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Where sustainable transport and social exclusion meet: households without cars and car dependence in Great Britain

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Abstract

A secondary analysis of the British National Travel Survey for the years 2002-2010 shows that the composition of the group of carless households is a good indicator for the level of car dependence in a local area: indeed, while non-car ownership in peripheral and rural areas very often corresponds to a marginal socio-demographic situation, this is less and less true as one moves towards larger urban areas. Similarly, while in sparse areas most households without cars are either virtually immobile or reliant on car lifts, in large urban areas the 'mobility gap' between car-owning and carless households is considerably smaller, as the latter are able to use modal alternatives to the car. These findings are interpreted with reference to an integrated theoretical framework, showing how changes in land-use and the environmental and social impacts of increasing motorisation are intimately linked. Notably, the consequences of the self-reinforcing cycle of car dependence on two forms of car-related transport disadvantage (car deprivation and forced car ownership) are highlighted. Overall, the article highlights how the socio-demographic composition and the travel behaviour of carless households vary systematically across different types of area: this has interesting implications for sustainable transport policy and research.

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Keywords

car ownership; households without cars; transport disadvantage; sustainable transport; car dependence

1. Introduction

1.1. The concept of car dependence

The trends in surface passenger transport of the last century have two kinds of problematic consequences: environmental and social. With regard to the first, the increase in travel distances, car use and ownership has made transport one of the main contributors to greenhouse gas (GHG) emissions (Schäfer, Heywood, Jacoby, & Waitz, 2009) and is thus unsustainable. On top of that, the remarkable resistance to change demonstrated by transport systems makes them one of the most challenging aspects on the climate change agenda (Chapman, 2007). Transport research generally acknowledges that car ownership is a crucial determinant of modal choice and travel behaviour, both at the individual (Van Acker & Witlox, 2010) and aggregate level (Kwon & Preston, 2005). This is worrying because the number of cars and vans worldwide is increasing rapidly and, if current trends continue, is expected to reach one or two billion within a couple of decades (Schäfer et al., 2009). Although growth is more rapid in developing countries, this trend calls European societies, where motorisation is approaching saturation, into question as well (Dargay, Gately, & Sommer, 2007). As Dennis and Urry (2009, p. 44) argue, if the rest of the world were to reach the motorisation rates of the EU, this would put too much strain on oil reserves and the atmosphere's capacity to absorb GHG emissions.

With regard to the second aspect, such trends also have profound implications for social inequality: in a more mobile world, the ability to cover greater distances and access to motorised means of transport arguably become a crucial factor for social inclusion, social status and quality of life (Knowles, 2006).

In this paper, I move from the premise that the environmental and the social consequences of increasing motorisation are deeply intertwined. In order to illustrate this point, I use the theoretical concept of 'car dependence'. This notion is used in a variety of ways in transport literature, with the main division running between a micro-social understanding of the term (where it is an attribute of the individual) and macro-social one (where it refers to a local society's reliance on the automobile). For this reason, it is important to clarify how I employ the concept in this article.

The micro-social understanding of car dependence is probably the most common in transport literature. From this perspective, it is an attribute of individual actors who are considered to rely or depend on the car. As illustrated by Stradling (2003), the term is used to identify both individuals who might want to reduce car travel, but cannot (because of constraints) and individuals who might be able to use alternative modes, but do not want to (because of personal attitude). In that sense, the micro-social understanding of car dependence focuses mostly on individual agency (or lack thereof) in daily travel behaviour.

In this work, by contrast, I employ a macro-social understanding of car dependence, whereby it is not the attribute of individual actors, but rather of (local) societies as whole. For example, Lucas and Jones (2009, p.116) define a "car reliant location" as one "where it is virtually impossible to access a given location by any other mode of transport, or where it is impossible to live in place without a car (e.g. deeply rural village with no local facilities)" and "a car reliant society" as one where "high and increasing levels of car use are observed among the

population as a whole and where people without cars are excluded from essential activities”. The focus here is on structural factors that sustain and reproduce increasing reliance on the car at a macro level, and thus explain resistance to change. In sociological terms, this approach is thus closer to the paradigm of structure rather than the paradigm of agency.

The notion of car dependence has notably been used – alongside similar concepts such as “automobility” (Urry, 2000) – to stress the positive feedback and the self-reinforcing dynamics of motorisation: in this framework, the sheer force of “more motorization” creates the preconditions for further motorisation (Newman & Kenworthy, 1999; Dupuy, 1999). Similarly to the notion of “path dependence”, this concept is also used to stress the resistance encountered by policy measures aimed at reducing car use and ownership².

1.2. Travel and the built environment

Most scholarly work employing a macro-social understanding of car dependence deals with the structural constraints related to the built environment, focusing notably on the self-reinforcing dynamic between land use and transport. According to Farber and Páez (2011), for example, these elements are:

“intimately linked in a cycle of reinforced urban expansion and development of automobile-oriented transport and land-use infrastructure. Automobility makes far-off places reachable, attractive, and therefore developable. These areas are then only feasibly reached by automobiles, therefore (...) inducing the adoption of the automobile by residents, and the promotion of automobile infrastructure” (p. 790)

² To be sure, the fact that this process is self-reinforcing does not exclude external determinants of motorisation such as rising income and decreasing motoring costs (see de Jong, Fox, Daly, Pieters & Smith, 2004).

Similarly, Dennis and Urry (2009) argue that the automobile has brought about an increasing fragmentation (or 'disembedding') of space, which in turn requires the use of a vehicle to be suitably re-embedded. Newman and Kenworthy (1999) define "automobile dependence" as "a situation in which a city develops on the assumption that automobile use will predominate" so that it is given priority in its design, infrastructure and operation (p. xiii, 60). In that sense, it manifests itself as "a combination of high car use, high provision for automobiles, and scattered low-density use" (p.124). As a result "other modes (...) become increasingly peripheral, marginal or non-existent until there are no real options for passenger travel other than the automobile" (p. 334).

In a nutshell, these studies highlight how increasing motorisation results in new land-use patterns, which in turn induce higher motorisation. This is consistent with existing evidence on the relationship between travel and the built environment, one of the most thoroughly researched topics in urban planning (Ewing & Cervero, 2010; Stead & Marshall, 2001; Handy, 2005). In this context, several features of the built environment have been studied and summarised by Ewing and Cervero (2010) under the 'six D's': density, diversity, design, destination accessibility, distance to transit and 'demand management' measures. The problem here is that the variables related to the six D's are generally strongly correlated: therefore, while their cumulative effect on travel behaviour is often found to be large and relevant, identifying the individual effect of a single variable is much more difficult (Stead & Marshall, 2001). As a result, while it is generally accepted that levels of car ownership and use are higher in low-density suburban and rural areas (as compared to central, high density urban areas) the exact role of each built-environment characteristic is much less clear. Moreover, while research in the American context has often focused on the impacts of density, Næss has argued that "in a European context (...) the location of the residence relative to the main

metropolitan centre and sub-centres within the metropolitan-scale spatial structure have turned out to be more influential” (2009, p. 295).

In this context, Van Acker and Witlox (2010) have shown how car ownership acts as a mediating variable between the built environment and car use: the spatial characteristics of the residential location (a long-term decision) influence the medium-term decision to own a car, which in turn strongly affects daily travel behaviour (a short term decision) (p. 65). This happens because car ownership is best conceived as a commitment to a specific mode, which reduces the usage of other modes (Simm & Axhausen, 2001). Therefore, the built environment has two kind of effects on travel behaviour, direct and indirect (i.e. via the effect on car ownership), and the latter can be very significant.

1.3. Car-related transport disadvantage

As travel distances and motorisation have increased, the disadvantages associated with being unable to cover greater distances and/or not having access to a motorised means of transport have become more important (Knowles, 2006). This explains why the growing number of studies that have tackled the links between transport, accessibility and social exclusion in recent years. Kenyon, Lyons and Rafferty (2002) provide a good definition of the field of ‘transport and social exclusion research’ (Currie, 2011), defining ‘mobility-related social exclusion’ as:

“the process by which people are prevented from participating in the economic, political and social life of the community because of reduced accessibility to opportunities, services and social networks, due in whole or in part to insufficient mobility in a society and environment built around the assumption of high mobility” (p.210-211)

In short then, the object of interest is the relationship between transport and accessibility to essential services and opportunities, on one hand, and social inclusion and/or well-being on the other. While it is beyond the scope of this article to provide a full review of this literature, in this section I briefly discuss how car ownership and use (or lack thereof) are related to patterns of transport disadvantage³. In order to do this, based on a review of the relevant literature, I distinguish between two main forms of *car-related transport disadvantage*: *car deprivation* and *car-related economic stress*.

