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Household car adoption and financial difficulties in deprived urban communities: a case of 'forced car ownership'?

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Abstract

This paper explores the relationship between car ownership and financial circumstances for people living in disadvantaged urban communities. Assumptions about cars signifying status and income are problematised by an examination of the characteristics of those who adopt cars over. We consider the possibility that, despite low incomes and financial problems, cars may be a necessity for some urban dwellers. Patterns of car ownership and adoption are analysed using cross-sectional and longitudinal survey data collected from communities in Glasgow, between 2006 and 2011, before, during and after the recession. Car ownership rates increased, as more people adopted a car than relinquished vehicles. The likelihood of household car adoption was influenced by changes in household size, increased financial difficulties in relation to housing costs, and where householders gained work. A small but growing proportion of households (up to 8.5% by 2011) are deemed 'forced car owners' by virtue of owning a car despite also reporting financial difficulties: three-quarters of this group maintain a car despite financial problems whilst a quarter adopt a car despite financial problems. Findings suggest that poor households are reluctant to relinquish their cars to ease money problems when under financial stress and that, for some, acquiring a car may be seen as necessary to better their circumstances. In neither case can we see evidence that the sustainable transport agenda is reaching disadvantaged communities and there are concerns that regeneration strategies are failing to promote mobility and accessibility for poor communities via transport policies.

Key words: forced car ownership; financial difficulties; deprived communities; employment; transport policy; regeneration.

1. Introduction

This paper presents case study analysis from Glasgow, Scotland, in order to investigate the possibility of 'forced' car ownership in low-income urban environments. We explore this issue by analysing relationships between car ownership and financial difficulties at household level in areas undergoing regeneration and during a period of recession and economic austerity.

Inadequate transport can exacerbate challenging circumstances, deepening physical and social isolation, particularly for people who already have lower levels of mobility, such as those with disabilities or only basic education (Davis et al 2014; Lyons 2003; Neilsen, 2015; Rock et al 2012). Place is of fundamental significance within transport policy and poorer communities have suffered the worst impacts from austerity policies (Joyce and Sibieta 2012; Milne and Rankine 2013; Whitehead 2014) such as benefits reductions and cuts to local jobs and services. It is particularly important to recall the role that transport policy can play in supporting disadvantaged communities (Veeneman et al 2015) in a time of austerity. When people feel impacts of unemployment or reduced income they make fewer or shorter trips, and even those with cars become more dependent on bus transport (Neilsen 2015; Ulfarsson et al 2015). During a recession, funding for public transport services is likely to be particularly strained and regeneration initiatives focused on economic development activity often favour road and rail infrastructure, which better serve the needs of business, rather than less affluent communities (Clark et al., 2016; van Wee 2011). Despite policy rhetoric around the need for holistic regeneration practices, recent research in the north of England found no evidence of integration between regeneration and public transport strategies (Turcu, 2012). As a result, those with limited transport alternatives may be forced into car ownership to meet their mobility needs, which, for those in lower-income households, can involve undesirable trade-offs with other needs due to household financial difficulties (Banister 1994; Johnson et al 2009).

Against a backdrop of increasing financial difficulty over a period of recession, this paper offers a detailed investigation of the relationships between car ownership and financial

difficulties in some of the most deprived urban areas in the country. The following section sets out the theoretical framework for the analysis, outlining key tensions in the complex relationship between car ownership and financial circumstances. Thereafter, the methods section describes the study area, measures and analytical approach. The analysis is presented in three stages, comprising: car ownership and financial difficulties at three time points; factors associated with car adoption; and exploring potential forced car ownership. We conclude by reflecting upon the policy implications of the research.

2. Financial Circumstances and Car Ownership

Despite a range of sociodemographic influences on car ownership, the positive relationship between income and car ownership remains strong, to the extent that car ownership is a well-established proxy for income (Carr-Hill and Chalmers-Dixon, 2013). Although there has been some evidence of decoupling in the car ownership – income relationship over recent years, transport demand remains closely correlated with economic activity (Sessa and Enei, 2010). A positive relationship between car ownership and income operates at different scales, with more affluent countries and households tending to have higher levels of car ownership than their less affluent neighbours (Paulley et al., 2006; Liddle, 2012). In Scotland, the percentage of people in households without a car has halved over the past 30 years (Brown et al., 2014). Access to a private vehicle is strongly socially and geographically patterned, with the lowest levels of car ownership in the most deprived areas, and the cost of car ownership and use is heavily implicated in this distribution (Lucas, 2012). For those who can afford it, car ownership offers psychological and emotional gratification as well as mobility: it is associated with freedom, affluence, status, and even romance (Steg, 2005, Urry, 2003). From a functional perspective, the advantages offered by a car include convenience, flexibility, comfort and the perception of being safer, compared with public transport (Iseki et al., 2006). However, there is an asymmetry in the dynamic: once someone has achieved an income level which makes a car affordable, it becomes very difficult to relinquish the car should income fall again (Dargay, 2001).

Urban form can also disrupt the relationship between car ownership and income. Relatively dense, mixed-use urban environments can reduce the need for car travel (Burton, 2003) if there is good provision of public transport. Central London is an example of an area where income and car ownership have decoupled (Church et al., 2000). There is also evidence elsewhere, including Scotland, of an increasing proportion of urban dwellers whose rejection of the car relates to lifestyle choice rather than affordability concerns (CEC, 2013; Delbosc and Currie, 2012; Melia, 2009). In rural environments car ownership can be a cause of financial distress, rather than an indicator of relative affluence (Christie and Fone, 2003; Farrington et al., 1998) because of a lack of alternative modes of transport. We argue that this might also be the case in urban areas with limited transport options.

The concept of 'forced car' ownership was originally associated with remote rural areas, which lacked alternative transport options (Jones, 1987). Forced car owners are usually defined as those who have poor accessibility and low incomes (Currie and Senbergs, 2007). Financial stress is a key aspect of forced car ownership, in that it becomes impossible to forgo the expense of owning and running a car, despite having to reduce spending in other essential areas or constrain travel horizons in ways which reduce options for social and economic participation (Banister, 1994; Mattioli, 2014; Taylor et al., 2009). These are circumstances that can also apply in an urban setting; people in peripheral urban areas face particular temporal challenges in managing multi-tasking and multiple responsibilities (Lucas, 2004). For people on low incomes and without car access, the geographical challenge of looking for work, accepting a job offer or participating in education is exacerbated by a spatial mismatch between work and housing locations, unconnected by main transport corridors (Hine and Mitchell, 2003; Jeekel, 2014). Along with grocery shopping and the school run, home and work locations have been identified as the main factors making a car necessary rather than simply desirable (Lucas and Jones, 2009). Combined, these challenges raise the possibility that public transport services, even for people living in more central urban areas, may not be fit for purpose, potentially forcing car ownership. In the

analysis, we therefore remain open to the possibility that forced car ownership may not be geographically determined, and that urban households who own a car despite financial difficulties *may* also be forced car owners. Currie and Delbosc (2009) have challenged the concept forced car ownership in some cases, pointing out that some people willingly trade off more desirable, or cheaper, but less accessible housing, putting themselves in a position where they require car access. However, for low income households, 'choice' of residence is far less of an option than for the more affluent and while they may 'opt' for more affordable, less accessible housing this might also be seen as a necessary rather than desirable situation. The full costs of transport may not be considered in the process of deciding residential location.

