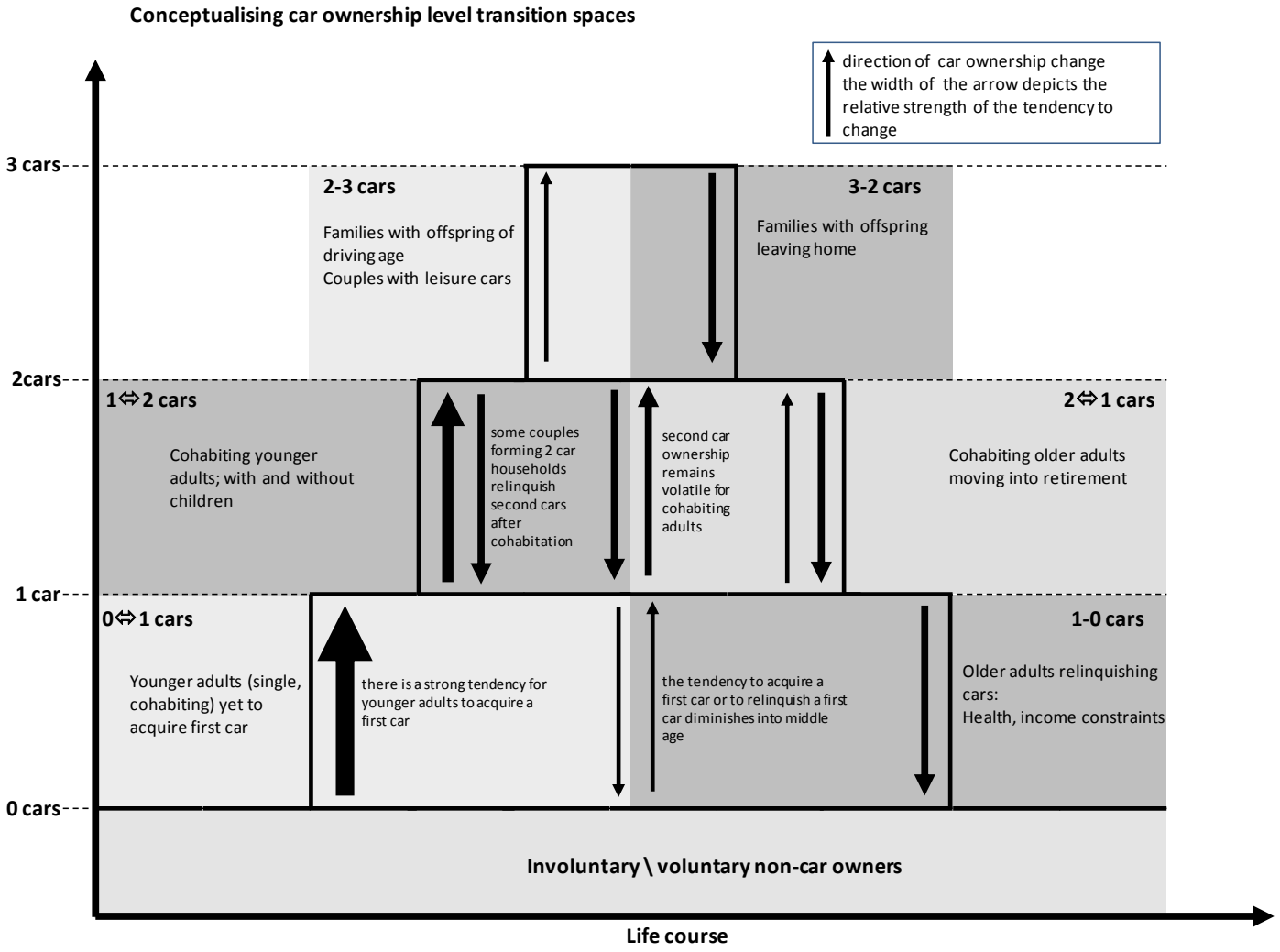


Figure 8-1: The household car ownership life cycle

A multi-variate analysis confirmed the direction and strengths of tendencies to change car ownership level amongst different household types. **Households with *no cars* at the point of household formation were the *most likely* to *gain* a vehicle over time**. Non-car ownership was confirmed to be an undesirable and hence unmaintained state for the majority of the survey population (albeit within an area of relatively high car ownership). However, a small minority of longer term non-car owners were also identified. These were people that were either prevented from owning a car due to specific constraints (health or income) or people that had developed a preference for living without a car (Melia et al, 2011, in press). Although outside the scope of this current study, it would be of interest to learn more about those who choose or are constrained to live without a car. This would be of particular relevance to developing policies and interventions concerned with reducing car dependency.

The survey data also supported the finding from the literature review that **the change between one and two cars (in either direction) tends to be the most common transition** (Dargay and Hanly, 2007). Indeed the multi-variate analysis confirmed that **cohabiting adults with *two cars* at the point of household formation were the *most likely* to *relinquish* a vehicle out of the survey sample**. A related finding was that the car ownership level was more likely to change amongst cohabiting adults than amongst single adult household structures. Again owing to the relatively small sample size available in this study, this finding also warrants testing on a wider section of the population. Nevertheless, this confirmed the more transient nature of second cars amongst cohabiting adult household structures, compared to first and only cars which tend to be retained permanently amongst both cohabiting and single adult households.

8.2.2 Explanatory insights

Through the adoption of a predominantly *qualitative* and *longitudinal* approach to enquiry, this study has also provided deeper *explanatory* insights into why household car ownership changes over time; the second aspect of objective one. These explanatory insights are now discussed.

Car ownership level changes are the outcome of a continual process

Following the literature review it was argued that household car ownership changes should be viewed as the outcome of a continual *process* of adjustment over the life course; rather than as discrete, isolated events. This was an important conceptual insight that has been empirically evidenced through the two

stages of primary research. A framework postulating the key elements through which this process operates was first generated though a thematic analysis of the in-depth interviews and with recourse to the literature. This framework is now reproduced in Figure 8-2:

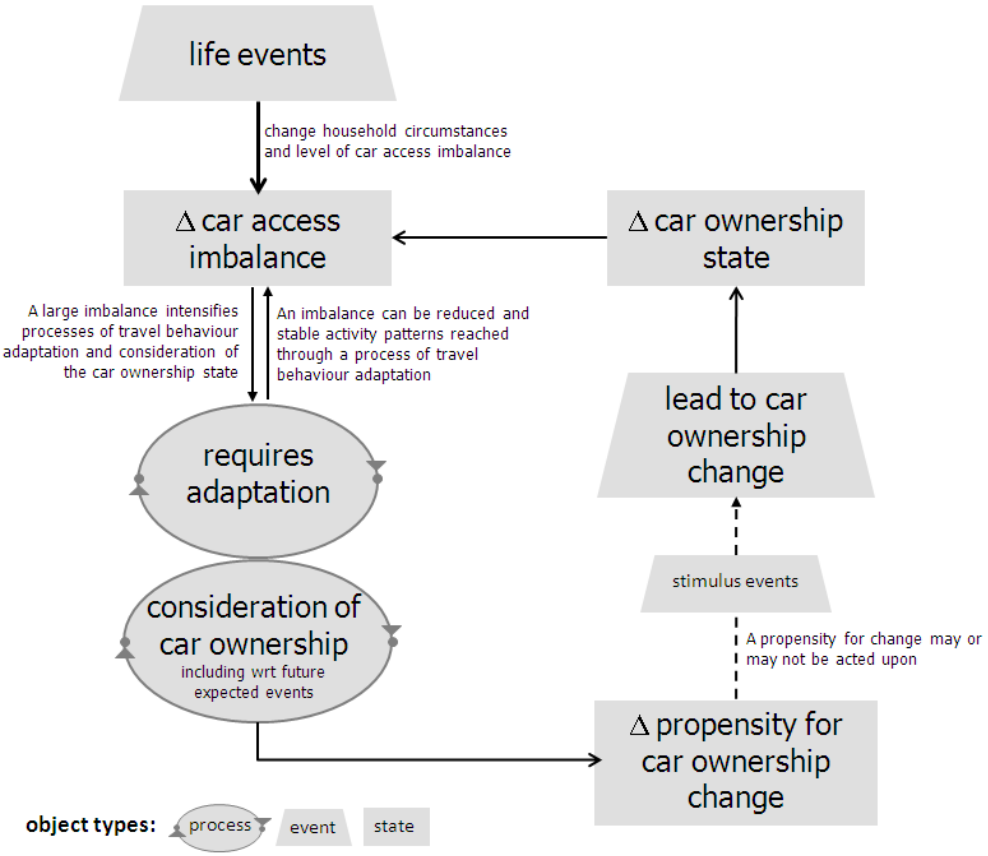


Figure 8-2: The framework depicting the process of car ownership change

Household car ownership level changes are driven by life events

The analysis of the in-depth interviews initially suggested that **life events are the drivers of changes in car ownership level**. This was confirmed by the neighbourhood survey. 70 per cent of recorded level changes were found to be associated with: a change in working circumstances, cohabitation, an adult joining or leaving the household, residential relocation, child birth, offspring reaching driving age, retirement or a health constraint arising. Respondents also agreed with the notion that car ownership changes had been prompted by life events. Of the 74 respondents that reported a level change (as opposed to a replacement) as their last car ownership change, 82 per cent of them agreed that the level change was associated with a life event. A necessary caveat to these findings is that the survey and interview participants reflected a particular

demographic. An area for further research would now be to establish whether similar or different life events are associated with car ownership level changes across wider groups in the population.

Nevertheless, life events at the *general* level were found to alter one or more of the following household attributes:

- the resources available to the household (e.g. income);
- the relationships between individuals within the household (cohabitation or non-cohabitation) and their ability to share resources (including cars);
- the roles performed by individuals in the household (at work and at home) and the activity patterns that are undertaken in order to fulfil those roles; and
- the consequent spatial and temporal distribution of the activity centres that are visited by the household.

The tendency for individuals to experience particular types of life event changes as individuals move through the life course. This links the process of car ownership change framework to the notion of a car ownership life cycle. For instance, in early adulthood individuals may be moving into the labour market for the first time; in later adulthood individuals may be retiring; in between these two extremes individuals may be experiencing partnership formation or dissolution.

The household car ownership state may not reflect an equilibrium position

The assumption that households are in a behavioural equilibrium is often implicit in cross-sectional studies of car ownership. The literature on travel behaviour dynamics suggested that instead, a household may be viewed as being partially through a process of adjusting their car ownership position to a new circumstance, for instance having the first child (Goodwin, 1998).

To reflect this notion of non-equilibrium car ownership states, the mediating concept of car access imbalance was introduced in a conceptual framework developed prior to carrying out the primary research (see section 3.4.3). Car access imbalance was defined as: the *household's subjective* assessment of the extent to which the present car ownership state meets or exceeds the household's *desires*. Parallels were drawn with the concept of *stress* defined by others in the literature. They suggest that longer term decisions (such as car ownership decisions) are triggered by *stressors* which they define as discrepancies "between the household's aspiration level and its current circumstance" (Oakil et al, 2011 p.5). Imbalances were considered to arise since

households can only make *discrete* changes to their car ownership state; either changing car ownership level or replacing a vehicle. They cannot make *continuous* marginal adjustments to their car ownership state to maintain an equilibrium position over time. It was posited in section 3.4.3 that only when a car access imbalance becomes too large, will the household be tipped into an active search for an alternative, preferred state (if resources allow).

The concept of household car access imbalance is subjective, time dependent and dependent on the views of several independent members of the household. It has consequently been unavoidably challenging to operationalise. Nevertheless this study has provided novel empirical evidence of its existence and how it operates. **The evidence supports the use of such 'stressors' in conceptualisations of the process through which household car ownership changes over time**.

Evidence for the existence of car access imbalances

The in-depth interviews demonstrated that car access imbalances arise as circumstances change, where a change in circumstance is typically marked by a life event. The interviews also provided accounts of how households may seek to reduce car access imbalances through a process of *adaptation* (i.e. changing travel behaviour) and a concurrent process of *consideration* (i.e. changing the aspiration for access to cars). If through these two processes, a satisfactory set of travel routines for the household is not established, then the household may develop a *propensity* to change the car ownership state.

The retrospective accounts of car ownership change generated by the interviews (reported in section 4.5) provided examples of implied *car access imbalances* having arisen *before* a car ownership change took place. Car access *deficits* had arisen as a result of intra-household conflicts over access to the vehicle fleet, or vehicles being of the wrong type (an available vehicle being uncomfortable to drive for example). Respondents also described car access *surpluses* arising as a result of vehicles being recognisably underutilised for a potentially long period of time. This was most prevalent amongst cohabiting adults running a relatively infrequently used second car.

Further empirical evidence for the existence of *current* imbalances was generated by the survey which revealed that a significant minority, one quarter of respondents felt they had too few or too many vehicles for their needs. The survey also confirmed the notion that a car access imbalance is distinct from the

household's *propensity* to change car ownership state. It provided further evidence that the two states were linked through a process of *consideration* which heightens as imbalances arise (as postulated in the framework depicting the process of car ownership change). For instance, a car access imbalance may exist as an assessment of 'I have too few cars'. Through consideration ('I have thought about it'), this may or may not manifest itself as a propensity to change car ownership state ('I am / am not able and intend / do not intend to acquire a further car').

Indeed, four household 'potential to change car ownership states' were identified:

1. Households that were satisfied with the current car ownership position and had no intention to change car ownership level in the future. The majority (116 out of 177 households or 66 per cent) of the sample were in a stable position, consistent with notions of state dependence (Simma and Axhausen, 2007).
2. Households that were satisfied with the current car ownership position, but expected to change car ownership level in the future (15 out of 177 households or eight per cent of the sample). These respondents were planning to make a change in response to a future *expected* life event such as retirement, or child birth.
3. Households that were dissatisfied with the current car ownership position, but had no intention to change car ownership level in the future (23 out of 177 households or 13 per cent of the sample). These households were either constrained from making a change or the level of dissatisfaction was not great enough for them to contemplate making a change. This supported the notion that only when a car access imbalance becomes too large, will the household be tipped into an active search for an alternative, preferred state.
4. Households that were dissatisfied with the current car ownership position and intended to change car ownership level in the future (23 out of 177 households or 13 per cent of the sample). These households considered that the *current* situation would be improved by the acquisition or relinquishment of a car.

It is recognised that these insights are based on a small numbers of case, given the need to generate qualitative insights from a relatively small target population and the finding that imbalances apply to an (albeit significant) minority of households at a single point in time. As has been noted before it would now be

appropriate to target a wider sample, to explore the broader range of circumstances under which such imbalances might arise.

Household car ownership change is subject to inertia

The Oxford English Dictionary (Oxford University Press, 2011) defines inertia, a concept arising from the discipline of Physics as: “That property of matter by virtue of which it continues in its existing state, whether of rest or of uniform motion in a straight line, unless that state is altered by an external force.”

The statement: household car ownership change is subject to inertia simply means that households resist changes to their car ownership state. Through the processes discussed before, it was observed that households build up a latent propensity to change car ownership level which may lie dormant for quite some time. The interviews and the survey generated (mainly qualitative) novel evidence for the presence of inertia, its causes and how it is overcome.

Inertia was most strikingly demonstrated through the repeated examples of second car relinquishments which occurred sometime following cohabitation. **The survey revealed that the time lag between the point of cohabitation and a vehicle relinquishment averaged three years – evidence for resistance to change**. The depth insights generated by the interviews revealed that this resistance to change car ownership level could arise from a combination of factors including for instance: a period of adaptation being required for the household to confirm that they can manage with one car, reluctance to give up an individual’s own car, the effort involved in selling the second vehicle and the relatively small amount of money gained from selling a second hand vehicle.

A further elegant aspect of the inertia analogy is that additional stimuli (external ‘forces’) were often required to overcome the inertia, prompting the household into taking action. In cases where there was a larger latent propensity to change, the external force prompting change could be quite small – the receipt of a tax renewal notice for example. In cases where there was a smaller latent propensity to change, the external force prompting change could be quite large – a vehicle write-off, a change in income or the unexpected opportunity to acquire a car cheaply (or for free) from friends or family members.

Comparing the insights offered by the interviews to those generated by the survey would suggest that, in order to fully understand inertia and how it is overcome requires detailed qualitative data of the form generated by the interviews. Thus, recognising the limited size and composition of the interview

sample, a simple extension of this study would be to conduct further interviews on a broader demographic to explore the wider causes of car ownership inertia.

8.3 Objectives 2 and 3: The potential for future car ownership change

Objectives two and three were:

2. To examine the extent to which the present car ownership state meets (or exceeds) the household's desires; and

3. To explore how households expect to change car ownership in the future.

These objectives are now discussed in a single section dedicated to the potential for car ownership to change in the future. This was partially addressed in the previous discussion of car access imbalance. It is also noted that this section discusses *respondent expectations* rather than the extent to which household car ownership changes might be actively encouraged by policy interventions. This is discussed later in section 8.5.

Household car ownership is state dependent

The interviews and survey provided evidence of what has previously been observed statistically as car ownership level state dependence (Hanly and Dargay, 2000). Most of the time people tend not to change car ownership level: 52 percent of the survey sample reported not having made a car ownership level change since the current household formed (over an average period of 8.6 years). With respect to the prevalence of car access imbalances across the survey neighbourhoods, it was revealed that the majority of households, 74 per cent of the sample, felt that they had just the right number of vehicles for their needs. Indeed, 79 percent of the sample expected to maintain their current car ownership level at the next car ownership transaction.

Relinquishments are most likely to occur amongst second car owners

In keeping with the findings relating to *past* car ownership changes, the most likely households to *relinquish* a vehicle were *second* car owners living within the *inner-urban* neighbourhood. Only eight out of 165 car owning households expected to relinquish a vehicle, seven of which lived in Bishopston. This was an indication that second cars were potentially more marginal in the inner-urban neighbourhood context than they were in the outer-urban neighbourhood. This offers a simple hypothesis that could be tested on a wider sample of inner and outer-urban neighbourhoods in Bristol and indeed across the country. The

qualitative accounts for these households were consistent with the process of change framework in that circumstances had already changed following a life event and a second car was no longer required for a previous routine purpose. However, inertia was acting to restrain these households from finally relinquishing the second car.

Expected acquisitions were more prevalent than expected relinquishments

Consistent with the notion of asymmetric car ownership churn (Dargay and Hanly, 2007, Chatterjee, 2001), reported in the literature review (section 2.5.2), there were more households expecting to *increase* car ownership level (30) than there were households expecting to *reduce* car ownership level (eight). Thus the eight relinquishments could be expected to be cancelled out at the aggregate neighbourhood level. Consistent with notions of a car ownership life cycle (Figure 8-1), reasons for car ownership increases were found to be associated with life stage and related to: young adult non-car owners that aspired to acquire their first car; couples sharing one car between them feeling a requirement for a second car; or multi-vehicle households with offspring approaching driving age.

8.4 Objective 4: Car ownership and residential location

Objective four was: to identify how residential location influences household car ownership and preferences towards car ownership over time.

As noted in chapter two, there is a complex debate in the literature over the extent to which there is a direct unidirectional relationship running from built environment to household car ownership. It is argued that households may self-select according to attitude; so for example households with a preference for less car dependent lifestyles choose to live in central urban areas with a greater range of transport alternatives.

The built environment does influence car ownership outcomes

From the evidence produced by this study it is concluded that there is a relationship between the built environment and household car ownership, but the relationship is complex. Given the longitudinal, qualitative nature of this study, the findings now summarised are again concerned with the *process* through which residential location choice exerts an influence at the *household* level. This is in contrast to testing the magnitude of a hypothesised unidirectional relationship running from built environment to car ownership at the aggregate neighbourhood level, as has been undertaken elsewhere in the literature (Cao et al, 2007).

The study has demonstrated that the cross sectional patterns observed between built environment and car ownership arise first through a process through which *preferences for particular lifestyles form over time*; second from a related *process of migration of similar population groups (e.g. young families) to similar areas (e.g. neighbourhoods with terraced homes)*; and third through a *process of behavioural adaptation to the built environment*. The historic context of the time is also an important factor – the timing of this study having coincided with the mass availability of cars and increasing disposable incomes over the longer term.

Preference formation and residential self-selection: Whilst it was not possible to generalise from the small sample, the interviews demonstrated that preferences towards a particular location type are not simply antecedent to the residential location choice. Preferences towards a particular location type are themselves partly shaped by past experience.

The interviews provided examples of how preferences towards a particular lifestyle (in the illustrated cases, city centre living) had developed over the longer term, based on either positive or negative life-experiences of living in a particular area type – for instance, the negative experience of a daily commute by car, or the positive experience of living in a capital city abroad with access to a variety of shops, cafés and other amenities. These experiences translated into a desire for city centre living, or living within walking distance of work, which was realised when the households next relocated. In chapter four the notion of residential self-selection was conceived as a *process* involving several feedback relationships which act over time, now reproduced overleaf as Figure 8-3.

A necessary caveat here is that these longitudinal insights are based on a very small number of cases from the in-depth interviews. Indeed, comparing the insights generated by the interviews and the survey would suggest that the more detailed retrospective accounts are required to explore longer term preference formation and the influence on subsequent car ownership outcomes. Thus a simple extension to this study would again be to conduct further interviews, of a similar format, on a wider demographic.

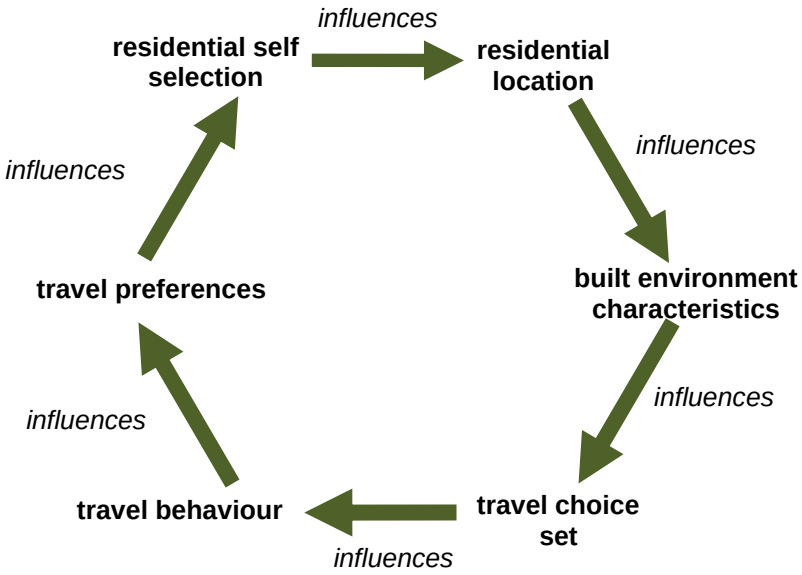


Figure 8-3: Residential self selection as a feedback process

Neighbourhoods choose household types: In relation to this process, the neighbourhood survey demonstrated that the characteristics of a neighbourhood (housing stock and location) may act to attract households of a particular type which maintains a stable population composition over time. In the survey neighbourhoods, a population comprising "young families in terraced homes" was maintained in the period since the 2001 census by younger households moving in and replacing older households moving out. **These neighbourhoods had in essence *selected* common households according to a shared life stage, purchasing power and preference for housing type and location**. As noted before, similar preferences may have been formed in part as a result of shared past life-experiences.

It was also observed that:

1. Households moving into the neighbourhood tended to gain cars as they moved through their life course in accordance with the car ownership life cycle; and
2. The aggregate car ownership level in both neighbourhoods had remained relatively stable.

This implied that some of the older households moving out of the neighbourhood had higher car ownership levels than the younger households moving into the neighbourhood. This again was consistent with being further on in a household car ownership life cycle as depicted in Figure 8-4 overleaf. The shaded areas

show the relative positions in the car ownership life cycle of households moving into and out of the neighbourhood and their corresponding tendencies for car ownership to change. The extent to which concurrent processes of population turnover and the car ownership life-cycle act to cancel each other out in other neighbourhood types is an area that would also benefit from further research.

Travel behaviour adaptation: The in-depth interviews also identified that following a move to a new location households go through a period of *adaptation* to establish new satisfactory routine (or otherwise) travel patterns. The form of the new local built environment was one factor (in addition to existing preferences towards alternative modes) that influences the transport options that a household feels able to 'try out' during adaptation. As discovered by Stanbridge (2007), the extent to which the household understands their post move travel options depends on the degree of pre-move planning with respect to transport. Households vary in this regard. Indeed, the interviews revealed that the pattern of adaptation that follows a move can lead to any of the three possible outcomes with respect to the future household car ownership state which may be planned or unexpected. These are:

1. The lack of a need to change car ownership level, if adaptation is successful. This can include the establishment of new preferences towards non-car modes e.g. cycling;
2. The need for an additional car (unexpected or planned); and
3. The opportunity to relinquish a car (unexpected or planned).

The survey provided wider evidence of this process. 10 out of the 109 recorded car ownership level changes were directly linked to a residential relocation, with five occurring in each neighbourhood. As noted earlier there was also a more general tendency for households to increase car ownership level following a move to either neighbourhood. Such changes were not necessarily related to the move and the form of the built environment, but rather could be associated with other changes in life. This implied that there was nothing particular about the transport conditions in either neighbourhood that acted to counter the typical tendency for younger adults to acquire cars over time.

