Gendered travel mode choice: a focus on car deficient households

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Abstract: This paper studies travel mode choice with a focus on car use in car deficient households from a gender perspective. Car deficient households are defined as households with more drivers than cars. We derive some key hypotheses from the literature and use the German Mobility Panel 1994 to 2008 to simultaneously test some of these hypotheses in a pooled data approach with cluster robust regression techniques. We find support for the social roles hypothesis which claims that mode choice may be impacted by the gendered roles a person takes in a household. Participation in paid work does not systematically affect car use more strongly than participation in unpaid work. Thus, there is no support for the economic power hypothesis which claims that car access is a function of intra-household economic power. The strong effect of 'sex' leads us to conclude that there must be more behind gender differences in mode choice than just social roles. Gender differences in travel mode choice even in households with as many cars as drivers suggest that preferences may be at play. The paper concludes with an outlook on further research.

keywords: gender, car use, travel mode choice, car deficient households, intra-household car allocation

Highlights:
- Car use is strongly gendered both in car deficient households and in households with as many cars as drivers
- Driving is positively affected by household work and employed work responsibilities
- The hypothesis of intra-household economic power relations affecting car use is not supported
- A strong 'sex' effect may point towards patriarchy and/or preference

1 Introduction

Travel mode choice has been studied extensively in trip-based models (e.g. Vance et al., 2005) and individual-based models (e.g. Cao et al., 2009), measured as mode-specific trip rates, individual mode split or mode specific distances travelled. Various studies have considered a large range of impact factors including individual and household sociodemographics, transport

system attributes, spatial context at a household's residence plus, in some cases, at the destinations (Cervero, 2002). More recently the framework has been extended to lifestyles and/or travel and residential preferences (Cao et al., 2009).

Gender has played an important role in this context since about 1980, when the issue of 'women and transport' entered the field (Rosenbloom, 1978; Giuliano, 1979, 1983). There is now substantial evidence for gender differences in travel behaviour. Relatively little is known, however, about the reasoning and mechanisms such differences are based on. Although various hypotheses have been developed to explain travel behaviour differences between men and women, many studies tend to compare the genders without a clear focus on theoretical reasoning.

A specific situation that may serve as a starting point to test various theories is the allocation of cars in car deficient households. Car deficient households are defined in this paper as households with fewer cars than drivers (licensed adults). There is some anecdotal evidence for men having first choice of car use in such households (Giuliano, 1983; Pickup, 1984; Brennecke, 1994). However, we are not aware of many studies that empirically investigate this notion. Controlling for a variety of gendered impact factors on car use in such households may help improve our understanding.

This paper studies which conditions shape car use in car deficient households. For comparison we estimate a model of car use in fully equipped households, i.e. households with as many cars as (or more cars than) drivers. In brief, we study the questions: Who uses the (only) car? Under which conditions does one of two partners increase his/her car use? Which role do gender structures play in this context? In the next section we give a brief overview of related research. Section 3 is devoted to methodological issues. Section 4 describes the results. The paper finishes with some conclusions and an outlook on further research.

2 State of the research

2.1 Travel mode choice among women and men

There has been criticism of the insensitivity of transport studies towards gender issues since the late 1970s, starting from a feminist notion of women's disadvantage (Rosenbloom, 1978; Giuliano, 1979). The initial focus of the emerging gender/travel research was on women's travel and mobility needs, studied from two distinct angles: constraints on women's mobility resulting from women's fear of male violence (Atkins, 1989), and women's shorter commute distances and/or durations (Hanson and Pratt, 1988).

Since about 1990 there has been increasing interest in other gender differences in mobility and access (Grieco et al., 1989). Two distinct focuses can be identified. The first comprises quantitative modelling approaches to travel behaviour in transport geography and transport engineering, including models of residential choice (Prashker et al., 2008). The second builds on an interpretive ethnological/sociological background from cultural studies and tends to be informed by the new mobilities paradigm or 'mobility turn' in social sciences (Cresswell and Uteng, 2008). The aim is to unravel the diversity, sheets of meaning, and socio-cultural contexts of travelling using primarily qualitative approaches (Law, 1999; see Hall, 2004, for a critical comment). The present paper has its roots in the first strand of research, but is theoretically informed by the second.

A key result of numerous quantitative studies is that there are significant gender differences in car use, particularly when a distinction is made between drivers and passengers. For instance, Giuliano (1983) reports a drive-alone proportion of 68% for men for commuting, as compared to

60% for women. Such differences tended to be even stronger in European contexts at this time, probably due to the lower level of car availability. For instance, Brennecke (1994) reports a car driver mode share of 48% for men in Germany in 1990, compared to 29% for women.

Increasing availability of licenses and cars (Beckmann et al., 2005 for Germany; Noble, 2005 for the UK) has resulted in convergence over time (Rosenbloom, 2006). For the USA, Crane (2007) (while focusing on commute distance and commute duration) finds convergence in commute mode choice over the period 1985 to 2005 in that women's transit use has declined faster than men's. Similarly, Hjorthol (2008) finds moderate gender convergence in travel mode choice for Norway over the period 1992 to 2005, particularly for job and business trips. Noble (2005) reports convergence in terms of license holding and vehicle kilometres driven for the UK. Scheiner (2006) finds steeply decreasing gender effects on mode choice in Germany over the period 1976 to 2002. Frändberg and Vilhelmson (2011) report a stronger increase for women than for men in Sweden both in daily travel and travelling abroad, resulting in gender convergence over the period 1978-2006.

Yet clear differences remain. Polk (2004) finds that women in Sweden use the car significantly less than men, and their intention to reduce car use is significantly stronger, even when controlling for sociodemographics and attitudes. Vance et al. (2005) report a significantly lower propensity for women to drive than for men. This finding is modified by interaction effects. For instance, children tend to increase women's but decrease men's car use. Vance and Iovanna (2007) study mode choice and vehicle miles travelled for maintenance trips in Germany. They find that women drive fewer vehicle miles for maintenance than men. Having fewer cars than drivers reduces women's car use more than men's, supporting the notion of gender inequality in access to household cars. Simma and Axhausen (2003) report that men in Austria are more likely to own a car than women, and accordingly make more trips by car, while women undertake more trips on foot and, with less difference, by transit. These findings refer to job trips and maintenance trips likewise. Limtanakool et al. (2006) find higher modal shares of train use and less car use among women than men for trips longer than 50 km, the differences being more pronounced for commuting than for business or leisure trips.

In the majority of related multivariate studies, the focus is on car use. From descriptive analyses involving all travel modes, one may generally conclude that there are still clear gender differences in car use as a (typically male) driver or a (typically female) passenger. Women also tend to walk more frequently, while gender differences in cycling and using public transport (PT) are limited (Hamilton, 2005 for the UK; Nobis and Lenz, 2005 for Germany).