Between 2008-2009 the UK suffered the worst period of recession since the Second World War, precipitating declining living standards, along with an extended period of austerity and welfare reform (Bhattacharyya, 2015; Crossley et al., 2013; Joyce and Sibieta, 2013). The majority of public transport systems are subsidised and government funding for transport has reduced significantly from 2008 onwards (Veeneman et al., 2015), accompanied by fare increases well above the rate of inflation (Davis et al., 2014). Figure 1 demonstrates the changes in the cost of public transport, relative to car ownership since 1987 in the UK. This relative increase in alternative modes relative to car ownership means that despite the financial implications of purchasing and maintaining a car it has become relatively affordable as a means of mobility which may make it more of an attractive option for many on low incomes. There has also been a reduction in the availability of regular, secure employment and an increase in part-time and irregular working (Boeri and Brueker, 2011; Lyonette et al., 2010).

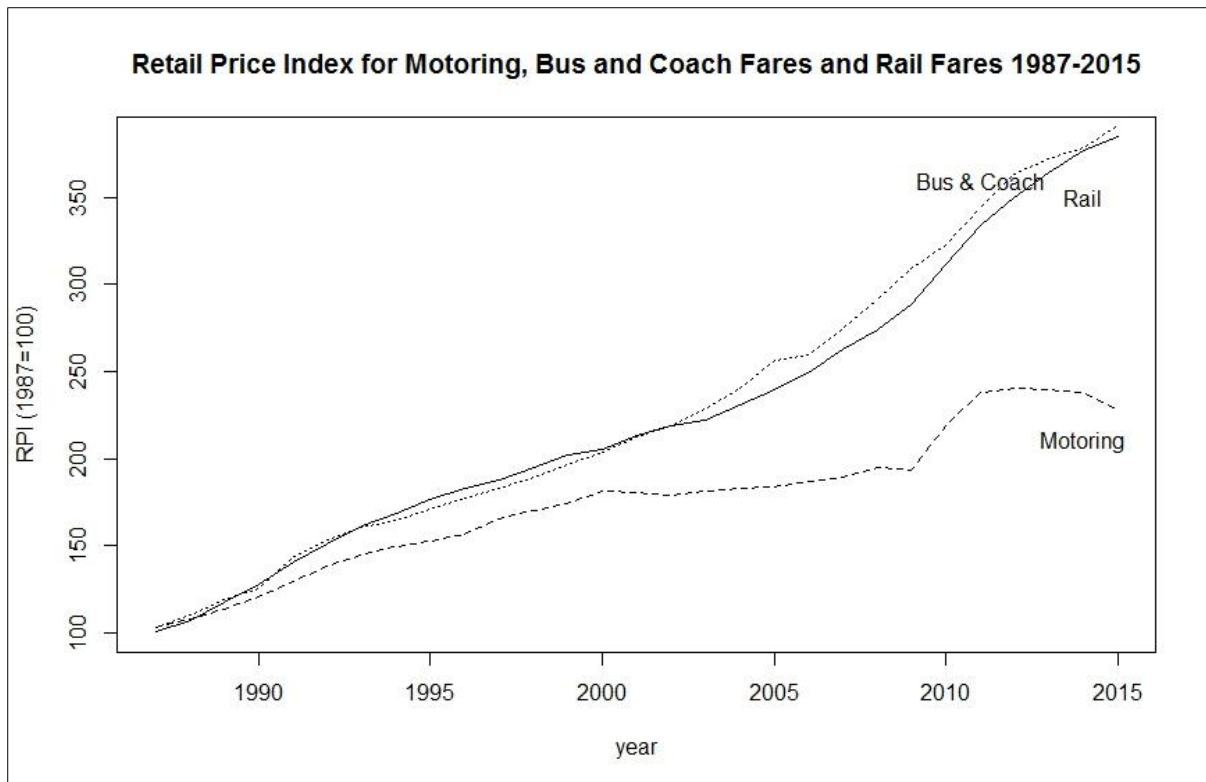


Figure 1- Relative Cost of Transport Modes since 1987 (Source dataset: Consumer Price Inflation time series dataset (MM23) www.ons.gov.uk)

Following this recent recession households, even in relatively accessible urban areas, face challenges of increased financial difficulties, the need for a wider travel radius to access or search for (sometimes insecure) employment, and cuts to public transport services. A car has been deemed a necessity for families with children, rather than simply desirable (Mack et al, 2013) for the first time for families in the UK. This assumption applies regardless of geography, supporting the argument that car ownership might be 'forced' based on socio-demographic and economic situations regardless of location.

People from disadvantaged neighbourhoods are most likely to have transport needs at times beyond the traditional 'peak travel' framework, when frequency of public transport may not be sufficient. Mobility disadvantages suffered by women and relatively low-paid, self-employed, part-time or contract workers are particularly marked in dense urban areas, where they face longer commute times (Jahanshahi et al., 2015). Therefore, even where public transport services exist, they are not necessarily suitable to replace car use for those with complex travel demands. We therefore examine the relationships between car ownership

and financial difficulties in deprived urban areas, in order to explore the phenomenon of forced car ownership. We argue that those who own a vehicle, despite financial hardships may rely on this as a means of mobility and therefore could be said to be forced into car ownership.

