

Gendered key events in the life course: effects on changes in travel mode choice over time

Joachim Scheiner

Prof. Dr. Joachim Scheiner, Technische Universität Dortmund, Faculty of Spatial Planning, Department of Transport Planning, 44227 Dortmund, Germany
phone ++49-231-755-4822, fax ++49-231-755-2269, e-mail joachim.scheiner@tu-dortmund.de

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Abstract: This paper studies changes in travel mode specific trip rates after life course (and accessibility) related key events from a gender specific perspective. It is theoretically informed by the mobility biographies approach, and by gender/travel studies. The data used is the German Mobility Panel (GMP) 1994 to 2010 in which households and their members are asked three times in three subsequent years to report the trips they made over a week. The changes reported are regressed to key events over the life course, cohort effects and period effects, while sociodemographics and spatial context attributes are controlled. A cluster-robust regression approach is used to account for the non-independent character of panel observations. Significant effects were found for some key events, including the birth of a child, entry into the labour market, and changes in spatial context, accessibility and mobility. Some effects differed distinctly between men and women, suggesting that men and women are differently affected by life course events. However, taken together the associations found, as well as their gender specifics are rather limited. Hence, key events over the life course seem to be only loosely associated with travel mode specific trip rates.

Keywords: travel mode choice, mobility biography, gender, key event, travel behaviour change

Highlights:

- Changes in travel mode use after life course and accessibility related key events are studied from a gender perspective
- Significant effects were found for some key events, including the birth of a child and entry into the labour market
- Changes in spatial context, accessibility and mobility were significant as well
- The effects of some key events differed distinctly between men and women
- Taken together the effects, as well as their gender differences, are limited

1 Introduction

It has long been recognised that the trajectories that shape individuals' life courses differ between the genders (Rossi, 1985). Life courses may be understood as paths from birth to death that are shaped by multi-faceted context factors including the social, economic, cultural, political, technological and regional circumstances in which an individual leads his or her life. What is more, an individual's preferences, goals and intentions shape his or her life-path and, possibly, the paths of connected others as well.

The impact of context as well as the way individuals make use of and shape context is strongly gendered in many respects. The reasons for this include gendered access to resources, social role expectations, preferences, and possibly the patriarchal structure of society which may be based on gendered power relations (see for discussion, e.g. Bianchi et al. 2000; Hakim, 2003; Babcock and Laschever, 2003; Blau et al. 2010; for contributions from transport geography see Hanson and Pratt, 1995; Polk, 1998; Law, 1999; Rosenbloom, 2006; Kwan et al., 2009; Grieco and McQuaid, 2012 and other papers in the same issue; Gil Solá, 2013; Schwanen et al., 2014).

The mobility biography approach has been developed over the past decade to capture the travel and mobility elements in people's life courses (Lanzendorf, 2003; Scheiner, 2003). In empirical applications of this approach, numerous key events over the life course have been found to significantly affect people's availability and/or ownership of mobility tools, such as cars or public transport season tickets, and their travel behaviour alike (review in Scheiner, 2007). However, this approach has as yet been little applied in combination with gendered analysis, although life courses have been shown to be gendered in many respects. Perhaps the most striking example is the traditionalisation of gender roles after childbirth, when women tend to take disproportionate responsibility for the child, the family and the housework while men tend to take on the breadwinning role (Best and Lanzendorf, 2005; Blau et al., 2010; Davis and Moore, 2010; Grunow et al., 2012).

The life course has become an important issue in geography in recent years, and its gendered nature as well as its links to travel have been clearly recognised (Rosenbloom, 1993; Jarvis et al., 2011). Yet the links between gender, travel and the life course have not been fully developed, let alone been clarified empirically. This paper aims to shed some light on the gendered nature of mobility biographies. Specifically, changes in individual travel mode use from one year to the next are studied focusing on the effects of key events in the life course while controlling for a large variety of potentially explanatory variables including sociodemographics and spatial context at the residence and the workplace. Separate models for men and women are estimated to account for the gendered nature of the key events. Employing a life course perspective on the gender-travel link extends existent research in the field and helps clarify gender equity issues in transport as well as recognise potentials for change at certain moments in life. A possible way of looking at the gendered character of the life course would be to focus on activity patterns which are known to be gendered in many respects. However, feminist/transport studies including geography have consistently argued that women's limited access to transport modes is a major source of inequality, i.e. women's disadvantageous time use, labour market access and activity patterns in general (Ortoleva and Brenman, 2004; Dobbs, 2005; Grieco, 2008). Hence the focus here is on travel mode use.