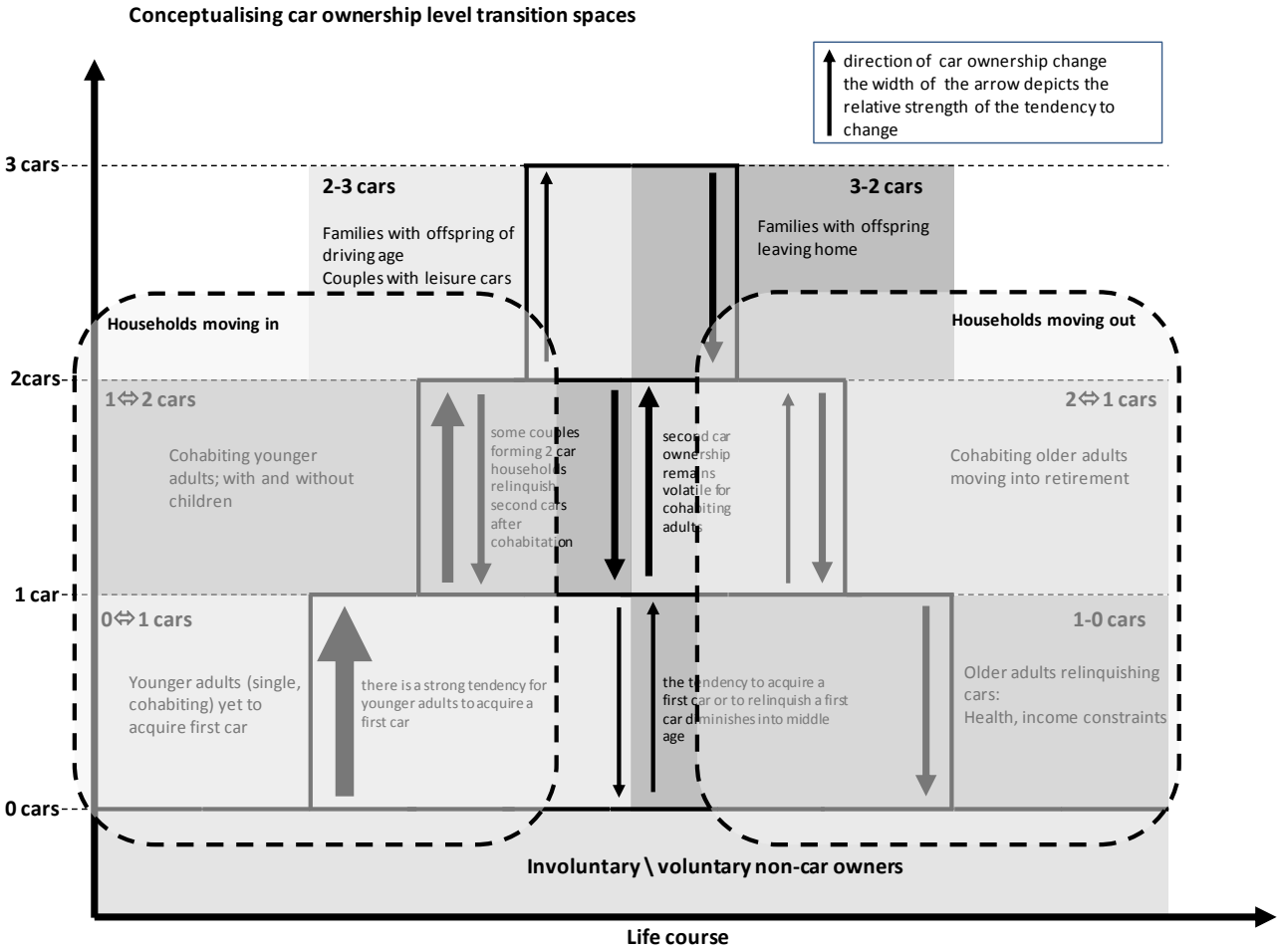


Figure 8-4: The household car ownership life cycle and neighbourhood churn

However, there was evidence of differing patterns of *travel behaviour* adaptation following a move to either the inner-urban or outer-urban neighbourhood. As expected, cars were used less frequently and other modes used proportionately more in the inner-urban neighbourhood. Nevertheless car ownership rates were the same in both neighbourhoods, owing in part to greater incomes in the inner-urban neighbourhood. In the case of the survey neighbourhoods, the built environment influenced *car use* more strongly than car ownership. Notwithstanding this finding, there did appear to be a greater unrealised *potential* for car ownership reductions in the inner-urban neighbourhood. Again, this offers a simple hypothesis that could be tested on a wider sample of inner and outer urban neighbourhoods in Bristol or indeed across the country. As reported previously, seven out of the eight expected relinquishments were reported by inner-urban residents. Furthermore 13 out of 15 respondents reporting ownership of too many cars also resided in the inner-urban neighbourhood. The related policy implications of these findings are discussed further in section 8.5.

The understanding of the processes through which the built environment influences household car ownership (developed through this study) is now summarised as follows:

1. Life stage governs the household's position in the car ownership life cycle. This influences the *tendency* for the household's car ownership level to increase or decrease over time;
2. Life stage and past experience influences the preference towards particular residential location types and transport modes. Households at a common life stage and with some shared lifestyle preferences become clustered in neighbourhoods;
3. The selected residential location influences the opportunity to use and reinforces preferences towards the use of alternative transport modes. This acts to strengthen or weaken the *tendency* for car ownership to increase or decrease over the household car ownership life cycle.

8.5 Objective 5: Policy implications

Objective five was: To provide policy relevant insights concerning the propensity for household car ownership states to change.

As noted in chapter two (section 2.2.5), at present there are no explicit national policies concerned with changing the *number* of privately owned vehicles across the population. The latest transport policy document recognises that "the car is the mode of choice for all but the shortest of trips, mainly because of its freedom and flexibility" (Department for Transport, 2011a p.68) and it is noted that the Government are "committed to making car travel greener by supporting the development of the early market in electric and other ultra-low emission vehicles" (Department for Transport, 2011a p.7). In this regard, in 2011 the Government launched two related initiatives: 'Plugged-In Places' is a £30m programme to support the installation of re-charging infrastructure, and the 'Plug-In Car Grant', is a £300m fund to reduce the cost of purchasing electric vehicles (Department for Transport, 2011b). Thus, the current emphasis is on encouraging the purchase of newer, cleaner vehicle types, rather than on changing the number of privately owned cars per se.

Nevertheless, the current policy framework is also supportive of schemes providing alternative models of car *access*, such as car clubs and car sharing noting that these "can help to address congestion and emissions while preserving the freedom and flexibility that the car brings" (Department for Transport, 2011a p.68). Indeed, understanding how the demand for private car ownership might be *reduced* through such interventions is arguably of interest to local planning authorities in densely populated urban areas. Such authorities are likely to be faced with issues concerned with managing parking supply in constrained residential areas and city centres for instance.

Accordingly the policy implications now discussed are concerned with both the potential for car ownership to be *reduced* in urban areas and the potential to encourage households to acquire more efficient vehicles. It is however recognised that the suggestion that planners and policy makers *ought* to be attempting to reduce the number of cars owned constitutes a *value judgement* (May, 2001 p.47).

8.5.1 Opportunities for car clubs

The finding that cohabitation can lead to the relinquishment of a second vehicle implies that the ability to share the car resource *within* the household leads to a

more efficient model of ownership. It implies that in single adult household structures, a growing demographic, the ratio of one privately owned car to one adult provides a redundant level of (instrumental) car access in some cases. The challenge for car clubs and other car sharing schemes is then, to facilitate the effective sharing of car resources *between* households; leading to reductions in aggregate car ownership at the neighbourhood level. Indeed, a recent analysis suggested that 0.42 cars are "disposed of, or not purchased for every car club member" (Cairns, 2011 p.14).

With regards to encouraging the wider uptake of car club membership, a number of observations from the primary research are of relevance. First, there appeared to be greater redundancy in car availability in the inner-urban neighbourhood than in the outer-urban neighbourhood. This would corroborate the suggestion that there is a larger potential market for car clubs in inner-urban areas (Cairns, 2011), which in some cases may remain dormant (given that none of the respondents surveyed in the inner-urban neighbourhood reported regular use of the nearby car club cars[27]). Second it was confirmed that life events reflect opportunities for households to reconsider their options with respect to car ownership; and third, it appeared that younger households moving into either neighbourhood had a tendency to *increase* car ownership level.

These observations indicate that the profile of car club membership could be raised through the use of *targeted* marketing messages. It is suggested that marketing material could be most effective when targeted at recent movers to a neighbourhood. The residential relocation reflects one such life event at which households are more likely to be reconsidering their transport options (Stanbridge, 2007). Hence the salience of such messages would be increased. Second, specific marketing messages could be targeted at the neighbourhood demographic. Such tailored marketing messages could in principle be generated on a neighbourhood by neighbourhood basis, given the quite sophisticated indicators of the demographic composition of small local areas that are now widely available through the census and other lifestyle profiling data sets (ACORN, MOSAIC). In the case of the survey neighbourhoods marketing material could target:

[27] The reasons for non-car club use were not probed during the survey as this was not a central focus of enquiry.

- Young single adults that are contemplating acquiring their first car: In this case, the messages could compare the cost and benefits of joining a car club and gaining access to a brand new car, with the costs and benefits of purchasing a second hand, potentially less reliable car; and
- Second car owning households, in particular young couples that may have relatively recently begun cohabiting. Car clubs typically already compare the cost of car club membership with the cost of running an existing underutilised second car. However, they could also point out that some couples often take some time (with a potentially considerable associated cost) to realise that they no longer need the second car (for instance by asking 'how often do you use both cars on the same day?').

A further observation of relevance is that households may be reluctant to relinquish second hand cars, partly as a result of the search costs (and small monetary reward) involved in selling the vehicle. Another mechanism through which car club operators may be able to incentivise membership would be through facilitating the easy and cost effective relinquishment of a vehicle.

8.5.2 Larger scale car sharing schemes

It is recognised that marketing messages can only go so far in motivating alternative behaviours however. Unpicking reasons for the acquisition or retention of a second car highlighted that there may be specific barriers to the wider uptake of car clubs. For instance, second cars had in some cases been acquired for child care needs. From the in-depth interviews one participant explained that car clubs were not well suited for child care activities given the need to carry car seats and other equipment to and from the car club parking bay. Similarly other households needed a second car, fairly regularly for work, but not necessarily on a daily basis. Current car sharing models are not well suited to journeys for which the car needs to be parked for some time before it is returned to the parking bay (Le Vine et al, 2009).

This suggests that over the longer term, such barriers may be addressed through more radical, larger scale, flexible car sharing systems. For instance, systems through which residents have access to a wider pool of shared local vehicles which can be accessed more flexibly: accommodating the use of a car all day, and being equipped for child care for instance. Organisations such as 'Whip

Car'[28], through which households rent out privately owned cars when they are not in use, are pioneering such systems. A wider uptake of such a scheme at the neighbourhood level could reduce the demand for private car ownership and remove some of the inflexibilities of current car club systems. This would require a significant cultural shift from economies of private car ownership to economies of car sharing at the local level however.

Alternatively, interventions could promote the idea that households can share ownership of cars with others in their local social networks. Services which make it simpler for people to temporarily insure themselves on the cars owned by others would be of benefit here.

8.5.3 Using messages to overcome inertia

The study has demonstrated that households may build up a latent propensity to change car ownership, but that given the costs and time involved in making a change, households tend to resist taking action. This suggests that interventions may themselves be designed to act as signals for car ownership change. Indeed, this has been exploited by the UK Government in introducing the recent vehicle scrappage scheme to both stimulate the automobile market in a recession and to incentivise the replacement of old vehicles with newer, cleaner models (Department for Business, Innovation and Skills, 2009).

It is suggested, given the Government's intention to update the vehicle fleet with more efficient technologies, that MOT or Vehicle Excise Duty (VED) reminders could be used as 'stimulants' to prompt households to reconsider their car ownership position (Cairns, 2011). Reminders could include messages to increase the awareness of current incentive schemes such as the 'plug-in car' grant. They could also alert householders to the true running costs of their current vehicles in comparison to alternative vehicle types, given that motorists may typically underestimate ownership costs by a factor of two (Lane and Potter, 2007). Such messages are likely to become more salient over time, given the expected sustained increases in the price of petrol and diesel.

Indeed, given current data availability and computing power, quite sophisticated, highly targeted messages could be generated on a household by household basis. For instance, it would in principle be possible for an algorithm to look-up the number, type, age and previous annual mileage (if recorded in the MOT) of

[28] www.whipcar.co.uk

the vehicles associated with a particular address. Information relating to the current running costs could then be provided and contrasted with the running costs associated with alternative vehicle types and indeed alternative models of ownership[29]. It would even be possible to lookup proximity to car club cars for the household and provide cost contrasts based on annual mileage. However, care would need to be taken not to present overly intrusive or coercive marketing messages in such reminders.

8.5.4 Establishing less car dependent lifestyles amongst younger cohorts

Given the state-dependent nature of car ownership, the long-term structural level of dependency on private car ownership could begin to be addressed by encouraging younger generations to adopt less car dependent lifestyles. This is particularly salient given the earlier finding that a lower proportion of current 17-30 year olds hold a driving license compared to previous cohorts reported in chapter two (section 2.2.3).

The interviews demonstrated that the acquisition of the first car was often coincident with another significant life event in early adulthood such as entering the labour market. Hence policies in this regard would seek to ensure that educational, training establishments (universities) and employers of young adults are encouraged to provide alternatives to car use where possible. Such policies are already being delivered through the adoption of work place travel plans. Encouraging the adoption of car sharing models of car access amongst younger cohorts may also prove beneficial in this regard.

8.5.5 Built environment design considerations

The primary research also demonstrated that households adapt their travel behaviours and preferences according to the form of their local built environment over a potentially long period of time. This serves as a reminder that the built environment (land use patterns, urban design and transport supply) is a key determinant of long term travel behaviours and preferences.

Given the current shortage of housing supply in some areas of the UK, it is therefore crucial that newly constructed neighbourhoods are designed to encourage multi-modal travel behaviours where possible. It is particularly

[29] For example, the company River Simple lease rather than sell hydrogen fuelled cars to end users through rental schemes that include fuel and repair costs. This incentivises the manufacturer to develop long lasting vehicles with low running costs (Palmer, 2009, River Simple, 2009).

important that the necessary infrastructure is in place at the outset of a new development, given that a residential relocation represents a key life event following which new travel behaviours may be adopted and become entrenched.

This involves incorporating a sensible balance of the well known ‘carrot and stick’ style measures in neighbourhood design including: sensitively balancing the supply of parking, incorporating car club parking bays, providing bicycle storage facilities, designing for mixed used development, incorporating good public transport links at the start of a development, using the principle of filtered permeability (Melia, 2008) to ensure that non-motorised modes are competitive with motorised modes and indeed providing electric vehicle recharging infrastructure.

Similar principles could also be applied to existing neighbourhoods. In particular, several study participants noted parking constraints as a factor in either the decision to relinquish underutilised cars or to not acquire additional cars. Hence re-allocating street space for other beneficial uses (wider pavements, planting of trees, provision of shared use cycle parking and so on) could offer a means of locking down existing parking supply reducing further growth in car ownership.

The well documented association between proximity to an urban centre and travel behaviour has also been demonstrated. Residents of the inner-urban neighbourhood were less reliant on their cars and more likely to suggest a willingness to relinquish a vehicle than residents of the outer-urban neighbourhood. This lends support to the claim that low-car developments or incentives concerned with reducing private car ownership are better located in more central urban areas (Melia et al, 2011, in press).

8.6 Reflections on the research process

A number of limitations were inevitably encountered and recognised with hindsight throughout the study. The sections to follow offer some reflections on the challenges and successes of the two stages of primary research that were undertaken in the study.

8.6.1 The in-depth interviews

Following on from the literature review, which demonstrated the predominance of quantitative and mainly cross sectional approaches to the study of car ownership, a rationale was developed that justified the use of qualitative, longitudinal in-depth interviews in the first stage of the study. Indeed, the interviews proved to

offer novel, and deeper evidence of the process through which household car ownership changes over time. It is argued that the findings presented in this thesis do reflect a contribution to knowledge that has not so far been covered elsewhere in the literature.

Nevertheless, this stage of the study did have some inherent limitations. Not least, the composition and to some extent small size of the sample that was achieved, which was biased towards individuals from higher socio-economic groups. This was mainly the result of the majority of respondents being recruited via word of mouth snowballing, which was initiated through the researcher's own social networks. While efforts were made to achieve a more balanced sample, through a flyer drop, and advertising on public websites, these recruitment strategies proved less fruitful than word of mouth. With hindsight, and following the successful experiences of the door-to-door survey, it seems that the use of personal contact would have boosted response rates from other groups, over and above the somewhat anonymous flyer postings. Such personal contact could have been achieved by targeting specific organisations for example social groups of one form or another (e.g. choirs, play groups, sports clubs).

It is also notable that the analysis of the interviews proved to be somewhat challenging, given their quite open and exploratory nature. There were few existing examples of how such mobility biography style data had been analysed, on which to base the approach. The analysis ultimately involved a lengthy process of identifying themes, describing them, considering how they link to the literature and providing interpretation in seeking meaningful explanation in relation to the research questions. Establishing the framework depicting the process of car ownership change proved to be of great benefit in this regard. While this framework may now seem intuitive, it was not initially apparent during the earlier phases of analysis and was iteratively refined over the course of the study with recourse to the literature. Having established this framework, the researcher found it much easier to construct a more general, interpretive (rather than descriptive) narrative of the accounts of car ownership change generated by the interviews.

The interviews also served to demonstrate the challenge of eliciting reliable retrospective mobility biographies, given the level of pre-interview preparation and process of guidance and revision that was required during the interviews. This suggested that self-completion questionnaires would not be well suited to

eliciting detailed and reliable mobility biography style data. This represents an important lesson for future research.

8.6.2 The neighbourhood survey

As described in chapter five (the stage two methodology) following substantial completion of the interview phase, a lengthy process of consideration followed in relation to the extent to which depth of exploration should be compromised in favour of testing for the wider prevalence of the findings. The interviews had demonstrated the complexity involved in explaining how and why household car ownership changes over time and the original rationale, that there was a need for longitudinal, depth of understanding still held. Moreover, the interviews had not yielded a clear set of hypotheses that could be tested through a structured, quantitative questionnaire. A strong case could be made for the continuation of a depth approach to further understand how differing patterns of adaptation emerge over time for similar groupings of households and to explore the related consequences for car ownership changes.

Nevertheless, given the limited sample size achieved during stage one, a survey of a wider sample of geographic households appeared to offer a more suitable means of achieving a balanced set of findings and addressing the full range of starting objectives for the study. The challenge then was to design a survey that would generate reliable, both qualitative and quantitative data that could be effectively analysed. In the end, a suitable balance between depth and breadth was achieved overall by limiting the size of the survey sample. This enabled the researcher to retain some depth of exploration on a wider sample by employing both a self-completion and interviewer led component to the survey.

Nevertheless, designing an effective survey instrument proved to be extremely time-consuming. There was an inevitable temptation to attempt to achieve the same level of insight that had been possible through the in-depth interviews. Indeed, a particular challenge was faced in establishing which of the complex concepts emerging from the in-depth interviews should not be operationalised and which could be sufficiently simplified through the survey instrument. For instance, it was apparent that the process of adaptation over time could not be sufficiently captured in the questionnaire, and was instead represented by an indicative measure of the household's current modal split and the extent to which the current car ownership position met their needs. Complementary qualitative

insights into the household's changing circumstances were elicited through the follow-up telephone calls.

With hindsight, a specific weakness in the survey instrument was not explicitly exploring why some households had not experienced a car ownership level change in greater detail. This would have been interesting in order to provide a contrast with similar households that had experienced car ownership level changes. Nevertheless, specific reasons for non-change would have been challenging to establish, compared to the arguably more tangible reasons for having experienced a car ownership level change. It would undoubtedly have been difficult, if not impossible to include further branching in the self-completion questionnaire that asked respondents comprehensible questions in relation to non-change. However, this could have been explored in greater detail during the follow-up telephone calls.

Indeed, a potentially effective alternative means of administering the two part survey would have been to conduct a smaller, but slightly more detailed set of follow-up telephone calls on a carefully selected sample of households displaying particular characteristics from either neighbourhood, rather than attempting to follow-up all respondents. This would have allowed a more detailed comparison of particular factors, including for instance, why some households had experienced a particular type of car ownership change while others had not.

Notwithstanding this oversight, targeting full coverage of two neighbourhoods ultimately proved to be successful; specifically in generating depth of insight at the neighbourhood level with boarder insights at the household level. The 'drop and collect' process of survey administration in particular proved to be a highly effective means of achieving very high response rates from the two neighbourhoods.

The survey also demonstrated the extent to which particular demographic groups become geographically clustered in particular neighbourhoods. This was an intentional outcome given the objective to probe how differing geographic contexts influence the process of car ownership change, holding other socio-economic and demographic factors constant as far as possible. It also meant that differing household car ownership trajectories could be categorised, compared and contrasted, controlling for particular factors relating to life stage or household structure. However, a consequence was that this limited the range of car ownership trajectories that were captured. For instance there were few examples

of older, retired households captured by the survey. On reflection this was beneficial, as the great heterogeneity in household car ownership histories was significantly challenging to analyse in itself, across what was an already limited demographic.

Lastly, it is argued here that a particular strength of the qualitative approach taken in this study has been the ability to directly link the occurrence of a life event with a change in car ownership through the respondent's own account. An important observation from the study has been the significant time-lags that can occur between an event and a car ownership level change taking place. In one extreme case the relinquishment of a vehicle occurred nine years after a move to an inner-urban location. Such long term associations between events would be difficult to identify in quantitative panel data sets. Indeed, quantitative approaches which are not also accompanied by such *qualitative* explanation, are at risk of making spurious links between car ownership changes and other more recent coincident, but nevertheless unrelated events.

8.7 Recommendations for further research

As is likely to be the case with most social scientific inquiries, there remains a need to design research methods that continue to develop both depth and breadth of understanding with respect to the process of household car ownership change. While the stage one depth study generated some valuable insights and a useful theory, it was based on a recognisably small sample size and a demographic biased towards highly educated, urban households. The interviewer guide itself was nonetheless arguably an effective instrument on which to base future research. As has been noted previously in this chapter, a simple extension would be to conduct a similar set of depth interviews on a wider demographic, including households from other age and socio-economic groups, from other cities and also from within rural areas.

The interviews also revealed a number of complex processes that influence the process of car ownership change that would benefit from further in-depth research. For instance, how individuals within households organise access to cars, how individual needs within the household translate into a household decision to change car ownership, how longer term lifestyle preferences form (e.g. preferences towards differing residential locations), how vehicles transactions are facilitated opportunistically through social networks and how behavioural adaptation influences car ownership pathways. All of these time

dependent processes require carefully designed longitudinal and qualitative research methods in order to develop the necessary *explanatory* insights. This remains a challenge for research.

There also remains a need to establish the most appropriate means of generating reliable data on a larger scale, which captures the links between life events and car ownership changes. The experience gained in this study would suggest that gathering such data *retrospectively* is best achieved through an interviewer led approach rather than relying on self-completion. A recruitment strategy which employs personal contact would also be recommended, to ensure that the survey response is not heavily biased towards those with a high level of education and includes those from harder to reach groups.

Such approaches should attempt to capture how *individual* lives resolve into car ownership changes at the *household* level. It is suggested that interviewer led surveys which develop event history calendars for individuals within households offer a suitable, if resource intensive way forward. An interviewer led questionnaire would take the form of a time-line grid covering a specific period of time upon which events of interest would be recorded (similar to the example provided by Beige and Axhausen (2006)). This would capture wider structured data concerning the lag and lead times between events and car ownership changes, lending itself to hazard based duration modelling (see section 2.7.1.2). It would also be of benefit to generate brief qualitative accounts of car ownership change for a subset of such a survey sample. As noted previously this would provide more reliable insights into which life events have influenced car ownership changes and why (including identifying large time lags between events and car ownership change which might otherwise be missed).

Lastly, a review of the developments in car ownership modelling was presented in chapter two. Following this it was observed that there remains a need for an agreed theoretical basis to underpin dynamic car ownership models. The qualitative insights generated by this study have revealed more about the behavioural processes through which changes in people's lives (marked by life events) translate into changes in car ownership level. An area for further research is establishing the extent to which elements of the framework depicting the process of car ownership change (Figure 8-3) can be operationalised in a dynamic car ownership model.

A first suggestion is that *micro-simulation* models offer a more suitable framework for reflecting some of these *processes* than purely econometric models. In econometric models, probabilities for car ownership outcomes are calculated and then applied to populations in areas to determine the proportion of households owning zero, one or two or more cars. In micro-simulation, individual household units are simulated in software and changes in their lives are calculated by algorithms (which also involve probability calculations) as they move through time. The algorithms enable events to be simulated and underlying decision making rules (reflecting process) to be programmed.

There are two notable micro-simulation land use models that are of relevance to developments in this respect. These are simDELTA (developed for the UK by the David Simmonds Consultancy (Feldman and Simmonds, 2007)) and ILUTE (Integrated, Land use, Transportation, Environment modelling system, developed by a team working for the University of Toronto (University of Toronto, 2004)). Both models use micro-simulation algorithms to simulate population renewal (births and deaths), household formation and dissolution and the process of residential relocation. These processes have been identified in this study as being crucial to consequent car ownership outcomes and it would seem natural for the next development to also simulate the process of car ownership change in a similar manner.

In this respect the ILUTE team have been in the process of conducting research to determine the most effective form of car ownership transaction model. Much of their research is reviewed in chapter two and is concerned with evaluating car ownership transaction models and hazard based duration models (see (Mohammadian and Miller, 2003, Roorda et al, 2000, Roorda et al, 2009)). The current version of simDelta does not use micro-simulation to model car ownership changes but instead applies a static discrete choice model. However, it is noted that “a strictly micro-simulation car-ownership model could draw on other existing research” (Feldman and Simmonds, 2007 p.73) and this study provides relevant insights.