2.1. Research Questions

In recent years, there has been some convergence in car ownership levels between affluent and disadvantaged communities, although the gap remains considerable (Lucas and Jones, 2009). Although this may be that this is a sign of more people successfully meeting their mobility needs, transport geography research has demonstrated the complexity of the income-car ownership dynamic. Yet, while there is a wealth of research understanding factors associated with car ownership, there is limited longitudinal evidence. In order to investigate changes in car ownership within deprived urban communities, we therefore address the questions of:

- *How are financial difficulties related to car ownership between 2006 and 2011 in deprived communities in Glasgow?*
- *What financial and socio-demographic factors lead to car adoption?*
- *To what extent is there evidence of forced car ownership in Glasgow and who and where are the forced car owners?*

3. Methodology

3.1. Glasgow

Our study utilises data from the [name to be added] project, which is an ongoing, ten year investigation of housing, regeneration and neighbourhood renewal in Glasgow. Glasgow is the largest city in Scotland with a population of nearly 600,000 and a metropolitan area of around 1.2 million people (WPR, 2016). Like many post-industrial cities, Glasgow has struggled to find a new role within the globalised economy (Pacione, 2009; Seaman et al.,

2015) and contains over 40% of the most deprived datazones in Scotland. The overall rate of household car ownership in Glasgow rose from 44% to 49% between the 2001 and 2011 censuses, still well below the Scottish rate of 69% for 2011. There are large disparities in access to a vehicle across the city. Household car ownership by, ranges from 6% to 94% patterned by deprivation.

3.2. Summary of study material

The [name of project removed for blind review] project is based on the study of fifteen deprived communities between 2006 and 2011. Fourteen of the areas have been classified as amongst the 15% most deprived neighbourhoods in Scotland, while six fall within the most deprived 5% based on national indices of deprivation (Bond et al., 2012). Within each of the fifteen study areas are a number of sub-areas. These data can assist in understanding the experiences of people in particularly disadvantaged communities prior to the recession, in the midst of the recession, and during subsequent economic austerity. Given the importance of transport in the regeneration process (see Dodds, 2011), this research offers valuable insights into the impact of the recession and financial difficulties on mobility in deprived communities using a longitudinal dataset. The remainder of Section 3 describes the study design and analytical approach.

3.3. Survey design and sample size

Surveys were conducted in 2006 (Wave 1), 2008 (Wave 2) and 2011 (Wave 3) using a repeat cross-sectional design with a nested longitudinal cohort. Random samples of addresses were selected for interview across the selected study areas in Waves 1 and 2. At Wave 3 all previous addresses where an interview had been conducted were selected for the sample. The surveys achieved response rates of 50.3% (6003) in 2006, 47.5% (4688) in 2008 and 45.4% (4175) in 2011. For the purposes of this analysis we excluded one study area which was not included in the sample until Wave 2, giving a final sample for analysis of

6003 (Wave 1), 4869 (Wave 2) and 4270 (Wave 3). As with all surveys there are limitations in terms of sample bias. In our sample, females and older adults are over-represented relative to the population in the study areas. We control for these factors in the analysis where appropriate and are sensitive to the sample bias in the interpretation of our results.

Retrospective matching of names and addresses was used to identify the longitudinal cases embedded in the surveys. We removed those who moved house between interviews, to ensure that change in residential location did not impact analyses. Although moving house may in itself be an important reason for car adoption, the small numbers did not allow inclusion here and it was not our focus in this paper. The final longitudinal sample numbers for this analysis are therefore 1050 (Wave 1 – Wave 2) and 1179 (Wave 2 – Wave 3). Retention bias is an issue in longitudinal surveys, as those who remain in the sample may differ from the baseline. The characteristics of our longitudinal samples do differ from the cross-sectional samples but this is mainly due to houses being demolished in some areas and less a result of bias in terms of respondent retention. Each survey was undertaken as a discreet survey with a repeated panel and longitudinal element. The longitudinal sample was derived by address-matching and therefore it is likely that respondents were not aware they had been 'retained.'

Using both cross-sectional and longitudinal data helps eliminate some of the limitations with each type of sample. Triangulating our results in this way gives confidence that the effect of sampling and retention bias is reduced. By using cross-sectional data, we can see whether the same patterns occur at repeated intervals without the possibility that the retained sample is biased. The longitudinal data however allows control for participant characteristics which helps address sample bias.

3.4. Measures

In this section, we outline the key measures used to answer our research questions, including socio-demographic variables. These include car ownership, financial difficulty, household public transport accessibility, and socio-demographic variables.

Car ownership

Our measure of car ownership asked whether the household owns or has the use of a vehicle (yes/ no response).

Financial difficulty

Income was not measured in the survey, rather we focused on financial circumstances through self-report measures of the experience of financial difficulties relating to: rent or mortgage costs; household energy bills; the cost of food; and household maintenance. Increases in the price of food and household energy were among the many impacts of the recession, while pressure on wages and household budgets led to severe affordability issues in relation to housing, with many in work but on low incomes struggling (Crossley, 2013; Gardiner and Alakeson, 2014). The survey question asked the household how often they struggle to afford each item, with four categories of response: never; occasionally; quite often; very often (recoded as 'experiences financial difficulty': yes/ no). For most of our analyses we combined these items into one binary measure of financial difficulty and report whether respondents are struggling to afford any of the household expenses or not. We also create separate measures combining food and energy bills into one measure and housing costs (rent, mortgage and repairs into another) based on preliminary descriptive analyses. Notably, all participants live in income deprived areas and in this context, those reporting financial difficulties can be understood to be experiencing severe hardships.

Area Level Measures of Income Deprivation and Geographic Access

We use area level measures of income and geographic access from the Government's Scottish Indices of Multiple Deprivation (SIMD)ⁱ. These scores are provided at the level of the datazone (homogenous areas with average populations of 860 people in the case of Glasgow and used for presentation of official statistics) and attached to our survey data-set according to the address of the respondent. SIMD statistics are not produced every year, but periodically. In this paper we use data from 2006 and 2009, which most closely match with our survey data.

The income deprivation score is calculated as the proportion of the datazone population either in receipt of, or dependent on someone in receipt of, any of the following: Income Support, Employment and Support Allowance, Job Seekers Allowance, Guaranteed Pension Credits, or Child and Working Tax Credits. A higher score therefore indicates that a datazone is more income deprived.

The Geographic Access domain score is calculated by ranking indicators of public transport journey times to the nearest General Practitioner (GP), post office and shopping facilities and car journey times to nearest GP, petrol station, post office, primary school, secondary school and shopping facilities. Scores for each indicator are standardised to a standard normal distribution and combined using weights generated by Factor Analysis. The drive times and public transport times are combined using the weightings: drive time: 0.75 and public transport travel times: 0.25ⁱ. A larger score indicates longer journey times and therefore that an area is more transport deprived.

Socio-demographic variables

Additional variables included in the analysis are: gender; number of adults and children in household; employment status; educational qualifications and built form of dwelling (multi-storey flat, other flat or house).

3.5. Analytical approach

ⁱ <http://www.gov.scot/Topics/Statistics/SIMD>

The analytical approach is in three stages.