The reader should keep in mind that the policy context for gender relations in Germany may differ from other countries. Germany is commonly considered a conservative (or social capitalist/corporatist) regime in terms of gender relations, similar to France, Belgium, and The Netherlands (van der Lippe et al., 2011; Kan et al., 2011). This regime is politically and culturally (and geographically) situated between the Mediterranean regime, from which it differs in having better developed social security systems and somewhat less 'catholic impact' and conservative gender ideology, and the Nordic social democratic regime in which both policy and society strongly promote gender equity by providing universal child care to allow women to take full-time occupations and by encouraging fathers to take parental leave (Ruppanner, 2010; Kan et al., 2011). Germany has some notable incentives for couples to conduct a male-breadwinner-and-female-housewife type of work sharing, including a joint income tax system for couples and a relatively poor provision of public childcare (Apps and Rees, 2005; Cooke, 2006; Kan et al., 2011). In line with this, female labour force participation rates are lower than in more 'progressive'

Nordic countries, but the fertility rate is still lower (Apps and Rees, 2005; Dustmann, 2005). In the eastern parts of Germany – the former GDR – public child care has traditionally been and still is more common (Cooke, 2006). Parental leave regulations in Germany are relatively generous (36 months since 1992), but included little financial benefit until 2006 (Geisler and Kreyenfeld, 2012). Female labour force participation rates have increased steadily over time, but with high proportions of part-time work when compared to countries as diverse as France, Italy, Sweden, Japan, Australia or the USA (Dustmann, 2005).

In the past few years, German governments have undertaken considerable efforts to expand child care facilities, encourage women into employment and fathers to take paternal leave. Since 2007 a new parental leave scheme that has been adopted from Sweden grants parents two thirds of their prior net income for 14 months. Two months are reserved for each partner, thus encouraging fathers to take at least two "daddy months" of leave (Geisler and Kreyenfeld, 2012).

Hence Germany has recently experienced a process of rapid change in gender relations. As the empirical work done in this paper is based on data spanning the period 1994-2010, I expect recent trends to have relatively little impact on the results. Within the scope of this paper, Germany should be considered a relatively conservative gender regime, with some trends towards modernisation and equity.

In the next section the state of the research is introduced. As the novelty of this paper lies in making a link between gender, the life course and travel (here: mode choice), the review does not attempt to provide a full picture of the rich gender/travel literature as far as it does not refer to the life course. The subsequent section describes the data and methodology of analysis. Subsequently the results are presented. The paper closes with some conclusions and an outlook on further research.

2 Life course, gender, and mobility biographies – state of the research

The state of the research is developed in three steps here. Firstly, gendered structures in the life course are briefly introduced, followed by (secondly) a short overview of the mobility biography approach. Thirdly, expectations concerning the gender specific effects of key events on mode use are elaborated upon.

2.1 Gender and the life course

Life course and biography research have become a broad field of inquiry over recent decades¹, the most pertinent disciplines being sociology and psychology (for an overview see Mortimer and Shanahan, 2006), both of which developed relatively independent perspectives on the life course (Diewald and Mayer, 2009). Gender as a basic concept is, however, somewhat underdeveloped in this research (Widmer and Ritschard, 2009, p. 29; see also Corna, 2013, for life course related health studies). This is despite the fact that it has been given some attention. For instance, in her essay Rossi (1980) reflects carefully on the nature of gender differences in the life course, with a focus on the biological nature of sex and on the distinctiveness of cohort affiliation.