A first suggestion as to how a micro-simulation model, in combination with econometric sub-models might reflect the mechanism through which car ownership levels have remained relatively stable in the two survey neighbourhoods is offered below.

1. The model first estimates the number of households, with a given structure, life stage and car ownership status moving out of a given neighbourhood each year.
2. The model then estimates the number of households, with a given structure, life stage and car ownership status moving into a given neighbourhood each year, based on vacant dwellings (these first two stages are handled in existing micro-simulations such as simDelta and ILUTE).
3. Econometric models calculate the proportion of households in the neighbourhood experiencing particular events relevant to car ownership such as having the first child each year.
4. Given an understanding of the proportion of households at particular life stages and experiencing particular events in the neighbourhood, car ownership transaction models (building in evidence based lag and lead times) calculate the proportion of households experiencing a particular car ownership transaction each year.
5. Interactive gaming techniques such as those being developed by Hensher (2008) could be used to explore how households of differing type respond to alternative scenarios with respect to car ownership changes. Probabilities derived from such experiments could be built into the micro-simulation to explore how car ownership across neighbourhoods may change in future years in response to particular scenarios.

Clearly however, these represent early thoughts that would need to be considered in some detail by modelling experts within the research community.

8.8 A concluding summary of the study

It remains at this point only to provide a concluding summary of the contribution of this study to the understanding of car ownership. First and foremost it has been argued both conceptually and empirically that household car ownership states must be viewed as the outcome of a continual process of adjustment over the life course; rather than as reflecting static, equilibrium states. This is perhaps *the* key point to be taken from the thesis.

This continual process of household car ownership change has been found through empirical research to be driven by life events. Such life events mark changes in circumstances and often reflect significant transitions between life stages; altering roles and relationships, spatial contexts and lifestyle preferences.

To understand why car ownership changes in response to life events requires an understanding of the complex processes of travel behaviour adaptation and changing preferences towards different transport modes over time. Only longitudinal research designs have the potential to offer such insights and it has been argued in this chapter that there remains a need for further research in this regard.

In considering the implications for policy, the study has demonstrated that the prevailing model of private car ownership can lead to 'marginal' (typically second) household cars. It suggests that awareness of the benefits of alternative models of car access (e.g. car clubs) could be increased through the use of targeted and in particular *well timed* messages. In this regard and in drawing this thesis to a conclusion, it is finally suggested that the findings of the study are supportive of a proposition which is becoming better evidenced over time as understanding of travel behaviour deepens. Namely, that transport policies and interventions concerned with changing the number and type of vehicles owned (and indeed wider travel behaviour) should consider *life events* as significant opportunities for change.

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Appendices

Appendix A - Plot of census 2001 car ownership rates

Image redacted for copyright reasons

Source: Census 2001 Standard Table 59 (Census Dissemination Unit, 2011)

Appendix B - The interview cover letter, consent form and moderator guide

Interview Cover Letter

Ben Clark, PhD student
Centre for Transport & Society
School of the Built and Natural Environment
University of the West of England, Bristol

Email: [redacted]
Mob: [redacted]
Tel: [redacted]

Research Project

Studying Car Ownership

Thank you for agreeing to be interviewed for this research project. Before the interview, it would be useful if you could think about the following two areas:

Your household's car ownership history

Using the table on the back of this page, for the last 10 years (or more):

- Try to list the cars or vans that you and other members of your household have owned or leased (including company cars) along with some rough dates.
- Note down some rough dates indicating when you've moved house.
- Note down some rough dates indicating when you and other members of your household have changed jobs.

  [If you rent a room in a shared house, only answer for yourself.]

Learning to drive

- When did you pass your driving test?
- When did you first have access to a car as a driver (for instance use of a family car)?
- When did you first have access to your very own car?

Year	Details of vehicles acquired or relinquished	Moved house (Y/N/Blank)	Household member changed jobs (Y/N/Blank)
e.g. 2009	*Bought Peugeot 206, X Reg*	*-*	*-*
e.g. 2008	*-*	*Y - (Moved to Bristol, September)*	*Y - Ben started job in Bristol (September)*
2009			
2008			
2007			
2006			
2005			
2004			
2003			
2002			
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1999			
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1992			
1991			
1990			
1989			

University of the West of England
BRISTOL

Centre for Transport & Society

PhD Research Project:

Car Ownership Study

This study is seeking to understand how car ownership levels are changing (an important consideration for planners and policy makers) by talking to people about their experiences of making car ownership decisions.

The research will explore what has happened in the past to explain present day household car ownership levels and investigate what households think might happen to their car ownership level in the future. The study will also examine how household car ownership needs are related to residential location.

CONSENT FORM

Material gathered during this research will be treated as confidential and securely stored. The interview will be recorded and transcribed, but your name will not appear on the transcript.

The research student may use selected information and quotes from the interview in his thesis, and in academic publications or presentations, but you will not be named.

Please answer each statement concerning the collection and use of the research data.

I have read and understood the information above	Yes	☐	No	☐
I have been given the opportunity to ask questions about the study	Yes	☐	No	☐
I have had my questions answered satisfactorily	Yes	☐	No	☐
I understand that I can withdraw from the study at any time without having to give an explanation	Yes	☐	No	☐

Name (printed) _____

Signature _____ Date_____

Name (printed) _____

Signature _____ Date_____

REMUNERATION

I have received £20 for participating in the research:

Name (printed) _____

Signature _____ Date_____

Countersigned by:

Name (printed) _____ (Researcher)

Signature _____ Date_____

STAGE ONE INTERVIEW MODERATOR GUIDE

MAKE SURE:

- THE ROOM IS QUIET
- YOU HAVE CALLED YOUR BUDDY
- THE RECORDING EQUIPMENT WORKS

Introduction

[Introduce myself, the PhD and provide administrative information about the interview]

First of all, thank you very much for your willingness to take part.

My name is Ben and I'm a second year PhD student at the Centre for Transport and Society, University of the West of England.

My research is about understanding how people decide how many motor vehicles to run and what type of motor vehicles to buy.

One of the ways I'd like to study this is by asking people to describe their vehicle ownership history and to explore how this relates to other changes in their lives, such as moving house or changing jobs.

The discussion should take around an hour and it is recorded to ensure a reliable analysis.

The material from the interview will be used in a PhD thesis, but will be anonymously processed. So quotes may be used, but they will be non-traceable. For instance, it may say things like "male".

If there are any questions that you prefer not to answer, please just let me know.

You can leave at any stage during the interview if you wish.

[Give them the project information sheet and ask them to sign the consent form.]

There are no right or wrong answers or views and I hope you find it enjoyable!

Section 1: Warm up

Could you start off by telling me a little about who you live with and the motor vehicles that are available to your household right now:

- Who lives in the household? [household structure];
- How many drivers are there in the household?
- Prompt for number of cars, type and age (own, company, vans, motorcycles);
- How long have you had the(se) cars?
- Who in your household has been involved in making car ownership decisions? [establish the nature of the decision making unit]

Understanding household car use

[This section is to explore car use within the household and to understand how the household organises access to the available cars]

Who can pick up a car key and drive the car(s) in your house?

If it helps, you could describe to me how you've been using the car(s) over the last week or so.

Prompt for giving lifts to others in the household, leisure, work, shopping, trip chaining

What journeys do they use the car for?

Why?

Are there ever days when (any of) the car(s) are not used at all?

How often?

Why?

Are there times when (a particular driver) leaves the car at home when they go out?

Why?

How have they got to where they were going?

How often are the car(s) (all) in use away from the home?

Are there times when other drivers in your household would like to use a car, but are unable to as the car(s) are being used elsewhere?

Does this happen often?

How do [these people] get around when the car isn't available to them?

Section 2: Car ownership history

[Drawing the mobility biography]

Now I'd like to get a feel for your [household's] car ownership history and how this relates to other changes in your life.

It helps me to remember what you've said if we draw car ownership changes on a timeline.

Here's my car ownership history [show them my example mobility biography] – the timeline will look something like this when it's finished.

Start with car ownership changes [working from the pre-interview preparation]

Move on to key events. Prompt for:

Passing the driving test

Leaving full time education

Moving house (home location)

Changing jobs (work location)

A change in the number of people living in the household:

Moving in with partner / marriage

Child birth

Retirement

Travel behaviour:

Enquire about typical daily travel patterns for household members, for definable periods in the respondent's history [e.g. after starting work, or between two house moves]

(Walk, Cycle, Bus, Rail, Car)

Ask about public transport season ticket availability during these periods

Section 3:

3a: Exploring car ownership changes

[This section of the interview has to flexibly respond to the information gathered in the mobility biography]

Now I'd like to ask you a little more about the times in your life when you've changed the number of vehicles available to you and your household, either up or down.

[Start off with the most recent car ownership level change

Explain what I understand to be their current car ownership state]:

You presently own x cars and you bought this car at [here] and this car [here]

Thinking about this last car ownership change (from x vehicles to y vehicles):

[Refer to the relevant transition type below. Then add these additional questions if it is a car acquisition]

- Were there particular things that you were looking for in acquiring this car. For instance did you have a particular price range, age of car, size of car that you were looking for? [probe for reasoning]
- What types of information did you look at before deciding to acquire this car?
- Roughly how long was it between deciding you need to change car ownership and completing the purchase (or sale) of the car?

[Times when the household moved from one to two cars]

- How were you and your household managing to travel during this period before acquiring the second car?
- Were there any particular problems with meeting your travel requirements during this period?
- What were the main reasons for acquiring a second car?
    - was there a particular point at which you realised that you needed a second car?
- Why did you choose to buy or acquire that particular car?

[Times when the household moved from two to one car]

- Why did you get rid of your second car during this period?
- Having got rid of the second car, how did your household's travel patterns change?

[Times when the household moved back from zero to one car]

- Before you acquired this car, what were the other travel options available to you?
- What didn't you like about these travel options?
- Could you tell me a little about the main reasons why you bought or acquired this car?
    - was there a particular point at which you realised that you needed a car?
- Why did you choose to buy or acquire that particular car?

[Times when the household moved from one to zero cars]

- Why did you get rid of your car during this period?
- Having got rid of this car, how did your household's travel patterns change?

[Acquiring the first car]

Could you tell me a little about:

- How you learnt to drive?
- When you passed your driving test?
- Why you decided to learn to drive at that time?
- When did you first have a car available to you as a driver?
- When did you first feel like you had "ownership" of a car?
- Before you acquired your first car, what were the other travel options available to you?
- What didn't you like about these travel options?

- Could you tell me a little about the main reasons why you bought or acquired your first car?
    - was there a particular point at which you realised that you needed a car?
- Why did you choose to buy or acquire that particular car?

3b: Deliberating on current car ownership status

[This section is to explore how satisfied the respondent(s) is/are with their current car ownership state]

X years have passed since you last changed car ownership and I'd like to talk to you about how satisfied you are with your cars right now.

Thinking about the car(s) that are available to your household now:

> Can you tell me about the positive aspects of having access to these cars?
> And
>
> Can you tell me about any negative aspects of running these cars?

[Let the respondent talk and then present prompts….]

Some prompts to help you think about satisfaction with your current car(s)…

- A car is always available to me / others in my household when it is needed
- Image
- Giving or receiving lifts
- Carrying heavy loads
- Enjoy driving
- Money: Fuel, maintenance, insurance, tax
- Financing replacing the vehicle
- Lifestyle: Taking part in activities (work / leisure)
- Time
- Getting around is easy where I live

3c: Prospects for changing car ownership status

I'd now like to talk to you about whether you've been thinking about changing car ownership in the near future at all.

Could you mark on this scale roughly where you'd say your household is in terms of thinking about changing car ownership level or vehicle type?

We hadn't thought about it at all	We know how long we intend to have these cars	We are actively seeking to change car ownership

Prompt to find out reasons for where they locate themselves on the scale.

What are they thinking about changing (level / vehicle type)?

Why?

How do they plan for costs associated with motoring (replacing a car for instance)?

If you were able to, is there anything that you would change about the car(s) that you own now? [more cars / less cars / different car type]

What is stopping you from making these changes?

Section 4: Response to losing one car

[Stated adaptation experiment]

Imagine you have lost access to [one of] your cars (perhaps because it was written off in an accident or stolen) and it'll be two months before a full time replacement car is available to you free of charge.

Show the stated adaptation chart and ask them to think about how they would reallocate their car trips across the alternative modes. Give them 10 tokens to represent 10 percentage points each and ask them to distribute them across the chart.

Section 5: Closing the interview down

Thank you very much for taking the time to talk to me today - I've gained some really useful insights from our discussion.

[If possible mention some examples of what the interviewee has said]

[Instigate some related but relaxed conversation about the interview as you close down]

Has anything come to mind that you haven't perhaps thought of before?

Give them my contact details

Give them the incentive

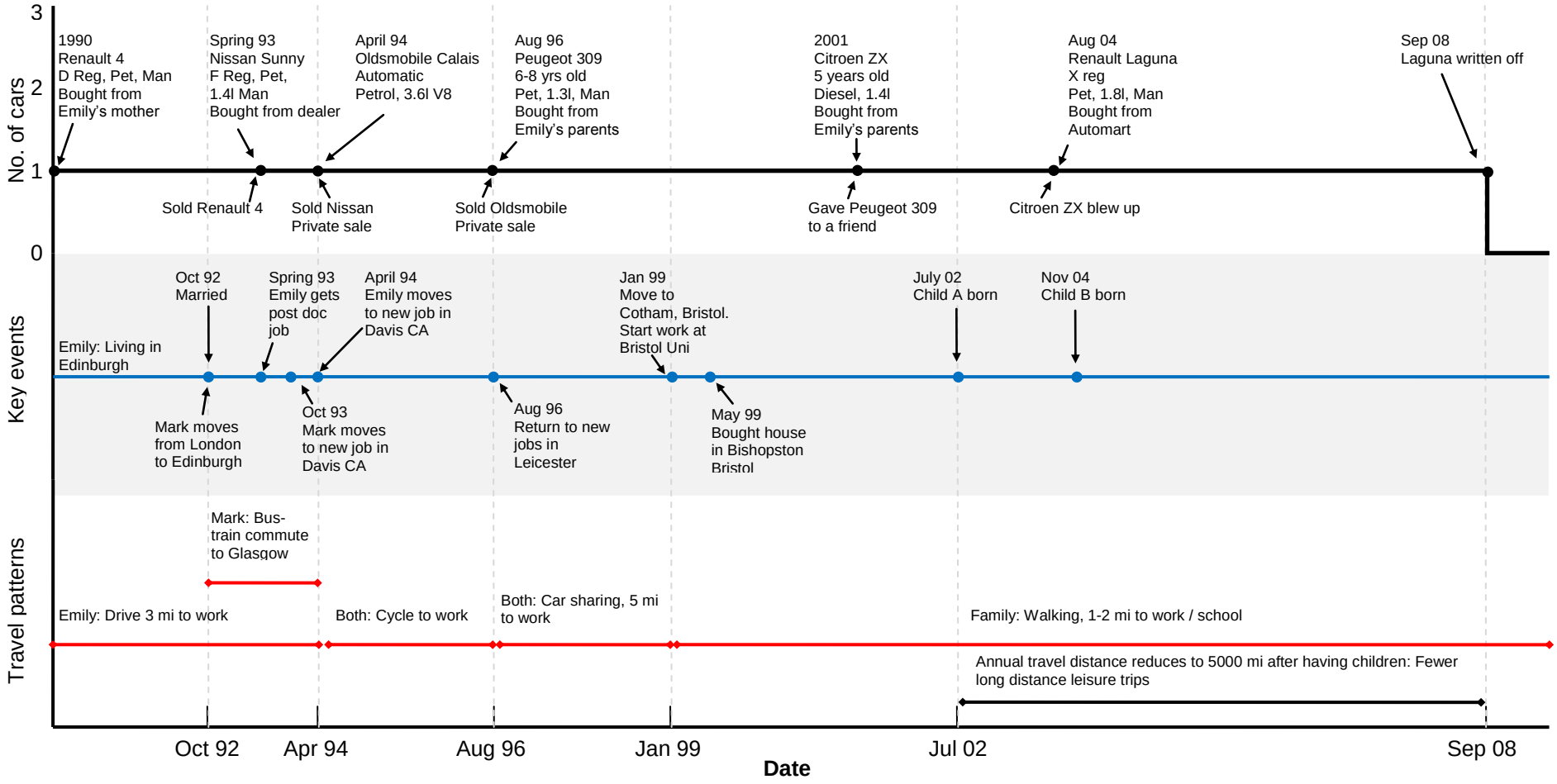
Ask for their contact details (email address)

Would you mind me contacting you if I have any further queries or questions about this discussion?

Turn off the recording device.

Appendix C - Mobility biography timeline, propensity to change car ownership scale and stated adaptation chart

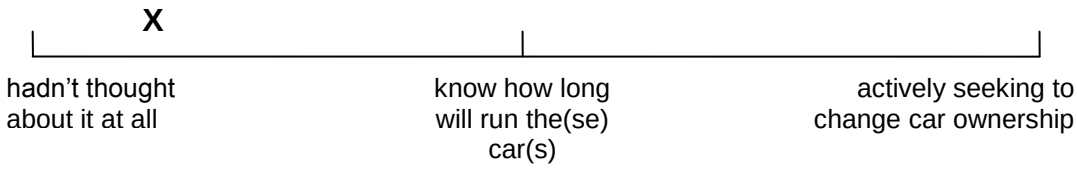
15M (Mark) and 15F (Emily): Mobility biography timeline



Participants 13M and 13F:

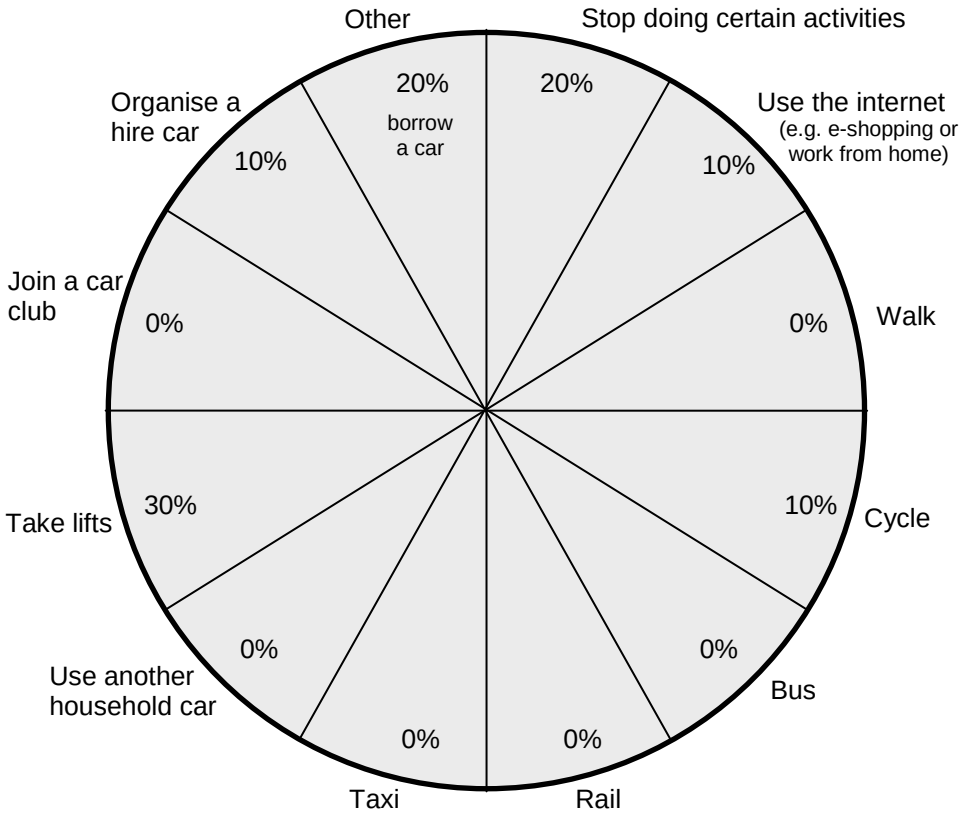
Propensity to change car ownership scale:

Have you been thinking about changing car ownership in the future?



Stated adaptation chart:

Your household loses access to one car for two months. How would you manage the journeys that are normally completed using that car?



Appendix D - Interviewee car ownership histories

This appendix provides a summary of the fifteen in-depth interviews. The accounts of car ownership change that follow have been structured to demonstrate how the qualitative interview data supports the analysis presented in chapter four.

Accordingly, for each interview there is a table setting out a description of every car ownership level change recorded during the interview. Where appropriate, the description has been annotated to demonstrate how it illustrates aspects of the framework depicting the process of car ownership change presented in Figure 4-1. It should be noted that the framework emerged inductively from the interview data (as opposed to being tested deductively using a structured interview guide) and care has been taken not to impose the framework on every account. Not all aspects of the framework were necessarily apparent from each account.

The car ownership level changes have also been assigned to a category (in the left hand column of the table). These categories reconcile with the motivations for acquiring the first car (presented in Table 4-2) and the life events associated with car ownership level changes (presented in Box 4-1).

The tables conclude by summarising the respondents' expectation for their next car ownership change.

Interview one:

This was an interview with a 28 year old female who lives with her partner in an owned house in a rural village on the outskirts of Reading. They have a car each (her partner's car is on a company lease arrangement): The respondent has a Vauxhall Corsa (mini class car) and her partner has a Saab (large class car).

Past changes	**Description**
0 to 1 car (first car) **Category:** Access to the labour market	**Events:** The respondent passed her driving test at 17, but did not drive regularly while she was at university. Following university, the respondent took her first job as a consultant in Reading. **Car ownership change:** She was given permanent access to a company van (her first vehicle) which she was required to use for work.
1 to 2 cars **Category:** New household	**Event:** The respondent then moved in with her car owning partner forming a two car household together. Both partners were required to use company vehicles independently for work at this point.
Replacements	**Event:** The respondent then left her job in Reading to start a PhD in Bristol. **Consideration:** This meant that she would lose access to her company car. Given that she would be required to commute from Reading to Bristol she decided to buy a car of her own. As a lone female driver, she wanted a reliable, robust, but (environmentally) efficient car for her long motorway commute. **Car ownership change:** She bought her current (brand new at the time) Vauxhall Corsa. **Event:** On starting her PhD she was required to work in Bath town centre for one day a week. **Adaptation:** As the office was located near to Bath railway station she realised that she could travel to Bath more easily by train than she could by car. She had not been a regular rail user up until this point. However, following this experience, she and her partner now frequently use the train for leisure activities.

Current travel patterns	The respondent drives to Bristol where she is studying towards her PhD and her partner uses his car for site visits. The couple tend to use the company Saab for leisure trips at the weekend in order to save wear and tear on the respondent's car. However, where possible they will book advance train tickets. The respondent reflected on the fact that she felt freer and more able to relax on the train.
Future expectation	**To replace their vehicles:** The couple have no intention to change the number of cars that they own, but will be shortly replacing the company car as part of the lease arrangements. The respondent explained that the couple would be re-assessing where they should live and work following completion of her PhD. **Lifestyle preferences and residential self selection:** She noted that if they were to move, then they would like to live close to the rail network. They would reconsider their car ownership position accordingly.
Current status	**Planning for an expected life event** (acquiring a new job / moving house)

Interview two:

This was an interview with a female in her early 30s who lives with her husband and two young children (aged two and four) in their owned home in central Bristol. They currently have one car: An Audi A4 (large class car).

Past changes	Description
1 to 2 cars (her first car) **Category:** Access to the labour market	**Event:** The respondent started a job as a consultant. This required her to travel longer distances for work. **Adaptation and a car access deficit:** She found travelling to client meetings to be inconvenient by public transport. This "galvanised" her efforts to pass her driving test. **Consideration:** She did not enjoy driving her husband's large car which was nevertheless available for use during the working week. She decided to buy a small car of her own which would be safe and reliable on longer motorway trips. **Car ownership change:** She bought her first own car: A small hatchback SEAT Arosa.
2 to 3 cars **Category:** Child Birth	**Events and opportunism:** The respondent became pregnant. A coincident opportunity arose to buy a four–door Vauxhall Corsa from a friend as a replacement for her two door SEAT Arosa. **Consideration:** She felt that a four door car would be more appropriate for child care. **Car ownership change:** She bought the Corsa in preparation for motherhood.
3 to 2 cars **Category:** Child Birth	**Inertia:** It took around six months for the household to get around to selling the two door SEAT Arosa. This transaction was finally triggered by imminent maintenance costs.

2 to 1 car **Category:** Child Birth	**Event:** After having children, the respondent's working patterns changed. **Adaptation and a car access surplus:** The couple were no longer using both cars at the same time on a regular basis. The respondent's husband had also replaced his car with a newer one which the respondent felt more comfortable driving herself. **Consideration:** The couple decided to sell the Corsa as it was no longer required. **Car ownership change:** The couple sold the Corsa returning to a one car household.
Current travel patterns	The respondent and her husband cycle to work in the "northern fringe" developments on the outskirts of Bristol. Their children walk to a nursery and a school that are just around the corner from their home. The car is generally used for leisure travel at the weekends and a monthly shopping trip. The respondent and her husband may lift share to work on rainy days. The car may also be used if either partner is travelling for work (though her husband is usually provided with hire cars for business travel).
Future expectation	**To replace their vehicle:** The respondent explained that they have no immediate plans but would replace their car (which is now ten years old) either if they received an expensive maintenance bill or if a suitable opportunity arose to acquire a newer vehicle.
Current status	**In a stable position**

Interview three

This was an interview with a 25 year old male PhD student who lives in a shared rented house in central Bristol. He owns one car: A Peugeot 205 (mini class car).