1) *Changes in car ownership and financial difficulties*

Aggregate-level data are presented to demonstrate trends in the relationship between car ownership and financial difficulties. We examine whether there has been significant change in car ownership in our sample and whether financial difficulties are significantly associated with car ownership at each survey wave. First, we examine the rate of car access among those with or without financial difficulties for the whole sample at each survey wave. Second, we plot the relationship at each wave between the aggregate rates of financial difficulty and car access at the level of the 32 subareas included in the study.

2) *Factors associated with car adoption*

For this analysis, we categorise respondents into four groups:

- Non drivers: do not have access to a car at any time point.
- Drivers: maintain a vehicle at both time points.
- Adopters: adopt a car.
- Relinquishers: relinquish a car.

Descriptive analyses are presented for each of the above categories using each of the two periods: 2006-2008 (period 1) and 2008-2011 (period 2). The differences in area-level income and transport accessibility SIMD scores among the categories presented above are examined using one way ANOVA. This allows us to understand the extent to which area level transport availability or area deprivation are related to car ownership status.

Next we use a sub-sample of the survey, taking only those who do not have a car at their first interview (either in 2006 or 2008). We then use car ownership as a binary outcome variable to examine factors associated with car ownership at second interview. Bearing in mind that all respondents in this analysis did not have a car at their first interview, this means that we are able to establish factors associated with a household adopting a car. We present two separate models for each longitudinal cohort (2006-2008 and 2008-2011). First, we use financial variables as predictor variables, categorising respondents into groups

based on changes in financial circumstances between interviews: those who are struggling experience financial difficulties at both interviews, 'slipping' means they report financial difficulties at second interview but not the first interview; those who are 'improving' no longer report financial difficulties in the second interview. The comparison group is those who do not experience financial difficulties at either interview. We have separated financial difficulties into two groups: 1) Food and energy bills and 2) Housing costs (rent/mortgage and households repairs).

We then examine the socio-demographic variables associated with car ownership at second interview for each longitudinal cohort. The predictor variables in these models are sex; household size, split into adults and children; changes in household size; employment status; education and built form.

3) *Identifying Forced Car Ownership*

Based on the first two sections of analyses we suggest there is value in exploring the characteristics of those who *could* be seen to be forced into car ownership, on the basis of owning a vehicle, despite financial difficulties. To do this we derive a classification of four groups of forced car owners, based on their experience of financial difficulties, and present an exploratory analysis of the socio-demographic and spatial distribution of these forced car owners. The four groups are:

- ***Financially struggling Driver*** - those who experience persistent financial difficulty and maintain a car
- ***Financially struggling Adopter*** - those who experience persistent financial difficulty yet adopt a car
- ***Financially slipping adopter*** - those who enter into financial difficulty and yet adopt a car
- ***Financially slipping driver*** - Those who enter into financial difficulty yet maintain a car.

4. Results

4.1 Changes in car ownership and financial difficulties

As might be anticipated, given that all of the study areas in the sample fall within the 15% most income deprived in Glasgow, aggregate-level data show the rate of household car ownership in the study areas is lower than across the city as a whole, with 27.7% of the households surveyed having access to a vehicle in 2011 compared to a city average of 49% (Census, 2011). There are also considerable differences evident between the study-sub areas; some have household car ownership rates below 10% while others approach 50%. This seems to reinforce the orthodoxy of a strong link between income and car ownership (Carr-Hill and Chalmers-Dixon, 2013).

There was an overall trend of increasing levels of car ownership across the study areas during the research period, from 24.5% in 2006, 25.7% in 2008 to 27.7%. Logistic regression models confirm a statistical relationship between year of survey and level of car ownership. In comparison with 2006, respondents in both 2008 (ORⁱⁱ=1.095, $p<0.05$) and 2011 (OR=1.202, $p<0.01$) were more likely to own a car. Focusing only on those reporting financial difficulties, the trend towards increasing car ownership in fact yields more pronounced results (2008: OR=1.603, $p<0.00$; 2011: OR=1.73, $p<0.00$). This finding indicates increased levels of car ownership even among people experiencing financial hardship.

In 2006, prior to the recession of 2008-2009, there was a 9% gap in levels of car ownership, between respondents with and without financial difficulties (Figure 2). From 2006 to 2011, car ownership levels remained relatively stable, but still relatively low, for interviewees who did not report any financial difficulty. However, for those who reported financial difficulty on any of the indicators, car ownership rates rose from below 20% to over 25% between 2006-2011. In 2006, interviewees reporting financial difficulties were less likely to have access to a car (OR=0.536, $p<0.00$) than those who did not report difficulties. Furthermore, the *number* of financial difficulties reported was also significantly associated with car ownership

ⁱⁱ OR=Odds ratio. This shows the odds ratio between car ownership rates in each year compared to the baseline in 2006. In 2008 respondents are 1.095 times more likely to own a car than in 2006. This is a low effect size, but shows general upward trend and is statistically significant.

(OR=0.869; $p<0.00$), as interviewees reporting more financial difficulties were less likely to have access to a vehicle. However, in 2008 and 2011 these relationships were not significant and the negative correlation between financial difficulties and car ownership was absent.