Attention has been given to the gendered character of the life course by economists (Dustmann 2005 and other papers in the same issue). However, the general focus is more on certain stages

¹ There is no distinction made here between life course and biography, even if there are notable differences in theory and methodology between life course research and biography research (Sackmann, 2007; see Rossi, 1980 and Elder et al., 2006 for brief discussions of the terms life course, life span, and lifecycle).

in the life cycle than on a true life course perspective. Rossi (1985) edited a seminal book on gender and the life course which covered historical, demographic, psychological and sociological, economic and political perspectives. Gender structures in the life course seem to be obvious, given that the timing, sequencing and occurrence of some life stages are characterised by strong gender inequalities. For instance, women leave their parental home earlier than men, marry earlier and become parents earlier in life (Hillmert, 2005 for Germany). Inasmuch as such structures open up or inhibit options for subsequent life stages, they may cause new inequalities at later stages. The most researched example and consistent finding in this respect is childbearing that has a traditionalising influence on ideology (Davis and Moore, 2010), on household work sharing and, hence, activity patterns (Apps and Rees 2005 for Australia, the UK, and Germany; Grunow et al., 2006, 2012 for Germany) and travel patterns (Best and Lanzendorf, 2005 for Germany). Apps and Rees (2005) add that the gender gaps in employment as well as in domestic work tend to become narrower again in later life stages.

These trends are on the household and individual level. On the aggregate level changes over time point in the other direction, i.e. more egalitarian gender relations (Blau et al., 2010 and Bianchi et al., 2000 for the USA, Schäfer, 2004 for Germany). This means that cohort and period effects in gender analysis may show opposed trends compared to life course effects. Period and cohort effects may also intersect with life courses from one generation to the next in gender-specific ways; e.g. the spread of the internet is one such cohort-specific change, and its adaptation is linked with the gender division of household work (Schwanen et al., 2014). Gender convergence in travel behaviour over time has also been observed to evolve in cohort specific ways (Scheiner et al., 2011), specifically in terms of decreased travel by men (Frändberg and Vilhelmson, 2011 for Sweden; Kuhnimhof et al., 2012 for Germany).

Even though economic inequality, norms or ideologies may foster such 'standard trajectories', considerable de-standardisation of life paths has been observed over time in Germany (Kohli, 2007; Scherger, 2009), Switzerland (Widmer and Ritschard, 2009) and the USA (Liefbroer and Elzinga, 2012). Standardisation refers to belonging to particular, 'normal' demographic states at certain ages and the transitions connecting these states to one another. Processes of destandardisation or individualisation refer more to women than to men (Scherger, 2009, Widmer and Ritschard, 2009), particularly because of women's increasingly diverse occupational trajectories.

2.2 Travel behaviour over the life course – mobility biographies

Gender specifics in the life course are closely related to activity patterns and, hence, may also be associated with travel behaviour. Changes in travel behaviour over the life course are an important topic of inquiry in recent research. This strand of research has its roots in the conceptual idea of space-time life paths employed in the time geography of the 1970s (Hägerstrand, 1970; Martensson, 1979). More recently it has been developed into the mobility biographies approach that focuses on the effects on travel behaviour of key events and transitions in a life course (Lanzendorf, 2003; Scheiner, 2003; Van der Waerden et al., 2003; Axhausen et al., 2006; Harms, 2007; Scheiner, 2007). The theoretical underpinning is that travel behaviour is relatively habitual as long as daily requirements, needs and conditions are stable. However, an individual's behaviour may change due to adaptation to new circumstances and/or learning processes. Key events that have been identified as transport relevant in this approach can be categorised into three life domains:

- household and family biography, including leaving the parental home, forming a household with a partner/founding a family, birth of children, divorce, children moving out (Zwerts et al., 2010; Lanzendorf, 2010);

- employment biography, including the commencement of job training or university entry, entry into the labour market (Harms, 2007), change of job or education, income changes (Dargay, 2001), retirement (Ottmann, 2007);
- residential biography, including residential moves and associated changes in the spatial context at the residence (Krizek, 2003; Scheiner, 2003; Axhausen et al., 2006).

Change may also be induced by processes of learning and experience gathered over longer periods. The effects of socialisation in childhood and adolescence on adult travel behaviour may serve as an example (Haustein et al., 2009).

Life domains, key events and experiences must not be considered in isolation. For instance, residential relocations often correspond with events in employment and household biographies, such as household formation, the birth of a child or workplace change (Dieleman and Mulder, 2002). When examining the effects of residential relocation it is therefore necessary to closely consider related changes in the household and employment context.