Past changes	**Description**
0 to 1 car (first car) **Category:** Family norms	**Event:** The respondent passed his driving test when he turned 18. He lived in a rural area at his parental home at the time. **Car ownership change:** His parents bought him his first car for his 18th birthday.
1 to 0 cars **Category:** Write off	**Event and car ownership change:** The respondent wrote his first car off during his first year of driving. He could not afford to replace it as he was moving away from the family home to start university in Bristol. **Adaptation:** While at university, he had no desire for a car as he lived centrally and was content using the bus services to get around town. **Consideration and a car access deficit:** However, he did occasionally feel that a car would be useful. Particularly when he returned to his parent's home in a rural area during holidays, where there were fewer transport options available to him.
0 to 1 car **Category:** Opportunism	**Event and opportunism:** An opportunity later arose for him to buy a car, quite cheaply from a trusted family friend. **Car ownership change:** He bought the car from his family friends. **Adaptation:** On returning to Bristol this allowed him to live further from the bus routes to university and he began using his car to travel to the campus.
Current travel patterns	The respondent drives the short distance to work every day and commutes to his girlfriend's home at the weekends. One of his other housemates also drives to the same work place. They did try car sharing but differing working hours meant that this was difficult to arrange.
Future expectation	**To replace his vehicle:** The respondent explained that he has no immediate plans, but is considering updating his vehicle when he starts a new job on completing his PhD.
Current status	**Planning for an expected life event**

Interview four

This was an interview with a male and female couple in their later 30s / early 40s. They live in their owned home in central Bristol with their two year old son. They have one car: A Ford Focus (medium class car).

Past changes	Description
0 to 1 car (first car) **Category** Access to the labour market	**Events and a car ownership change:** The male respondent acquired his first car to help with finding his first job after leaving university.
0 to 1 car (first car) **Category** Access to the labour market	**Events and a car ownership change:** The female respondent bought her first car when her employers provided her with a car related finance package. She was required to travel by car during the working day.
1 to 2 cars **Category** New household	**Event:** The respondents moved in together forming a two car household.
2 to 1 cars **Category** Cohabitation	**Events:** The couple spent some time living together in Brighton and Paris, before relocating to Bristol. **Lifestyle preferences and residential self-selection:** They developed a preference for city centre lifestyles during this period. This was accommodated when they relocated to Bristol city centre. **Adaptation:** Following the move to Bristol, the male partner was able to cycle to work and the female partner was predominantly working from home. **Consideration, inertia and a car access surplus:** After several years they realised they could manage with one car between them. They reported that they had discussed selling one of the cars but had never got around to it. Both parties had a personal attachment to their own car and valued the independence it gave them. They also realised that the cars would not be worth much if they sold them. However ongoing maintenance costs eventually triggered the decision to relinquish the second car. **Car ownership change:** The couple sold both cars and bought a shared household car together.

Current travel patterns	The family cover less than 10,000 car miles per annum and mainly use the car for leisure trips. The male partner cycles to work in the city centre. The female partner uses a combination of cycling and the car to get to her workplace on the northern fringe of the city.
Future expectation	**To replace their vehicle:** The couple are satisfied with their current car and have recently spent quite a lot of money on maintenance. The male respondent commented that they may consider buying a smaller more fuel efficient car, the next time they replace their vehicle.
Current status	**In a stable position**

Interview five:

This was an interview with a female in her early 40s who lives with her husband (also in his early 40s) and two children (aged 10 and eight) in their owned home in central Bristol. They own one car: A Honda Civic (medium class car).

Past changes	Description
0 to 1 car (first car) **Category** Access to the labour market	**Events and a car ownership change:** The respondent acquired a company car (her first car) when she took a job as a consultant. This required some travel by car for work. **Access to cars through family networks:** Before acquiring the company car she had been borrowing her parent's second car to get to work.
Replacements	**Events:** She relocated to Bristol and moved in with her husband. This meant that she lost access to her company car. **Access to cars through family networks:** She replaced the company car with a second hand car which she sourced from her uncle who was a car mechanic.
1 to 2 cars **Category** Company car	**Events and a car ownership change:** Her husband later acquired a company car as he was required to travel long distances for work.
2 to 1 car **Category** Company car	**Events and a car ownership change:** Her husband lost access to the company car when he changed jobs. The couple also had children around this time. **Adaptation:** After having children, the respondent's working patterns changed and she no longer drove to work on a daily basis. On returning to work, the respondent began cycling rather than driving.
Current travel patterns	Now both partners cycle to work, but retain a car for other purposes (child care and leisure).
Future expectation	**Replacing a vehicle and access to cars through family networks:** The family are currently in the process of receiving a replacement car from the respondent's parents. (Her parents were themselves acquiring a newer car). **Inertia:** The family will temporarily become a two car household but expect to sell their current vehicle when they have time.
Current status	**Undertaking a car ownership change**

Interview six:

This was an interview with a female (23) who lives with her partner (27) in a rented house in Stoke Gifford; an outer-urban suburb on the northern outskirts of Bristol. The couple have two cars: A Ford Fiesta (mini class car) and a Peugeot 106 (mini class car).

Past changes	**Description**
0 to 1 car (first car) **Category** Independence	**Event:** The male participant passed his driving test at the age of 18. **Adaptation and a car access deficit:** He was living in a rural location at his parent's home at the time and was required to get two buses to college. **Consideration:** Accordingly he wanted a car of his own to establish his own independence. **Car ownership change:** He bought his first car at the age of 18 as soon as he passed his driving test.
1 to 2 cars (first car) **Category** Access to the labour market	**Events and a car ownership change:** The female respondent moved in with her partner at the same time as taking on a PGCE in Bristol. She acquired her parent's old car (opportunistically) at the same time to help with travelling to work placements.
Current position	The couple have lived the short time together as a two car household. **Adaptation:** They moved within Bristol to their current home to be nearer to Bristol Parkway station. The male partner commutes on a daily basis to Swansea by train and his car is stored in Swansea to service the journey between Swansea rail station and his workplace. The female partner drives when she is on placement at a school but is able to cycle to the university for lectures and so on.
Future expectation	**To replace the male partner's vehicle:** The male partner's vehicle is now quite old and they expect to replace it shortly. This may be prompted by a maintenance bill.
Current status	**A propensity for car ownership change**

Interview seven:

This was an interview with a single mother (43) who lives in an owned home in central Bristol with her five year old daughter. She owns one car: A VW Polo (mini class car).

Past changes	Description
0 to 1 car **Category** Family norms	**Events and a car ownership change:** The respondent was given a first car by her father when she passed her driving test in her late teens. She lived with her parents in London at the time and her parent's felt that she would be safer travelling on her own in her own car. She later moved in with her partner. They lived together in London as a one car household for many years. Her partner used a motorbike at the time. They had a daughter together and then relocated to Bristol.
0 to 1 car **Category** Household dissolution	**Events:** She split up with her husband and moved into a home on her own with her daughter. **Adaptation and a car access deficit:** She and her husband continued to share the previous car for a period. The respondent would cycle when she did not have access to the car. **Consideration and opportunism:** This arrangement became "irritating" and the respondent's mother-in-law realised that she had a second car that she no longer required. **Car ownership change:** The respondent's mother-in-law donated her second car to the respondent.
Current travel patterns	The respondent has lived as a one car household with her daughter ever since. She is currently self-employed and works from home. The car is mainly used for leisure activities and shopping.
Future expectation	**No plans:** The respondent explained that she had no plans to change car ownership at present and is not budgeting for the next car.
Current status	**In a stable position**

Interview eight:

This was an interview with a single mother (53) who lives with her 16 year old daughter in her owned home in Filton; a intermediate-urban area of Bristol. She has one car: A Vauxhall Astra (medium class car).

Past changes	Description
0 to 1 car (first car) **Category** Household dissolution	**Events and a car ownership change:** The respondent bought her own first car after splitting up with her first husband whom she had shared a car with.
2 to 1 car **Category** Cohabitation	**Events:** The respondent moved in with her second husband. **Adaptation and a car access surplus:** They were able to manage with one car between them after moving in together. **A car ownership change:** They sold the respondent's car
1 to 2 cars **Category** Employment / home location	**Events:** The couple had a daughter and the respondent's working hours reduced. After some time she returned to work and her working hours then increased. **Adaptation and a car access deficit:** The couple were finding it increasingly difficult to manage work journeys with one car between them. **Consideration and a prompt for change:** Weekend working was described as the "final straw" which prompted the decision to get a second car. The respondent's husband's work place then offered employees a favourable deal to buy a new car from the local Vauxhall dealership. **Car ownership change:** The couple purchased the current Vauxhall Astra.
2 to 3 cars **Category** Company car	**Events:** The respondent's husband acquired a company car following a job change. They retained their privately owned cars.
3 to 2 cars **Category** Company car	**Events:** The respondent's husband lost access to the company car following a job change.

2 to 1 car **Category** New household	**Events:** The respondent split up with her husband, forming two, one car households. **Residential self-selection** She relocated to her current home in Filton. This location choice was partly motivated by a desire to be near to her daughter's existing school and social network.
Current travel patterns	**Adaptation:** Her new home is now quite close to her workplace. This, coupled with the introduction of parking fees at her workplace, has been instrumental in her decision to walk rather than to drive to work.
Future expectation	**To replace her car:** It has taken her some time to adjust to her new life. Nevertheless, she has recently begun considering whether to exchange her car for something smaller, given that she no longer uses her car that frequently.
Current status	**In a stable position, but contemplating the future**

Interview nine:

This was an interview with a 39 year old male who lives with his partner (41) in an owned house in a new Marina style development in an intermediate-urban area of Bristol. He and his partner have one car each: A Mazda MX5 (sports car) and a Mitsubishi Charisma (large class car). The respondent has also recently bought a Vesper (moped) for fun which he increasingly uses for trips around town.

Past changes	**Description**
0 to 1 car (first car) **Category** Family norms	**Events and a car ownership change:** Coming from a family of car lovers, the respondent was bought his first car at the age of 15. He has been a car owner ever since and indeed is something of a car enthusiast, often buying sports cars to use on a daily basis and various additional classic cars which he tinkers with as a hobby.
1 to 2 cars **Category** New household	**Event:** The respondent moved in with his partner forming a two car household.
Replacements	**Access to the vehicle pool:** The respondent has had a high turnover of vehicles. In the period leading up to buying a house he ran a succession of cheap old cars in order to save money. He bought several of these from friends. His partner's current car was passed down to him by his father.
2 to 3 cars **Category** Leisure	**Leisure:** The respondent has also bought various third classic cars from time to time.
Current travel patterns	The respondent's partner drives to work every day in Avonmouth. His company have recently relocated from Pucklechurch (which was nearer to home) and the new commute, coupled with the lack of amenities in Avonmouth have prompted his partner to consider changing jobs. The respondent is presently on a career break, but uses his car on a daily basis to get around town. The couple tend to share cars at the weekend for leisure journeys.
Future expectation	**To replace the Mitsubishi:** The couple are actively considering replacing the Mitsubishi which is now quite old.
Current status	**A propensity for car ownership change**

Interview ten:

This was an interview with a 29 year old male researcher living in a rented flat with his partner in an intermediate urban area of Bristol. They have one car: A Mazda 323 F (medium class car).

Past changes	Description
0 to 1 car (first car) **Category:** Independence	**Events:** The respondent's family moved from Plymouth to Brixham when the respondent was in his late teens. The respondent passed his driving test in his late teens whilst living at the family home. **Car access deficit**: The respondent wanted to be able to visit his old friends in Plymouth but felt restricted in terms of the available transport options from Brixham. **Consideration:** This was a factor in his desire for a car of his own. **Car ownership level change:** He saved money through his first year of university and bought his own first car (an old Rover Metro) the following summer.
1 to 0 car **Category:** Employment / home location	**Event**: The respondent was required to move to Luton to undertake a six-month work placement. **Car ownership level change:** His first car blew up on the drive to Luton. **Adaptation:** He found that it was easy to get to his new employer by public transport in this new area. **Consideration:** He decided it was unnecessary to replace his car.
0 to 1 car **Category:** Employment / home location	**Event:** He was then required to move to rural Norfolk for another six month work placement. **Adaptation and a car access deficit:** There were no adequate alternative transport modes available at this new location (he was living 'on site' away from the local villages). **Consideration:** He had no alternative but to get a car of his own as there were limited other transport options. **Car ownership level change:** His father arranged the purchase of a VW polo for him.

Current travel patterns	The respondent has had one car ever since and now shares access to it with his partner. He upgraded to his current vehicle when he left university and gained full time employment. Both he and his partner tend to walk or cycle to work. The car is presently mainly used for shopping trips, evening leisure trips around Bristol (to the cinema for instance) and longer distance leisure travel at the weekend.
Future expectation	**To replace his vehicle** **Future event:** The respondent is currently in the process of finding a new job having completed a PhD. **Car ownership change:** He is expecting to replace his current car when he acquires a new job and has more money. The type of car that he buys will depend on whether he is required to commute to his new job by car or not.
Current status	**Planning for an expected life event** (a new job)

Interview eleven:

This was an interview with a 49 year old male System's Analyst living with his partner in an owned home in central Bristol. They have one car: A VW Golf (medium class car).

Past level changes	Description
0 to 1 car (first car) **Category:** Household formation	**Events:** The respondent got married to his then partner and they bought a house together in rural Norfolk. **Consideration:** They knew that moving to a rural area would require them to also acquire a car in order to be able to get to work in Norwich. **Car ownership change:** They bought a car together as part of the decision to move to a rural location.
1 to 2 cars **Category:** Employment / home location	**Events:** The respondent was made redundant from his job in Norwich and found alternative employment in Bury St Edmonds. **Adaptation, consideration and a car access deficit:** He and his partner would no longer be able to car share to work and there were no adequate alternative transport options available to manage the 35 mile journey to Bury St Edmonds. **Car ownership change:** The respondent was urgently required to buy a second car.
2 to 1 car **Category:** Employment / home location	**Events:** The respondent got another job in Norwich. **Adaptation and a car access surplus:** This meant that he could return to car sharing with his wife. **Car ownership change:** The second car was sold as it was no longer required.
Current travel patterns	**Lifestyle preferences and residential self-selection:** The respondent has had one car ever since. He now lives with a new partner in central Bristol which he intentionally moved to in order to avoid the unwanted commute by car. He and his partner now cycle to work. The couple now use the car mainly for leisure activities: The respondent carries his bass equipment to two band practices a week and they leave Bristol on longer weekend excursions roughly twice a month on average.

Future expectation	**To replace his vehicle:** The respondent occasionally has a desire for something more powerful than his current Golf, but expects to keep his current car until it becomes unreliable. The car is not used that frequently now that he and his partner cycle to work.
Current status	**In a stable position**

Interview twelve:

This was an interview with a 40 year old male programme manager living with his wife and two young children (aged three and five) in their owned home in central Bristol. The family have one car: A VW Passat (large class car).

Past level changes	Description
0 to 1 car (first car) **Category:** Household dissolution	**Event:** The respondent split up with his then girlfriend who he had been living with. **Car access deficit and consideration:** He had previously had access to her car, and decided he needed a car of his own after they split up. **Car ownership change:** He acquired his first car which he initially used to commute between London and Bristol.
1 to 2 cars **Category:** New household	**Event:** The respondent moved in with his car owning partner, forming a two car household.
2 to 1 car **Category:** Child birth	**Events:** He and his now wife had a child. His wife reduced her working hours and income also reduced. **Adaptation and a car access imbalance:** The couple both had sports style cars at this point. They found carrying baby equipment in these cars to be inconvenient. **Consideration:** This led them to consider replacing their two sports cars with a single estate car. **Car ownership change:** Struggling with carrying baby equipment in a sports car whilst on a family holiday prompted the family to replace the two sports cars with a single estate car: A Suburu Impretza which retained the sports styling.
Replacements	**Consideration and a prompt for change:** They found the Suburu to be very expensive to run (insurance and maintenance). On receiving an insurance renewal notice, the couple decided to replace the car with their current VW Passat which would be cheaper to insure.
Current travel patterns	The household have had a single estate car ever since (currently a VW Passat). The respondent cycles to work and his wife is able to walk to her local school where she works part time (while bringing up children). The car is mainly used for leisure activities.

Future expectation	**To replace his vehicle:** The respondent would like a second sports car for leisure use, but does not expect to acquire one owing to income constraints and family obligations. He expects to replace the current car in a couple of years as it now has quite high mileage.
Current status	**In a stable position**

Interview thirteen:

This was an interview with male and female partners, both in their early 40s, living with their two daughters (12 and 14) in their own home in an outer-urban area of Bristol. The family have one car: A Nissan Almera Tino (medium class car).

Past level changes	Description
0 to 1 car (first car) **Category:** Independence	**Events:** The male partner's parents moved from Bristol to Exeter, leaving him with no access to the family car. He had moved into shared rented housing at this time and travelled to work by bus. **Car access deficit and consideration:** The male partner bought his first car as a young man after he had observed all of his friends getting cars of their own. He felt a greater need for transport independence of his own at this point. **Car ownership change:** He bought a first car of his own from a colleague at work.
Replacements	**Events:** He subsequently moved in with his now wife, forming a one car household together. They moved from central Bristol to outer Bristol. **Adaptation:** The couple took some time to adapt their travel patterns to the new location. Having established that the bus service was limited and that parking in the city centre was expensive, the male partner began cycling to work which subsequently became a routine travel pattern. **Consideration:** This has been a factor in the household consequently not requiring a second car which they have nevertheless considered in the past. **Event:** The couple also had children following the move to the new home. **Associated car ownership changes:** They have bought successively bigger cars as the family have got older e.g. Initially replacing a two door car with a four door car to make child care easier. They have also successively acquired cars with bigger engines.

Current travel patterns	**Evidence of travel behaviour self-selection:** The family are currently running the Nissan Almera Tino. The male partner now always makes sure he works within cycling distance of home. His office is presently situated near to Bristol Temple Meads rail station so he uses the rail link from Keynsham to Temple Meads as an alternative to cycling. The female partner has a short drive to work in a school in nearby Kingswood. The two children walk to school. The couple actively chose the local school, partly to avoid a longer commute to a reportedly better school.
Future expectation	**To gain a car in the longer term:** The family are content with their current car, although if money were no object they would like a camper van. They are considering acquiring a second car in the longer term for their daughters to learn to drive in.
Current status	**In a stable position**

Interview fourteen:

This was an interview with male and female partners in their late twenties. They have recently moved to Bristol and live in a rented flat in the city centre. They currently have one van (a Toyota Hiace) between them which they are converting into a camper van.

Past level changes	Description
0 to 1 car (first car) **Category:** Opportunism	**Opportunistic car ownership change:** The couple were living in Leeds in their early twenties while they completed their PhDs. They had no desire for a car and were not considering acquiring one. However, the female respondent was given a first car for free by her sister.
Replacements	**Access to the vehicle pool::** The couple have owned two older cars prior to buying the van. Both of these had been acquired opportunistically via the female respondent's family. She had also borrowed cars from her family for significant periods of time. On reflection the couple realised that the female partner's family (parents, sisters, cousins) collectively own a car pool which had enabled her to access cars cheaply either through transferring full ownership or via long term loans. **External contextual events:** In early 2008 they replaced their car with a van with the intention of converting it into a camper van so that they could travel around Europe. However, their plans changed with the onset of the recession as they were unable to draw enough equity from the house that they had bought in Leeds, to fund the trip.
Current travel patterns	**Residential self selection:** They now use the van mainly for longer distance weekend trips, visiting friends, family and camping. They intentionally moved to a central location in Bristol in order to avoid having to use the van for local transport. The male partner walks to his new job in Bristol. The female partner will be starting a new job in the coming months.
Future expectation	**A car access deficit – Gaining a second car:** The couple expect to keep the van, and are expecting to acquire a smaller additional car to manage shorter trips around town when they have enough money. The female partner may acquire a company car when she starts her new job in the coming months. They are currently in a transitional period having only just moved to Bristol and taken on new jobs following the completion of PhDs.
Category	**Planning for an expected life event** (starting a new job).

Interview fifteen:

This was an interview with male and female partners both in their early 40s. They live with their two young children (six and four) in central Bristol. They are both lecturers at the university. They do not currently have a car.

Past level changes	Description
0 to 1 car (first car) **Category:** Opportunism	**Opportunistic car ownership change:** The female respondent purchased her first car from her mother as a young woman while studying for a PhD. She and her husband lived together as a one car household until recently.
1 to 0 car **Category:** Employment / Home location change	**Events:** The couple married in 1992 and following some time spent in the USA returned to the UK for a life together in Leicester. At this time they had one car between them and car shared to work, a distance of five miles. **Lifestyle preferences and residential self selection:** When they relocated to Bristol, they intentionally sought a location in which they could both walk to work in order to avoid the commute. **Adaptation and a car access surplus:** The couple became accustomed to walking to work and to the local amenities close to their new home. Their reliance on the car reduced over this period. **Event and car ownership change:** Nine years after the move, their only car was vandalised and written off. **Consideration:** Weighing up the cost of running the car following the insurance settlement against the fact that their car was now rarely used, the couple decided against replacing it. **Adaptation and a car access deficit:** Since losing access to their car, the family have been finding new ways of managing the trips for which the car had been useful.
Current travel patterns	All family members walk to their respective schools and workplaces. This was the case even before the loss of their car. They now use buses, taxis and trains to replace trips that were previously undertaken by car.

Future expectation	**To remain car free unless their circumstances change:** The family have no intention of re-acquiring a car in the short term, but are still considering whether a car would be useful. The couple explained that they would consider re-acquiring a car if their employment circumstances or if a house move required them to.
Category	**Adapting to a change in car availability** (the loss of an only car).

Appendix E - Interview stated adaptation experiment

The stated adaptation experiment posed the scenario:

"Your household loses access to one car for two months. How would you manage the journeys that are normally completed using that car?"

The respondents were asked to consider how they might expect to manage this situation by either allocating former car trips to alternative modes or by making alternative arrangements (for example using the internet, or stopping certain activities). The alternative options were represented as equal segments on a circular chart and the respondents were allocated 10 tokens (each representing 10 percentage points of the former car trips) to show how those trips would be managed following the loss of the car. The intention was not to get an accurate modal split, but to use the experiment to elicit deliberative responses from the participants to gauge how dependent they perceived themselves to be on the lost car.

It is also noted that participants 15F/M had relinquished their car nine months previous to their interview and for consistency, they were similarly asked to consider how they had rearranged their lives, with reference to the same chart. This gave an impression of *revealed* adaptation to the loss of an only car and allowed some scope to analyse the contrast between the responses of actual car relinquishers and the speculative responses of the remaining participants. It should also be noted that other participants mentioned experience of albeit temporary loss of access to their cars, generally as a result of maintenance issues and this to some extent appeared to inform their responses (9M, 10M,13F/M).

The following paragraphs consider the participant's general responses with reference to particular ways of re-organising former car trips.

Car clubs

On the whole, there seemed to be a general lack of awareness surrounding car clubs, although participants 4F/M had considered joining one after they relinquished their second car. Those that understood the general concept were unsure about how it would work in practice (how far in advance do you have to book and so on). Others noted that it would be too much 'hassle' to join just for two months (given the expectation of having to pay start up fees, and inconvenience associated with adapting to the system). One participant (9M)

suggested that the whole process “fills [him] with horror”. Another (11M) commented that taxis would seem to serve one off car trips just as well as a car club. Finally, participant 2F recalled how a friend had had difficulty using a car club with young children, given the requirement to carry your own child seat (while accompanying children) to the car. She noted that this is a market that car clubs perhaps could never fully cater for (as car club cars could not all be equipped with child seats).

From a policy point of view, these findings may suggest that offering a no joining fee, trial membership for a short period of time may offer a means of overcoming such perceptions and boosting longer term membership and use. Especially given that a short term structural change (as presented in the proposed scenario) would appear to provide an excellent opportunity to break habits and begin to encourage alternative patterns of behaviour.

Car sharing

Two sets of participants (1F and 6F) from two car households stated that they would re-organise many of their trips around the remaining household car, although it took both of these households some deliberation to realise that this option was open to them. These participants viewed their cars as belonging to themselves as individuals rather than as household commodities.

Participant 9M, also from a two car household, admitted that he would immediately make arrangements to replace his own car, and knew that he would be able to permenantly borrow his sister’s second car in the short term - evidence of access to the car pool through social networks. Indeed four other households (2F, 3M, 13F/M, 14F/M) also realised that they would be able to borrow apparently underutilised cars from friends, neighbours, housemates or family members for a short period of time. On the other hand, participants 14F/M, having just moved to the area, noted that this option was not available to them, though they would have considered borrowing cars from friends or family in their previous home location. This highlights the importance of local social ties in providing access to the private vehicle pool.

The apparent prevalence of recognition that underutilised cars could be fairly easily borrowed was unexpected and indicates an avenue that would benefit from further research.

Taking lifts

Taking lifts was mentioned as an option if participants were confident that they knew people locally that could serve specific, routine trips easily. That is people living in a similar area, travelling to the same destination, probably to take part in the same activity e.g. travelling to work or to an evening leisure pursuit (playing in a band). One participant (5F) mentioned that she would be happy to ask for lifts, given that being without her own car would only be a temporary state, and she would be able to "reciprocate" in future. Not wanting to appear to be a burden on others was an important consideration for this participant (hence creating some pressure to own her own car).

Along similar lines, participants 4F/M suggested that having a small child precluded them from taking lifts.

Public transport

Buses were frequently expected to substitute for some local trips. Others perceived the bus as not being a viable option to replace car trips, either because they lived in a location where walking would be easier than getting the bus, because they had a particularly anti-bus attitude (which may have been amplified by experience or growing up with a particular set of family norms) or because they expected to be able to borrow someone else's car.