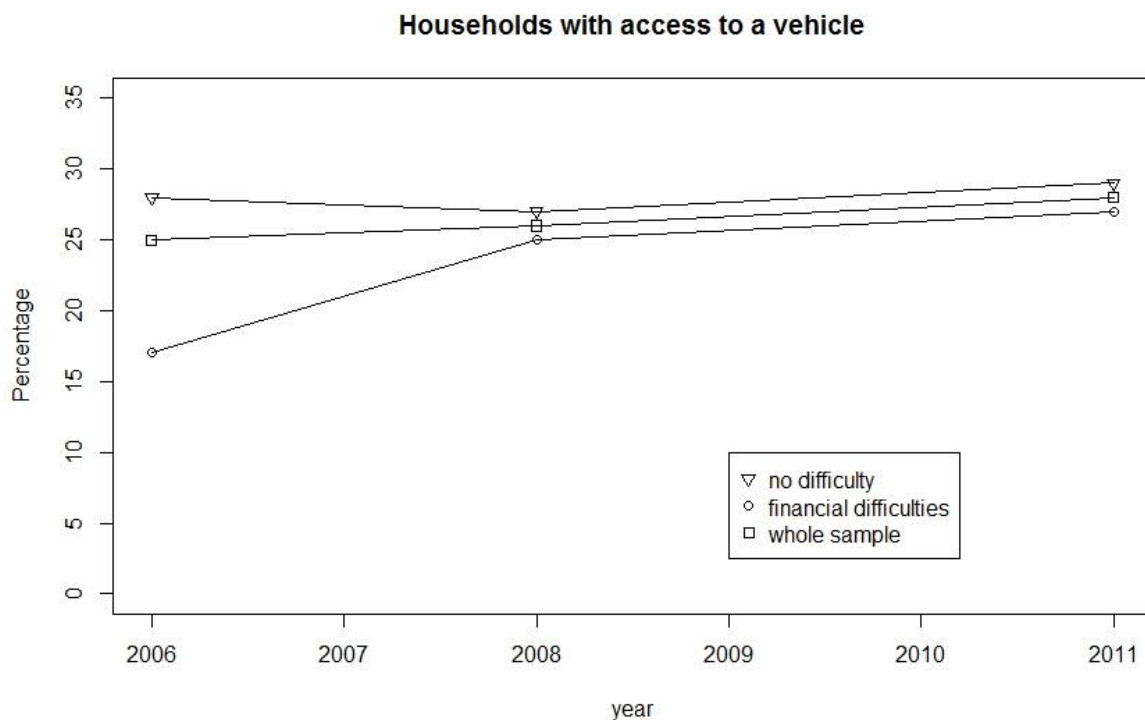


Figure 2 – Percentage of respondents with access to a vehicle at each survey wave, split by reporting of financial difficulty

In Figure 3 the relationship between financial difficulties and household car ownership is broken down to the sub-area level. In 2006 higher rates of financial difficulty are associated with lower rates of car ownership, as would be expected based on the traditional associations between these factors, although the effect size is small. However, the following two graphs suggest this association has dissolved post-recession. Further, whereas only three of the subareas had rates of car access of 40 percent or above in 2006, this was true of eight subareas in 2008 and seven in 2011.

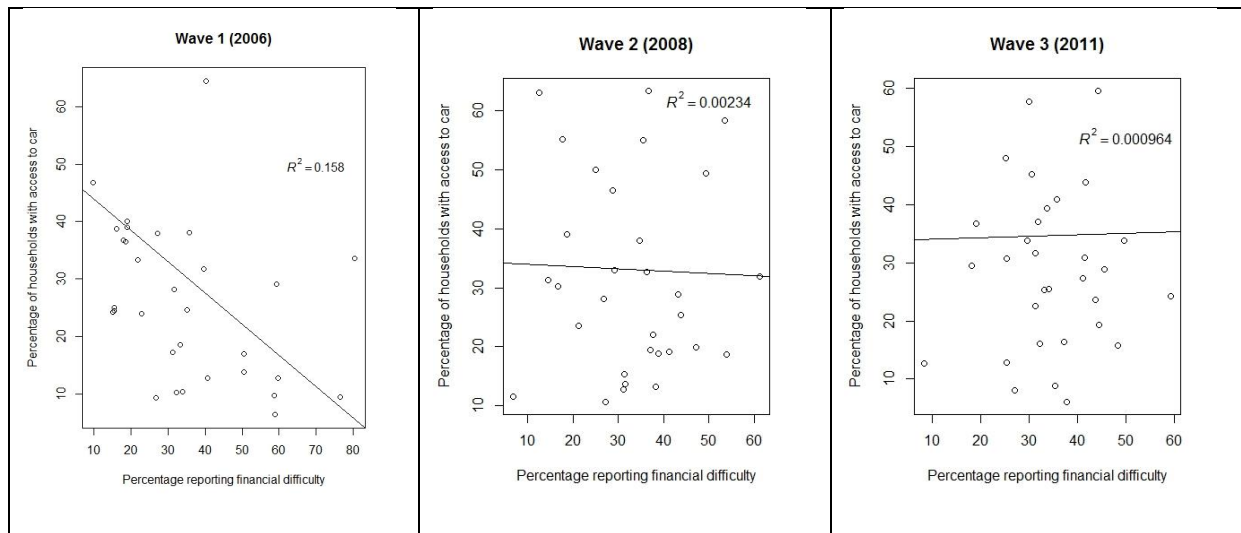


Figure 3 Relationship between financial difficulty and car ownership rates at sub-area level, by survey wave

While it is surprising to find apparently increasing levels of car ownership, alongside persistent or increasing financial difficulties, at this aggregate level of analysis it is not possible to conclude that it is the same individuals who are experiencing financial hardship and increasing car ownership. However, this analysis provides the context within which we can explore the survey data in more depth and further investigate the relationships between financial difficulty and car ownership over the period of recession at the individual level. Section 4.2 presents analysis of individual changes in car ownership, related to financial and socio-economic characteristics.

4.2 Factors associated with car adoption

The cross-sectional analyses presented so far suggest that the relationship between car ownership and financial difficulty has weakened since 2008, while car ownership has been rising. This does not allow us to understand the factors associated with such changes in car ownership. To understand factors associated with change we must exploit the longitudinal nature of our dataset.

We categorised respondents according to their car ownership status between pairs of survey waves. Area level accessibility in an area is potentially a key determinant of changes in car

ownership and arguably a necessary factor for the concept of forced car ownership (Currie and Senbergs, 2007). In order to understand whether car ownership has changed in relation to area-based accessibility or income deprivation, the neighbourhood-level SIMD (Scottish Indices of Multiple Deprivation) scores for geographic access and income are compared across the categories of change in car ownership (Table 1).

Table 1 – Proportion of respondents in longitudinal survey in each category of car ownership compared with mean area level deprivation scores

Category of change in car ownership status	Description	2006-2008	Income deprivation Score (confidence interval) higher score=more deprived (SIMD 2006)	Geographic Access Score (confidence interval) higher score=more deprived (SIMD 2006)	2008-2011	Income deprivation Score (confidence interval) higher score=more deprived (SIMD 2009)	Geographic Access Score (confidence interval) higher score=more deprived (SIMD 2009)
Non drivers	No car at either wave	72.5%	0.353 (0.345,0.361)	7.61 (7.187,8.022)	66.1 %	0.385 (0.376, 0.394)	7.712 (7.345,8.080)
Drivers	Retained car between waves	12.5%	0.322 (0.301,0.343)	9.61 (8.481,10.726)	17.9 %	0.322 (0.304, 0.340)	8.638 (7.861,9.416)
Adopters	Adopted car between waves	9%	0.344 (0.324,0.363)	6.79 (5.51,8.06)	9.3%	0.384 (0.361,0.407)	7.816 (6.786,8.846)
Relinquishers	Relinquished car between waves	6%	.0344 (0.341, 0.355)	8.55 (6.804, 10.287)	6.7%	0.399 (0.370, 0.429)	6.684 (5.648, 7.720)
One way ANOVA for differences in SIMD measures among categories of car owners			F=3.030, p<0.05, df 3,956	F=5.365, p<0.01, df 3,956		F=14.776, p<0.01, df 3,1044	F=2.99, p<0.05, df 3,1044

Higher income and geographic access deprivation scores indicate more deprived areas. For example, drivers live in more transport deprived areas, but less income deprived areas. If confidence intervals between categories of car ownership are not overlapping then there is a significant difference in the kind of area the types of driver live in.