Women's less frequent driving and more frequent use of other modes has raised serious concern about women's time poverty as induced by using slow modes that require long travel times (Turner and Grieco, 2000). However, overall findings are inconclusive. Gordon et al. (1989) report limited gender differences in travel mode choice for the USA and reject the idea of patriarchal constraints in commuting. Dargay and Hanly (2007) do not find a significant gender effect on the probability of commuting by car in the UK. In their Cologne study Best and Lanzendorf (2005) find significantly less car use among women for maintenance trips, but not for commuting. The contradictory findings may be due to study context, measurement issues or interpretation. Arguably, interpretations of a difference (beyond statistical significance) may vary widely between meaningful and limited or even marginal, depending on the author's purpose or goals.

2.2 Travel behaviour and gender – some hypotheses

There are a number of key hypotheses that may be drawn from work on gender difference in travel behaviour (for discussions see Camstra, 1996; Law, 1999; Hamilton and Jenkins, 2000;

Clark and Wang, 2005; Crane, 2007). Despite a certain amount of overlap, these hypotheses are associated with various disciplines and theoretical perspectives.

1. Economic power hypothesis: Gender differences in economic (plus social and temporal) resources and related gendered power structures are highlighted in feminist research and economics. Most prominent is a focus on women's relatively low incomes and restricted access to labour markets (Blumen, 1994) due to occupational segregation and women's 'spatial entrapment' in certain spatial contexts (England, 1993; MacDonald, 1999). Even between partners who share their household budget or bank account, inequality in economic power may be at play because of unequal contributions to this budget. In an extended form the economic power hypothesis may be termed 'access to resources', among which money is only the most prominent. Other resources in this context are time, the private car, and mobility in general. E.g., Prashker et al. (2006) find that women are more sensitive than men to distance in residential choice. Some recent studies find lower levels of car availability among women (Simma and Axhausen, 2001; Cao et al., 2007), while other studies show gender as having no significant effect (Scheiner, 2010; Van Acker and Witlox, 2010) on car availability. Again, the divergent findings may be due to differences in socio-spatial context and/or measurement. For instance, Van Acker and Witlox (2010) measure car availability at the household level which may explain the lack of gender differences. The data used by Scheiner (2010) were collected in the urban region of Cologne, where gender differences may be relatively small. Note that Simma and Axhausen (2001) find stronger gender differences in Switzerland and Great Britain than in Germany, and Cologne is one of the more 'modern' regions of Germany.

2. Social roles hypothesis: Sociological theories highlight social roles that may commit women more than men to taking on household and family responsibilities that limit their economic independence. In transport studies this hypothesis was developed mainly in the 1980s (Hanson and Johnston, 1985; see Turner and Niemeier, 1997 for an overview). Wen and Koppelman (2000) support this framework by arguing that in households with fewer cars than drivers the allocation of cars is dependent on activity allocation. Accordingly, 'male roles' as well as 'female roles', i.e. employment as well as maintenance activity obligations (household work, childcare) may increase a household member's chances of accessing a car.

3. Preference hypothesis: Social psychologists and some sociologists study the importance of gender attitudes and norms based on preference (e.g. Hakim, 2000). Preferences are attitudes towards an alternative, typically conceived of as shaping individual or household decisions and actions (Mas-Colell et al., 1995). A number of recent studies in the transport field also make an explicit empirical distinction between the binary variable sex and gender attitudes (Özkan and Lajunen, 2006; Ettema and Van der Lippe, 2009). The preference hypothesis is supported by the finding that even women with easy access to a car use PT more than men, and they are more inclined to reduce their car use than men (Matthies et al., 2002; Polk, 2004). These findings may be traced back to women's more prevalent ecological norms and sustainability goals, and to their less ingrained car habits (Matthies et al., 2002; Hjorthol, 2008).

4. Patriarchy hypothesis: Feminist theory highlights patriarchal power relations that may operate over and above economic inequalities. This 'dual system oppression' borne by capitalism and patriarchy (Hartmann, 1979; Walby, 1990) impacts social role patterns, the availability of resources, and norms. Observed gender differences in car availability, travel mode choice and activity patterns are thus subject to power relations, particularly to women's weak negotiating positions in the household or on the labour market. However, patriarchy is clearly much more than just economy; it may have emerged from long-standing traditions and routines of control that have developed since migration flows in the Neolithic age (Borneman 1975).

These hypotheses should not be understood as being independent of each other. However, an attempt to determine the causal relationships between the four hypotheses on the basis of the literature and our own considerations did not result in a clear picture of causality. For instance, gendered social roles on the intra-household level may be an outcome or a driver of inequality between two partners' economic power. Patriarchy may drive economic inequality, but economic inequality may also help maintain patriarchy over time.

The notion of preference assumes individual freedom of choice, but preferences may have their roots in societal traditions and may hence operate on the basis of patriarchy, inequality and culturally defined social roles. Thus, preferences may mirror societal power relationships rather than having much explanatory power in themselves. On the other hand, given the relatively high level of individual freedom in modern western societies, preferences may drive inter-personal (and, thus, societal) relationships.

One may argue that, at the very least, sex is exogenous to social roles, economic power and preference. However, we do not consider sex to reflect biology. Rather, sex effects should reflect patriarchy. As patriarchy is a societal system that sets the context for inter-personal relationships, it should result in a general level of inequality between men and women and, thus, in 'sex' effects. Hence, the measurement of patriarchy by the variable 'sex' does not imply that patriarchy results from biology.

Due to the lack of unidirectional cause-impact flows between these concepts and, hence, the independent variables used in this paper, Figure 1 suggests mutual relationships, indicated by two-headed arrows. The figure also indicates the most obvious ways of empirically measuring the concepts, showing those available for our study in bold. There are no travel behaviour data available that cover all the issues discussed here. Our data allow the capturing of social roles, economic power, and binary 'sex' effects that may capture gender differences that work over and above social roles and household economics (see Section 3.3 for further discussion of the variables used). What is more, interaction effects between 'sex' and other variables may reflect patriarchy, but may also be an result of preferences.

Geographical context plays an important role in this framework, as intra-household negotiations may interact with the opportunities provided by the spatial setting in which the household lives. For instance, a good PT connection to his wife's workplace may serve as an argument for her husband to use the household car for his own commute.

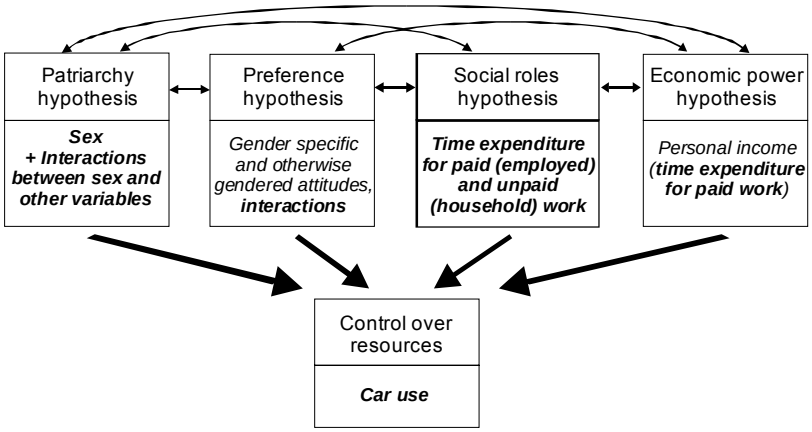

Figure 1: Model structure on the basis of hypotheses discussed and variables for measurement

Examples for variables capturing the concepts are in italics. Variables in bold are available in our data.
Two-headed arrows are not considered in our modelling approach.
Source: authors' concept.