Rail was typically noted as the expected means of replacing longer weekend leisure journeys. A few participants would consider hiring a car at weekends for destinations or activities that could not easily be reached by rail. Several participants suggested that given that they would only be without a car for two months, such trips would be delayed until the car had been replaced (or friends and family would be encouraged to visit them rather than the other way around).

Walking and cycling

Some participants explained that the car is not used for trips that could be undertaken by foot or by bike i.e. they do as much walking and cycling as they can anyway and so there would be no additional transfer onto walking and cycling. Others admitted that they may be forced to walk or cycle more if their car was no longer available to them. Clearly what is perceived to be an achievable walking or cycling trip varies by person. Participant 3M suggested that he would consider buying a bike if he was without a car for a period of time.

Changing or stopping activities

Only one participant (1F) felt that the loss of her car would require her to stop or at least significantly re-arrange her work activities. She undertakes a long commute from Reading to Bristol on one or two days per week and, since she requires flexible, non specific working hours on those days, she is unable to book cheap rail tickets in advance and hence requires access to a car. After some deliberation she realised that the most likely solution would be to reduce the number of days that she travels to Bristol, by organising meetings more intensively on those days. She would then be able to use her partner's car on the fewer days each month that she would be required to travel to Bristol.

Nine of the participants felt that the loss of one car would hardly restrict their activity patterns (placing one token or less on this segment). People expected that it would impact on their ability to spontaneously travel longer distances at the weekend and stated that they would probably just choose a more local activity. Given that this would only be for a two month period, curtailing some activities was not perceived to be a great inconvenience.

These perceptions are in contrast to the revealed adaptation described by participants 15F/M whom had relinquished their only car nine months previously. Again they felt that not having a car had not overtly restricted the activities that they take part in (placing just half a token on that segment). This in some respects contradicted their verbal responses: The female partner admitted to initially feeling *"very much more limited"* and noted that to start with they had curtailed spontaneous activities like *"just go[ing] to the zoo for half an hour".*

However, she describes how their thought process has changed from "*Lets do this, oh we can't, we can't get there."* to *"Let's do this, how are we going to get there?".* This suggests that following the loss of one car, there is a period in which certain activities are curtailed, but these are reinstated when new ways of travelling have been explored and adopted.

"To be honest, that was sort of acutely we stopped doing things. But actually we've picked that up again".

15F

Internet

Perhaps surprisingly, only three participants said that they would use the internet more (placing one token on this segment) if they lost access to one of their cars, predominantly for e-shopping. However, the car relinquishers (15F/M) described how they do *"a lot more internet shopping"* and estimated that this had substituted for 20 per cent of their car use. This may suggest that the participants with one car had underestimated the level of inconvenience associated with shopping or needing to carry bulky objects without a car.

Taxis

Taxis were frequently mentioned as being too expensive to use in Bristol. However, again the car relinquishers (15F/M) mentioned that they can justify spending money on a taxi, now that they no longer have to fund the running of their own car. Perhaps the temporary nature of the car loss presented in the scenario influenced responses with respect to travel by taxi i.e. respondents were expecting to move back into car ownership after the two month period and so would continue to require a budget to service their car ownership requirements.

Appendix F - Material used in the neighbourhood survey

Survey Pre-call Postcard

Telling us your thoughts about transport

The University of the West of England are currently carrying out some research to help understand people's every day transport needs.

As part of the study, I'll be calling at your home in the next few days to ask if you'd be willing to fill in a questionnaire.

The questionnaire takes around 20 minutes and as a thank you for your time, you would receive a £10 gift voucher.

Your help with the study would be really appreciated and I look forward to meeting you in the next few days.

Best wishes,

Ben Clark
ben4.clark@uwe.ac.uk

UWE BRISTOL
University of the West of England

Survey Questionnaire

University of the West of England
BRISTOL

Collection Date.....At.....

Your thoughts about transport and your car ownership needs

What is this questionnaire about?

This questionnaire is to help us find out about your day to day travel and how this relates to your household's car or van ownership needs.

The questionnaire is relevant to you whether or not you own or have access to a car or van.

Who should fill it in and how long will it take?

It should be filled in by an adult member of your household and should take around 20 minutes to complete. Hopefully you'll find it to be an interesting review of your daily travel needs.

How will my time be rewarded?

As a thank you for returning a fully completed questionnaire, you will receive a £10 Sainsbury's gift voucher.

How will the information I provide be used?

The survey is part of a 3 year research project taking place at the University of the West of England. The study is helping to increase understanding of the role of cars and vans for different groups in the population.

Any information you provide will be used confidentially and for our research purposes only.

How will I find out more about the results?

After the survey, to keep you up to date with how the study progresses, we will send you a short summary of the main findings for your area.

Who can I contact if I have any questions about the survey?

If you have any queries, please feel free to contact Ben Clark at the Centre for Transport and Society, UWE on 0117 32 83890 or email ben4.clark@uwe.ac.uk.

Please sign in the box below to confirm that you agree to your questionnaire responses being used in the study:

We very much appreciate your time and input in helping us with this important research and we look forward to receiving your questionnaire.

Ben Clark

ABOUT THE CARS AVAILABLE TO YOUR HOUSEHOLD

Throughout the questionnaire we will be asking questions about the household you live in. By household we mean you and any other people you live with.

We would like you to answer questions on behalf of the whole household.

1. **How many cars or vans are owned, or available for use by one or more members of your household?** (please tick only one box)
   Include vehicles owned by the household and company or lease cars / vans.

   ☐ 1
   ☐ 2
   ☐ 3
   ☐ 4 or more, please write in number: ....
   ☐ 0 → **1a. (If 0) Have you or others in your household ever owned a car or van?** (Include company or lease cars / vans)
   ☐ Yes **(go to question 4)**
   ☐ No **(go to question 4)**

2. **Please describe the cars / vans that are available in your household:** Include company or lease cars / vans.

Vehicle description (e.g. make / model)	When did you get the car /van?				
	in the last year	between 1-3 yrs ago	between 3-5 yrs ago	over 5 yrs ago	tick here if company car
Example: Peugeot 206 →	☐	☒	☐	☐ →	☐
1. →	☐	☐	☐	☐ →	☐
2. →	☐	☐	☐	☐ →	☐
3. →	☐	☐	☐	☐ →	☐
4. →	☐	☐	☐	☐ →	☐

Please turn over

3. **Please indicate how often each of your household's cars or vans is used for different journey types. Complete for <u>every vehicle</u> in your household:**

3a. Vehicle 1. Please write make and model: ☐

Is used for:	Most days or more	A few times a week	Once or twice a week	A few times a month	Less than that	Never
Shopping (please tick one box)	☐	☐	☐	☐	☐	☐
Work (please tick one box)	☐	☐	☐	☐	☐	☐
Leisure (please tick one box)	☐	☐	☐	☐	☐	☐

↓

3b. Vehicle 2 if you do not have two vehicles, tick here: ☐ and move onto question 4

Please write make and model: ☐

Is used for:	Most days or more	A few times a week	Once or twice a week	A few times a month	Less than that	Never
Shopping (please tick one box)	☐	☐	☐	☐	☐	☐
Work (please tick one box)	☐	☐	☐	☐	☐	☐
Leisure (please tick one box)	☐	☐	☐	☐	☐	☐

↓

3c. Vehicle 3 if you do not have three vehicles, tick here ☐ and move onto question 4

Please write make and model: ☐

Is used for:	Most days or more	A few times a week	Once or twice a week	A few times a month	Less than that	Never
Shopping (please tick one box)	☐	☐	☐	☐	☐	☐
Work (please tick one box)	☐	☐	☐	☐	☐	☐
Leisure (please tick one box)	☐	☐	☐	☐	☐	☐

↓

3d. Vehicle 4 if you do not have four vehicles, tick here ☐ and move onto question 4

Please write make and model: ☐

Is used for:	Most days or more	A few times a week	Once or twice a week	A few times a month	Less than that	Never
Shopping (please tick one box)	☐	☐	☐	☐	☐	☐
Work (please tick one box)	☐	☐	☐	☐	☐	☐
Leisure (please tick one box)	☐	☐	☐	☐	☐	☐

4. **Thinking about how people in your household travel on a day to day basis, please indicate which of the following statements your household is closest to:** (please tick only one box)

- ☐ it often feels like we have too few cars or vans for our needs
- ☐ it sometimes feels like we have too few cars or vans for our needs
- ☐ it often feels like we have too many cars or vans for our needs
- ☐ it sometimes feels like we have too many cars or vans for our needs
- ☐ we have just the right number of cars or vans for our needs

5. **Please indicate how much you have thought about whether you have the right number of cars / vans for your needs:** (please tick only one box)

- ☐ I hadn't really thought about it
- ☐ I sometimes think about it
- ☐ I am very conscious about it

6. **How many motorcycles or mopeds are owned or available for use by one or more members of your household?** (please tick only one box)

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3 or more

7. **Do any adults of driving age in the household own a monthly or yearly public transport season ticket?** (please tick only one box)

- ☐ Yes Please specify .....
- ☐ No

8. **Do you or other people in your household regularly cycle for reasons other than leisure (once a week or more)?** (please tick only one box)

- ☐ Yes
- ☐ No

THINKING ABOUT PAST CAR OWNERSHIP CHANGES

We would now like to find out whether the household you live in has ever undergone a car or van ownership change (including those involving company or lease cars).

We would like you to complete this section even if you do not have access to a car or van.

We know that car ownership decisions can sometimes be made jointly in some households - families or couples living together for example.

So, in the following section we need to know how long you have been living either as an independent adult, or with your partner, as we are only interested in car or van ownership changes that have occurred during this period.

To remind you, please remember to answer for your current household, rather than for yourself.

9. Do you live with a partner? (please tick only one box)

☐ Yes → **9a. (If Yes) Approximately how long have you lived with your current partner?** Please specify the length of time (and not your age or a date) in the box: .....yrs /..... mnths

(please now go to question 10)

☐ No

9b. (If No) Approximately how long have you lived (as an adult) with this arrangement? Please specify the length of time (and not your age or a date) in the box below:

.....yrs /..... mnths **(please now go to question 10)**

10. At the start of this period, how many cars or vans were owned by your current household (including company or lease cars)? (please tick only one box)

☐ 0
☐ 1
☐ 2
☐ 3
☐ 4 or more, please write in number: ....

11. During this period, please indicate which statement best describes your current household's last car or van ownership change (including those involving company or lease cars)? (please tick only one box)

During this period my current household:

last got an extra car / van - the number of vehicles available increased by 1	☐ → **go to question 13**
last lost a car / van - the number of vehicles available reduced by 1	☐ → **go to question 13**
last replaced a car / van - the number of vehicles available stayed the same	☐ → **go to question 12**
has not made a change – not got an extra, not lost, not replaced a car / van	☐ → **go to question 17**
other (please specify)	☐ → **go to question 12**

12. **(If replaced or other) Have there been any changes in the number of cars / vans owned by your household (including company or lease cars), during the period of time stated in your answer to question 9?** (please tick only one box)

- ☐ Yes
- ☐ No **(go to question 17)**

13. **Which of these statements best describes the last change in the number of cars / vans owned or available to your household?** (please tick only one box)

- ☐ A change from 0 to 1 cars / vans
- ☐ A change from 1 to 0 cars / vans
- ☐ A change from 1 to 2 cars / vans
- ☐ A change from 2 to 1 cars / vans
- ☐ A change from 2 to 3 cars / vans
- ☐ A change from 3 to 2 cars / vans
- ☐ Other (please specify) .....

14. **Approximately when did this last change in the number of cars / vans owned or available to your household occur?**

month		year			
m	m	y	y	y	y

15. **Would you say that this change in the number of cars / vans owned or available to your household was related to any other specific events that were happening in your lives?** For example someone changing jobs, moving house, having a baby, getting married, retiring, learning to drive. (please tick only one box)

- ☐ Yes
- ☐ No

16. **Please briefly explain why the number of cars / vans owned or available to your household changed at this time:**

Perhaps take some time to think carefully about what prompted the change. If applicable, please note the relevant events that were going on at the time.

.....

.....

.....

.....

.....

Go to question 17

THE NUMBER OF CARS THAT YOU OWN AND WHERE YOU LIVE

17. Approximately how long have you lived in the Bristol area?

.....

18. Approximately when did you move to the Bishopston area?

month		year			
m	m	y	y	y	y

19. Approximately when did you move to your present address?

month		year			
m	m	y	y	y	y

20. Was there a change in the number of cars / vans owned or available to your household (including company or lease cars) during the 12 month period before or after the move to the Bishopston area? (please tick only one box)

- ☐ Yes
- ☐ No **(go to question 26)**

21. (If Yes) Did you tell us about this particular change in the number of cars / vans owned or available to your household in the previous section? (please tick only one box)

- ☐ Yes **(go to question 26)**
- ☐ No

22. (If No) Which of these statements best describes this particular change in the number of cars / vans owned or available to your household? (please tick only one box)

- ☐ A change from 0 to 1 cars / vans
- ☐ A change from 1 to 0 cars / vans
- ☐ A change from 1 to 2 cars / vans
- ☐ A change from 2 to 1 cars / vans
- ☐ A change from 2 to 3 cars / vans
- ☐ A change from 3 to 2 cars / vans
- ☐ Other (please specify) .....

23. When did this particular change in the number of cars / vans owned or available to your household occur?

month		year			
m	m	y	y	y	y

Go to question 26

24. **Would you say that this particular change in the number of cars / vans owned or available to your household was related to moving to the Bishopston area?** (please tick only one box)

- ☐ Yes
- ☐ No

25. **Please briefly explain why the number of cars / vans owned or available to your household changed around the time of the move:**

Perhaps take some time to think carefully about what prompted the change. If applicable, please note any other relevant events that were going on at the time. For example someone changing jobs, moving house, having a baby, getting married, retiring, learning to drive.

.....

.....

.....

.....

.....

26. **To what extent do you agree or disagree with this statement: "Living in Bishopston has an influence on the number of cars my household needs"** (please tick only one box)

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree
- ☐ No opinion

27. **To what extent do you agree or disagree with this statement: "Travel issues (e.g. getting to work / shops / parking) were an important consideration when choosing to move to Bishopston"** (please tick only one box)

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree
- ☐ No opinion

28. **Do you own or rent the accommodation that you live in?** (please tick only one box)

- ☐ Own outright
- ☐ Own with a mortgage or loan
- ☐ Pay part rent and part mortgage (shared ownership)
- ☐ Rent
- ☐ Live here rent free

THINKING ABOUT FUTURE CAR OWNERSHIP CHANGES

29. **When would you expect your household to next make a car or van ownership change? Think about when your household might next replace a vehicle, get an extra vehicle or get rid of a vehicle.** (please tick only one box).

- ☐ In the next 6 months
- ☐ Between 6 and 12 months
- ☐ Between 1 and 2 years time
- ☐ In more than 2 years time
- ☐ Never **(go to question 34)**
- ☐ I don't know

30. **Which of these car or van ownership changes is most likely to happen to your household next?** (please tick only one box)

- ☐ A car / van replacement
- ☐ An increase in the number of cars / vans available to your household
- ☐ A decrease in the number of cars / vans available to your household

31. **Would you expect this next change to be related to any specific events that might happen or might already have happened in your lives?**

For example, someone changing jobs, moving house, having a baby, getting married, retiring, learning to drive. (please tick only one box)

- ☐ Yes
- ☐ No

Go to question 34

32. **Please indicate the extent to which you have considered or not yet considered making your next car or van ownership change:** (please circle only one number)

1= not really considered it yet | 1 | 2 | 3 | 4 | 5 | 5 = seriously considering it now

33. **Please explain why you might expect the next car or van ownership change to happen**

If applicable, please write down the options you might have in mind (e.g. "We might replace our car, but we might also get rid of it all together"). Also think about what might prompt you to make a change – For instance note down any relevant events that might happen to you such as a job change:

.....

.....

.....

.....

.....

.....

34. Thinking about everyone in your household (including children), please indicate how often you and the people you live with use the following ways of travelling: (please tick one box on every line)

someone in my house will...	Most days or more	A few times a week	Once or twice a week	A few times a month	Less than that	Never
use one of the household cars or vans tick if no car: ☐	☐	☐	☐	☐	☐	☐
walk (for reasons other than leisure)	☐	☐	☐	☐	☐	☐
cycle (for reasons other than leisure)	☐	☐	☐	☐	☐	☐
travel by bus	☐	☐	☐	☐	☐	☐
travel by train	☐	☐	☐	☐	☐	☐
use a taxi	☐	☐	☐	☐	☐	☐
take a lift (from people living outside your household)	☐	☐	☐	☐	☐	☐
use a car club	☐	☐	☐	☐	☐	☐
use a hire car	☐	☐	☐	☐	☐	☐
other (please specify)	☐	☐	☐	☐	☐	☐

please tick one box on every line

35. Which of these statements best describes whether your household could permanently manage with 1 less car / van? (please tick only one box).

☐ I / we do not have a car / van **(go to question 37)**

permanently living with 1 less car / van would be...

☐ no problem

☐ possible, but sometimes inconvenient

☐ possible, but often inconvenient

☐ impossible **(go to question 37)**

Go to question 37

36. Thinking carefully, please indicate how your household's travel patterns might change if you had 1 less car / van. Read all of the options through first and then perhaps consider how you would have managed over the last month. (please tick one box on every line).

We would.....	a lot more	a little more	no change
use the internet (work from home, e-shopping) tick here if NA: ☐	☐	☐	☐
walk	☐	☐	☐
cycle	☐	☐	☐
travel by bus	☐	☐	☐
travel by train	☐	☐	☐
use taxis	☐	☐	☐
share another household car tick here if NA: ☐	☐	☐	☐
take lifts (from people living outside your household)	☐	☐	☐
use a car club	☐	☐	☐
organise hire cars	☐	☐	☐
other (please specify)	☐	☐	☐

please tick one box on every line

SOME FINAL QUESTIONS ABOUT YOUR HOUSEHOLD

37. Which of these best describes the type of household that you live in? (please tick only one box)

- ☐ Couple
- ☐ Parent(s) or guardian(s) with children
- ☐ Other (please specify) .....

38. Please tell us about who lives in your household, <u>including children</u>, starting with yourself:

please include children

Person	Gender		Age	Driving license holder		Employment status: child	full time employed	part time employed	unemployed	retired	full time student	looking after family or home	other (specify)
Example	☐ m	☒ f	35	☒ Y	☐ N	☐	☒	☐	☐	☐	☐	☐	
Yourself	☐ m	☐ f		☐ Y	☐ N	☐	☐	☐	☐	☐	☐	☐	
2	☐ m	☐ f		☐ Y	☐ N	☐	☐	☐	☐	☐	☐	☐	
3	☐ m	☐ f		☐ Y	☐ N	☐	☐	☐	☐	☐	☐	☐	
4	☐ m	☐ f		☐ Y	☐ N	☐	☐	☐	☐	☐	☐	☐	
5	☐ m	☐ f		☐ Y	☐ N	☐	☐	☐	☐	☐	☐	☐	
6	☐ m	☐ f		☐ Y	☐ N	☐	☐	☐	☐	☐	☐	☐	
7	☐ m	☐ f		☐ Y	☐ N	☐	☐	☐	☐	☐	☐	☐	
8	☐ m	☐ f		☐ Y	☐ N	☐	☐	☐	☐	☐	☐	☐	

39. Please select the highest level of education completed by any member of your household: (please tick only one box).

- ☐ Compulsory up to 16
- ☐ O-level or GCSE-grade
- ☐ A-level
- ☐ Vocational training (e.g. NVQ, HNC, HND)
- ☐ Degree (e.g. BA, BSc)
- ☐ Post-graduate qualification (e.g. MA, PhD, PGCE)
- ☐ Other (please specify) .....

40. What is the approximate annual income of your household (before tax)? (please tick only one box)

- ☐ Less than £15,000
- ☐ £15,001 - £30,000
- ☐ £30,001 - £50,000
- ☐ £50,001 - £70,000
- ☐ £70,001 - £100,000
- ☐ Over £100,000
- ☐ I do not know
- ☐ I would prefer not to say

To check that we have correctly understood your answers, we would very much like to follow up the questionnaire with a brief (5-10 minute) telephone call.

We are keen to talk to as many people as possible and as a thank you for your extra time on the phone you would be entered into a prize draw for **£350** (as well as receiving your £10 gift voucher).

41. Could we contact you to take part in a short follow up phone call? (please tick only one box)

- ☐ Yes
- ☐ No

42. Please indicate your preferred time for us to phone you for the follow up discussion. You can tick more than one box:

- ☐ weekday daytime time preference (optional) .....
- ☐ weekday evening time preference (optional) .....
- ☐ weekend daytime time preference (optional) .....
- ☐ weekend evening time preference (optional) .....
- ☐ Anytime

Please turn over

To receive your £10 gift voucher and / or to take part in the follow up phone call, please fill out your contact details below. We will treat these details confidentially, using them only for our research and to send you the £10 gift voucher. We will not pass your contact details on to anyone else according to the **Data Protection Act 1998**.

Please use BLOCK CAPITALS

Name .....

Phone number .....

House number / street .....

City / town .....

Post code .....

Email address .....

43. Please indicate what mainly motivated you to complete and return this questionnaire: (please tick only one box)

- ☐ £10 voucher
- ☐ Prize draw
- ☐ Enjoy completing surveys
- ☐ Interest in the topic
- ☐ Other (please specify) .....

Thank you very much for completing our questionnaire!

Survey Interviewer Led Questions

Introduction

My name is Ben Clark, and I'm a researcher at the University of the West of England. You might recall recently returning a questionnaire on your day-to-day travel and your car ownership needs.

First of all, thank you very much for taking the time to complete the questionnaire. It is very much appreciated.

You indicated on your form that you would be happy to take part in a follow up discussion, is that still the case?

Is now a convenient time? It should take around 5-10 minutes.

That's great. The purpose of the discussion is to clarify that I correctly understand your questionnaire answers. I won't be recording the phone call, but I would like to make some notes while we talk. All of the information will be anonymously processed. Is that OK?

- If there are any questions that you prefer not to answer, please just let me know.
- You can stop the discussion at any stage if you wish.
- You can also contact me and withdraw your information from the study at any time.
- Are you happy to go ahead [gaining consent]?
- Do you have any questions before we begin?

First of all I'd like to check just a couple of answers on your questionnaire

Question error	Done

Next, I'd like to get a bit more information about your household's car ownership history than I could capture through the questionnaire:

You have lived together / on your own for:					
At the start of this period you had					cars / vans
Now you have					cars / vans
During this period you	*have*	*have not*	changed the number of cars available		
If changed number of cars					
The last time, you changed from			to		cars / vans
This happened because:					

Have there been any other changes to the number of cars available to your household since you have been living together / on your own?				
Yes	*No*			
This happened because:				
Thinking about the future, you said you were most likely to:				
replace	*increase*	*reduce*		
This next change is likely to happen because:				
Car access imbalance indicated on the questionnaire:		*too many*	*just right*	*too few*
You said it would be	*possible*	*impossible*	to live with 1 fewer car	
Could you just give me a quick idea of what you use the car(s) for now?				

Lastly you said you	*agreed*	*disagreed*	with the statement
“living in [neighbourhood] has an influence on the number of cars that my household needs”			
Can you explain why (If disagreed what are the main things you need the car for?)			

Thank you very much for your time. You should have received your £10 gift voucher and I’ll enter you into the prize draw too.

Appendix G - Survey household categorisation schema

Decision Making Unit	Household structure	Life stage
one household head	single occupancy	single occupancy <35
		single occupancy 35-65
		single occupancy 65+
	lone parents with children	single parent children<5
		single parent children 5-11
		single parent children 12-15
		single parent children 16+
		single parent children age unknown
	shared housing	shared housing students
		shared housing <35
		shared housing adults
two household heads	couple	couple <35
		couple 35-65
		couple 65+
	parents with children	both parents children<5
		both parents children 5-11
		both parents children 12-15
		both parents children 16+
		both parents children age unknown
other	other	other
Notes: Informed by (Jones et al, 1983)		

Supporting statistics for section 5.9

Table H-1: Income by neighbourhood

Income		Bishopston	Bradley Stoke	Total
less than £15,000	Count	11	6	17
	Expected Count	8.9	8.1	17.0
	% within neighb.	11.8%	7.1%	9.6%
£15,001-£30,000	Count	20	23	43
	Expected Count	22.5	20.5	43.0
	% within neighb.	21.5%	27.1%	24.2%
£30,001-£50,000	Count	17	32	49
	Expected Count	25.6	23.4	49.0
	% within neighb.	18.3%	37.6%	27.5%
£50,001-£70,000	Count	16	9	25
	Expected Count	13.1	11.9	25.0
	% within neighb.	17.2%	10.6%	14.0%
£70,001-£100,000	Count	16	1	17
	Expected Count	8.9	8.1	17.0
	% within neighb.	17.2%	1.2%	9.6%
over £100,000	Count	2	0	2
	Expected Count	1.0	1.0	2.0
	% within neighb.	2.2%	.0%	1.1%
don’t know	Count	1	4	5
	Expected Count	2.6	2.4	5.0
	% within neighb.	1.1%	4.7%	2.8%
prefer not to say	Count	10	10	20
	Expected Count	10.4	9.6	20.0
	% within neighb.	10.8%	11.8%	11.2%
Total	Count	93	85	178
	% within neighb.	100.0%	100.0%	100.0%

$\chi^2 = 24.958$; df = 7; p=0.001

4 cells (25.0%) have expected count less than 5. The minimum expected count is 0.96

Table H-2: Highest level of educational attainment by neighbourhood

Education		Bishopston	Bradley Stoke	Total
compulsory	Count	2	5	7
	Expected Count	3.7	3.3	7.0
	% within neighb.	2.1%	6.0%	3.9%
GCSE	Count	2	10	12
	Expected Count	6.4	5.6	12.0
	% within neighb.	2.1%	11.9%	6.7%
'A' level	Count	7	7	14
	Expected Count	7.4	6.6	14.0
	% within neighb.	7.4%	8.3%	7.8%
vocational	Count	4	23	27
	Expected Count	14.3	12.7	27.0
	% within neighb.	4.2%	27.4%	15.1%
degree	Count	32	18	50
	Expected Count	26.5	23.5	50.0
	% within neighb.	33.7%	21.4%	27.9%
post grad	Count	44	17	61
	Expected Count	32.4	28.6	61.0
	% within neighb.	46.3%	20.2%	34.1%
other	Count	4	4	8
	Expected Count	4.2	3.8	8.0
	% within neighb.	4.2%	4.8%	4.5%
Total	Count	95	84	179
	% within neighb.	100.0%	100.0%	100.0%

$\chi^2 = 35.318$; df = 6; p<0.000

4 cells (28.6%) have expected count less than 5. The minimum expected count is 3.28.