To be clear, the goal here is not to put forward a notion of car-related transport disadvantage as opposed to other mode-specific forms of transport disadvantage. Instead, I aim to show how forms of transport disadvantage vary in relation with car ownership and use, as well as other intervening factors. This allows me to put forward, in the next section, an integrated framework to conceptualise both the environmental and social consequences of car dependence.

Car deprivation can be defined as the form of transport disadvantage that might derive from not having access to a car. In this context, it is assumed that car deprivation has, at least potentially, a negative impact on social inclusion and/or well-being, insofar as it may limit access to essential services, opportunities and networks. To be clear, this does not mean that the lack of a car always corresponds to transport disadvantage, nor that having access to a

³The notion of 'transport disadvantage' (Hine & Mitchell, 2003; Dodson, Gleeson & Sipe, 2004; Currie, Stanley & Stanley, 2007) can be defined as the lack of access to services and opportunities arising from the interaction of three sets of factors: land use patterns, the transport system and individual characteristics (Currie & Delbosc, 2011a, p. 15). It is assumed that this has a potentially negative impact on social exclusion and/or well-being at least.

vehicle is an absolute defence against it. However, a considerable amount of research shows that in certain contexts and for certain categories of people, lack of car availability is a crucial determinant of transport disadvantage.

Car deprivation is certainly the most intensively investigated form of transport disadvantage in research on transport and social exclusion (Currie & Delbosc, 2011a, p. 23). In the US, as early as the 1970s, researchers were defining 'being carless' as "a fundamental reason for being disadvantaged with regard to getting around" (Paaswell & Recker, 1976, p. 1). In the last two decades, an increasing number of studies in the US have focused on the role of transport in the welfare-to-work transition, generally concluding that non-car ownership significantly reduces the likelihood of finding a job (Blumenberg & Manville, 2004). Similarly Lucas, synthesizing the results of an international scoping study on transport and social exclusion (2003) has concluded that "in the context of G7 countries at least, a car is essential to full participation in economic and social life" (p.13).

From an analytical perspective, lack of car access translates into transport disadvantage if access to essential services and opportunities with alternative modes of transport is problematic. This can be the result of dispersed land use patterns (resulting in greater distances between destinations), attributes of the transport system (e.g. poor public transport services) and/or individual characteristics (e.g. disability, safety concerns, etc.). Disadvantage can arise, in a rather direct way, by the fact that accessing certain services, opportunities or networks without a car is difficult, and this discourages participation. Alternatively, it can also be the outcome of an indirect process whereby, for example, access to employment is possible, but commuting with modes alternative to the car is so time-consuming that little time is left for other activities essential for social inclusion, thus resulting in time poverty (Farber and Páez, 2011).

With regard to differences across types of area, existing literature suggests that the *intensity* of car deprivation is higher in areas where car dependence is stronger. This argument is supported by empirical studies relying on a diversity of methods, ranging from econometrics (Dargay, 2002) to quantitative surveys (Gray, Farrington, Shaw, Martin, & Roberts, 2001) and focus groups (Smith, Hirsch, & Davis, 2012). However, given higher levels of motorisation in these areas, the *share* of the population that is exposed to car deprivation is lower.

Car deprivation has undoubtedly attracted most attention in transport and social exclusion research. In recent years, however, as the motorisation rate of low-income groups has grown and fuel prices have increased, there has been increasing recognition that there are also forms of transport disadvantage associated with car-access. In this context, different terms are used to indicate the economic stress associated with owning, maintaining and running the household car(s) and its potential consequences in terms of social exclusion and reduced well-being. Currie and Delbosc (2011b), for example, use the term *forced car ownership* (FCO) to describe the situation of:

“low-income car users located in areas with poor accessibility and limited mobility alternatives (...). The high costs of car ownership are said to be forced on households with a limited capacity to afford them where no cheaper mobility alternatives are available” (p. 193)

FCO is a form of transport disadvantage because excessive expenses for car ownership and use can lead households to cut spending in other essential areas, with knock-on effects on social inclusion and well-being (Taylor, Barnard, Neil & Cregan, 2009). Alternatively, households may choose to allocate enough money to other activities (considered essential), and reduce travel spending accordingly: this can force them to restrict their activity spaces, thus reducing the opportunities for them to participate in mainstream society.

Existing empirical evidence suggests that FCO is observed more frequently in peripheral, low-density areas where car dependence is strong but housing is cheap: this tends to attract low-income households who cannot afford expensive housing in more central areas, but struggle to cope with higher transport expenditure in the new residential location. This phenomenon has notably been observed in Australia (Dodson & Sipe, 2007; Currie & Delbosc, 2011b) and France (Polacchini & Orfeuil, 1999; Motte-Baumvol, Massot & Byrd, 2010).

Research and policy interest in this form of transport disadvantage are likely to intensify in the future, as fuel prices keep rising. In this context, Dodson and Sipe (2007) have used the term 'oil vulnerability' to refer to people who are not necessarily experiencing car-related economic stress now, but are likely to do so in the future in the event of increasing fuel prices.

2. Research framework, data and methodology

2.1. Theoretical framework

Having set out the main empirical concepts, in this section I put forward an integrated theoretical framework to conceptualise both the environmental and social consequences of car dependence (Fig.1). This aims to fill a gap in existing literature, since the corresponding research fields have remained mostly separated until now. Indeed, although studies in transport and social exclusion research literature devote considerable attention to car deprivation and other forms of car-related transport disadvantage, they often fail to situate the issue within the broader process of increasing motorisation. Even when they do so, pointing out that it results in diminishing accessibility for non-motorised households (see for example Clifton & Lucas, 2004, p. 15-16), they generally pay less attention to the resulting increased pressure to own a car felt by these households – and thus to the self-reinforcing dynamic of the process as a whole. Conversely, studies focused on the negative environmental

consequences of car dependence generally overlook the significance of transport disadvantage in explaining the self-reinforcing nature of motorisation.

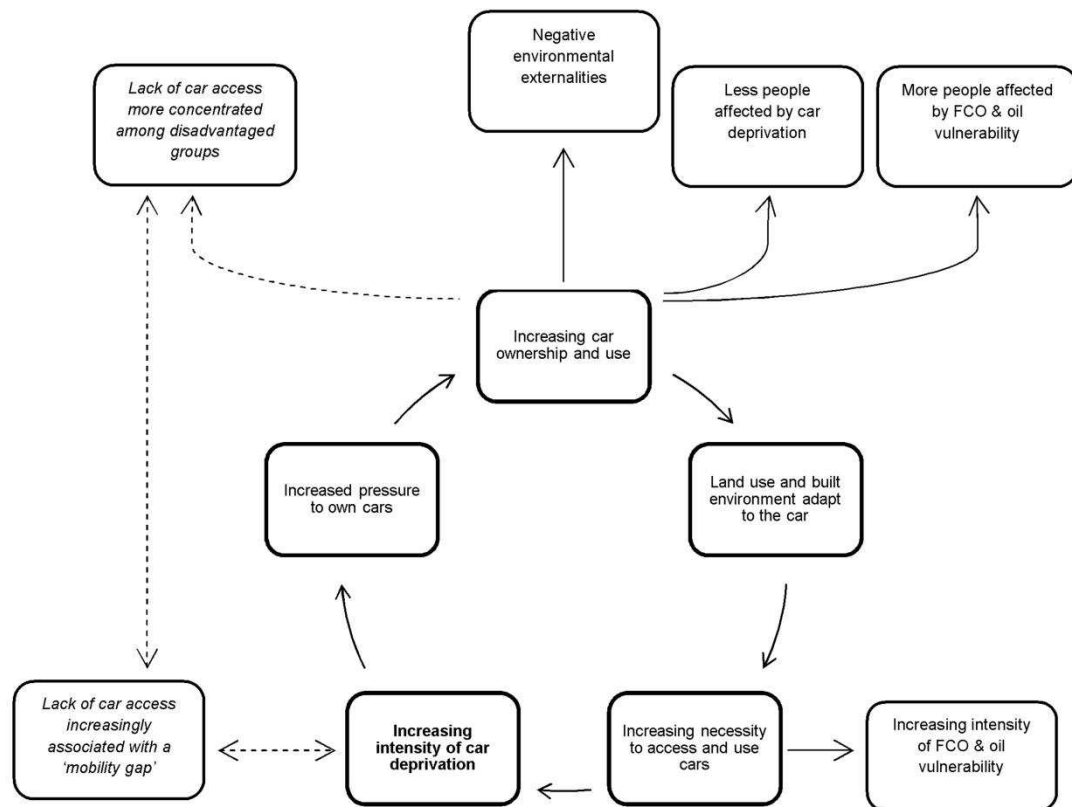


Figure 1. Self-reinforcing cycle of car dependence with social and environmental externalities. Source: Own elaboration.