Although the majority of respondents did not have access to a vehicle at any survey wave, more people adopted a car than relinquished one between each survey wave, reflecting the overall increase in car ownership. Comparing the 2006-2008 and 2008-2011 periods it is clear that there were more drivers in the second instance.

Variance tests (ANOVA) show there were significant differences between at least two car ownership groups in each case. We used Bonferroni post-hoc tests and describe the *significant* differences between groups here. Between 2006 and 2008 the *drivers* live in less income deprived areas than *non-drivers*, supporting the idea of a relationship between car

ownership and income. *Drivers* also live in areas of poorer accessibility than *non-drivers*. *Adopters* however live in areas of better accessibility than *drivers* which may explain why they had recently adopted a vehicle, rather than having maintained one.

In 2008-2011, *drivers* live in less income deprived areas than *non-drivers*. We also found that both *adopters* and *relinquishers* live in more income deprived areas than *drivers*, suggesting that for some households, levels of income deprivation have led to relinquishment of vehicles, whereas others become vehicle owning households despite income deprivation. In general, interviewees who maintained a car lived in less income deprived areas than those whose car ownership circumstances fluctuated. *Relinquishers* lived in areas of better accessibility than *drivers* or *non-drivers*.

This broad, area-level analysis gives us some insights into how car ownership is related to area level income and transport deprivation across the study areas. In order to analyse the effects of individual and household factors on changes in car ownership we now present a series of multiple logistic regression models for car adoption (Table 2). The model summary shows the low explanatory power (demonstrated by Nagelkerke R^2)ⁱⁱⁱ of the models, indicating that the financial difficulty variables do not account for a large proportion of the variation in car ownership. The financial difficulty model suggests that those who were struggling with rent and repairs were more likely to adopt a vehicle both between 2006 and 2008, and between 2008 and 2011. This may be because they were less likely to own a car in the first instance or because the car may be seen as a solution to difficult financial circumstances by providing mobility and therefore access to a broader range of jobs.

Table 2 – Logistic regression models predicting household car ownership at second interview for two time periods for those who did not have a car in household at first interview

Financial difficulty model	Time Period	
	2006-2008	2008-2011
Financial difficulty: food & energy bills ref: no change & no difficulty		
Struggling	0.677 (0.288, 1.590)	0.852 (0.336, 2.165)
Slipping	0.525 (0.237, 1.160)	1.072 (0.518, 2.217)

ⁱⁱⁱ Nagelkerke R^2 is a model fit statistic for logistic regression models and can be interpreted in a similar way to R^2 in linear regression (Field, 2009).

	Improving	0.785 (0.370, 1.664)	1.452 (0.727, 2.901)
Financial difficulty: rent & repairs			
ref: no change & no difficulty			
	Struggling	3.041 (1.169, 7.916)	4.081 (1.384, 12.031)
	Slipping	0.901 (0.296, 2.74)	1.808 (0.756, 4.323)
	Improving	1.50 (0.768, 2.931)	1.376 (0.617, 3.067)
	Constant		0.067
	Model:	n=790; NR ² =0.022	n=1329; NR ² =0.02
Socio-demographic model			
	Sex (ref: male)	0.649 (0.387, 1.089)	0.982 (0.557, 1.732)
	Total adults (baseline)	2.146 (1.546, 2.98)	1.346 (0.925, 1.957)
Change in adults (ref: no change)			
Increased number of adults		2.539 (1.174, 5.491)	1.296 (0.613, 2.737)
Decreased number of adults		0.455 (0.172, 1.205)	0.661 (0.251, 1.729)
	Total children (baseline)	1.524 (1.164, 1.995)	1.364 (1.03, 1.807)
Change in children (ref: no change)			
Increased number of children		1.617 (0.748, 3.3497)	4.176 (2.016, 8.649)
Decreased number of children		0.176 (0.054, 0.569)	0.778 (0.261, 2.336)
Change in employment			
(ref: stay in unemployment)			
remain in work		2.040 (0.9, 4.622)	3.930 (2.001, 7.718)
Retired		1.648 (0.826, 3.286)	0.788 (0.372, 0.1668)
become unemployed		4.566 (1.283, 16.244)	(n=0)
move into work		2.150 (0.848, 5.449)	5.242 (2.386, 11.517)
Educational qualifications (ref: none)		1.740 (0.954, 3.171)	1.343 (0.773, 2.336)
Built Form (reference: multi-storey flat)			
Other flat		1.107 (0.616, 1.987)	1.3 (0.721, 0.343)
House		2.977 (1.44, 6.154)	3.197 (1.501, 6.81)
Constant		0.19	0.026
	Model:	n=743; NR ² =0.180	n=711; NR ² =0.228

(Bold=result significant at $p < 0.05$)

The socio-demographic model has higher Nagelkerke R^2 values than the financial difficulty model, suggesting that the predictive power of the socio-demographic variables in explaining vehicle adoption is greater than the financial difficulty variables. Households with more adults and those with an increased number of adults were more likely to adopt a vehicle (2006-2008). Similarly households with more children were more likely to adopt a vehicle (2006-2008/2008-2011) as were those with an increased number of children (2008-2011). Between 2006 and 2008 households with a decreased number of children were less likely to adopt a vehicle. Household size is therefore a key determinant of whether a household adopts a car. This might be related to demands on time and mobility requirements for households with children and can be supported by the inclusion of a car as a requirement in the UK's minimum income standard for households with children (Mack et al, 2013). For adults, it may be that changing numbers of adults in the household increases the overall resources and ability for the household to operate a vehicle, or that the increase in adults reflects grown-up children who are a keen car adopter group.

Householders who remained in work or moved into work (2008 – 2011) were more likely to adopt a vehicle, supporting the idea that material resources are important in terms of being able to afford private vehicle ownership. For those who move into work, a car may have enabled the uptake of employment for some. Perhaps more surprisingly, respondents who became unemployed were more likely to adopt a vehicle (2006-2008), although this is consistent with the finding that living in income deprived areas was associated with vehicle adoption and may be explained by the car being seen as a means to changed circumstances or allowing access to a wider range of job opportunities.

Those living in houses, rather than flats were more likely to adopt a vehicle (2006-2008/2008-2011). This may be because the built form of the home is an indicator of socio-economic status. It may also be that houses signify a less dense type of urban morphology and are located in areas where car mobility is considered more necessary than in flatted areas.