The empirical focus here is on car deficient households. There are several recent studies that focus on car allocation in such households (Wen and Koppelman, 2000; Anggraini et al., 2008; Petersen and Vovsha, 2005; Roorda et al., 2009). However, the aim of these studies is to improve transport modelling frameworks rather than to examine gender relations and the gendered nature of the conflicts about limited resources. They are nonetheless helpful in that impact factors are carefully assessed. For instance, Anggraini et al. (2008) consider activity schedule and space-time setting (number and duration of work episodes, weekday, travel time ratio PT/car, price of parking, density at residence), individual and household characteristics (e.g. age, number of employed individuals in the household, age bracket of youngest child) as impact factors. Schwanen (2007) finds evidence for the impact of time budgets (in terms of commute duration) and spatio-temporal flexibility (in terms of commute mode) on the allocation of child escort trips between two parents.

However, a note on causality is warranted here. While differences in activity and trip patterns (e.g., trip chain complexity, trip distances) may explain mode choice, the reverse may also play a role, i.e. differences in mode choice may help explain variance in activity and trip patterns.

Spatial context may also be relevant, for instance urban contexts may be more characterised by modern egalitarian attitudes and lifestyles, while more traditional gender divisions of labour and access to resources may prevail in rural areas. This is reflected in women's relatively high labour force participation in cities (Camstra, 1996).

To sum up, there are few studies on car allocation in auto deficient households, and none that explicitly focus on gender relations. This is despite long-standing anecdotal evidence of gender inequality in access to household cars. For instance, Pickup (1984) states that in the UK 'the general pattern is for husbands to have first choice of car use, usually for commuting' (p. 63; similarly: Giuliano, 1983, p. 104 for the USA; Brennecke, 1994, p. 4-5 for Germany; Naess, 2008, p. 190 for Denmark).

In this context, we study the questions: Who uses the (only) car in a household with fewer cars than drivers? Which conditions shape the car use of either of two partners? Which role do gender structures play in this context?

3 Methodology

3.1 Data

The data used here is the German Mobility Panel (GMP) 1994 to 2008[1]. The GMP is a household survey with overlapping waves of samples. Each household is surveyed three times over three consecutive years (Chlond and Kuhnimhof, 2005). Information on trips made over a whole week is collected from all household members aged ten or over. Household and individual sociodemographic attributes are collected as well as spatial context attributes at the residence and at the household members' places of work or education.

It should be noted that the data refer only to trips made within one week. Untypical weeks may thus affect the results, e.g. illness of a household member could cause trip allocation between members to change temporarily. However, given the considerable effort of data report for the respondents, one week trip diaries may be considered a very good data base. For instance,

[1] The GMP is conducted by the University of Karlsruhe on behalf of the Federal Ministry of Transport, Building and Urban Development (BMVBS). The data are provided for research use by the Clearingstelle Verkehr (www.clearingstelle-verkehr.de).

Schad et al. (2001) report a high degree of stability in travel mode use over the week. In any case, a dummy variable with a self-reported measure of whether or not the week reported was 'more or less as always' is included. It is thus possible to identify untypical weeks for control analysis.

A second data limitation is the lack of information on personal income, typical for travel surveys. Even information on household income has only been available since 2002. Income is thus excluded from the analysis (see below).

We examine which variables help explain car use. We focus on gender and so limit our analysis to households with a male and a female partner. Furthermore, our regression models consider only individuals with driving licenses who live in households with at least one car, but with fewer cars than licensed adults. We also exclude households without an employed individual (mostly retirees) because intra-household work-sharing arrangements are used as explanatory variables. From a total sample of 11,380 individuals this procedure results in 2,569 individuals, of whom all the information required for our regressions is available for 1,969 individuals. Our comparative analysis of licensed adults living in fully equipped households (i.e. households with at least as many cars as drivers) includes 1,942 individuals.

Our analysis of car deficient households refers to one third (33.0%) of all German adults making up 21.9% of households. Licensed adults living in fully equipped households account for 32.8% of all adults, non-licensed adults make up 4.7%. These figures are complemented by individuals living in households in which neither partner is employed (27.1%), those identified as homosexual couples (0.8%), and licensed adults living in non-retiree households without a car (1.6%).

3.2 Analysis approach

The panel nature of our data means that we face non-independent (clustered) observations, thus violating a most basic assumption of statistical analysis. The use of OLS regression with such data may result in underestimation of standard errors because the amount of independent information available is inflated. The significance of parameters may therefore be overestimated (Hedeker et al., 1994)[2].

There are two basic ways of treating panel data in regression: employ either a random effects model or cluster-robust estimation based on pooled data. The former has the disadvantage that it assumes constant correlation between successive observations of the same unit. In contrast, clustered regression with pooled data allows for arbitrary correlation. The estimates are less efficient, and, similar to OLS, the standard errors may be too small when the number of clusters is finite (Wooldridge, 2003; Nichols and Schaffer, 2007). However, the cluster-robust standard error estimator converges to the true standard error as the number of clusters (not the number of observations) approaches infinity (Kézdi, 2004; Nicols and Schaffer, 2007). Given our relatively large sample and cluster number, neither of these issues should raise serious concern.

We use a pooled data approach and account for clustering by using a robust estimation method controlling for autocorrelation within subjects emerging from the temporal order (sequence) of records. As our analysis is at the person level, this means that the correlation matrix of within-

[2] Although it is standard practice in transport studies to ignore cluster structures in data that emerge from observing multiple trips made by one person, or from multiple persons living within the same household, the problem of non-independence is likely to be even more marked in repeat observations of the same individuals.

subject dependencies is estimated as part of the model. We use the SPSS procedure GEE (generalised estimating equations) for our analysis.

Concerning model specification (see Garson, 2010 for details), we use the autoregressive correlation type, because the temporal order of within-subject measurements means that values at a given point in time are a function of prior values plus error term. When working with continuous dependent variables we assume normal distribution with untransformed variables ('identity link' in SPSS) in order to keep interpretation on an intuitive level. For trip level modelling of car use we work with binary dependent variables for which we employ a binary logit model structure. There is no reason to test for a certain sequential order of model predictors, which technically means we choose SPSS analysis type 3.

For comparison we estimate OLS regressions (for the continuous dependent variables) and 'ordinary' binary logit models (for the binary dependent variables) with a reduced sample of observations, drawing one random year of observation for each respondent. The results exhibit different levels of significance in some cases, but in terms of sign and magnitude of the coefficient estimations the results are very similar to the ones reported here. There are no cases of significant effects changing their sign, supporting the robustness of our findings.

Unlike OLS regression, there is no determination coefficient available for cluster robust regression. SPSS reports a quasi likelihood under independence criterion (QIC) which is an extension of the Akaike Information Criterion (AIC) for repeated measures (Garson, 2010). It is available in a corrected form (QICC) that penalises model complexity and small sample size. QICC works in a 'the smaller the better' form. We report this for our models as well as for the intercept models. However, there is no formal test of significance in model improvement available. Thus, to aid intuition, we also report R^2 values from our OLS regressions and Pseudo R^2 values from our logit models with independent data.