Fig.1 depicts the self-reinforcing cycle of car dependence, as well as several ‘externalities’ arising from this process. It illustrates how increasing motorisation results in new land use patterns that, in turn, increase the necessity for car access and use. This arguably increases the intensity of all forms of car-related transport disadvantage. Notably, it reduces accessibility for non-car users, thus aggravating car deprivation. This, in turn, is likely to result in increasing

pressure to own a car, thus feeding back into the first step of the cycle. Such an increase in car ownership and use is of course associated with negative environmental externalities.

This illustrates how the spatial changes associated with increasing car dependence result in increasing intensity in both car deprivation and FCO. However, there is a crucial difference: while the aggravation of FCO can be considered as an *externality* of this process, the intensity of car deprivation is a *key factor* in the cycle of car dependence. As Dupuy (1999) argues, the existence of a fundamental gap between the benefits of the automobile system for car users and the situation of non-car users is a crucial driver of the process of car dependence, as it arouses the interest of outsiders who then want to join the system; at the same time, this gap increases as new members join the 'club', thus having positive feedback on the system itself.

If we were to consider how many people were affected by the different forms of car-related transport disadvantage, instead of the intensity of said forms, the picture is different. Every spin of the cycle results in an increasing number of people affected by FCO and oil vulnerability, as it brings about increased pressure to own a car despite the financial burden associated with it (notably for low-income households). However, the opposite is true for car deprivation since, as motorisation increases, less people lack access to cars. Therefore, the self-reinforcing cycle of car dependence results in an *increasing intensity of car deprivation for a decreasing proportion of the population*.

This allows the formulation of two hypothesis concerning people without car access (depicted in Fig. 1 with dashed arrows and italics font). Firstly, as Clifton and Lucas have suggested, increasing pressure to own cars results in a *concentration of lack of car access in disadvantaged groups* (2004, p. 15-16). Although the authors do not develop the hypothesis further, it is plausible that, as car access increasingly becomes a necessity, lack of car access will increasingly be concentrated among those who, for whatever reason (e.g. low income,

disability, lack of driving licence, old age, etc.), face important barriers to car ownership and use.

Secondly, the increasing intensity of car deprivation is likely to be associated with a widening gap between the mobility levels of people without car access and their motorised counterparts. In other words, as access to services and opportunities with alternative modes becomes more and more difficult, the relative mobility levels of non-car users are likely to reduce.

2.2. Research hypothesis

In the previous section, I have adopted a diachronic perspective, discussing the notion of car dependence as a self-reinforcing process that develops over time. If I were to adopt a synchronic perspective instead, it must be acknowledged that this process has not been equally pervasive in all types of area. In fact, as argued above, it is possible to distinguish between *more* and *less* car dependent areas, depending on spatial characteristics such as (among others) density, centrality and diversity of land uses.

To simplify this discussion, in Tab.1 I assume the existence of only two extreme types of area, with reference to the European city-type. All other types of area are assumed to be located somewhere between these two poles.

Table 1. Car dependence, intensity of car deprivation, size and composition of the group of people without car access across different types of area in the European urban structure

	High-density historic city centre	Low-density peri-urban or rural area
<i>Car dependence</i>	Min.	Max.
<i>Intensity of car deprivation</i>	Min.	Max.
<i>Share of people without car access</i>	Max.	Min.
<i>Composition of the group of people without car access</i>	?	?

As illustrated in the table, there is a consensus in relevant literature that low-density peri-urban and rural areas are characterised by the highest levels of car dependence; accordingly, the intensity of car deprivation there is at its peak. On the other hand, the share of people lacking car access is lowest in these areas (highest motorisation rates). At the opposite end of this (deliberately simplified) opposition, high-density historic city centres are the least car dependent areas: here lack of access to cars is the least associated with transport disadvantage, given the high performance of modal alternatives. The proportion of the population living without car access is also highest here. In a nutshell then, car deprivation has a peculiar relationship with the level of car dependence of the local area: the stronger car dependence, the lower the likelihood of finding people without car access, but the higher the chances that this results in serious disadvantage.

The last row in Tab.1 shows a blind spot in the literature: while there is considerable evidence to demonstrate that less people lack car access in low-density peripheral areas (as compared to compact inner cities), less is known about who these people are, i.e. about how the *composition* of this group varies across different types of area. In this paper, I aim to fill this evidence gap, putting forward two hypotheses.

1. I expect the group of people without access to cars in compact cities to be not only larger, but also more diverse in terms of socio-economic composition. By contrast, in peripheral and rural areas the group is likely to be more concentrated among marginal social groups
2. I expect the group of people without car access in peripheral and rural areas to include a great share of people with low mobility levels (as compared to people with car access). By contrast, I expect the equivalence between autolessness and low mobility to be attenuated in dense urban areas

2.3. Research object

In order to test these hypotheses, in this article I present the results of a secondary analysis of the British National Travel Survey (NTS) for the years 2002-2010. The analysis is focused notably on households who do not own cars, and this requires some explanation.

Clearly, household car ownership is not necessarily the same thing as individual access to a car, even though of course there is a great degree of overlap. In fact, non-drivers in car-owning households have to rely on other household members in order to take advantage of the vehicle(s). Furthermore, 'car deficient households' (Scheiner & Holz-Rau, 2012), where there are less cars than licensed drivers, are regularly confronted with the question of which household member is entitled to use the vehicle; this process of allocation can result in considerable inequality in car availability, notably along gender lines (Anggraini, Arentze & Timmermans, 2008; Scheiner & Holz-Rau, 2012). Therefore, even licensed adults in car-owning households have sometimes restricted access to cars, and this can result in transport disadvantage with negative impacts on well-being and social-exclusion (Delbosc and Currie, 2012). In a nutshell then, even individuals in car-owning households might experience lack of

car access and car deprivation. On the other hand, individuals in non-car owning households may have access to vehicles, either as drivers of borrowed or rental cars or as passengers (informal car-pooling, lift-giving, etc.). Therefore, non-car ownership does not necessarily entail lack of access to a car.

Despite these limitations, I argue that, in the context of this article, focusing on households without cars is the best research strategy. The reason for this is that, while the two concepts are not synonymous, lack of household car ownership is arguably a good *proxy* for lack of car access. This is confirmed by descriptive statistics for Great Britain (NTS 2002-2010), showing that 82% of individuals living in households without cars do not have access to a car as drivers, considerably more than in motorised households (34%⁴). Therefore, even though *in theory* lack of household car ownership is not equivalent to lack of individual car access, *in practice* there is a considerable degree of overlap⁵.

Therefore, in the remainder of this article the operational definition of ‘the carless’ is ‘individuals in households who do not own cars’. Accordingly, the research hypotheses are explored with reference to this subsample. This, like every methodological choice, obviously limits the scope of the analysis and creates blind spots. Notably, it overlooks differences in access to vehicles *within car owning households*, and thus the issue of car deprivation in ‘car-deficient households’. On the other hand, however, this approach allows me to assess the existence of differences *between* households. It also allows me to explore the extent to which individuals in non-car owning households make use of the automobile, and how this varies

⁴ The figures include individuals under 16 who by definition cannot be drivers.