These results show that a much wider range of factors are associated with changes in car ownership than financial difficulty alone and may challenge the use of car ownership as a proxy for income. In some cases there are unexpected findings, such as those slipping into financial difficulty or unemployment adopting vehicles.. Indeed, the fact that in some cases car ownership in our study areas approaches the city average despite being among the most income deprived areas is evidence that the relationship between financial circumstances and car ownership is not straightforward. The results presented thus far provide some evidence of forced car ownership, that is, vehicle ownership despite persistent or increasing household financial difficulties. In Section 4.3 we present an approach to categorising and understanding who the forced car owners might be.

4.3 Identifying forced car ownership

We define forced car owners as people in households that own a vehicle despite financial difficulties. Geographical proximity to destinations is important to those with little money, and a good public transport system should eliminate the necessity of a private vehicle. Therefore,

we suggest that if a household has a car despite financial difficulties, the public transport system must be inadequate to satisfy the particular mobility needs of the household in question.

Using the longitudinal dataset, 4.2% (Wave 1), 7.4% (Wave 2) and 8.5% (Wave 3) of the sample can be defined as forced car owners. The increase in the proportion of interviewees who own a vehicle despite reporting financial difficulty contributes to the weaker relationship between financial difficulty and car ownership during and after the period of recession. Within this group of forced car owners there are four distinct groups, categorised based on financial and car access status at each wave as listed in Section 3.5. (Table 3):

Table 3 – Categorisation and characteristics of ‘forced car owners’

	Prevalence within ‘forced car owners’		Typical demographic Characteristics 2006-2008	Typical demographic Characteristics 2008-2011
	2006-2008 (n=54)	2008-2011 (n=60)		
<i>Financially Struggling Driver</i> -those who experience persistent financial difficulty and maintain a car	24%	28%	Female. Unemployed. Educational qualifications.	2+ adults. 2+children. Unemployed. Educational qualifications
<i>Financially Struggling Adopter</i> – those who experience persistent financial difficulty yet adopt a car	28%	12%	Female, 2+ adults. 2+ children. High proportion (73%) unemployed. Educational qualifications. Live in multi-storey flats.	Female. 2+ adults. 2+children.
<i>Financially Slipping Adopter</i> – those who enter into financial difficulty and yet adopt a car	19%	14%	Male, 2+ adults. 2+ children. Unemployed. Live in multi-storey flats.	Female. 2+children. Unemployed
<i>Financially Slipping Driver</i> – Those who enter into financial difficulty yet maintain a car	30%	46%	Female, 2+ adults. Unemployed.	2+children. Educational qualifications.

The proportion of each *type* of forced car owner who report financial difficulty both before (2006-8) and during (2008-11) the recession is shown in Table 3. During both time periods the largest single category of forced car owners are financially *slipping drivers*, who entered into financial difficulty and maintained. This is consistent with the evidence to suggest that relinquishing a vehicle is difficult, even if financial circumstances change (Dargay, 2001). The data also showed a considerable and increased proportion of struggling drivers who maintained a vehicle despite ongoing financial difficulties. Despite car ownership having risen, particularly for those with financial difficulties (Figure 2), *slipping adopters* who acquired vehicles despite moving into financial difficulty comprised a small and decreased proportion of the forced car owners. Finally, *struggling adopters*, who acquire a vehicle despite ongoing financial difficulties decreased as a proportion of the forced car owners, partly as a function of the increased car ownership, but also indicating that over the recession period (2008-2011 results) those who had ongoing financial difficulties were less likely to adopt a vehicle. This indicates that the increase in car ownership among those with financial difficulties in the cross-sectional analysis represents increases in both financial difficulty and car ownership, rather than increased car ownership among those already experiencing financial difficulty. There is some evidence of being *forced into* car ownership it appears that people felt unable relinquishing a vehicle, despite financial difficulties. This is especially the case in the 2008-2011 data, suggesting that during the period of recession an existing vehicle may be crucial for accessing employment opportunities.

To examine who the forced car owners are we compared the proportion of each category of forced car owners who fell into each of the socio-demographic categories with those who are not forced car owners. Typical characteristics of each group of forced car owners are shown in Table 3 (full results are included as an appendix). These descriptions are included for illustrative purposes but the small sample of forced car owners means that the results are not robust to statistical analyses. These descriptors can be used to indicate which groups may be more or less likely to be forced car owners, care must be taken in interpretation and

when drawing conclusions from these results. Results show the proportion of forced car owners with two or more children was considerably higher than either non-car owners or car owners without financial difficulties. This shows that households with children felt the need for a vehicle despite financial difficulty, which may also be exacerbated by greater numbers of children. A greater proportion of struggling and slipping drivers have educational qualifications, which may indicate an element of social expectation among different socio-economic groups as some people may feel social pressure to maintain a vehicle, despite financial difficulties.

Given the importance attached to geographical location in the concept of forced car ownership it is also relevant to understand the geographical distribution of forced car ownership across our study areas. Between 2006 and 2008, those who have a vehicle despite financial difficulties were geographically clustered. In four of the 32 sub-areas over 15% of the population were classed as forced car owners. In the remaining 28 sub-areas that proportion was under 10% of the population, including 12 sub-areas which had no respondents classed as forced car owners. In one sub-area almost 30% of the population were forced car owners, despite being geographically close to the city centre (6.5km). Given its central location, the sub-area is relatively transport deprived according to SIMD. In the 2008-2011 sample, the distribution across study areas was more even, alongside an overall increase in forced car owners. This suggests that forced car ownership became more prevalent across the study areas rather than clustered in a few areas as only six sub-areas had no forced car owners. Two sub-areas had over 30% of respondents classed as forced car owners and eight sub-areas had over 10%. This increase in car owners with financial difficulties is concerning against a backdrop of regeneration over the same time period in these study areas because the nature of the regeneration process in these areas may have not ensured adequate access to services, which is essential for addressing the inequalities faced by these communities. Rather there is a perceived or real reliance on cars among those experiencing financial difficulty, despite geographical proximity.

5. Discussion and Conclusions

The study of transport and social exclusion in deprived urban communities experienced a revival following the publication of the SEU report, 'Making the Connections' in 2003. However, the policy response, mainly concerned with accessibility planning, has been criticised for taking a 'black box' approach (Lucas, 2006), focusing on time-based exclusion, and failing to recognise individual experience (Curl et al, 2011). Furthermore, Scheiner (this issue) notes a lack of empirical longitudinal studies in transport studies related to residential location. In contrast, we present the individual experience of financial difficulties as related to car ownership using a longitudinal dataset, offering unique and valuable insight into the impact of the recession and financial difficulties on deprived communities. This enables us to contribute to the evidence on how transport and other household costs impact people in difficult financial circumstances.