As discussed above, we do not assume clearly determined cause-impact relationships between our explanatory variables. Anyway it should be noted that the non-consideration of causal interdependencies between explanatory variables may result in biased estimates.

3.3 Variables

In our regressions we use three measures of car use as dependent variables:

(1) Proportion of trips made as a car driver

(2) Proportion of trips made as a car driver or passenger

(3) Car use as a driver for a given trip.

We start with some descriptive gender comparisons. For regression analysis we use household and individual sociodemographics, spatial context, individual activity and trip measures as explanatory variables. An overview of the variables used plus their definitions and descriptive statistics is given in Table 1 and Table 2. Due to our assumption that car use is subject to intra-household negotiation, we use relative measures for as many variables as possible, i.e. relative dominance of one partner over the other in terms of education, employment, housework, quality of PT connection to the workplace and so on. We also add level variables for the household, e.g. household education level is represented by the highest school-level qualification achieved by one of two partners.

Gender is represented in our framework by a binary variable plus two variables measuring the respondent's share in both partners' total out-of-home household work and in total out-of-home employed work (see also Figure 1). Simultaneously including the latter plus employment status

results in excessive variance inflation due to multicollinearity. We thus exclude employment status. Effects of the household work and employed work variables reflect a respondent's social roles, but as employed work is strongly correlated with personal income (about which we have no information), employed work should also reflect economic power effects, to a certain extent. Effects of the binary gender variable should therefore support hypotheses other than social roles or economic power, i.e. either preferences or patriarchal power, which we cannot separate from each other using our data.

A more detailed consideration of household tasks, e.g. subcategories of participation in domestic v. out-of-home work, could allow for a more nunanced interpretation, but we do not have information on domestic activities. However, need to use the car should be captured to some extent by a number of the variables used, such as the quality of the PT connection to work, distance to work, and trip chain complexity (which is affected by the type of job and occupational sector, as well as by household tasks undertaken by an individual).

As we are interested in gender specific effects, we also include interaction terms with gender. Due to patriarchal power hierarchies it can be expected that factors improving a respondent's chances of car access are less effective for women than for men, while factors which decrease car access should be more effective for women. Due to the use of interaction terms, the interpretation of coefficients is not straightforward (Aiken and West, 1991). Main effects in our models should be interpreted as conditional effects for men, while interaction terms with gender should be interpreted as effects for women as compared to men.

There is also strong multicollinearity between gender and other starkly gendered variables, particularly the interaction terms with gender. In cases of multicollinearity the coefficient estimates are consistent, but due to variance inflation the significance levels may be underestimated (Berry and Feldman, 1985, p. 37ff). The most pronounced case is between gender and the variable 'interaction between gender and respondent's share in household work'. As this interaction effect was not significant in any model except the one for fully equipped households, we tentatively excluded it from the models. The result was that all variance inflation factors (VIF) fell below the usual threshold of acceptance (VIF<10, Schendera, 2008, p. 105), while all coefficients and significance levels were robust.

We also estimated a series of more parsimonious models including only those variables that seem indispensable for our framework, i.e. gender, social roles, number of children in three age brackets (assuming starkly gendered role behaviour in households with children), and both partners' need to use the car for commuting. For control reasons we included municipality size categories and time spent out-of-home, both of which turned out strongly significant in the full models, as well as interaction terms with gender. There was no case where any significant coefficient in these models changed its sign, and the effect magnitudes were generally stable as well.

Additionally, we estimated a series of models excluding interaction terms of gender with a respondent's share in household work (or employed work, respectively), PT connection to work, and relative education level. As the multicollinearity problems we faced were mostly a result of the interaction variables, this procedure resulted in a steep reduction of VIF values (all VIF<3.2). Our key findings were not much affected by these control analyses, but in cases where main effects and interaction effects show opposite signs, the exclusion of interactions naturally weakened the main effects.

Generally, the results of these procedures support the reliability of our findings. Given that we are explicitly interested in interactions between gender and other variables, excluding interaction terms seems unsatisfactory from a theoretical point of view. Hence, we opted to report the full

models with all interaction terms, whether significant or not (see Berry and Feldman, 1985 for further discussion). All other models are available from the authors upon request, as well as VIF values and tolerance levels for the models presented here. Note that treating multicollinearity this way means that we accept the possibility of underestimating significance levels.

4 Results

4.1 Descriptive analysis

We start with some descriptive analysis of mode choice for adults categorised by license holdership and household car ownership. The modal split shows larger proportions of driving for men than women in virtually all sub-groups (Table 3). The difference is relatively minor in households without a car, where car use is low for both men and women. In car deficient households the gender difference is most pronounced, with licensed men driving 56.6 percent of their trips compared to women's 36.5 percent. This finding supports the idea of men being first in line for the household car.

It is important for the interpretation that men drive markedly more than women even in fully equipped households, although the gender differences are smaller in these households. Lower levels of driving among women thus appear to have to do with activity patterns, trip distances and/or deliberate choice, rather than just limited access. However, they may also be a result of negotiation between two partners about who will drive when undertaking shared trips. Again there may be some 'first choice' issue at play, but this could just as well mean that women have first choice in being driven.

Another observation worth mentioning is that driving is more prevalent among men than women even for individuals without a license. This suggests that false reporting of license holding plays a role here, or that men may report driving even when they are not licensed. Social status effects are possibly at play in this respect. Individuals without a car license but who ride a motorcycle also play a certain role, as 24 percent of the 'false' reports are due to individuals holding a motorcycle license (compared to 15 percent for the whole sample of trips)[3].

Conversely, women report being a passenger more often than men. Again the gender difference is most pronounced in car deficient households, but it is also significant in fully equipped households. The results for other modes confirm well-known observations: women's walking shares are somewhat higher than men's, while for cycling and PT use the differences are minor.

4.2 Regression analysis

By using regression models we seek to disentangle the factors that impact car use in car deficient households (Table 4). As noted above, there is no exact measure of model fit for cluster robust regression. The R^2 values from our OLS models suggest reasonable performance for individual level models (23.2 percent and 12.6 percent, respectively). Even if Pseudo R^2 values from Logit models are not immediately comparable, the trip level models seem to perform less satisfactorily, which suggests a higher degree of random variance on the level of a single trip.

[3] It is not possible to definitely determine all causes for this observation, as possession of a motorcycle license was only recorded until 2003. We can exclude faults due to the mixing up of two different years of observation. However, driving in the week of report and the loss of the license between the week of report and the survey may also play a minor role.

The driver Model 1 generally performs better than Model 2 that includes trips made as driver or passenger, exhibiting stronger effect magnitudes and a higher R^2. This means that social differences are more pronounced when only trips made as a driver are considered.