⁵ Focusing the analysis on individuals who do not have access to a car as drivers would be equally arbitrary, as it would mean assuming that non-drivers in households with cars have less car access than drivers in households with cars – a questionable assumption.

across different types of area, thus partially addressing the question of the difference between car access and ownership.

2.4. Data and methodology

Since 2002, the British National Travel Survey has been carried out on a continuous basis on a sample of about 9,000 households per year. All household members, children included, have to complete a one week travel diary, by proxy if necessary. Besides travel behaviour, a range of household and individual characteristics are assessed in the questionnaire. The survey is representative for Great Britain (Northern Ireland is excluded).

For the analyses in this article, I have used pooled data from the NTS 2002-2010 database⁶ (Department for Transport, 2012). This allows me to work with a larger sample size: this is crucial since the carless are only a small subset of the total sample. While this obscures any differences between years, it allows for more disaggregate analysis and more robust estimates than would be possible for individual years.

3. Empirical results: households without cars in Great Britain

3.1. Socio-demographic composition

As noted above, 25% of households in the pooled sample, corresponding to 19% of individuals (20,416 households, 36,064 individuals and 316,325 trips) do not own cars. In terms of socio-

⁶The NTS 2002-2010 was conducted by the National Centre for Social Research on behalf of the Department for Transport, which owns the data. The dataset is kindly provided by the Economic and Social Data Service (ESDS) through the UK Data Archive at the University of Essex, Colchester.

demographic profile, preliminary descriptive analysis (Tab. online 1) shows that singles, households without members under sixteen and family units with a household reference person (HRP) that is either female or not employed are overrepresented among carless households⁷. In terms of age, both younger and older households are overrepresented, and the same applies to households including at least one member with mobility difficulties (on foot and/or by bus). Finally, non-car ownership is also disproportionately concentrated amongst low-income households, with approximately 70% of carless households in the two lowest quintiles.

Table 2. Size and composition of the carless households group in different types of area (percentage values). Source: own elaboration on NTS 2002-2010 data.

	London Boroughs	Metropolitan built-up areas	Other urban over 250k	Urban over 25k to 250k	Urban over 10k to 25k	Urban over 3k to 10k	Rural	Total
Households without cars	41	33	25	25	23	19	10	100
<i>As percentage of households without cars</i>								
Single-person units	49	54	58	59	64	66	68	57
No member under 16	82	82	83	82	84	87	88	83
Female HRP	53	59	60	61	65	67	65	60
Age of HRP: 60+	33	47	48	52	61	65	72	49
No employed member	49	67	67	70	76	80	81	66
At least one member with mobility difficulties	24	38	37	38	44	46	49	37
Two lowest income quintiles	55	76	70	73	75	77	76	70
Four characteristics or more	44	62	62	66	72	78	80	62

⁷ In the NTS, the HRP is defined as “the householder with the highest income, or their spouse or partner” who answered the household questionnaire (Rofique, Humphrey, Pickering, & Tipping, 2011, p. 16).

The incidence of non-car ownership is obviously very uneven across different types of area⁸ (Tab.2): while 41% of family units in London Boroughs do not own cars, this figure is as low as 10% in rural areas. The descriptive statistics illustrated in Tab.2 also provide a first piece of evidence to show that the socio-demographic profile of carless households becomes less diverse as the degree of urbanisation decreases. For example, only 33% of carless households in London are over 60 years old, a figure which is as high as 72% in rural areas. The same pattern is apparent for all seven key socio-demographic characteristics listed in Tab.2, even though for some, such as the absence of young children, the increase is only moderate. The last row shows how the percentage of carless households that accumulate four or more of the characteristics listed above (such as, for example, a household composed of a single woman over 60) varies across different types of area: an increasing trend is apparent in this case too, with households with a marginal socio-demographic profile accounting for 80% of households without cars in rural areas, but for less than half of the group (44%) in London.

⁸ In this and in the following section, I illustrate differences between areas with reference to the variable 'type of area'. However, every trend has been double-checked using two other geographical variables: population density in the Local Authority and in the Primary Sampling Unit. The results broadly confirm the findings illustrated here.

Table 3. Odds ratios of not owning a car for key socio-demographic characteristics, by type of area. Source: own elaboration on NTS 2002-2010 data.

	London Boroughs	Metropolitan built-up areas	Other urban over 250k	Urban over 25k to 250k	Urban over 10k to 25k	Urban over 3k to 10k	Rural
Single-person units	3.9	5.6	5.8	6.6	8.3	9.1	10.5
No member under 16	2.1	2.2	2.1	2.0	2.4	2.7	2.9
Female HRP	2.4	3.4	3.6	3.8	4.8	5.2	5.4
Age of HRP: 60+	1.6	2.5	2.6	2.9	3.6	3.6	4.9
No employed member	4.4	7.1	7.4	8.2	9.2	11.6	12.1
At least one member with mobility difficulties	1.9	2.6	2.7	2.8	3.4	3.7	4.4
Two lowest income quintiles	3.6	6.3	5.8	6.4	6.7	8.3	8.0

However, these trends might be (at least in part) the by-product of socio-demographic differences between different types of area. Tab.3, which shows odds ratios for the same seven key socio-demographic variables across different types of area, controls for this confounding effect. For every variable and every area, the odds ratio is defined as the odds of not owning a car (rather than owning it) for households who have the characteristic in question, divided by those same odds for other households. So for example the first row shows that, in London, the odds of not having a car (rather than having one) are 3.9 times more for single-person households compared to family units with two or more members. This figure increases steadily as one moves towards less urban areas, reaching a staggering 10.5 in rural areas. The same trend is apparent for all other variables, although the increase is less pronounced for most of them – and notably is almost absent for the variable assessing the presence of young children. This indicates that the positive association between the six key socio-demographic variables and non-car ownership is substantially greater in peripheral and rural areas. This confirms that the carless are more concentrated among marginal social groups where the degree of urbanity is lower.

This conclusion is further supported by more formal analyses: in this context, the values of McFadden's pseudo R^2 (a goodness of fit statistic) have been computed for a series of logistic regression models including only socio-demographic predictors that have been fitted separately for the different types of area (Fig. online 1)⁹. The results clearly show that the values increase significantly as we move from London to less urbanised areas, from 0.20 to 0.39 (in small urban municipalities between 3,000 and 10,000 inhabitants) before declining slightly for rural areas. Therefore, the fit of the model in the more peripheral areas should be considered very good, especially if one acknowledges that it deliberately excludes any independent variable related to the area of residence (such as public transport access and the like), which could arguably increase the predictive power even further. This result can be interpreted as follows: predicting which households do not own cars on the basis of socio-demographic variables is much easier in sparser areas than in cities.

At this point, the evidence provided should suffice to show that in the NTS 2002-2010 sample the socio-demographic composition of the carless group varies systematically with the degree of urbanisation of the local area: notably, households without cars are much more concentrated in marginal social groups in more car dependent areas, thus corroborating the hypothesis put forward above.

⁹ The detailed results for the models are not reported here for the sake of brevity. The models include the following independent variables: number of household members (simple and squared terms); number of members under 16; female HRP (dummy variable); age group of HRP (categories: 16-29; 30-39; 40-49; 50-59; 60-69; 70+); number of employed members; at least one member with mobility difficulties (dummy); income quintile. In addition, a 'survey year' predictor was included to control for differences between waves.

3.2. Travel behaviour

The NTS questionnaire includes a one week travel diary that is completed by every household member. Therefore, while the unit of analysis in the previous section was the household, here I will focus on the travel behaviour of individuals living in carless households.

Fig.2 provides a first piece of evidence in support of the hypothesis that the ‘mobility gap’ of carless individuals is greater in more car dependent areas.