Table H-3: Tenure by neighbourhood

Tenure		Bishopston	Bradley Stoke	Total
own outright	Count	34	3	37
	Expected Count	19.3	17.7	37.0
	% within neighb.	35.4%	3.4%	20.1%
own with a mortgage	Count	50	44	94
	Expected Count	49.0	45.0	94.0
	% within neighb.	52.1%	50.0%	51.1%
rent	Count	11	41	52
	Expected Count	27.1	24.9	52.0
	% within neighb.	11.5%	46.6%	28.3%
rent free	Count	1	0	1
	Expected Count	0.5	0.5	1.0
	% within neighb.	1.0%	.0%	.5%
Total	Count	96	88	184
	% within neighb.	100.0%	100.0%	100.0%

$\chi^2 = 44.4$; df = 3; p<0.000

2 cells (25.0%) have expected count less than 5. The minimum expected count is 0.48.

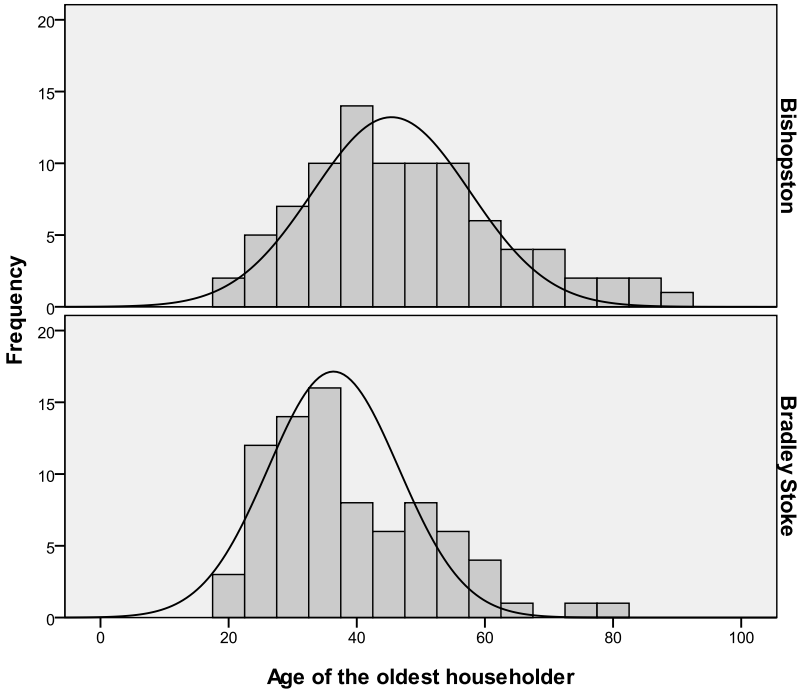


Figure H-1: Distribution of ages of the oldest householder by neighbourhood

Table H-4: Household structure by neighbourhood

Household structure		Bishopston	Bradley Stoke	Total
couple	Count	16	22	38
	Expected Count	19.8	18.2	38.0
	% within neighb.	16.7%	25.0%	20.7%
parents with children	Count	46	27	73
	Expected Count	38.1	34.9	73.0
	% within neighb.	47.9%	30.7%	39.7%
other	Count	4	2	6
	Expected Count	3.1	2.9	6.0
	% within neighb.	4.2%	2.3%	3.3%
single occupancy	Count	15	23	38
	Expected Count	19.8	18.2	38.0
	% within neighb.	15.6%	26.1%	20.7%
shared housing	Count	9	1	10
	Expected Count	5.2	4.8	10.0
	% within neighb.	9.4%	1.1%	5.4%
single parent with children	Count	6	13	19
	Expected Count	9.9	9.1	19.0
	% within neighb.	6.3%	14.8%	10.3%
Total	Count	96	88	184
	% within neighb.	100.0%	100.0%	100.0%

$\chi^2 =$ 16.907; df = 5; p=0.005

3 cells (25.0%) have expected count less than 5. The minimum expected count is 2.87.

Supporting statistics for section 6.4

Table H-5: Mean characteristics of car ownership pathway groups

Pathway type (No. of cars)		Age of the oldest householder (years)	Duration of the household unit (months)	Car use intensity	Income ranking	No. of householders	No. of driving license holders
0 to 0	Mean	37.17	82.42	0.00	2.17	1.54	0.38
	N	12	12	13	12	13	13
	SD	19.75	102.19	0.00	1.95	0.78	0.506
0 to 1 to 0	Mean	43.00	288.00	0.00	2.00	1.00	1.00
	N	1	1	1	1	1	1
	SD	.	.	.	.	.	.
1 to 0	Mean	63.40	149.20	0.00	1.50	1.40	0.60
	N	5	5	5	4	5	5
	SD	14.01	78.43	0.00	0.58	0.89	0.89
0 to 1	Mean	41.89	222.90	0.62	4.05	2.29	1.48
	N	19	21	21	21	21	21
	SD	16.24	196.43	0.19	2.16	1.23	0.51
1 to 1	Mean	42.56	86.80	0.72	2.95	2.09	1.23
	N	54	54	57	55	57	57
	SD	15.57	82.23	0.13	1.70	1.11	0.46
2 to 1	Mean	41.55	117.90	0.63	4.27	2.77	1.64
	N	20	20	22	22	22	22
	SD	11.66	91.69	0.17	2.29	1.38	0.49
1 to 2 to 1	Mean	55.50	193.50	0.78	4.00	2.75	2.00
	N	4	4	4	3	4	4
	SD	14.01	134.20	0.22	3.46	0.96	0.00
0 to 1 to 2	Mean	55.33	334.33	0.51	4.00	3.67	2.00
	N	3	3	3	3	3	3
	SD	17.90	203.81	0.10	1.73	1.53	0.00
1 to 2	Mean	41.47	147.56	0.62	4.06	3.22	2.11
	N	17	18	18	18	18	18
	SD	9.38	126.13	0.19	1.83	1.11	0.32
2 to 2	Mean	42.41	128.60	0.68	4.28	2.85	2.00
	N	22	25	22	25	26	26
	SD	12.64	112.91	0.16	1.97	1.01	0.28
2 to 1 to 2	Mean	69.00	220.00	0.45	3.50	3.50	2.00
	N	1	2	2	2	2	2
	SD	.	147.08	0.12	0.71	0.71	0.00
x to 3+	Mean	48.09	181.75	0.56	4.67	3.92	2.83
	N	11	12	10	12	12	12
	SD	9.93	102.61	0.17	1.92	0.90	0.94
Total	Mean	43.52	135.69	0.59	3.61	2.52	1.57
	N	169	177	178	178	184	184
	SD	14.81	126.33	0.26	2.04	1.25	0.75

Table H-6: Car ownership pathways by neighbourhood

Pathway type (No. of cars)		Bishopston	Bradley Stoke	Total
0 to 0	No. of households	7	6	13
	% within pathway type	53.8%	46.2%	100.0%
	% within neighbourhood	7.3%	6.8%	7.1%
0 to 1 to 0	No. of households	1	0	1
	% within pathway type	100.0%	0.0%	100.0%
	% within neighbourhood	1.0%	0.0%	0.5%
1 to 0	No. of households	4	1	5
	% within pathway type	80.0%	20.0%	100.0%
	% within neighbourhood	4.2%	1.1%	2.7%
0 to 1	No. of households	13	8	21
	% within pathway type	61.9%	38.1%	100.0%
	% within neighbourhood	13.5%	9.1%	11.4%
1 to 1	No. of households	20	37	57
	% within pathway type	35.1%	64.9%	100.0%
	% within neighbourhood	20.8%	42.0%	31.0%
2 to 1	No. of households	14	8	22
	% within pathway type	63.6%	36.4%	100.0%
	% within neighbourhood	14.6%	9.1%	12.0%
1 to 2 to 1	No. of households	3	1	4
	% within pathway type	75.0%	25.0%	100.0%
	% within neighbourhood	3.1%	1.1%	2.2%
0 to 1 to 2	No. of households	2	1	3
	% within pathway type	66.7%	33.3%	100.0%
	% within neighbourhood	2.1%	1.1%	1.6%
1 to 2	No. of households	10	8	18
	% within pathway type	55.6%	44.4%	100.0%
	% within neighbourhood	10.4%	9.1%	9.8%
2 to 2	No. of households	14	12	26
	% within pathway type	53.8%	46.2%	100.0%
	% within neighbourhood	14.6%	13.6%	14.1%
2 to 1 to 2	No. of households	2	0	2
	% within pathway type	100.0%	0.0%	100.0%
	% within neighbourhood	2.1%	0.0%	1.1%
x to 3+	No. of households	6	6	12
	% within pathway type	50.0%	50.0%	100.0%
	% within neighbourhood	6.3%	6.8%	6.5%
Total	No. of households	96	88	184
	% within pathway type	52.2%	47.8%	100.0%
	% within neighbourhood	100.0%	100.0%	100.0%

Appendix I - Neighbourhood car ownership churn calculation

This appendix presents an estimation of how net changes in the aggregate car ownership levels in Bishopston and Bradley Stoke since the 2001 census, arose from individual changes occurring at the household level. It supports the analysis presented in chapter 6, section 6.3.

A net change in neighbourhood car ownership level since the 2001 census must arise from a combination of households moving into and out of the neighbourhood after the census (bringing and taking cars with them respectively), and households remaining in the neighbourhood changing car ownership level (Box I-1):

Box I-1: Calculation of neighbourhood car ownership churn

Net change in neighbourhood car ownership level since the census =

+ Cars brought into the neighbourhood by households moving in after the census [A]

- Cars removed from the neighbourhood by households moving out after the census [B]

+ Net change in number of cars owned since the census (households that moved in before the census) [C]

+ Net change in number of cars owned since the census (households that moved in after the census) [D]

Calculation assumptions

The 2010 survey did not achieve a response from every household in the two output areas. There are consequently fewer responses in the 2010 survey than there were in the 2001 census.

In order to approximate how the aggregate car ownership level has changed, the average car ownership rate from the 2001 census for each output area has been used to estimate how many cars would have been present in 2001 across the smaller number of households surveyed in 2010.

For example, 83 households were surveyed in Bishopston in 2010 which together owned 113 cars. The average car ownership rate from the 2001 census for Bishopston was 1.27 cars per household. Thus it has been assumed that the 83

households would have collectively owned 1.27 x 83 = 105 cars in 2001 and there has subsequently been a net increase of eight cars across these households.

This assumes that the survey households are fully representative of the output area. This is a limited assumption as it does not account for possible response biases; for instance, the possibility that there were lower response rates amongst single occupancy and / or non-car owning households in the 2010 survey.

Nevertheless the assumption has enabled a useful approximation of how net changes in car ownership at the aggregate neighbourhood level might have arisen as a result of individual changes (arising from house moves and car ownership changes) occurring at the disaggregate, household level.

Bishopston

83 of the 96 questionnaire responses from Bishopston contained information about whether and how the household car ownership level had changed following the move to Bishopston. The number of cars available to the household at the time of relocation was not gathered for every household as the survey captured information from the point of household formation which may have occurred following the move.

A comparison of average household car ownership at the 2001 census and at the PhD survey point is provided in Table I-1. As noted before, this comparison implies that the 83 surveyed households owned eight more cars at the time of the survey than the equivalent number of households would have done at the 2001 census:

Table I-1: Bishopston - Net change in car ownership since the 2001 census

Total households surveyed in census (2001)	130
Total cars recorded in census (2001)	165
Average number of cars per household	1.27
Total households surveyed in PhD study (2010)	83
Total cars recorded in PhD study (2010)	113
Census equivalent number of cars (2001)	105
Net change in cars owned across these households since 2001	**+8**
Notes: 2001 data extracted from 2001 census, table KS17 (Census Dissemination Unit, 2011)	

Of the 83 surveyed households, 36 households lived in Bishopston at the time of the 2001 census, while 47 households moved into the neighbourhood after the 2001 census. This implies that 47 households had also moved out of the neighbourhood since the 2001 census.

A summary of the net changes in car ownership level across non-movers and households that moved into the neighbourhood after the census is provided in Table I-2 (crossed referenced with the components of the churn calculation identified in Box I-1):

Table I-2: Bishopston - Households changing car ownership level

	No. of households	**Net change in no. of cars**
Surveyed households that lived in Bishopston at the last census, and have not changed car ownership level	25	0
Surveyed households that lived in Bishopston at the last census, and have since changed car ownership level [C]	11	+6
Surveyed households that moved into Bishopston after the last census and brought cars with them [A]	47	+56
Surveyed households that moved into Bishopston after the last census and then changed car ownership level [D]	10	+2
Observed net change in car ownership since the 2001 census		**+64**
Households moving out of Bishopston (implied) [B]	47	-56
Overall net change in car ownership		**+8**

The approximation suggests that the 56 additional cars brought to the neighbourhood by new residents were cancelled out by the cars removed from the neighbourhood by households moving elsewhere. The suggested eight car net increase arose predominantly as a result of existing residents increasing their car ownership level.

A closer inspection of the 11 households that were resident in the neighbourhood at the last census and have since changed car ownership level, revealed that nine cars had been gained generally as a result of the car ownership life cycle effect observed by Dargay and Vythoulkas (1999). These were mainly young family households that had aged since the 2001 census and acquired second or third cars for reasons such as work, or offspring reaching driving age. Three cars had been lost similarly for life cycle reasons as two older households moved into retirement age and relinquished cars (see Table I-5 at the end of the appendix for a description of these car ownership transactions).

The 10 households that had moved into the neighbourhood and subsequently changed car ownership level also tended to be young couples or young families with children. The net gain of two cars amongst this category could also be attributed to the car ownership life cycle effect. The net gain arose through three early life stage households acquiring their first cars. There were seven further examples of moves between one and two cars in either direction which more or less cancelled each other out (see Table I-6 at the end of the appendix for a description of these car ownership transactions).

Overall this analysis, albeit based on a partial comparison, would suggest that the Bishopston neighbourhood has been characterised by young adult households moving in which have a tendency to increase car ownership level over time as they move through the car ownership life cycle. As there may have been a slight move through the life course across the neighbourhood (suggested by there being slightly more parents with children and fewer couples than there were in 2001) this approximation suggests (though does not prove) a marginal increase in car ownership at the aggregate neighbourhood level.

Bradley Stoke

72 of the 88 questionnaire responses from Bradley Stoke contained information about whether and how the household car ownership level had changed following the move to Bradley Stoke. The number of cars available to the household at the time of relocation was not gathered for every household, as the survey captured information from the point of household formation which may have occurred following the move to Bradley Stoke.

A comparison of the neighbourhood car ownership rate at the 2001 census and at the PhD survey point is provided in Table I-3. This comparison implies that the 72 surveyed households owned one more car at the time of the 2010 survey than the equivalent number of households would have done at the census point i.e the aggregate car ownership level had remained relatively stable.

Table I-3: Bradley Stoke - Net change in car ownership since the 2001 census

Total households surveyed in census (2001)	126
Total cars recorded in census (2001)	165
Average number of cars per household	1.31
Total households surveyed in PhD study (2010)	72
Total cars recorded in PhD study (2010)	95
Census equivalent number of cars	94
Net change in cars owned across these households since census	**+1**
Notes: 2001 data extracted from 2001 census, table KS17 (Census Dissemination Unit, 2011)	

Of the 72 surveyed households, 16 households lived in Bradley Stoke at the time of the 2001 census, while 56 households moved into the neighbourhood after the 2001 census. This implies that 56 households had also moved out of the neighbourhood since the 2001 census.

A summary of the net changes in car ownership level across non-movers and households that moved into the neighbourhood after the census is provided in Table I-4 (cross referenced with the components of the churn calculation identified in Box I-1):

Table I-4: Bradley Stoke - Households changing car ownership level

	No. of households	**Net change in no. of cars in the area**
Surveyed households that lived in Bradley Stoke at the last census and have not changed car ownership level	11	0
Surveyed households that lived in Bradley Stoke at the last census, and have since changed car own level [C]	5	+2
Surveyed households that moved into Bradley Stoke after the last census and brought cars with them [A]	56	+69
Surveyed households that moved into Bradley Stoke after the last census and then changed car own level [D]	11	+4
Observed net change in car ownership		**+75**
Households moving out of Bradley Stoke (implied) [B]	56	-74
Overall net change in car ownership		**+1**

This approximation suggests that households leaving the neighbourhood had five more cars at the time of the move than households moving into the

neighbourhood. However, this net reduction in car ownership was cancelled out by households within the neighbourhood increasing car ownership level after the last census. Consistent with the findings of the Bishopston analysis, a closer inspection of the reasons for car ownership changes revealed that these net increases could be attributed to the car ownership life cycle effect i.e. young households acquiring additional cars as children are born, or as offspring reach driving age (see Table I-7 and Table I-8 at the end of the appendix for a summary of these car ownership transactions).

Overall this analysis, albeit based on a partial comparison, would suggest that the Bradley Stoke neighbourhood has been characterised by young adult households moving in which have a tendency to increase car ownership level over time as they move through the life cycle. As the aggregate car ownership level has remained stable in the neighbourhood since the 2001 census, this would imply that households moving out have tended to have a higher level of car ownership than those moving in. The fact that the overall population composition has also remained relatively stable in terms of life stage characteristics, would also suggest that those households leaving the neighbourhood were at a later life stage than those households moving into the neighbourhood.

Table I-5: Households residing in Bishopston before the census, changing car ownership after the census

ID	Life stage	Car ownership change	Description
a7	both parents children 12-15	1-2 [+1]	+2nd car as train fares increased on commute to London and a second car offered a cheaper alternative.
a31	both parents children 12-15	2-3 [+1]	+3rd car as acquired classic car from a friend.
a42	both parents children 16+	1-2 [+1]	+2nd car as male partner's job changed; used to use public transport to get to work; now works from home and needs a car to get to client meetings.
a50	both parents children 12-15	2-3 [+1]	+3rd car as husband bought a sports car on impulse for leisure use.
a61	both parents children 16+	2-3 [+1]	+3rd car as bought classic Land Rover as a hobby car.
a64	both parents children 12-15	2-3 [+1]	+3rd car as son started at Bath University and respondent needed to buy an automatic due to health reasons; kept old car for son to use.
a69	single parent children 16+	1-2 [+1]	+2nd car when son started learning to drive.
a78	couple 65+	1-2 [+1]	+2nd car when retired as needed a car each for leisure: "wife is at home with her own life to lead".
a84	single parent children 16+	1-2 [+1]	+2nd car after moving to Bishopston meant a longer journey to work for one household member.
b55	single occupancy 35-65	2-1 [-1]	-2nd car when husband diagnosed with macular degeneration and could no longer drive.
b60	single occupancy 65+	2-1 [-1]	-2nd car when separated from husband who took his car with him.
b60	single occupancy 65+	1-0 [-1]	-1st car when it was vandalised and decided not to replace.
Net change:		**+6 cars**	

Table I-6: Households moving to Bishopston after the census, and changing car ownership after the census

ID	Life stage	Car ownership change	Description
a2	both parents children<5	1-2 [+1]	+2nd car when had children. Husband using the other car for a long commute. Partner had difficulty getting around town with young children without a car.
a9	both parents children<5	2-1 [-1]	-2nd car as husband gave up work to look after their first child.
a13	shared housing <35	0-1 [+1]	+1st car as given a van by a friend.
a33	couple <35	2-1 [-1]	-2nd car as able to car share after moving in together and both cycling to work. Car failed MOT. Realised could "save money" and cycle more frequently to work.
a37	couple <35	1-2 [+1]	+2nd car as bought camper van to travel in Europe.
a38	both parents children age unknown	1-2 [+1]	+2nd car as female had been commuting to work by train but could not get to a new job in Bath by public transport.
a55	single parent children 12-15	2-1 [-1]	-2nd car when husband left the household.
a71	both parents children<5	0-1 [+1]	+1st car when moved to Bristol from London; Partly to help with child care; mainly as the public transport system is very city centre focussed compared to London.
a121	both parents children 12-15	2-1 [-1]	-2nd car following a "conscious decision not to run 2 cars".
b64	shared housing <35	0-1 [+1]	Young professional male acquiring his first car. The survey did not capture the exact reasons for this change.
Net change:		**+2 cars**	

Table I-7: Households residing in Bradley Stoke before the census, changing car ownership after the census

ID	Life stage	Car ownership change	Description
x3	both parents children 16+	1-0 [-1]	Temporarily lost driving licence due to speeding fine so sold car.
x5	both parents children 5-11	2-3 [+1]	Husband received a company van.
x5	both parents children 5-11	3-4 [+1]	Eldest son has bought his own car as he is nearly 17.
x86	both parents children 16+	2-3 [+1]	Son reached driving age and acquired his own car.
x154	both parents children 12-15	2-3 [+1]	Eldest son reached driving age and bought his own car.
x170	couple <35	2-1 [-1]	Passed motorcycle test and replaced one car with a motorbike.
Net change:		**+2 cars**	

Table I-8: Households moving to Bradley Stoke after the census, and changing car ownership after the census

ID	Life stage	Car ownership change	Description
x13	couple <35	1-2 [+1]	Male partner changed job location and found it took too long to travel by public transport (which he had done previously). Other car in use by partner.
x15	both parents children<5	1-2 [+1]	Moved to Bradley Stoke from city centre. Could no longer manage both partners' journeys to work and children to school with one car so bought a second car.
x17	couple 35-65	2-1 [-1]	One partner is not working at present and so recently sold the 2nd car
x20	shared housing adults	2-3 [+1]	Two Eastern European families in shared house. One adult bought a cheap third car to learn to drive in.
x30	single parent children 5-11	2-1 [-1]	Separated from husband who left the household taking his car with him.
x81	both parents children<5	0-1 [+1]	Bought a car as having a baby.
x90	both parents children 16+	0-1 [+1]	Acquired a 1st car in the UK as soon as the family had relocated from Eastern Europe.
x92	both parents children 16+	1-3 [+2]	Both adult offspring passed their driving test and acquired their own car.
x97	single parent children 16+	2-1 [-1]	The survey did not capture the reasons for this change.
x158	both parents children<5	1-2 [+1]	Recently acquired a second car as expecting their first child.
x160	single parent children<5	1-0 [-1]	Partner left the household taking his car with him. Single female parent with no driving license. Has never owned a car of her own.
Net change:		**+4 cars**	

Supporting statistics for section 7.2

Table J-1: Car access imbalance by neighbourhood

Car access imbalance		Bishopston	Bradley Stoke	Total
Too few vehicles	Count	18	15	33
	Expected Count	17.1	15.9	33.0
	% age access imbalance	54.5%	45.5%	100.0%
	% age neighbourhood	18.9%	17.0%	18.0%
Too many vehicles	Count	13	2	15
	Expected Count	7.8	7.2	15.0
	% age access imbalance	86.7%	13.3%	100.0%
	% age neighbourhood	13.7%	2.3%	8.2%
Just the right number of vehicles	Count	64	71	135
	Expected Count	70.1	64.9	135.0
	% age access imbalance	47.4%	52.6%	100.0%
	% age neighbourhood	67.4%	80.7%	73.8%
Total	Count	95	88	183
Chi-square test : $\chi^2 = 8.447$, df=2, p=0.015; 0 cells (0.0%) have expected count less than 5				

Table J-2: Car access imbalance by number of cars owned

Car access imbalance		Zero vehs.	One veh.	Two vehs.	Three or more vehs.	Total
Too few vehicles	Count	15	14	2	2	33
	Expected Count	3.2	18.8	8.8	2.2	33.0
	% age access imbalance	45.5%	42.4%	6.1%	6.1%	100.0%
	% age no. of cars	83.3%	13.5%	4.1%	16.7%	18.0%
Too many vehicles	Count	0	3	9	3	15
	Expected Count	1.5	8.5	4.0	1.0	15.0
	% age access imbalance	.0%	20.0%	60.0%	20.0%	100.0%
	% age no. of cars	.0%	2.9%	18.4%	25.0%	8.2%
Just the right number of vehicles	Count	3	87	38	7	135
	Expected Count	13.3	76.7	36.1	8.9	135.0
	% age access imbalance	2.2%	64.4%	28.1%	5.2%	100.0%
	% age no. of cars	16.7%	83.7%	77.6%	58.3%	73.8%
Total	Count	18	104	49	12	183
Chi-square test $\chi^2 = 74.260$, df=2, p<0.000; 5 cells (41.7%) have expected count less than 5						