We also estimated models using self-reported 'normality' of the week of report ('was more or less as always') as a filter variable. These models are very similar to the findings reported here. Interestingly, the adjusted R^2 values from OLS models slightly increase at 0.5 percent to just under 2 percent when the analysis is limited to weeks reported as being 'normal' by both the respondent and his/her partner. This suggests that limiting the analysis to 'normal' daily life increases social difference, while 'non-normality' tends to blur clearly defined social roles and fixed arrangements.

Turning to the coefficient estimates, there are no cases of significant effects with signs differing between the models. However, there are many instances of effects being significant in one model, but not in another. Various key findings may be highlighted. We first focus on Models 1 to 3, referring to car deficient households.

1. Relative education level. We expect educational dominance over the partner to be associated with increased chances of accessing the car. Indeed, dominating strongly in educational achievement results in significantly enhanced car use. Conversely, however, having a partner who strongly dominates in educational terms also results in *increased* car use, at least for men. This seems to suggest that strong inequity in education level between two partners increases an individual's car use, compared to the reference category of equal education level. This finding is modified by the negative interaction term with gender in Model 1. The interaction suggests that having a partner who dominates in education level increases driving only for men, but not for women. We do not want to overstress interpretation, but the finding that the husbands of highly educated wives drive more could support some psychological notion of male driving as a surrogate for status.

In total, the effects of relative education level do not exhibit a linear relation to driving. We suspect that education level represents a mixture of economic power plus green attitudes, as green voting is correlated closely with higher education (Forschungsgruppe Wahlen, 2011), which may explain the inconclusive results.

2. The effects of household education level (significant in Model 2) suggest that education level is negatively correlated with car use. Some evidence for a weakly negative or at least a lack of positive correlation between education level and car use has been reported before for Germany in recent years (Beckmann et al., 2006; Scheiner, 2006).

3. Age difference is negative (significant in Models 1+2), indicating that elder partners tend to use the car less. Thus, 'authority by age' seems not to be at work, rather the contrary.

4. Spatial effects are in the expected direction. Municipality size categories suggest less car use in towns and cities than in villages, with the effect being most pronounced in large cities. On the more finely grained level of neighbourhood structure, living in a central area of a city, and having a large number of different facilities and a large variety of public transport systems accessible on foot from the residence, contribute to decreased car use.

5. The quality of the PT connection to the place of work or education influences intra-household negotiations. When a respondent's partner needs the car but the respondent does not, the respondent's car use is significantly reduced. When neither of two partners needs the car for commuting, this decreases car use. Apparently, access to workplaces serves as an argument for negotiating car access. The lack of significant interaction terms with gender means that these

negotiations do not exhibit any evidence for systematic gendered inequity between two partners. Hence, spatial context does not appear to serve patriarchy here.

6. Most trip and activity pattern characteristics play a relatively minor role in our models. Three issues may be highlighted.

First, time spent out-of-home reduces men's car use, but increases women's car use (Models 1+2). Each additional hour reduces men's mode split share of driving by 0.1 percent, but increases women's share by 0.1 percent. The values for Model 2, including trips made as a car passenger, are similar. We suspect this to be an effect of employment among women, while the decrease among men may be an effect of the woman having a better negotiating position when her husband spends 'too much' time at his workplace so that the household car is left at home to allow his wife to organise the household work. However, a note on causality is warranted here. The effects discussed here may hide endogeneity in time expense, as time expense may be an outcome of rather than an impact factor for mode choice.

Second, making a large number of trips slightly and non-significantly increases women's car driving, but reduces their car use as a driver or passenger (only just significant). This suggests that for women making many trips is associated with a mode split change towards driving at the expense of being a passenger. Again, the possibility of endogeneity means the interpretation should be treated with caution.

Third, the overall relatively weak effects of activity and trip patterns may seem surprising. One may have expected, e.g., entropy in activity patterns and trip chain complexity to increase car use, particularly for men, for whom complex patterns may be somewhat unusual and thus difficult to handle. However, in total there is little evidence for gendered negotiation about the car based on trip and activity patterns.

7. Having small children in the family decreases men's, but increases women's car use (the interaction term with gender outbalances the main effect). This may reflect some kind of bargaining in which two partners agree that the car should be available for the mother as long as the youngest child is relatively small. Older children also tend to increase their mother's car driving, but to a lesser extent.

8. A number of other key gender issues have to be discussed.

First, doing household work and/or employed work increases a person's car use, lending support to the social roles hypothesis.

Second, there is no clear evidence that taking on the breadwinning role of employed work increases a person's car use more than taking on household responsibilities. Thus, there is no support for the hypothesis of economic power being at play over and above social roles.

Third, there is a noteworthy significant negative interaction effect for employed work in Model 1. This means that contributing to breadwinning increases men's car use more than women's, which supports the notion of patriarchy.

Fourth, gender per se ('sex') is strongly significant in Models 1 and 2. Holding all other control variables including social roles and economic power constant still results in women driving some 23 percent less of their trips than men (Model 1). This figure well reflects the descriptive analysis, in which the gender difference was 20 percent. In Model 2 the 'sex' effect even exceeds the descriptive analysis (10 v. 5 percent).

This 'sex' factor is worthy of further discussion. Social roles and economic power effects should (albeit perhaps crudely) be covered by worksharing arrangements. Reference to personal capabilities is unhelpful, as all individuals under study have a license. However, perhaps men

may feel more attached to the car, they may just 'love' the car (or driving, or the technology) more than women. This interpretation would support some kind of preference notion. Or perhaps patriarchy is at play – some deeply rooted gender norms beyond social roles and economic power that fuel a strongly significant gender difference in all models presented.

9. Last, but not least, the year of observation has no notable effect, suggesting that there is little change over the study period with respect to the issue under consideration.

Turning briefly to the model for fully equipped households (Model 4), many effects are similar to the models for car deficient households, suggesting that the decision rationales on travel mode choice are not that different when car access is unlimited. Hence mode choice may not just be a matter of access, there may be other rationales or mechanisms at work.

All variables of responsibility for household work and employed work have positive effects here, suggesting that an increase in responsibility tends to increase car use, which seems reasonable when car access is not limited. The positive interaction effects suggest that for women this is even truer than for men, but the interaction is only significant for household work. These responsibilities go along with the effect of entropy in women's activity patterns, which is also positively associated with car use.

A high household education level tends to decrease car use, which underlines our above interpretation of higher education being correlated with green attitudes.

Finally, there is even some evidence for change here: car use among men in fully equipped households decreases significantly over time, which points to a trend of gender convergence.

5 Conclusions and outlook

This paper studied travel mode choice with a focus on car use in car deficient households from a gender perspective. Based on some key hypotheses derived from the literature we found support for the social roles hypothesis which claims that mode choice may be impacted by the gendered roles a person takes on in a household, as suggested by Wen and Koppelman (2000), among others. This hypothesis has been studied extensively from the perspectives of household responsibilities (e.g. Turner and Niemeier, 1997), while employed work responsibilities have been included less frequently in the same framework, although employment status is known to be a standard control variable in travel behaviour studies.

The effect magnitudes of household work v. employed work responsibilities do not lend support to the economic power hypothesis, i.e. participation in paid employed work does not systematically affect car use more strongly than participation in unpaid household work.