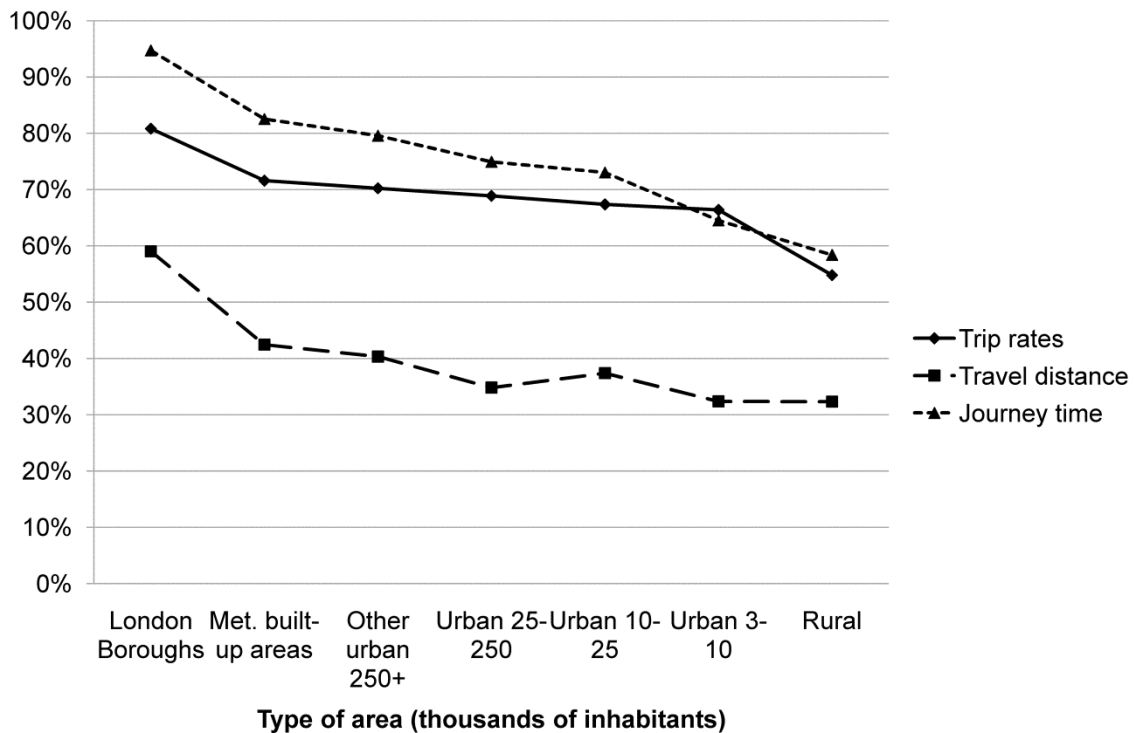


Figure 2. Travel behaviour indicators for carless individuals, as percentage of the same indicator for individuals in car-owning households, by type of area. Source: Own elaboration on NTS 2002–2010 data.

The graph shows how the values of three travel behaviour indicators for carless individuals (trips rates, travel distance and journey time), computed as percentage of the same indicator for individuals in car-owning households, vary across different types of area. The values should

be interpreted as follows: in London, carless individuals make on average approximately 80% of the trips of their motorised counterparts. This figure decreases as the degree of urbanity decreases, reaching 55% in rural areas. The same trend is observed for travel time and distance. Overall, then, it can be concluded that non-car ownership in low-density, peripheral areas corresponds to lower levels of mobility (as compared to motorised households), while this relationship is attenuated in dense urban areas. This corroborates the hypothesis put forward above.

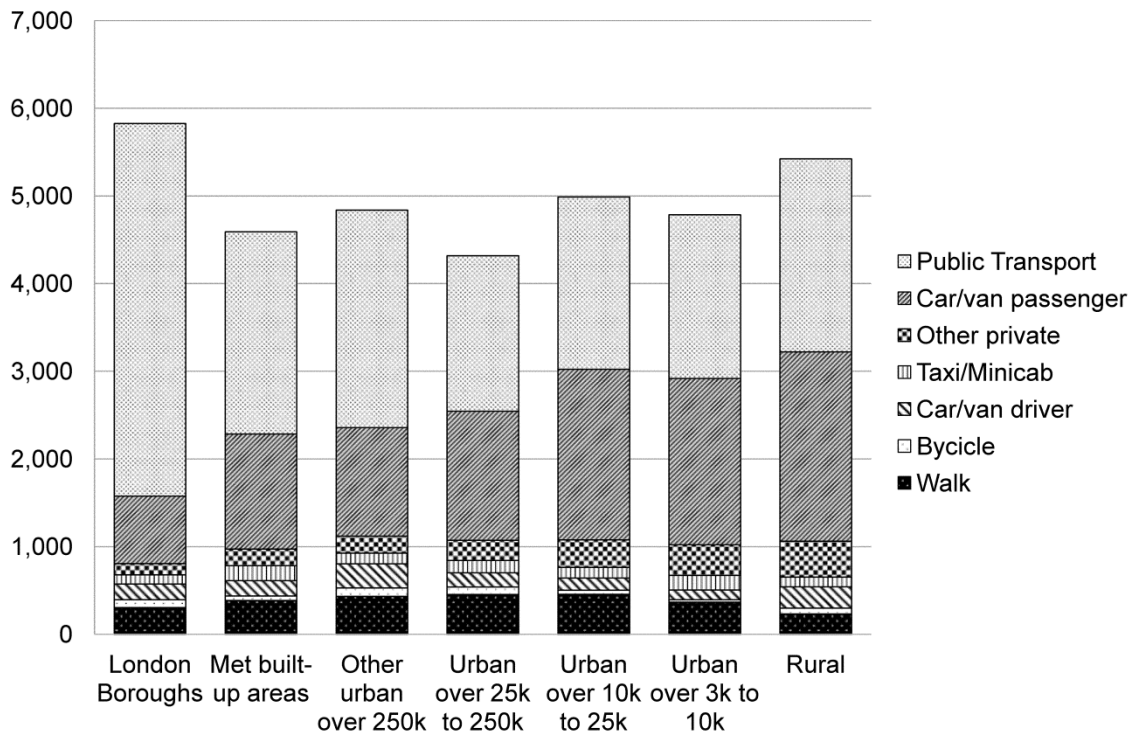


Figure 3. Total annual distance per person (km), by transport mode and type of area, for carless individuals. Source: Own elaboration on NTS 2002–2010 data.

However, further analyses suggest that this is not the only systematic difference in the travel behaviour of carless individuals in different types of area: indeed, carless individuals in car

dependent areas rely much more on the car. Fig.3 shows the average annual travel distance by transport mode, across different types of area. Overall, it appears that the degree of urbanity does not make much difference to travel distance: this stands in stark contrast with corresponding figures for members of car-owning households (Fig. online 2) showing that London residents travel on average much less than their rural counterparts. However, this stability for carless individuals is the result of two diverging trends: indeed, while the distance covered as a car passenger increases steadily as the degree of urbanity decreases in Fig.3, the opposite is true for public transport. As a result, the modal split is very different across types of area, with London carless individuals covering 73% of their travel distance by public transport and only 13% as car passengers, while the corresponding figures in rural areas are 41% and 40%. This pattern might be explained by the better provision of public transport in larger cities; yet, the changing composition of the carless group across different types of area illustrated in the previous section is probably not unconnected to these differences in modal behaviour.

To explore this hypothesis further, in the remainder of this section I present the results of a cluster analysis conducted on the subset of carless individuals, on the basis of travel behaviour variables. Two groups have been excluded from the analysis: children under the age of 16, because they are often accompanied by their parents, and adults who did not report travel during the survey week, due to missing information. The input variables used for the cluster analysis were: weekly travel distance; average speed of travel; the share of total distance travelled by car (either as driver or passenger), taxi or other private motorised transport means and the share of trips made for work or education related purposes¹⁰.

¹⁰ The clustering was conducted using a k-means algorithm, Euclidean distance as dissimilarity measure and standardized input variables. A four cluster solution was retained, representing the most distinct clustering, as attested by the maximum value of the Calinski/Harabasz pseudo-F statistic.