Table J-3: Car access imbalance by household structure

Car access imbalance		Single adult household head	Cohabiting household heads	Total
Too few vehicles	Count	15	18	33
	Expected Count	12.6	20.4	33.0
	% age access imbalance	45.5%	54.5%	100.0%
	% age household structure	21.4%	15.9%	18.0%
Too many vehicles	Count	4	11	15
	Expected Count	5.7	9.3	15.0
	% age access imbalance	26.7%	73.3%	100.0%
	% age household structure	5.7%	9.7%	8.2%
Just the right number of vehicles	Count	51	84	135
	Expected Count	51.6	83.4	135.0
	% age access imbalance	37.8%	62.2%	100.0%
	% age household structure	72.9%	74.3%	73.8%
Total	Count	70	113	183
Chi-square test $\chi^2 = 1.59$, df=2, p=0.452; 0 cells (0.0%) have expected count less than 5				

Table J-4: Car access imbalance and car use intensity

Car access imbalance	Mean car use intensity	N	SD
Too few vehicles[1]	0.73	16	0.17
Too many vehicles	0.50	14	0.20
Just the right number of vehicles	0.67	129	0.15
Sample	0.66	159	0.17
Kruskal-Wallis test: χ^2 = 11.129, df=2, p=0.004			
notes: 1. excludes non-car owners reducing the number of cases from 33 to 16			

Table J-5: Awareness of car access imbalance by neighbourhood

Awareness of car access imbalance		Bishopston	Bradley Stoke	Total
Hadn't thought about it	Count	35	37	72
	Expected Count	37.6	34.4	72.0
	% age consideration	48.6%	51.4%	100.0%
	% age neighbourhood	36.5%	42.0%	39.1%
Sometimes think about it	Count	31	29	60
	Expected Count	31.3	28.7	60.0
	% age consideration	51.7%	48.3%	100.0%
	% age neighbourhood	32.3%	33.0%	32.6%
Very conscious about it	Count	30	22	52
	Expected Count	27.1	24.9	52.0
	% age consideration	57.7%	42.3%	100.0%
	% age neighbourhood	31.3%	25.0%	28.3%
Total	Count	96	88	184
Chi-square test: χ^2 = 1.007, df=2, p=0.604; 0 cells (0.0%) have expected count less than 5				

Table J-6: Awareness of car access imbalance by number of cars owned

Awareness of car access imbalance		Zero vehs.	One veh.	Two or more vehs.	Total
Hadn't thought about it	Count	7	49	16	72
	Expected Count	7.4	40.7	23.9	72.0
	% age consideration	9.7%	68.1%	22.2%	100.0%
	% age no. of cars	36.8%	47.1%	26.2%	39.1%
Sometimes think about it	Count	8	26	26	60
	Expected Count	6.2	33.9	19.9	60.0
	% age consideration	13.3%	43.3%	43.3%	100.0%
	% age no. of cars	42.1%	25.0%	42.6%	32.6%
Very conscious about it	Count	4	29	19	52
	Expected Count	5.4	29.4	17.2	52.0
	% age consideration	7.7%	55.8%	36.5%	100.0%
	% age no. of cars	21.1%	27.9%	31.1%	28.3%
Total	Count	19	104	61	184
Chi-square test: $\chi^2 = 9.097$, df=4, p=0.059; 0 cells (0.0%) have expected count less than 5					

Table J-7: Awareness of car access imbalance by household structure

Awareness of car access imbalance		couple	parents with children	single occupancy	single parent with children	Total
Hadn't thought about it	Count	8	24	25	9	66
	Expected Count	14.9	28.7	14.9	7.5	66.0
	% age consideration	12.1%	36.4%	37.9%	13.6%	100.0%
	% age household structure	21.1%	32.9%	65.8%	47.4%	39.3%
Sometimes think about it	Count	17	27	4	7	55
	Expected Count	12.4	23.9	12.4	6.2	55.0
	% age consideration	30.9%	49.1%	7.3%	12.7%	100.0%
	% age household structure	44.7%	37.0%	10.5%	36.8%	32.7%
Very conscious about it	Count	13	22	9	3	47
	Expected Count	10.6	20.4	10.6	5.3	47.0
	% age consideration	27.7%	46.8%	19.1%	6.4%	100.0%
	% age household structure	34.2%	30.1%	23.7%	15.8%	28.0%
Total	Count	38	73	38	19	168

Chi-square test: $\chi^2 = 20.896$, df=6, p=0.002; 0 cells (0.0%) have expected count less than 5.

Notes: Excludes other and shared housing categories due to low counts

Table J-8: Awareness of car access imbalance by car access imbalance

Awareness of car access imbalance		Too few vehicles	Too many vehicles	Just the right no. of vehicles	Total
Hadn't thought about it	Count	5	3	64	72
	Expected Count	13.0	5.9	53.1	72.0
	% age consideration	6.9%	4.2%	88.9%	100.0%
	% age access imbalance	15.2%	20.0%	47.4%	39.3%
Sometimes think about it	Count	19	7	33	59
	Expected Count	10.6	4.8	43.5	59.0
	% age consideration	32.2%	11.9%	55.9%	100.0%
	% age access imbalance	57.6%	46.7%	24.4%	32.2%
Very conscious about it	Count	9	5	38	52
	Expected Count	9.4	4.3	38.4	52.0
	% age consideration	17.3%	9.6%	73.1%	100.0%
	% age access imbalance	27.3%	33.3%	28.1%	28.4%
Total	Count	33	15	135	183
Chi-square test: χ^2 = 18.796, df=2, p=0.001; 2 cells (22.2%) have expected count less than 5					

Supporting statistics for section 7.3

Table J-9: Next expected car ownership change by neighbourhood

Next expected car ownership change		Bishopston	Bradley Stoke	Total
Replacement	Count	64	63	127
	Expected Count	67.1	59.9	127.0
	% next car ownership change	50.4%	49.6%	100.0%
	% neighbourhood	68.1%	75.0%	71.3%
Increase	Count	13	17	30
	Expected Count	15.8	14.2	30.0
	% next car ownership change	43.3%	56.7%	100.0%
	% neighbourhood	13.8%	20.2%	16.9%
Decrease	Count	7	1	8
	Expected Count	4.2	3.8	8.0
	% next car ownership change	87.5%	12.5%	100.0%
	% neighbourhood	7.4%	1.2%	4.5%
No change	Count	10	3	13
	Expected Count	6.9	6.1	13.0
	% next car ownership change	76.9%	23.1%	100.0%
	% neighbourhood	10.6%	3.6%	7.3%
Total	Count	94	84	178
Chi-square test: $\chi^2 = 8.275$, df=3, p=0.041; 2 cells (25.0%) have expected count less than 5				

Table J-10: Next expected car ownership change by number of cars owned

Next expected change	Zero vehs.	One veh.	Two or more vehs.	Total
Replacement	0	82	45	127
Increase	8	16	6	30
Decrease	0	0	8	8
No change	10	2	1	13
Total	18	100	60	178

Table J-11: Next expected car ownership change by household structure

Next expected car ownership change		Single adult household head	Cohabiting household heads	Total
Replacement	Count	44	83	127
	Expected Count	47.1	79.9	127.0
	% next car ownership change	34.6%	65.4%	100.0%
	% age household structure	66.7%	74.1%	71.3%
Increase	Count	9	21	30
	Expected Count	11.1	18.9	30.0
	% next car ownership change	30.0%	70.0%	100.0%
	% age household structure	13.6%	18.8%	16.9%
Decrease	Count	1	7	8
	Expected Count	3.0	5.0	8.0
	% next car ownership change	12.5%	87.5%	100.0%
	% age household structure	1.5%	6.3%	4.5%
No change	Count	12	1	13
	Expected Count	4.8	8.2	13.0
	% next car ownership change	92.3%	7.7%	100.0%
	% age household structure	18.2%	0.9%	7.3%
Total	Count	66	112	178
Chi-square test: $\chi^2 = 20.034$, df=3 p<0.000; 2 cells (25.0%) have expected count less than 5				

Table J-12: Next expected car ownership change and car use intensity

Next expected change	Mean car use intensity	N	SD
Replacement	0.67	124	0.14
Increase	0.71	21	0.18
Decrease	0.39	7	0.16
Sample	0.66	152	0.16
Kruskal-Wallis: $\chi^2 = 15.158$, df=2, p=0.001			

Table J-13: Mean consideration of next car ownership change by neighbourhood

Neighbourhood	Mean consideration score	N	SD
Bishopston	2.53	85	1.45
Bradley Stoke	2.39	82	1.37
Mann-Whitney test: U=3297.5, Z=-0.625, p=0.532			

Table J-14: Mean consideration of next car ownership change by number of cars owned

No. of cars	Mean consideration score	N	SD
One or more cars	2.40	159	1.38
No car	3.75	8	1.39
Total	2.46	167	1.41
Mann-Whitney test: U=314.5, Z=-2.508, p = 0.012			

Table J-15: Mean consideration of next car ownership change by household structure

Household structure	Mean consideration score	N	SD
Couple	2.82	38	1.27
Parents with children	2.29	72	1.41
Other	2.00	6	0.89
Single occupancy	2.37	27	1.52
Shared housing	3.00	7	1.73
Single parent with children	2.47	17	1.51
Total	2.46	167	1.41
Kruskal-Wallis test: χ^2 = 5.481, df=5 p=0.360			

Table J-16: Mean consideration of next car ownership change by car access imbalance

Car access imbalance	Mean consideration score	N	SD
Too few vehicles	3.20	25	1.35
Too many vehicles	3.07	14	1.44
Just the right no. of vehicles	2.25	128	1.36
Total	2.46	167	1.41
Kruskal-Wallis test: χ^2 = 12.744, df=2, p=0.02			

Supporting statistics for section 7.4

Table J-17: Manage with one fewer car by neighbourhood

Managing with one fewer car would be:		Bishopston	Bradley Stoke	Total
No problem	Count	9	7	16
	Expected Count	8.2	7.8	16.0
	% manage with 1 fewer car	56.3%	43.8%	100.0%
	% neighbourhood	10.7%	8.8%	9.8%
Possible but sometimes inconvenient	Count	14	13	27
	Expected Count	13.8	13.2	27.0
	% manage with 1 fewer car	51.9%	48.1%	100.0%
	% neighbourhood	16.7%	16.3%	16.5%
Possible but often inconvenient	Count	30	20	50
	Expected Count	25.6	24.4	50.0
	% manage with 1 fewer car	60.0%	40.0%	100.0%
	% neighbourhood	35.7%	25.0%	30.5%
Impossible	Count	31	40	71
	Expected Count	36.4	34.6	71.0
	% manage with 1 fewer car	43.7%	56.3%	100.0%
	% neighbourhood	36.9%	50.0%	43.3%
Total	Count	84	80	164

Chi-square test: $\chi^2 = 3.332$, df=3, p=0.343; 0 cells (0.0%) have expected count less than 5

Excludes non-car owners

Table J-18: Manage with one fewer car by number of cars owned

Managing with one fewer car would be:		One car	Two or more cars	Total
No problem	Count	9	7	16
	Expected Count	10.0	6.0	16.0
	% manage with 1 fewer car	56.3%	43.8%	100.0%
	% age no. of cars	8.7%	11.5%	9.8%
Possible but sometimes inconvenient	Count	15	12	27
	Expected Count	17.0	10.0	27.0
	% manage with 1 fewer car	55.6%	44.4%	100.0%
	% age no. of cars	14.6%	19.7%	16.5%
Possible but often inconvenient	Count	26	24	50
	Expected Count	31.4	18.6	50.0
	% manage with 1 fewer car	52.0%	48.0%	100.0%
	% age no. of cars	25.2%	39.3%	30.5%
Impossible	Count	53	18	71
	Expected Count	44.6	26.4	71.0
	% manage with 1 fewer car	74.6%	25.4%	100.0%
	% age no. of cars	51.5%	29.5%	43.3%
Total	Count	103	61	164

Chi-square test: $\chi^2 = 7.663$, df=3, p=0.054; 0 cells (0.0%) have expected count less than 5

Excludes non-car owners

Table J-19: Manage with one fewer car by household structure

Managing with one fewer car would be:		Single adult household head	Cohabiting household heads	Total
No problem	Count	7	9	16
	Expected Count	5.3	10.7	16.0
	% manage with 1 fewer car	43.8%	56.3%	100.0%
	% age household structure	13.0%	8.2%	9.8%
Possible but sometimes inconvenient	Count	8	19	27
	Expected Count	8.9	18.1	27.0
	% manage with 1 fewer car	29.6%	70.4%	100.0%
	% age household structure	14.8%	17.3%	16.5%
Possible but often inconvenient	Count	12	38	50
	Expected Count	16.5	33.5	50.0
	% manage with 1 fewer car	24.0%	76.0%	100.0%
	% age household structure	22.2%	34.5%	30.5%
Impossible	Count	27	44	71
	Expected Count	23.4	47.6	71.0
	% manage with 1 fewer car	38.0%	62.0%	100.0%
	% age household structure	50.0%	40.0%	43.3%
Total	Count	54	110	164

Chi-square test: $\chi^2 = 3.622$, df=3, p=0.305; 0 cells (0.0%) have expected count less than 5

Excludes non-car owners

Table J-20: Manage with one fewer car by car access imbalance

Managing with one fewer car would be:		Too few vehicles	Too many vehicles	Just the right no. of vehicles	Total
No problem	Count	0	6	10	16
	Expected Count	1.8	1.5	12.8	16.0
	% manage with 1 fewer car	.0%	37.5%	62.5%	100.0%
	% age access imbalance	.0%	40.0%	7.6%	9.8%
Possible but sometimes inconvenient	Count	5	6	16	27
	Expected Count	3.0	2.5	21.6	27.0
	% manage with 1 fewer car	18.5%	22.2%	59.3%	100.0%
	% age access imbalance	27.8%	40.0%	12.2%	16.5%
Possible but often inconvenient	Count	4	2	44	50
	Expected Count	5.5	4.6	39.9	50.0
	% manage with 1 fewer car	8.0%	4.0%	88.0%	100.0%
	% age access imbalance	22.2%	13.3%	33.6%	30.5%
Impossible	Count	9	1	61	71
	Expected Count	7.8	6.5	56.7	71.0
	% manage with 1 fewer car	12.7%	1.4%	85.9%	100.0%
	% age access imbalance	50.0%	6.7%	46.6%	43.3%
Total	Count	18	15	131	164

Chi-square test: $\chi^2 = 31.731$, df=6, p<0.000; 5 cells (41.7%) have expected count less than 5

Table J-21: Mean modal share by manage with one fewer car categories

Mode	No problem N=16	Possible but sometimes inconvenient N=24	Possible but often inconvenient N=48	Impossible N=69	Full sample N=175	Kruskal-Wallis Test
Car use	0.28	0.35	0.33	0.39	0.32	χ^2 = 9.458, df=3, p=0.024
Walking	0.24	0.24	0.25	0.23	0.25	χ^2 = 0.767, df=3, p=0.857
Cycling	0.11	0.10	0.09	0.06	0.08	χ^2 = 7.092, df=3, p=0.069
Bus use	0.12	0.09	0.10	0.09	0.11	χ^2 = 2.816, df=3, p=0.421
Train use	0.07	0.06	0.07	0.05	0.06	χ^2 = 4.200, df=3, p=0.241
Taxi	0.06	0.06	0.06	0.06	0.06	χ^2 = 1.847, df=3, p=0.605
Lift	0.10	0.08	0.07	0.09	0.09	χ^2 = 3.032, df=3, p=0.387
Car club	0.00	0.00	0.00	0.00	0.00	χ^2 = 0.706, df=3, p=0.872
Hire car	0.00	0.01	0.02	0.01	0.01	χ^2 = 7.579, df=3, p=0.056
Other	0.00	0.01	0.00	0.01	0.01	χ^2 = 0.715, df=3, p=0.870

Table J-22: Proportional modal uptake by neighbourhood

Mode	Bishopston N=44	Bradley Stoke N=38	Full sample N=82	Mann-Whitney Test
Internet	0.10	0.06	0.08	U=634.5, Z=-2.096, p=0.036
Walk	0.18	0.19	0.18	U=807.5, Z=-0.268, p=0.789
Cycle	0.09	0.11	0.10	U=825.0, Z=-0.111, p=0.912
Bus	0.15	0.17	0.16	U=794.0, Z=-0.396, p=0.692
Train	0.07	0.06	0.07	U=764.0, Z=-0.755, p=0.450
Taxi	0.06	0.06	0.06	U=801.5, Z=-0.362, p=0.717
Other household car	0.07	0.08	0.07	U=791.5, Z=-0.522, p=0.601
Lift	0.12	0.18	0.14	U=728.5, Z=-1.018, p=0.309
Car club	0.03	0.01	0.02	U=706.5, Z=-2.033, p=0.042
Hire car	0.03	0.01	0.02	U=787.5, Z=-0.709, p=0.478
Other	0.01	0.00	0.00	U=798.0, Z=-1.322, p=0.186
No change	0.09	0.08	0.09	U=826.0, Z=-0.192, p=0.848

Table J-23: Proportional modal uptake by manage with one fewer car categories

Mode	No problem N=14	Possible but sometimes inconvenient N=21	Possible but often inconvenient N=47	Full sample N=82	Kruskal-Wallis Test
Internet	0.04	0.08	0.10	0.08	χ^2 = 3.662, df=2, p=0.160
Walk	0.18	0.22	0.17	0.18	χ^2 = 1.727, df=2, p=0.422
Cycle	0.07	0.13	0.10	0.10	χ^2 = 1.965, df=2, p=0.374
Bus	0.09	0.17	0.18	0.16	χ^2 = 4.302, df=2, p=0.116
Train	0.05	0.05	0.08	0.07	χ^2 = 2.271, df=2, p=0.321
Taxi	0.06	0.06	0.06	0.06	χ^2 = 0.046, df=2, p=0.977
Other household car	0.02	0.06	0.09	0.07	χ^2 = 2.122, df=2, p=0.346
Lift	0.10	0.21	0.13	0.14	χ^2 = 7.376, df=2, p=0.025
Car club	0.02	0.02	0.02	0.02	χ^2 = 0.918, df=2, p=0.632
Hire car	0.01	0.01	0.03	0.02	χ^2 = 2.353, df=2, p=0.308
Other	0.00	0.00	0.01	0.00	χ^2 = 1.508, df=2, p=0.471
No change	0.36	0.00	0.04	0.09	χ^2 = 16.109, df=2, p<0.000

Table J-24: Proportional modal uptake by number of cars owned

Mode	1 car N=42	2 cars N=31	3+ cars N=9	Full sample N=82	Kruskal-Wallis Test
Internet	0.09	0.09	0.04	0.08	χ^2 = 1.702, df=2, p=0.427
Walk	0.19	0.19	0.18	0.18	χ^2 = 0.321, df=2, p=0.852
Cycle	0.11	0.10	0.04	0.10	χ^2 = 2.682, df=2, p=0.262
Bus	0.18	0.15	0.11	0.16	χ^2 = 2.849, df=2, p=0.241
Train	0.10	0.03	0.03	0.07	χ^2 = 11.432, df=2, p=0.003
Taxi	0.09	0.04	0.04	0.06	χ^2 = 6.857, df=2, p=0.032
Other household car	0.00	0.14	0.18	0.07	χ^2 = 32.568, df=2, p=0.000
Lift	0.14	0.15	0.16	0.14	χ^2 = 0.120, df=2, p=0.942
Car club	0.02	0.02	0.00	0.02	χ^2 = 1.673, df=2, p=0.433
Hire car	0.03	0.01	0.00	0.02	χ^2 = 2.892, df=2, p=0.235
Other	0.01	0.00	0.00	0.00	χ^2 = 1.928, df=2, p=0.381
No change	0.05	0.10	0.22	0.09	χ^2 = 2.941, df=2, p=0.230

Supporting statistics for section 7.5

Table J-25: Mean consideration of transport when moving to the neighbourhood, by household structure and number of cars owned

Household structure	Number of cars	Mean consideration score	N	SD
couple	zero	1.00	1	.
	one	0.82	17	1.59
	two	0.69	16	1.25
	three or more	0.00	1	.
	Total	0.74	35	1.38
parents with children	zero	1.00	2	1.41
	one	0.55	33	1.23
	two	0.33	27	1.44
	three or more	0.33	9	1.23
	Total	0.45	71	1.30
other	one	-0.50	2	0.71
	two	1.50	2	0.71
	three or more	0.00	1	.
	Total	0.40	5	1.14
single occupancy	zero	0.71	7	1.38
	one	0.50	26	1.53
	Total	0.55	33	1.48
shared housing	zero	1.50	4	0.58
	one	0.80	5	0.45
	Total	1.11	9	0.60
single parent with children	zero	2.00	2	0.00
	one	0.00	13	1.08
	two	-0.50	2	2.12
	Total	0.18	17	1.29
Total	zero	1.13	16	1.09
	one	0.50	96	1.34
	two	0.47	47	1.38
	three or more	0.27	11	1.10
	Total	0.54	170	1.32
Kruskal-Wallis test: $\chi^2 = 5.424$, df=5, p=0.366				

Table J-26: Mean consideration of transport when moving to the neighbourhood, by number of cars owned

No. of cars	Mean consideration score	N	SD
One or more cars	0.47	154	1.33
No car	1.13	16	1.09
Total	0.54	170	1.32
Mann-Whitney test: U=870.5, Z=-2.013, p = 0.044			

Appendix K - Travel patterns in the survey neighbourhoods

1. Introduction

This appendix presents an analysis of modal use data generated by the neighbourhood survey. It accompanies chapter 7 which explores the potential for household car ownership change.

2. Car use relative to other modes

In order to gauge how much households rely on their cars relative to other modes, respondents were asked to report how often they and the people they live use a range of different transport modes (question 34).

Participant responses were coded on a scale of 0 to 5 as follows:

5 – Most days or more, 4 – a few times a week, 3 – Once or twice a week, 2 – A few times a month, 1 – Less than that, 0 – Never.

A total travel score for the household was then calculated by summing up the responses across all modes. An indicator of relative modal share was then calculated for each mode. For example:

$$Mode\_Share_{car} = \frac{Mode\_Score_{car}}{TotalTravelScore}$$

This analysis assumes that the frequency categories are equidistant i.e. the gap between a ‘few times a week’ and ‘most days of more’ is assumed to be the same as the gap between ‘less than that’ and ‘a few times a month’.

The ways in which differing groupings within the sample had adapted to their available mobility resources was then explored. The following sub-groupings within the survey sample were compared:

- Neighbourhood (Bishopston, Bradley Stoke);
- Number of vehicles owned (zero, one, two or three or more vehicles);
- Household structure (couple, parents with children, lone parents with children, single occupancy, shared housing, other); and
- Car access imbalance (too few vehicles, too many vehicles, just the right number of vehicles).

2.1 Relative modal share by neighbourhood

Across the sample, respondents on average reported car use as the highest relative modal share at 32 per cent. This was followed by walking, bus use, taking lifts and cycling (Figure K-1):

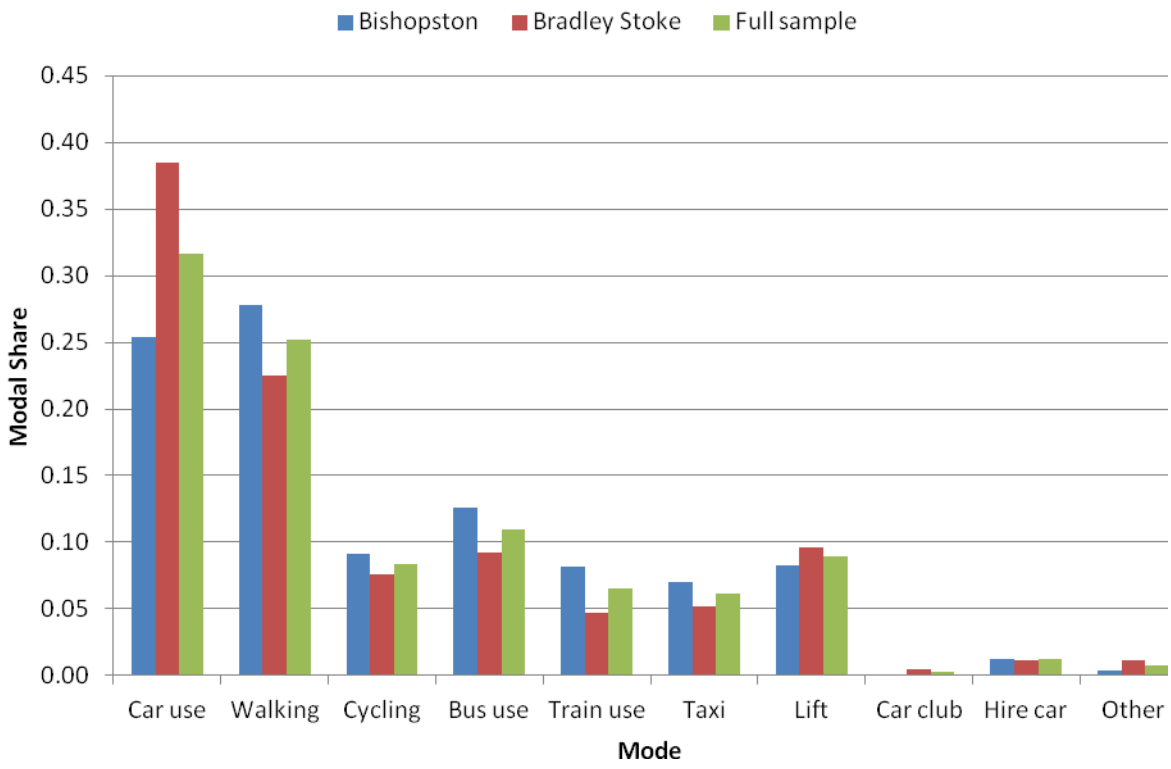


Figure K-1: Relative modal share by neighbourhood

Analysing the modal shares by neighbourhood revealed that on average Bradley Stoke residents reported a 13 per cent higher car use modal share than Bishopston residents. This was counter-balanced by Bishopston residents on average reporting higher walking and cycling modal shares (around 6.8 per cent higher taking both modes together) and a higher public transport modal share (around 6.6 per cent higher taking train and bus use together).