The strong effects demonstrated by 'sex' lead us to conclude that there must be more behind gender differences in mode choice than just social roles. We suggest that deeply rooted gender norms are at play. Unfortunately we cannot decipher whether these norms reflect patriarchal power or deliberate preference, or a mixture of both. The observation of gender differences even in fully equipped households that own at least as many cars as drivers suggests that preferences play an important role, although we do not have direct information on preferences. Negotiations between two partners about car use for commuting also do not provide evidence for systematic gendered inequity. Finally, Germany has achieved a relatively high level of gender equity since the Social-Democratic plus Green Federal Government period of 1998 to 2005, as compared to, say, the 1980s, even if Germany may in gender terms be classified as a relatively conservative regime, similar to France, the Netherlands, Belgium and Austria (Van der Lippe et al., 2011). This may also support a notion of preference rather than inequity in power. In any case this issue of 'sex' remains unsatisfactory and calls for further research.

All spatial effects are in the expected direction, suggesting less car use in large cities and particularly at central locations within a city. There is little evidence for interactions of spatial context (quality of the PT connection to work) or trip patterns with gender. Hence, inequality in negotiations does not seem to be at work here.

There are some noteworthy shortcomings of this study.

First, our analysis is obviously limited to few key travel behaviour variables and could easily be extended to other gendered measures of behaviour, access and mobility.

Second, in our analysis economic power is based on a relatively crude measure of contribution to breadwinning in terms of time expense for employed work ('input') rather than personal income ('output').

Third, our measures of responsibilities are limited to out-of-home activities, while domestic work remains unconsidered. This is likely to underestimate women's contributions to total work. On the other hand, the complexity of men's daily lives is likely to be underestimated as well. The overwhelming evidence for women's relatively complex daily lives is typically based on women's responsibility for a multitude of tasks, while men 'just go to work and return home'. However, in empirical studies (whether based on trip diaries or activity/time budget diaries) employed work is mostly treated as a black box. That is to say, we do not know about complexity within employed work sequences.

Fourth, we do not have information on gendered attitudes, norms, or preferences that could help improve our understanding of the rationales underlying behaviour, and that could shed some light on the 'sex' effect black box discussed above.

Fifth, we have argued that we do not assume unidirectional causal relationships between the basic hypotheses we introduced and associated explanatory variables used. However, should such causal relationships exist, then our models would suffer from misspecification, which may result in biased estimates (Lewis-Beck 1980).

However, it is arguable that even the best control variables would be of limited help. Even if we had control items covering, say, gender norms, we would still be unsure whether these norms reflected some kind of short-term preference (i.e. freedom of choice) or certain deeply rooted power relations. People's ability to connect their own attitudes to causes is limited, and we suspect that, if asked, they tend to overstate the freedom and self-determination of their attitudes. Ultimately, we have only very limited scientific tools with which to understand the emergence of differences in gender specific behaviour, because we have little access to the mechanisms and rationales of action. More in-depth qualitative studies focusing on gendered negotiations, taking into account each of the two partners, could be of help. Gender/travel studies are strongly influenced by feminist perspectives that tend to interpret findings from a notion of women's weakness, whatever the nature of the findings. Other interpretations are practically non-existent, despite the fact that gender studies have long claimed a relational rather than a women's perspective (see Law, 1999 for transport studies).

Future research should thus focus on the *emergence* of difference or similarity between the travel behaviour of men and women, rather than on the behavioural outcomes. In this respect, it is of particular importance to ask the extent to which unequal power relations are at play, or whether rather preference or agreement as an outcome of negotiations between two equal partners is evident. In the case of the latter, it would be of interest to investigate whether such agreement is based on conflicting or shared interest, e.g. in terms of optimising worksharing arrangements in the household. Only in the case of unequal power relations would there be reason to point to a deficit in sustainability in terms of social inequity. Preference or agreement between two equal

partners would rather suggest the liberation of both genders being reality, no matter whether women's and men's observed behaviours differ or not.

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	Car deficient households						Fully equipped households			
	Models 1+2 (person level)				Model 3 (trips)*		Model 4 (trips)			
	Mean	SD	Min	Max	Mean	SD	Mean	SD	Min	Max
Car use over the week of report (%)										
…as a driver	47.68	31.57	0.00	100.00						
…as a driver or passenger	62.37	28.67	0.00	100.00						
Respondent's share in...										
…household work: shopping and escort trip plus activity duration as percent of couple's total	0.50	0.26	0.00	1.00	0.52	0.25	0.52	0.27	0.00	1.00
…employed work: commute and business trip plus activity duration as percent of couple's total	0.50	0.35	0.00	1.00	0.50	0.35	0.50	0.31	0.00	1.00
…household work * female	0.30	0.34	0.00	1.00	0.31	0.35	0.33	0.37	0.00	1.00
…employed work * female	0.17	0.28	0.00	1.00	0.16	0.27	0.17	0.25	0.00	1.00
Age difference (years, respondent minus partner)	0.01	5.30	-38.00	38.00	-0.01	5.16	-0.07	5.61	-34.00	34.00
Age difference * female	-1.52	3.39	-38.00	24.00	-1.50	3.30	-1.50	3.62	-31.00	34.00
No. of children in household (< 10 yrs)	0.50	0.83	0.00	4.00	0.56	0.86	0.59	0.84	0.00	5.00
No. of children in household (10-13 yrs)	0.19	0.47	0.00	3.00	0.21	0.48	0.16	0.43	0.00	2.00
No. of children in household (14-17 yrs)	0.19	0.44	0.00	2.00	0.19	0.44	0.20	0.46	0.00	2.00
No. of children (< 10 yrs) * female	0.25	0.64	0.00	4.00	0.30	0.69	0.32	0.68	0.00	5.00
No. of children (10-13 yrs) * female	0.10	0.34	0.00	3.00	0.11	0.36	0.08	0.32	0.00	2.00
No. of children (14-17 yrs) * female	0.10	0.33	0.00	2.00	0.10	0.33	0.10	0.34	0.00	2.00
Relative activity and trip patterns over a week: Difference in... (for each variable: respondent minus partner)										
...number of trips	0.00	1.71	-7.29	7.29	0.38	1.82	0.45	1.90	-10.52	10.52
...distance to work / education (km) (mean of job/education trips)	0.10	25.96	-160	160	-0.74	24.98	-0.89	26.6	-204.17	204.17
...entropy in activity pattern (Shannon)**	0.00	0.37	-1.54	1.54	0.03	0.37	0.05	0.36	-1.41	1.41
...time spent out-of-home (hours)	0.05	24.40	-168.07	168.07	1.59	21.93	1.52	21.8	-191.17	191.17
...number of trips per trip chain (mean of trip chains)	0.00	0.81	-10.33	10.33	0.04	0.86	0.06	1.02	-21.50	21.50
...number of trips * female	0.05	1.20	-7.29	7.00	0.27	1.33	0.38	1.40	-5.86	10.52
...distance to work / education * female	-3.93	17.85	-160.00	99.83	-4.31	17.53	-4.84	18.6	-204.17	154.40
...entropy * female	0.02	0.26	-1.54	1.43	0.04	0.26	0.05	0.26	-1.18	1.41
...time spent out-of-home * female	-1.30	17.15	-168.07	145.08	-0.26	14.66	-0.29	15.4	-191.17	144.17
...number of trips per trip chain * female	-0.03	0.57	-10.33	7.64	-0.02	0.57	0.00	0.72	-7.00	21.50
Variety of facilities in neighbourhood that are accessible on foot***	3.25	1.36	0.00	5.00	3.30	1.35	2.80	1.40	0.00	5.00
Year of observation (first year=0)	6.97	3.91	0.00	14.00	7.00	3.89	7.57	3.90	0.00	14.00
Year of observation * female	3.47	4.45	0.00	14.00	3.55	4.48	3.83	4.73	0.00	14.00
n	3,230				85,951		87,470			

Table 1: Continuous variables used in regression: definitions and descriptive statistics

* Min and max as in person level models.