		Slow and Local	Car reliant	Public transport commuters	Immobile	Long distance week	Carless adults	NTS sample
Cluster size	%	40	23	23	8	6	100	-
<i>Travel week</i>								
Trips	<i>mean</i>	16.7	11.8	17.3	0	16.3	14.4	19.8
Distance travelled (km)	<i>mean</i>	64	79	105	0	551	100	237
Journey time (h:min)	<i>mean</i>	6:32	4:02	8:26	0	12:23	6:15	7:39
Average length of trips (km)	<i>mean</i>	5.6	8.2	7.6	-	40.1	9.3	13.7
<i>Modal split (basis: distance)</i>								
Walking		16	4	8	-	1	7	2
Cycling		2	1	3	-	0	2	1
Car/van driver		0	5	2	-	9	4	58
Car/van passenger	%	7	63	12	-	29	25	21
Public Transport		72	12	70	-	53	55	15
Taxi/minicab		2	6	3	-	1	3	1
Other private		0	9	2	-	7	4	2
Share of trips for work or education	%	8	9	66	-	27	28	36

Table 4. Typology of carless adults: clusters size and descriptive statistics for selected travel behaviour variables. Source: own elaboration on NTS 2002-2010 data.

While the values of the centroids for the four-cluster solution retained are reported in Tab. online 2, Tab.4 shows how the clusters differ in size and some key travel behaviour variables, which in turn are strongly related to the input variables. To allow comparison, corresponding values for carless adults as a whole and for the NTS sample are reported in the rightmost columns.

The table also shows results for a fifth cluster, labelled Immobile (IM, 8%), consisting of those respondents who were excluded from the cluster analysis because they did not travel at all during the survey week. While this group was not obtained by clustering methods, it is arguably characterised by very peculiar travel behaviour, and is thus an integral part of the typology put forward here. Another small group (6%), labelled Long Distance Week (LDW), has

the highest values on all indicators of overall travel, apart from the number of trips. Accordingly, it probably includes adults who made at least one long distance journey during the survey week (probably not representative of their ordinary travel behaviour): for this reason, I will ignore this cluster in the following. The Car Reliant cluster (CR), accounts for approximately one quarter of the subset and is characterised mainly by the high modal share of the car as passenger (63%) – motorised private means of transport and taxis taken together account for a staggering 83% of the distance travelled. Accordingly, individuals in this group are those that spend less time travelling, despite covering considerable distances, as they rely on faster travel modes. Moreover, people in this cluster virtually do not travel for work or education reasons, something which suggests low participation in employment and education. In a nutshell, people in this group, despite being carless, rely on car lifts, taxis and the like for most of their travel. The Public Transport Commuters cluster (PTC) also accounts for 23% of the carless, but it could not be more different: the distance travelled here is higher, but the speed lower, as public transport is clearly the dominant transport mode (70% of travel distance). Moreover, 66% of the trips made by individuals in this group are for work or education purposes. In short then, about a quarter of carless individuals are reliant on public transport in order to reach their work or study place. Finally, the biggest cluster (41%) shows a profile that is intermediate between the two previous: virtually no trips for work or education, but also no reliance on the car, which accounts for only 11% of the distance travelled. In contrast with both previous groups, this is the cluster with by far the lowest travel distance and speed, as it relies mostly on walking and public transport in order to travel short distances: accordingly, I have labelled it Slow and Local (SL).

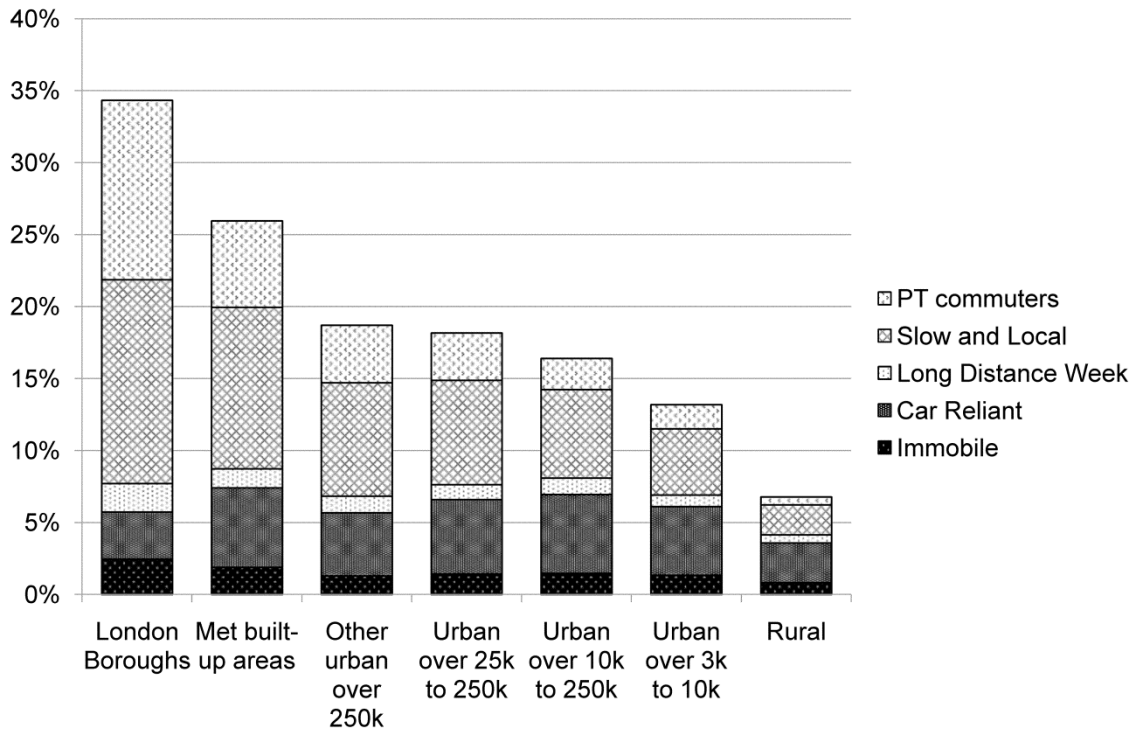


Figure 4. Size and composition of the group of carless adults across different types of area, by travel behaviour type. Data source: NTS 2002–2010.

Fig.4 depicts how the size of the groups varies across types of area: it can be observed that, while the CR and IM clusters (depicted with black background patterns) do not account for a much larger share of the total population in London than they do in rural areas, the size is much more variable for the SL and the PTC groups (white background patterns). As a result, while in rural areas approximately half of carless adults are either immobile or car reliant, but only 8% commuters, in London the latter group accounts for 36%, as compared to 10% for the CR cluster. Accordingly, most of the increase in the share of carless households that can be observed between the different areas is attributable to variations in clusters characterised by an intensive use of modal alternatives to the car. To sum up then, evidence from travel-diary data shows that the carless group is more diverse in terms of travel behaviour in more urban areas, with the large majority of individuals able to travel autonomously. This stands in stark

contrast with peripheral and rural areas, where the lack of a car more often than not corresponds either to immobility or dependence on others for lifts.

This is not the only point where clusters differ: descriptive statistics (Tab. online 3) show that the over 60s constitute the large majority (over 60%) of both the CR and the IM group. By contrast, the elderly account for just less than half of SL, and less than 4% of PTC. Other socio-demographic characteristics also show a stark contrast between CR and IM on the one hand – mostly composed of retired people and even more concentrated among the poor than the carless group average – and PTC on the other, where other household types (including families with children) and middle-upper classes are more represented. The SL group has a socio-demographic profile that is somewhat intermediate between the two, although it is especially concentrated among the poor (48% in the lowest income quintile). Finally, subjects with mobility difficulties are also overrepresented among CR and IM (about 50% in both clusters).

3.3. Discussion

The findings illustrated in the previous sections provide support for the two hypotheses. Firstly, the socio-demographic composition of the group of carless households varies systematically with the spatial features of the local area, with households without cars in peripheral and rural areas significantly more concentrated among marginal social groups¹¹. Secondly, the ‘mobility gap’ of individuals living in carless households also increases as the degree of urbanity decreases. Finally, the analysis shows the existence of another significant trend: carless individuals in small cities and rural areas rely significantly more on the car as passengers and less on public transport than their counterparts in larger urban areas.

¹¹ The results of a similar study on German data (Mattioli, 2013a) confirm this conclusion.