Mann-Whitney tests indicated statistically significant variations ($p<0.05$) between the two survey neighbourhoods for car use (higher in Bradley Stoke), walking (lower in Bradley Stoke), bus (lower in Bradley Stoke) and train use (lower in Bradley Stoke).

This suggests that there were greater opportunities and / or a propensity for Bishopston residents to adapt to the use of non-car based modes (walking, cycling and public transport). It is consistent with the findings (reported in chapter

7) that car use intensities were lower in Bishopston and that Bishopston residents were more likely to report feeling that they owned *too many* cars.

2.2 Relative modal share by number of cars owned

Households with no cars reported relying mainly on walking, but also making greater use of buses and taking lifts than car owning households (Figure K-2). The reported level of cycling was not significantly different to that of car owning households.

Households with two cars reported relying proportionately more on their cars (were less multi-modal) than only and three or more car owning households. They reported cycling and using buses proportionately less. This indicates that single car households (with potentially several household members) are required and able to adapt to use alternative modes when the only car is in use elsewhere.

The three car owning households reported using trains and taxis proportionately less than other car owning states, but interestingly reported cycling the most.

Kruskal-Wallis tests indicated statistically significant variations ($p<0.05$) between the different car owning states for car use, walking and bus use. This variation is mainly due to the significantly different modal shares for non-car owning households who have a greater reliance on walking and bus use. If non-car owning households are excluded from the test then only bus use remained statistically significant between the car owning states, being lower for two car owning households.

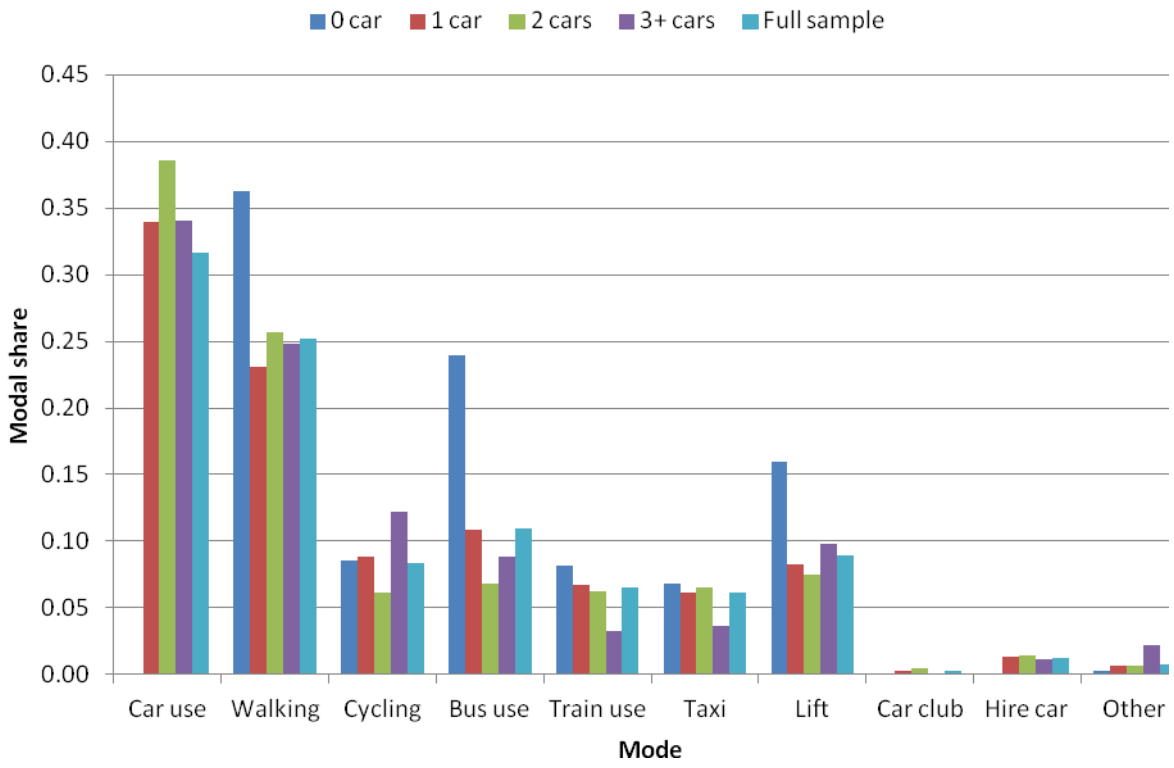


Figure K-2: Relative modal share by number of cars owned

2.3 Relative modal share by household type

Respondents from shared houses reported much lower levels of car use than other household types (Figure K-3). This is likely to be due to this category having comparatively low car ownership rates (six cars across 10 households). Their low levels of car use were compensated for by proportionately higher levels of walking, bus use, trains, taxis and taking lifts.

Single parent households also reported proportionately higher use of lifts relative to other household categories (and this contributed to a statistically significant difference for this mode). This suggests that single parent households were more reliant on access to cars outside of the household than households in which both parents cohabit. Parents with children reported lowest bus use, but highest cycling use. Couples reported the highest car use, but lowest cycling use.

Kruskal-Wallis tests indicated statistically significant variations ($p<0.05$) between the household structure categories for car use, taking lifts and using hire cars. This was mainly due to the shared housing category reporting comparatively lower levels of car use and higher reliance on taking lifts. Use of hire cars was

reported by a small number of parents with children, single occupancy households and couples, but not by shared houses or single parents.

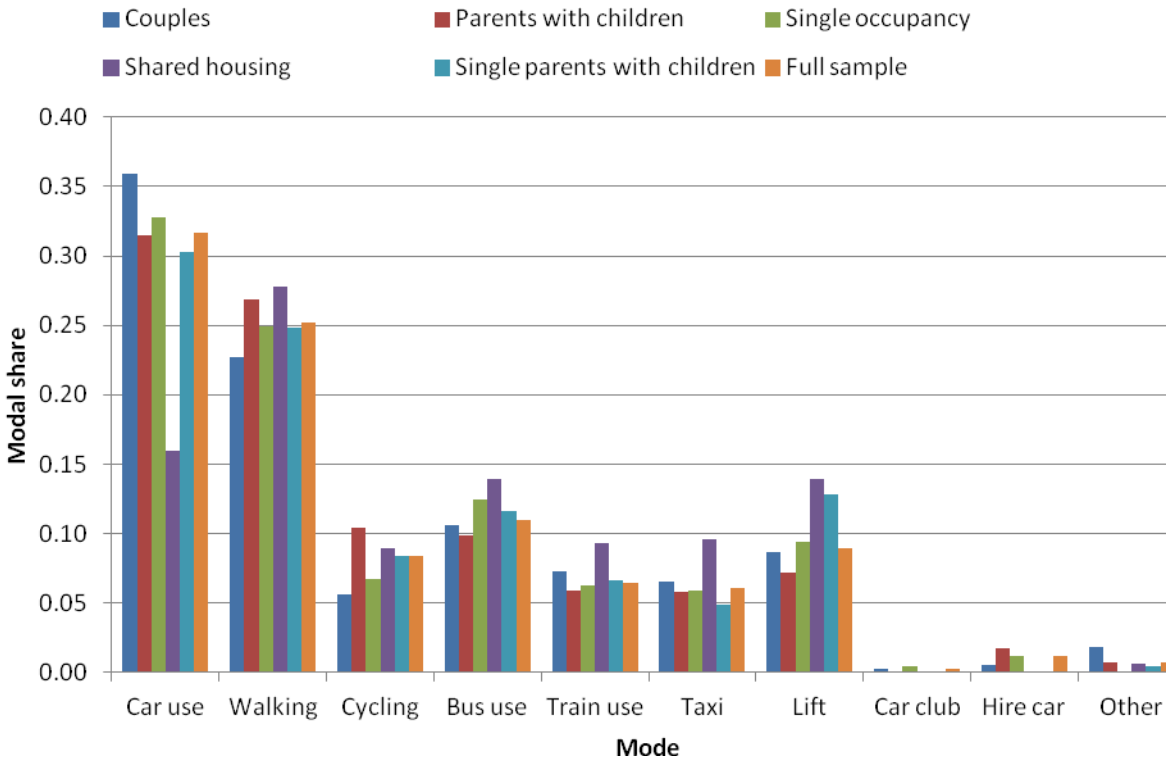


Figure K-3: Relative modal share by household type

2.4 Relative modal share by car access imbalance

Households reporting ownership of too few cars also reported the lowest car use proportions as this group includes non-car owners (Figure K-4). The lack of car availability was compensated for by proportionately higher reliance on buses, walking and taking lifts. This group were also more likely to report making use of the 'other' transport mode category noting use of a school bus (one case), coaches (one case) or motorbikes (two cases).

Households reporting ownership of too many cars reported the highest cycling proportion relative to other modes - a tentative indication that having one or more members of the household with a propensity to cycle is associated with a surplus in car availability.

Households reporting ownership of just the right number of cars reported the highest proportionate level of car use relative to other modes.

Kruskal-Wallis tests indicated statistically significant variations ($p<0.05$) between the car access imbalance categories for car use, bus use, and the 'other' transport modes.

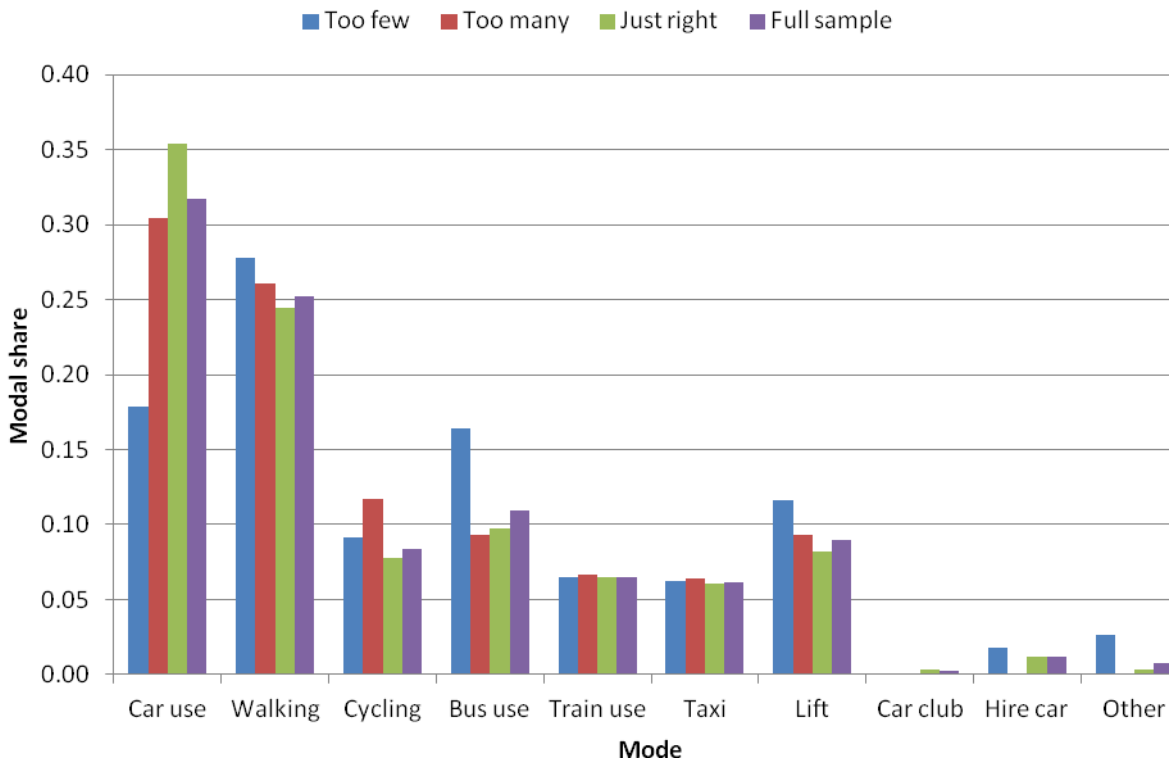


Figure K-4: Relative modal share by car access imbalance

3. Car use and commitment to other mobility tools

The questionnaire included some closed questions on whether the household had ownership of any other common mobility tools, reflecting a commitment to use of a non-car mode (Simma and Axhausen, 2007). Respondents were asked:

- Whether they had one or more regular cyclists in the household;
- Whether they had a public transport season ticket; and
- Whether they owned one or more motorcycles or mopeds.

3.1 Regular cycling

22 per cent of households reported that at least one household member made regular use of a bicycle for reasons other than leisure. A larger proportion of these households lived in Bishopston and a chi-square test indicated that living in Bishopston was associated with an increased likelihood of having a regular cyclist within the household ($\chi^2 = 3.956$, df=1 $p=0.047$). This is in line with expectations, given the closer proximity to the city centre.

Chi-square tests revealed no relationship between having a regular cyclist in the household and number of cars owned, car access imbalance or household type.

Households making regular use of a bicycle reported lower car use intensities on average than households without regular use of a bicycle and a Mann-Whitney test indicated that this relationship was statistically significant (U=2047, r=-2.496, p=0.013). This implies that while regular bicycle use was not associated with car ownership level or car access imbalance, it was associated with lower levels of car use (Table K-1):

Table K-1: Regular cycling and car use intensity

	Car use intensity	N	SD
No cyclists in the household	0.61	138	0.25
One or more cyclists in the household	0.52	40	0.27
Total	0.59	178	0.26
Mann-Whitney test: U=2047, r=-2.496, p=0.013			

Having one or more cyclists within the household was as expected associated with a higher modal share for cycling. (This offers confidence that the questionnaire was internally consistent). This was compensated for by a lower modal share for car use rather than lower modal shares across other non-car based modes (Figure K-5).

The difference in modal shares between cycling and non-cycling households was statistically significant for the following modes according to Mann-Whitney tests ($p<0.05$): Car use (lower for cycling households), walking (lower for cycling households) and cycling (higher for cycling households):

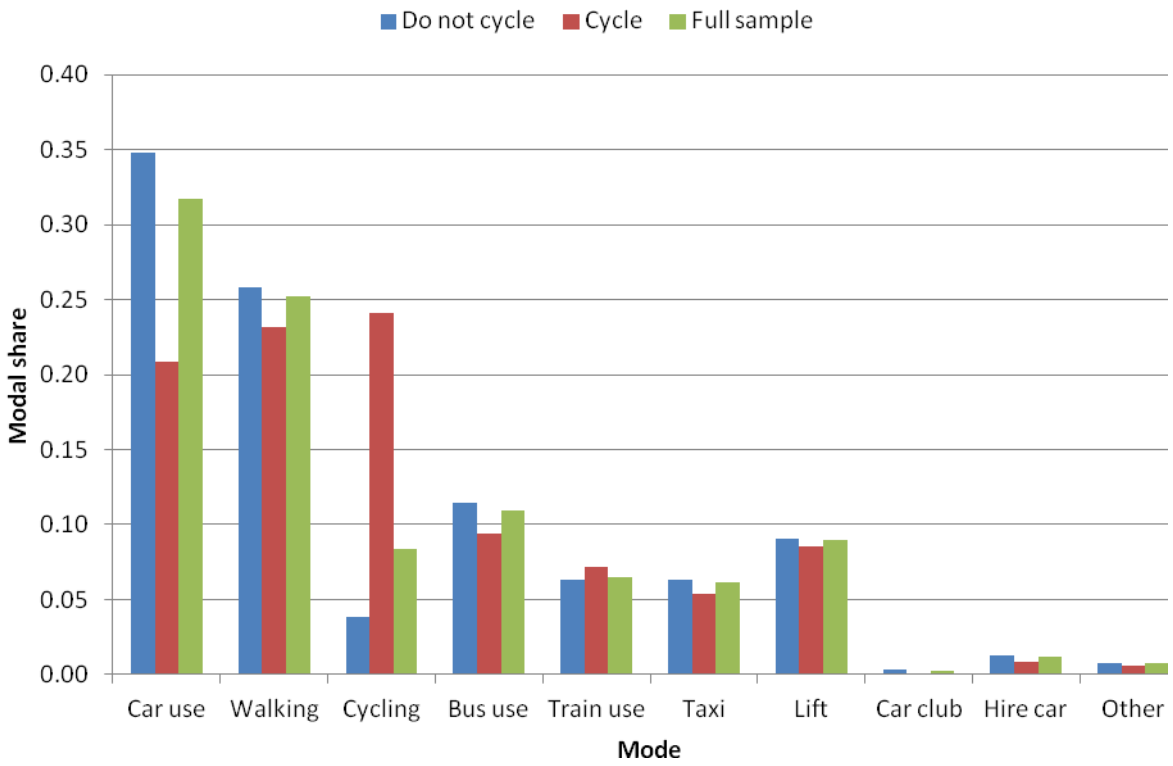


Figure K-5: Relative modal share by bicycle use

3.2 Public transport season tickets

Only 19 households reported having a public transport season ticket (Table K-2) a possible reflection on the quality of the public transport network in Bristol:

Table K-2: Public transport season tickets owned

Ticket type	Frequency
Older person concessionary bus pass	9
Ulink bus pass (students)	2
Monthly train commuter tickets	2
Free bus pass for bus drivers	2
First bus passes	3
Family rail card	1

Clearly concessionary and student bus passes were more prevalent amongst the older person and student population groups. Chi-square tests revealed no

relationship between owning a public transport season ticket and neighbourhood, number of cars owned, or reporting a car access imbalance.

While season ticket holders reported lower car use intensities on average than non-holders (Table K-3), the difference between means was not statistically significant according to a Mann-Whitney test (U = 1253, z=-0.905, p=0.366):

Table K-3: Public transport season ticket ownership and car use intensity

	Car use intensity	N	SD
No PT season ticket	0.60	160	0.25
Have a PT season ticket	0.52	18	0.31
Total	0.59	178	0.26
Mann-Whitney test: U = 1253, z=-0.905, p=0.366			

As expected, public transport season ticket holders reported making more use of buses relative to other modes and this variation was statistically significant according to a Mann-Whitney test ($p<0.05$)[30]. This was compensated for by lower car use and cycling modal shares (Figure K-6).

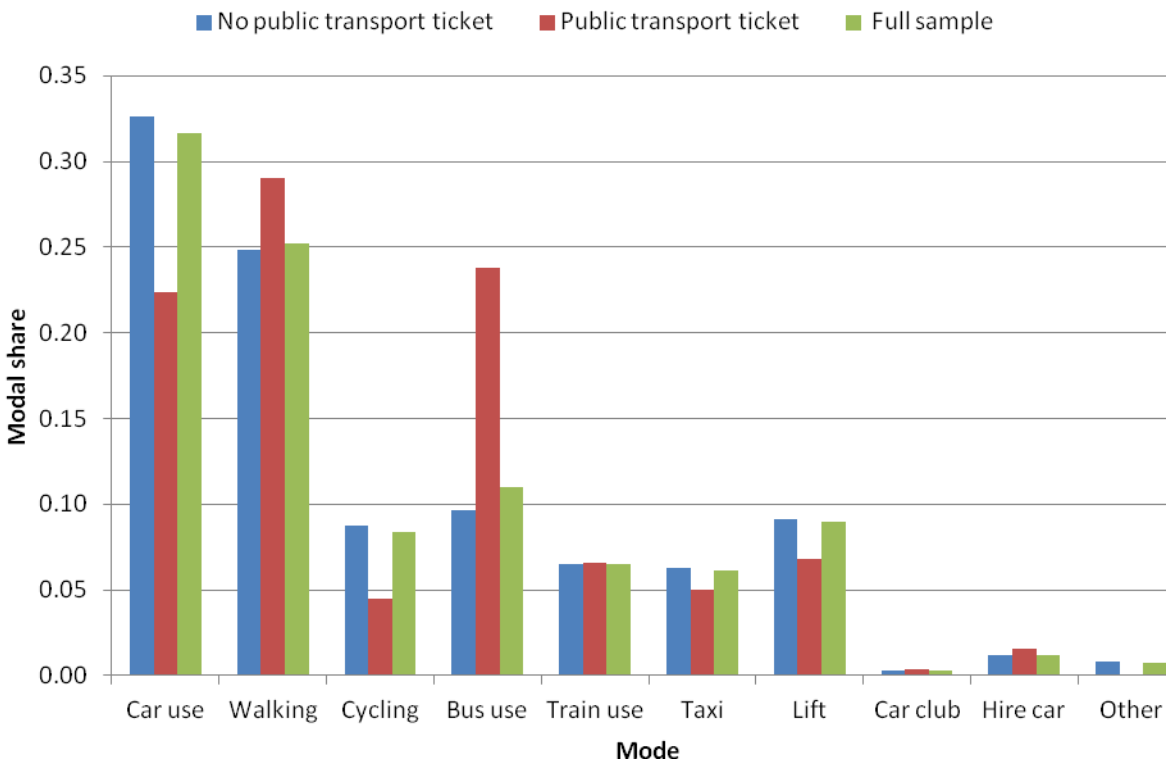


Figure K-6: Relative modal share by public transport season ticket ownership

[30] No other statistically significant variations were detected.

3.3 Motorcycle ownership

Only 10 households reported owning one or more motorcycles. No statistically significant associations were found between owning a motorcycle and neighbourhood, household type or reporting a car access imbalance. However, six of the motorcycle owning households also own three or more cars, suggesting that motorcycle ownership may be associated with an enthusiasm for motor vehicles.

On average, motorcycle owners reported similar car use intensities to non-motorcycle owners implying that motorcycles tend not to be used for routine travel (Table K-4):

Table K-4: Motorcycle ownership and car use intensity

	Car use intensity	N	SD
No motorcycles or mopeds	0.59	169	0.26
One or more motorcycles or mopeds	0.59	9	0.18
Total	0.59	178	0.26

However this analysis of means masked routine use of motorcycles at the disaggregate level. Three of the 10 motorcycle owning households used the 'other' mode category in the modal share question to report using motorcycles regularly during the week. These were all residents of Bradley Stoke (two with one car and one with three cars). Hence, when exploring travel behaviour across all modes, the 'other' category was used to report a higher proportionate modal share for motorcycles compared to non-motorcycle owners (Figure K-7):

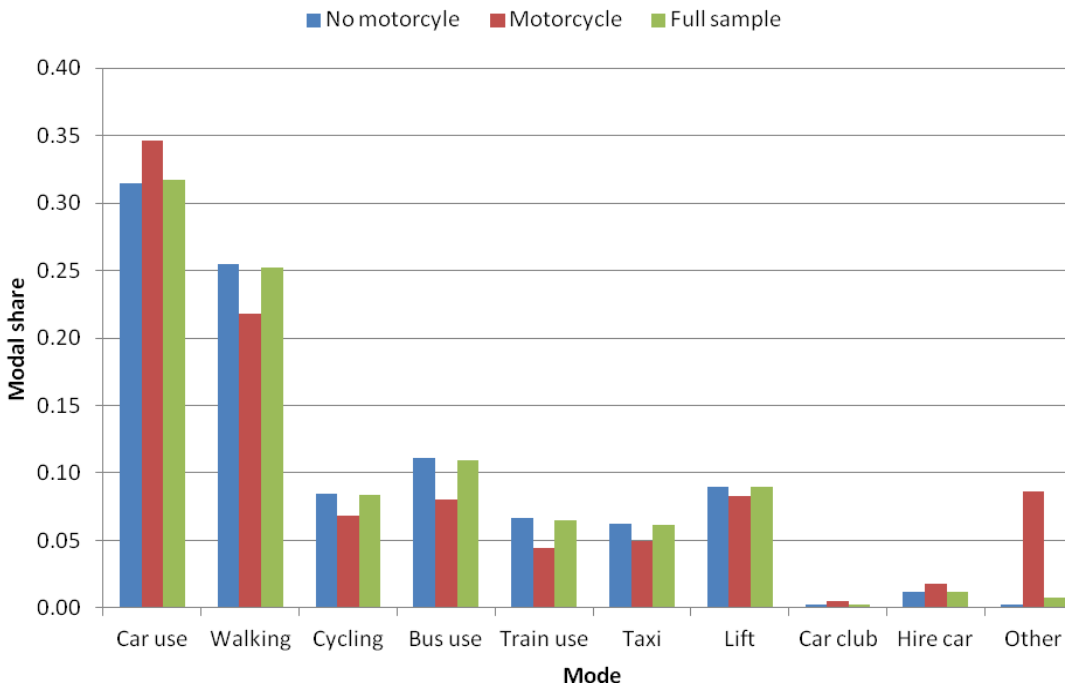


Figure K-7: Relative modal share by motorcycle ownership

Motorcycle owners also reported higher car use modal shares than non-motorcycle owners. This was compensated for by lower cycling, bus use, and train use overall. Only the 'other' category (which was used to record motorcycle use) contributed to a statistically significant difference between motorcycle owners and non-owners according to a Mann-Whitney test ($p<0.05$).

4. Summary

The analysis of modal use has demonstrated both a number of intuitive relationships and the internal consistency of the questionnaire. Notable findings include:

- Residents of the outer-urban neighbourhood were confirmed to be more reliant on their cars and less multi-modal than residents of the inner-urban neighbourhood;
- Having at least one regular cyclist in the household was associated with being resident in the inner-urban neighbourhood and lower car use modal shares;
- Those reporting ownership of *too few* cars also reported higher reliance on buses and taking lifts than those reporting ownership of *too many* or *just the right* number of cars; and
- Ownership of a public transport season ticket was as expected associated with higher bus use modal shares, demonstrating a commitment to that mode.