** The Shannon entropy is a measure of qualitative variance. It is defined as $-\sum (p_i * \log_2(p_i))$ (Coulter 1989). In our case the p_i are the shares of time spent for an activity plus associated trips in the week of report. Six activity classes are available for analysis plus 'housing', which remains unconsidered here.

*** Number of 'yes'-counts out of groceries, other shops, restaurants/ pubs, leisure facilities, sports facilities; (Cronbach's α=0.73).

	Car deficient households		Fully equipped house-holds
	Person level	Trip level	Trip level
	(percent 'yes')		
Car use as a driver (trip level)		47.1	70.0
Gender female	49.8	50.4	49.6
male (reference category)	50.2	49.6	50.4
Relative education level; constructed out of five categories: (1) no qualification; (2) elementary school qualification without apprenticeship; (3) elementary school qualification plus apprenticeship; (4) secondary school qualification level I; (5) final secondary school qualification (university entrance)			
Both partners have same level (reference)	51.8	51.4	53.6
Respondent dominates strongly: respondent's qualification is 2+ categories higher than his/her partner's, and respondent achieved at least category 4	4.6	4.8	4.9
Respondent dominates somewhat: respondent's qualification is one category higher than his/her partner's, or respondent achieved no more than category 3	19.6	20.1	19.8
Partner dominates strongly: see above	4.5	4.0	3.7
Partner dominates somewhat: see above	19.5	19.7	18.0
Respondent dominates strongly * female	1.3	1.2	2.4
Respondent dominates somewhat * female	8.2	8.5	8.8
Partner dominates strongly * female	3.2	2.9	1.8
Partner dominates somewhat * female	11.3	11.6	10.1
Education level of household			
Both partners have elementary school or no qualification (reference)	20.5	0.3	14.9
At least one partner has secondary school level I	34.1	52.4	29.4
At least one partner has final secondary school qualification (university entrance) or university degree	45.4	47.3	55.7
Large car deficiency in household (2+ cars too few)	8.2	8.1	
Large car deficiency * female	4.1	4.1	
Municipality with < 20,000 inh. (reference)	42.2	42.2	51.2
Municipality with 20,000-100,000 inh.	28.1	28.6	28.8
Municipality with 100,000-500,000 inh	16.4	16.6	13.4
Municipality with > 500,000 inh	13.3	12.6	6.6
Central residential location within city (self-report)	14.8	15.3	8.9
Large variety of PT systems in neighbourhood: 3+ out of five different systems (bus, tram, tube, regional train, long-distance train) are accessible on foot	47.8	48.4	36.8
Need for car use for commute, depending on PT connection to both partners' places of work or education ('PT good' means that the respondent reports a fast direct connection; 'PT poor' means that there is a slow direct connection, a connection where (s)he has to change, or no PT connection at all)			
Both partners need car (PT poor) (reference)	40.6	41.3	54.3
Neither partner needs car (PT good or person not employed/in education)	16.6	16.6	7.7
Partner needs car (PT poor), while respondent does not (PT good or respondent not employed)	21.3	21.3	18.6
Respondent needs car (PT poor), while partner does not (PT good or partner not employed)	21.5	20.8	19.4
Neither partner needs car * female	8.2	8.2	3.3
Partner needs car, while respondent does not * female	15.1	15.1	13.3
Respondent needs car, while partner does not * female	6.2	5.9	5.2
n	3,230	85,951	87,470

Table 2: Dummy variables used in regression: definitions and descriptive statistics

All variables are coded as yes=1, no=0. Reference categories are listed in regression table.

	Adults without license			Licensed adults		
	M	W	all	M	W	all
	Household has no car at all					
On foot	46.2	45.6	45.8	35.3	40.3	38.3
Bicycle	14.0	13.9	14.0	21.4	18.5	19.6
Car driver	4.3	0.6	1.9	6.3	2.7	4.2
Car passenger	7.4	10.8	9.6	7.5	9.3	8.6
PT	27.5	28.9	28.4	29.3	29.1	29.2
Other	0.5	0.1	0.3	0.3	0.1	0.2
Total	100.0	100.0	100.0	100.0	100.0	100.0
	Household has less cars than drivers					
On foot	25.7	30.8	28.4	18.2	22.6	20.4
Bicycle	25.9	20.4	23.0	11.0	11.4	11.2
Car driver	3.1	1.1	2.0	56.6	36.5	46.7
Car passenger	23.2	25.8	24.6	8.3	23.1	15.6
PT	21.6	21.3	21.5	5.3	6.2	5.8
Other	0.5	0.5	0.5	0.5	0.1	0.3
Total	100.0	100.0	100.0	100.0	100.0	100.0
	Household has as many cars as drivers (or more)					
On foot	23.2	30.2	27.7	15.9	17.9	16.9
Bicycle	21.0	13.8	16.3	5.6	5.7	5.6
Car driver	12.9	6.0	8.4	69.4	60.9	65.2
Car passenger	24.2	35.2	31.4	5.7	12.1	8.9
PT	18.4	14.7	16.0	3.1	3.2	3.2
Other	0.3	0.1	0.2	0.4	0.1	0.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

Table 3: Modal split by gender, license status and household car ownership

Car driver includes small proportions of motorcyclists.
n=11,294 trips (household has no car at all), n=143,449 (car deficient households), n=155,607 (fully equipped households). Gender differences in mode choice significant in all subgroups (Chi Square test, p=0.05)