Both travel behaviour patterns can be explained with reference to the concept of 'car dependence': as it is more difficult to reach destinations without cars in car dependent areas, the carless experience a larger 'mobility gap', and at the same time tend to rely more on car lifts. By contrast, in large cities, the better provision of modal alternatives and the shorter distances to services and opportunities tend to reduce this gap, making their travel behaviour more similar to that of their motorised counterparts (in terms of distance, time and number of trips), but reducing the need to rely on car lifts and other surrogates of private car ownership.

While this explanation is plausible, it should not be forgotten that the composition of the carless group varies systematically between areas, and this explains at least part of the observed differences in travel behaviour, as illustrated in Fig.5.

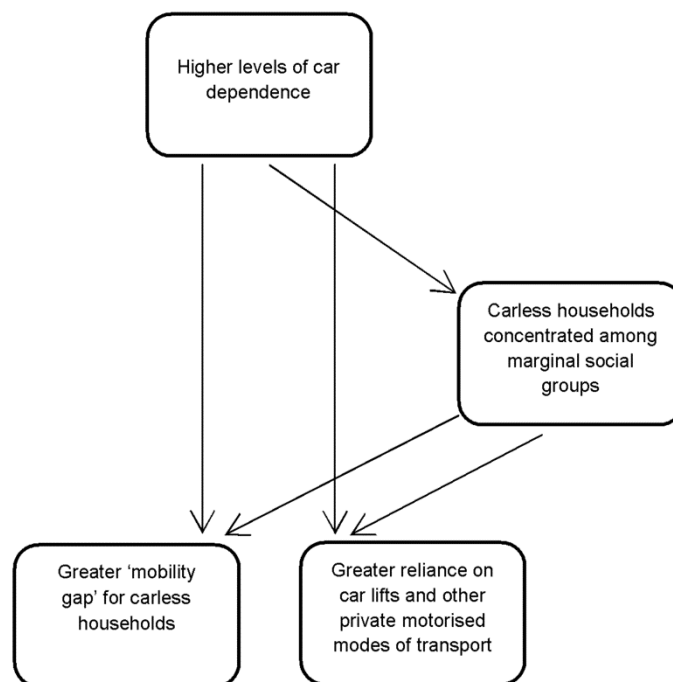


Figure 5. Diagrammatical representation of the relationships between car dependence, socio-demographic composition of the carless group and travel behaviour. Source: Own elaboration.

The graph shows that car dependence has both direct and indirect effects on the observed travel behaviour of individuals in carless households: 'indirect' effects are mediated by the changing composition of the carless group across different types of area. Indeed, carless households in peripheral, low-density areas are significantly more concentrated among marginal social groups (such as older people, disabled, etc.), who in turn are more likely to travel less and/or to rely on car lifts. In other words, the use of modal alternatives is made difficult not only by attributes of the local area (e.g. low-density, poor public transport service), but also by the individual characteristics of the carless living in that area.

4. Conclusions

In recent years, there has been a surge of studies in the field of transport and social exclusion research. While these studies have considerably deepened our knowledge of transport disadvantage, they have generally remained separate from studies concerned with the negative environmental consequences of transport. In this article, based on existing literature on car dependence and on travel and the built environment, I put forward an integrated theoretical framework to conceptualise both the environmental and the social consequences of increasing motorisation.

There are two main reasons why these two aspects should be studied together. Firstly, most environmental policy in the field of transport makes reference to the concept of 'sustainable transport', including not only the goal of reducing environmental externalities, but also contrasting social inequalities. Secondly (and relatedly), scholars have observed that there is sometimes a tension between these two goals (Lucas, Grosvenor, & Simpson, 2001; Cucca & Tacchi, 2012) and that this can be an obstacle to environmental policy-making (Mattioli, 2013b). Recognition of this latent tension has underpinned a recent attempt by the British

Sustainable Development Commission to put forward an integrated policy framework to tackle both the social and the environmental consequences of transport (2011). In a nutshell, the Commission proposes a new 'sustainable transport hierarchy' where higher priority is given to measures that reduce the need to travel, such as changing land use and the built environment (minimising distances between destinations) and the promotion of 'virtual mobility' solutions to accessibility problems using ICTs (see Kenyon, Lyons & Rafferty, 2002). Conversely, lower priority should be given to other sustainable transport measures, such as modal shift, efficiency improvements and capacity increases for powered transport. The goal of the hierarchy is thus to ensure that 'win-win' measures, able to simultaneously reduce the negative environmental impacts of transport and transport disadvantage, are implemented.

The theoretical framework put forward in this article, based on the notion of car dependence as a self-reinforcing process with both social and environmental consequences, is intended to be a contribution to this debate.

From an empirical viewpoint, the goal of this article was to show how the composition and travel behaviour of the group of households without cars changes systematically across different types of area. Based on the empirical results for the British case study, I put forward the argument that *the composition of the group of households without cars is a good indicator for the level of car dependence in a local area.*

By showing the variety of situations that correspond to non-car ownership, the findings reported in this article are potentially useful for sustainable transport policy and research, both in terms of environmental and social goals.

Studies assuming an *environmental* perspective have shown the variety of situations that corresponds to car ownership, both in terms of socio-demographic conditions and of preferences. This reflects the policy goal of encouraging modal shift and multimodal travel

behaviour among car users. The variety of situations that correspond to non-car ownership has received comparatively less attention, perhaps reflecting the assumption that the travel behaviour of the carless is less problematic from an environmental perspective.

I argue by contrast that studying the composition of the group of carless households is a good way to reveal the structural constraints that sustain car ownership and use. In other words, looking at who non-car owning households are and how they travel sheds light on why many others are reluctant to make do without cars in that area. The results of the cluster analysis provide several interesting examples of this. The fact that the PTC cluster is only of a significant size in the largest urban areas, for example, could be taken to indicate that it is only in that type of area that accessing employment and education with public transport is possible without excessive inconvenience. Similarly, the size of the SL cluster might indicate the extent to which it is possible to access other essential services and opportunities with modal alternatives to the car. Finally, the results show that the CR and IM clusters are best conceived as the hard core of the carless and represent approximately the same share of the total population across types of area¹²: they are associated mainly with old age, mobility difficulties, low mobility levels and/or reliance on others for car lifts. When most of the carless group is composed of this kind of household, it suggests that powerful structural constraints stand in the way of more environmentally sustainable travel patterns in that area.

Studies in the *transport and social exclusion research* field have devoted considerable attention to the issue of car deprivation. However, they often focus on the most marginal and immediately policy-relevant types of carless households. An inadvertent outcome of this

¹² It must be remembered, however, that the analysis focuses exclusively on individuals in non-car owning households. In fact, some members of 'car deficient households' might also be described as 'car reliant', insofar as they depend on lifts from others.

situation is that the overall view of the sheer variety of forms of transport disadvantage associated with lack of car access is lost.

In this article, I have put forward a typology of carless households, based on their travel behaviour, showing how it is articulated across different types of area. This counters the simplistic assumption that lack of car ownership is *per se* conducive to transport disadvantage, and the typology might serve as a blueprint for further studies based on ad-hoc surveys or adopting a qualitative approach. In the following, I provide two examples of possible research directions.

The CR cluster is interesting in that it shows how older non-drivers (more than 60% do not have a driving licence) can also be very dependent on the automobile for their daily activities. When this is the case, they are very much dependent on others for travel. Existing literature suggests that such reliance on car lifts, while it can partially offset their transport disadvantage (Gray, Shaw & Farrington, 2006), can be a burden for those who offer lifts (Rosenbloom, 2010) and challenge the sense of independence of the elderly (Davey, 2007), with potential knock-on effects on their well-being (Currie, 2011). The fact that CR is the largest cluster in the most car dependent areas suggests that measures such as car clubs / car sharing are unlikely to reduce the transport disadvantage of non-car owning individuals in these areas, since most of them are unable to drive anyway¹³. Other measures, such as community transport, are probably better suited to improve the living conditions of older people and of their car-owning relatives and friends.