Considering factors that affect car adoption, having children in the household was a key influence, reinforcing the importance of recent changes highlighted in the minimum income standard (Davis et al, 2014), which now includes a car as a necessity for families with children. The decoupling of car ownership from financial difficulties is an especially worrying trend, within this context, given that it may be indicative of forced car ownership in financially distressed families rather than reflecting shifting cultural norms. Contrary to the policy aspiration of transport sustainability, several aspects of our analysis suggest that the car may be seen as a route out of poverty, by providing access to a wider range of economic opportunities. Moreover, regeneration policy may be failing to ensure access to local employment without recourse to private modes of transport, and lack integration with public transport strategies (Turcu 2012).

Our results indicate there is a growing phenomenon of 'forced car ownership' within deprived parts of the city where people, especially those with children, face particular challenges of multi-tasking and multiple responsibility (Lucas 2014). The majority of those we identified as forced car owners retained a car, despite ongoing or worsening financial difficulties. Fewer

adopted a car alongside financial difficulties (although some did so), suggesting that rather than being forced *into* car ownership, the majority of respondents felt unable to give up a car despite experiencing financial difficulties. Our findings lead us to suggest that within low income groups living in disadvantaged areas, many people see car ownership as necessary for one or more reasons. These reasons include searching for jobs or the take up of employment for those out of work, perhaps increasingly so given the growth of the 'gig economy' (Hutton 2016), as a means to cope with the complexity of household mobility needs where numbers of children or numbers of adults in a household increases, and, potentially, as a perceived cheaper or more convenient alternative to the use of a mixture of public transport and taxis/cabs. It is striking that in our analysis, those with financial difficulties are more likely to adopt a car than others, and this presents a conundrum for policy-makers concerned with transport and welfare.

Increases in car ownership may reflect low baseline levels of car ownership in our study areas. However, given this increase occurred over a time of economic recession, alongside increasing financial difficulties for a number of people, we are concerned that it may reflect a more worrying trend of declining local services and poor accessibility, within the economic context of a shrinking jobs market and local government cutbacks and that this forces poorer households into car ownership.

Another possible explanation for increased car ownership and a decoupling of car ownership and financial difficulties could be a decrease in the cost of car ownership. As shown in Figure 1, the cost of motoring has decreased *relative* to alternative modes. This relative, but not absolute, decrease in costs might help explain why car ownership has increased despite financial difficulties and supports the notion of forced car ownership.

Although we recognise a number of limitations with this study, it provides a valuable contribution to the debate around transport disadvantage, focusing on individual experience using longitudinal evidence. However, a more detailed understanding of how travel behaviour, in terms of numbers of trips and main modes of travel, had changed over the

period of the study would provide further valuable insights beyond our single measure of car ownership. Furthermore, the static nature of our survey data limits the insights we can draw into changes occurring between survey waves. In relation to our category of *slipping adopters* we do not know whether respondents have adopted a car despite falling into financial difficulty or fallen into financial difficulty because they felt a car was necessary. More in depth longitudinal research would allow some of these complexities and dynamics to be more thoroughly understood.

Despite the limitations it is important to challenge the assumption that car ownership is an unproblematic proxy for income. We have demonstrated evidence of increasing car ownership among households experiencing financial difficulty, which we interpret as forced car ownership. To assume that car ownership is a choice for those on low incomes underestimates the mobility and financial challenges faced by those seeking to manage competing time demands and adapt to the changing employment market. Accessibility is not just about proximity, but also the quality, frequency and viability of the public transport and land use system to provide an alternative to car ownership for all in society and to allow full participation in economic and social activity. To suggest that geographical proximity means car ownership is not necessary for those on low incomes risks entrenching socio-economic disadvantages associated with not having access to a car, rather than addressing the reasons why a car is deemed necessary.

Conceptually, the topic of forced car ownership is likely to remain contentious. There is the potential perception that car ownership is a choice, rather than forced for in people who have chosen homes in less accessible areas (Currie and Delbosc, 2009). Our approach however, has centred on understanding patterns of car ownership and adoption in very deprived, urban communities. The findings suggest serious weaknesses in any simplistic assumption that, for those in relatively dense urban areas, car ownership and adoption must be a matter of choice because public transport offers an adequate alternative. We have found that, both at the individual and aggregate levels, the relationship between financial difficulties and car

ownership has weakened, indicating a more complex and dynamic relationship between financial circumstances and car ownership than conventional wisdom would indicate. Indeed, our findings support Dargay (2001) in suggesting that once a car has been acquired it is difficult to relinquish it, even in times of financial difficulty.

Although forced car owners appear to be geographically clustered, our research raises concerns that the issue is becoming more widespread across the study population. We suggest that the car may be viewed as a route out of poverty for some people, given the characteristics associated with car adoption and forced car ownership. That forced car ownership is growing in areas which have been the focus of regeneration initiatives is a concerning trend and suggests that transport and regeneration policy need to work more in tandem to ensure that the car is not a necessary route out of deprivation but, rather, that transport and land use planning support accessibility to jobs and services.

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Appendix

Table A – Comparison of socio-demographic characteristics across categories of forced car owner (2006-2008)

	Non forced car owners		Forced car owners			
	Car owners	Non-car owners	Struggling driver	Struggling adopter	Slipping adopter	Slipping driver
Female	55%	63%	62%	67%	40%	63%
2+ adults	63%	35%	62%	73%	80%	60%
2+children	24%	15%	15%	53%	30%	13%
Remain in unemployment	25%	43%	31%	73%	30%	33%
Remain in work	34%	8%	23%	13%	10%	20%
Retired	32%	41%	23%	13%	10%	20%
Gain employment	6%	5%	15%	7%	20%	0%
Educational attainment	31%	15%	62%	40%	20%	33%
Multi-storey	20%	42%	23%	53%	50%	31%
Flat	44%	45%	54%	40%	40%	38%
House	36%	12%	23%	7%	10%	31%

Table B - Comparison of socio-demographic characteristics across categories of forced car owner (2008-2011)

	Non forced car owners		Forced car owners			
	Car owners	Non-car owners	Struggling driver	Struggling adopter	Slipping adopter	Slipping driver
Female	58%	63%	52%	82%	85%	63%
2+ adults	71%	37%	88%	73%	54%	66%
2+children	17%	11%	44%	55%	31%	24%
Remain in unemployment	18%	40%	50%	36%	67%	26%
Remain in work	41%	11%	25%	18%	22%	39%
Retired	31%	44%	17%	0%	0%	29%
Gain employment	10%	4%	8%	45%	11%	6%
Educational attainment	47%	22%	71%	36%	15%	51%
Multi-storey	19%	35%	4%	27%	23%	15%
Flat	10%	51%	56%	64%	62%	51%
House	41%	14%	40%	9%	15%	34%