	Share of car use in trips as driver (Model 1)		Share of car use in trips as driver or passenger (Model 2)		Car use as a driver (trip level) in car deficient households (cars < drivers) (Model 3)			Car use as a driver (trip level) in fully equipped households (cars >= drivers) (Model 4)		
	B	Sig.	B	Sig.	B	Exp(B)	Sig.	B	Exp(B)	Sig.
Intercept	60.1	0.00	78.0	0.00	0.19	1.21	0.28	1.40	4.06	0.00
Gender roles										
Gender (female=1)	-23.1	0.00	-10.4	0.03	-1.02	0.36	0.00	-1.08	0.34	0.00
Respondent's share in household work	13.7	0.00	7.8	0.02	1.00	2.72	0.00	0.22	1.25	0.16
Respondent's share in employed work	15.9	0.00	11.4	0.00	0.42	1.53	0.01	0.32	1.38	0.06
Respondent's share in household work * female	-5.3	0.24	-0.1	0.97	-0.18	0.84	0.49	0.48	1.62	0.04
Respondent's share in employment work * female	-10.8	0.03	-5.7	0.22	0.00	1.00	0.99	0.30	1.35	0.23
Age difference (respondent minus partner)	-0.5	0.01	-0.5	0.00	-0.02	0.98	1.00	-0.00	1.00	0.79
Age difference * female	0.2	0.37	0.5	0.06	0.01	1.01	0.29	0.00	1.00	0.64
Number of children in household (< 10 yrs)	-2.6	0.01	-3.3	0.00	-0.11	0.90	0.02	0.02	1.02	0.73
Number of children in household (10-13 yrs)	-0.3	0.85	0.2	0.90	0.05	1.05	0.54	0.04	1.05	0.56
Number of children in household (14-17 yrs)	2.7	0.10	3.5	0.03	0.08	1.09	0.31	-0.10	0.91	0.17
Number of children (< 10 yrs) * female	7.4	0.00	3.6	0.02	0.29	1.33	0.00	0.12	1.13	0.07
Number of children (10-13 yrs) * female	4.8	0.03	-0.2	0.93	0.09	1.09	0.45	0.08	1.08	0.45
Number of children (14-17 yrs) * female	3.9	0.10	-0.2	0.93	0.24	1.27	0.05	0.21	1.23	0.03
Relative education level (reference: both partners have same level)										
Respondent dominates strongly	7.3	0.01	6.3	0.01	0.37	1.44	0.02	-0.17	0.85	0.19
Respondent dominates somewhat	-1.8	0.36	-1.6	0.38	-0.11	0.90	0.29	0.17	1.19	0.07
Partner dominates strongly	8.1	0.03	7.3	0.04	0.24	1.27	0.16	0.32	1.38	0.08
Partner dominates somewhat	-0.6	0.77	0.3	0.88	-0.07	0.94	0.51	0.24	1.27	0.02
Respondent dominates strongly * female	-3.9	0.44	-4.6	0.30	-0.29	0.75	0.30	0.25	1.28	0.36
Respondent dominates somewhat * female	2.2	0.42	3.1	0.22	0.02	1.02	0.87	-0.06	0.95	0.65
Partner dominates strongly * female	-10.3	0.03	-6.9	0.14	-0.31	0.73	0.23	-0.51	0.60	0.04
Partner dominates somewhat * female	2.7	0.34	1.0	0.73	-0.04	0.97	0.80	-0.08	0.93	0.54
Education level of household (ref.: both partners elementary school or no qualification). At least one partner has...										
...secondary school level I	-1.1	0.49	-2.7	0.07	0.06	1.06	0.38	-0.19	0.83	0.00
...final secondary school qualification (university entrance) or university degree	-2.8	0.10	-4.6	0.00	-0.09	0.91	0.13	-0.09	0.92	0.10

Car deficiency (ref.: one car too few)										
Large deficiency (two or more cars too few)	-2.2	0.43	-3.6	0.17	-0.07	0.93	0.56			
Large deficiency * female	9.0	0.02	7.9	0.03	0.26	1.30	0.17			
Municipality size category (ref.: < 20,000 inh)										
20,000-100,000 inh	-3.6	0.02	-4.4	0.00	-0.06	0.94	0.37	0.03	1.03	0.59
100,000-500,000 inh	-3.2	0.07	-3.1	0.08	-0.03	0.97	0.69	-0.06	0.94	0.42
> 500,000 inh	-8.3	0.00	-10.0	0.00	-0.28	0.76	0.00	-0.16	0.86	0.11
Central residential location within city	-4.1	0.01	-3.9	0.01	-0.21	0.81	0.01	-0.19	0.83	0.03
Large variety of PT systems in neighbourhood	-2.3	0.03	-2.5	0.02	-0.06	0.94	0.25	-0.11	0.90	0.03
Variety of facilities in neighbourhood	-2.0	0.00	-2.7	0.00	-0.11	0.89	0.00	-0.07	0.94	0.00
PT system quality to place of work or education. Ref.: both partners need car (poor PT connection)										
Neither partner needs car	-5.0	0.02	-4.5	0.04	-0.17	0.84	0.09	-0.28	0.76	0.01
Partner needs car, while respondent does not	-5.0	0.03	-4.5	0.05	-0.29	0.75	0.01	-0.26	0.77	0.01
Respondent needs car, while partner does not	1.9	0.28	1.8	0.31	0.13	1.14	0.15	0.01	1.01	0.87
Neither partner needs car * female	2.0	0.51	2.1	0.48	0.07	1.07	0.64	0.06	1.06	0.72
Partner needs car, while respondent does not * female	-1.0	0.73	0.8	0.79	-0.07	0.93	0.60	0.13	1.14	0.30
Respondent needs car, while partner does not * female	1.2	0.66	-0.7	0.81	0.04	1.04	0.80	-0.07	0.93	0.61
Activity and trip patterns (for each variable: respondent minus partner). Difference in...										
...number of trips per week	0.8	0.11	0.2	0.74	0.05	1.05	0.06	0.00	1.00	0.98
...distance to work / education	-0.1	0.06	-0.0	0.28	-0.00	1.00	0.79	-0.00	1.00	0.03
...entropy	1.6	0.41	1.9	0.34	0.13	1.14	0.22	-0.11	0.89	0.25
...time spent out-of-home	-0.1	0.00	-0.1	0.00	-0.00	1.00	0.09	0.00	1.00	0.47
...number of trips per trip chain	-0.5	0.66	-0.2	0.89	0.02	1.02	0.73	0.02	1.02	0.51
...number of trips per week * female	1.0	0.12	-1.3	0.05	0.04	1.04	0.29	-0.02	0.98	0.54
...distance to work / education * female	0.0	0.35	0.0	0.55	0.00	1.00	0.60	0.00	1.00	0.63
...entropy * female	2.9	0.29	1.0	0.72	0.09	1.09	0.57	0.41	1.51	0.00
...time spent out-of-home * female	0.1	0.02	0.1	0.00	-0.00	1.00	0.91	-0.00	1.00	0.30
...number of trips per trip chain * female	0.9	0.51	1.4	0.29	0.03	1.03	0.65	-0.04	0.96	0.33
Year of observation (base year=0)	-0.0	0.84	-0.1	0.56	-0.00	1.00	0.90	-0.03	0.97	0.00
Year of observation * female	0.3	0.33	0.3	0.33	0.00	1.00	0.78	0.01	1.01	0.39
(Scale)	765.9		718.6		1.00			1.00		
QICC**	344		329		111.7			104.2		

QICC, intercept model**	324	268	118.9	106.8
R^2 adj. (OLS regression)*	23.2	12.6		
Pseudo R^2 (Cox & Snell)*			7.7	2.7
Pseudo R^2 (Nagelkerke)*			10.3	3.9
n (observations)	3,230	3,230	85,951	87,470
n (individuals)	1,969	1,969	1,969	1,942

Table 4: Regression models of car use

* from models with independent observations, excluding multiple observations of the same individuals.
** for trip model div. by 1,000