In many respects, 'public transport commuters' are the polar opposite of CR. However, it would be unwise to conclude that they are not at any kind of disadvantage: the vast amount of

¹³ However, they might make a difference for members of 'car-deficient households'.

time that individuals in the PTC group spend travelling (one hour more than the average Briton) and the fact that they do not seem to travel much for reasons other than work or education, for example, both suggest that the lack of a household car for these individuals might lead to them missing out on activities that are essential for participation in society, as a consequence of time poverty. The results of the analysis presented here suggest that this particular form of transport disadvantage – perhaps counter intuitively – might be more widespread in the *least* car dependent areas.

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Online figures

	Households without cars	NTS 2002-2010 sample
Single-person units	57	29
No member under 16	83	73
Female HRP	60	37
Age of HRP	16-29	10
	30-59	56
	60+	34
At least one member with mobility difficulties	37	23
HRP not in employment	70	39
Income quintile: lowest or second	70	40

Tab. online 1 – Composition of the carless households group, for key socio-demographic characteristics, as compared to the NTS 2002-2010 sample (percentage values). Source: own elaboration on NTS 2002-2010 data.

	Slow and local	Car reliant	Public transport commuters	Long distance week
<i>Travel week</i>				
Distance travelled (km)	-0.28	-0.18	-0.01	+2.87
Average Speed (kmh)	-0.42	+0.34	-0.25	+2.46
Share of travel distance by car, taxi and other private motorised modes	-0.63	+1.30	-0.42	+0.36
Share of trips for work / education	-0.53	-0.49	+1.63	+0.16

Tab. online 2 – Cluster analysis results, values of the centroids (standardized input variables). Source: own elaboration on NTS 2002-2010 data.

		Slow and local	Car reliant	Public transport commuters	Immobile	Long distance week	Carless adults
Household structure	1 or 2 adults youngest child 0-15	19	16	31	10	14	20
	Family adult child(ren)	11	8	15	13	9	12
	Pensioner household	41	56	2	53	24	35
	Other household	29	20	52	24	53	33
Singles		41	54	18	46	38	39
Age	16-29	21	15	45	17	34	25
	30-59	33	24	51	23	39	35
	60+	46	61	4	61	27	40
Mobility difficulties (foot and/or bus)		21	45	3	51	11	24
Income quintile	Lowest	48	42	29	43	28	41
	Second	29	33	22	31	21	28
	Third or higher	23	25	49	26	51	31

Tab. online 3 – Typology of carless adults: descriptive statistics for selected socio-demographic and mobility difficulties variables. Source: own elaboration on NTS 2002-2010 data.

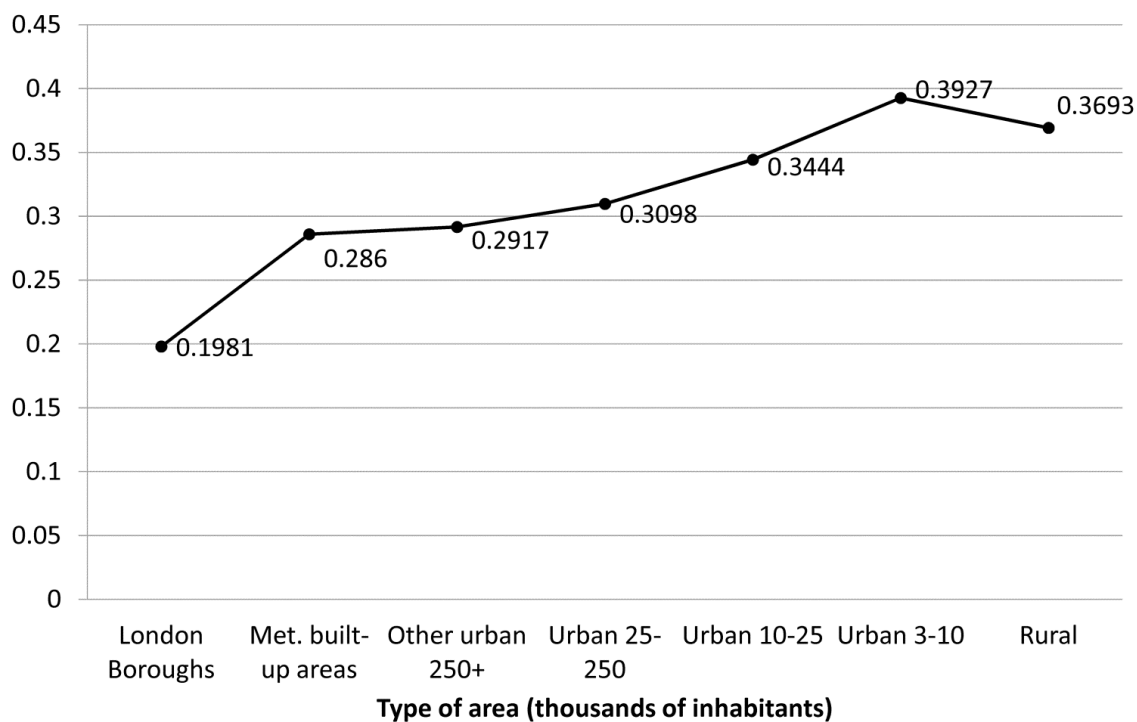


Fig. online 1 – Values of McFadden's pseudo-R² for logistic regression models including only socio-demographic predictors, fitted separately for the different types of area. Source: own elaboration on NTS 2002-2010 data.

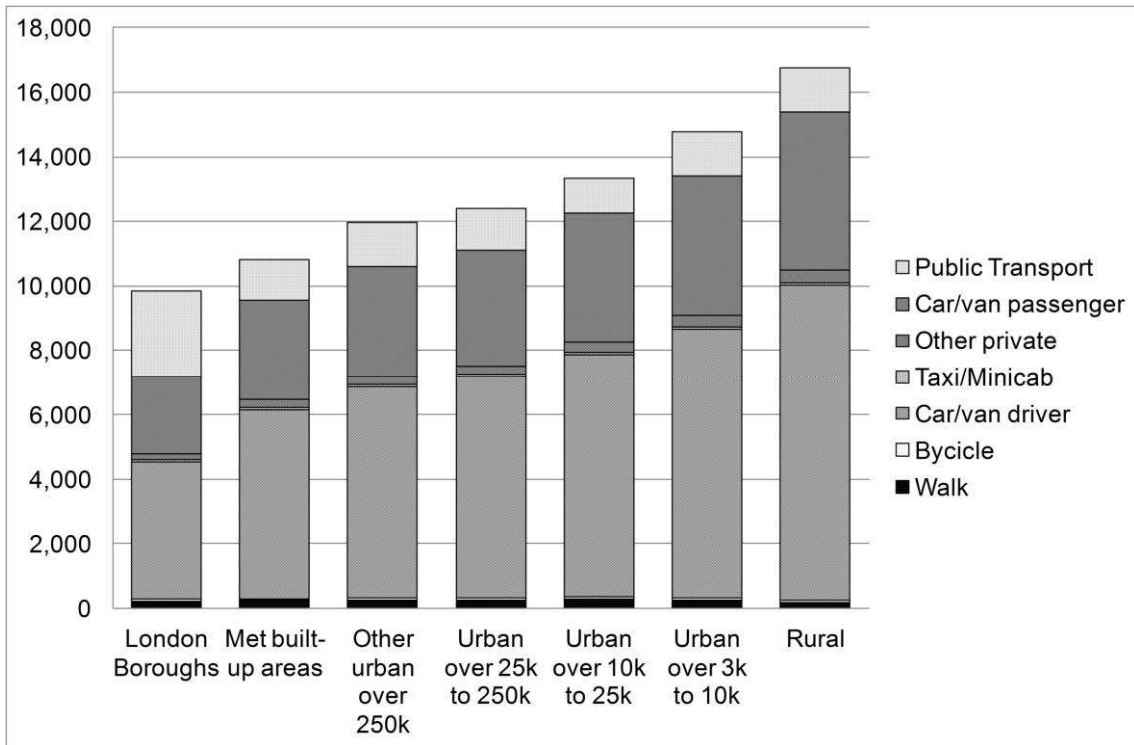


Fig. online 2 – Total annual distance per person (km), by transport mode and type of area, for car-owning individuals. Source: own elaboration on NTS 2002-2010 data.