The mobility biography approach is individualist in nature, and thus tends to neglect generation specifics in biographies. For instance, out-migration and long-distance commuting are not just individual, but generation specific experiences shared by East German adults who were part of the labour force after German reunification in 1990. Such collective patterns should result in cohort specific elements in mobility biographies (Thakuria et al., 2010). Individualist approaches also tend to neglect changing structural circumstances that result in period effects which operate over and above individual life situations.

Such circumstances have been highlighted from a historical perspective in Kohli's theory of the institutionalised life course. Kohli (2007) argues that over the 20th century the life course has become a distinctive dimension that structures society, similar to gender or class. The life course, thus, can be understood as a societal institution which has emerged, first, by the relative security of becoming old – rather than the pre-modern omnipresence of a relatively high likelihood of dying at a young age. Second, the life course as an institution has been and still is formed by the emergence of a strong state administration and its normative and legislative frameworks, one of the most distinctive being the definition of the age of consent that legally marks the end of adolescence. In Germany and other countries, this age is closely linked to transport as it permits individuals to own a driving license. Another distinctive boundary that has emerged with the welfare state (pension insurance) is between employment age and retirement (Kohli 2007). Beyond this socio-historical perspective, one may add that other structural conditions of the life course include the technological, economic and cultural context in which individual life courses are embedded.

2.3 Gender specific effects of key events on mode choice

The reasoning behind gender differences in travel and mobility highlighted in the literature may be traced back to four basic hypotheses (Scheiner and Holz-Rau, 2012). As these hypotheses claim to explain the processes that lead to gender differences in behaviour, they may also serve to understand behavioural changes. They are typically discussed in concert and considered to be complementary rather than competitive with no author championing one hypothesis to the exclusion of all others (see Hanson and Pratt, 1995; Law, 1999; MacDonald, 1999; Hamilton and Jenkins, 2000; Blumen, 2000; Clark and Wang, 2005; Crane, 2007; Sandow, 2008 for well-balanced discussions). Very briefly put, these hypotheses claim that (a) women are disadvantaged in terms of economic power and associated access to economic, social, spatial and temporal resources, (b) women are disadvantaged due to their disproportionate commitment to household and family responsibilities that limits their economic independence, (c) women are

disadvantaged due to long-standing patriarchal power relations that may operate over and above economic inequalities, and (d) women themselves may be blamed for these disadvantages because they do not strive enough for more power or better negotiating positions – they just 'don't ask' (Babcock and Laschever, 2003).

While this latter position has received much attention, the overwhelming majority of gender studies are still clearly dominated by a view of female disadvantage. Some support for the effect of preferences, as highlighted by Hakim (2003), may be concluded from a study that found that women's participation in the labour market as well as their wage output strongly depends on perceptions of women's role as a homemaker, egalitarian views, and inner conflicts between family values and egalitarian views ('mother's guilt') (Fortin, 2005, in a cross-national study covering 25 OECD countries). This may also serve as an example of what Law (1999) describes as 'gender gives meaning' in her comprehensive gender concept.

These hypotheses should not be understood as being independent of each other. Neither can the causal relationships between them be clearly determined. 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. It is difficult to empirically dissect preferences from constraints as preferences may emerge under constrained conditions that people may not be aware of when they reflect their own practices. For instance, Gil Solá (2013) finds that women wish to commute short distances when they have small children more than men, but this 'wish' may rather be the outcome of an internalised social role than a preference, as women are typically socialised to take on this responsibility for being a 'good mother' (Lee and McDonald 2003, p. 1285, Schwanen, 2007)². Socialisation is a powerful institution that serves to maintain existing structures, not only in terms of social roles and life trajectories (Liefbroer and Elzinga, 2012), but also in terms of mode choice, although evidence is rare (see Haustein et al., 2009 for an exception).

The mobility biographies and related approaches have produced a substantial number of empirical studies in recent years, particularly with respect to the effects of various key events. However, few of them take gender structures into account.

The most obvious example for such gendered key events with respect to travel is again the birth of a child. It has been a focal point in gendered travel analysis since the beginning of the approach in the late 1970s, aiming to highlight women's disproportionate responsibility for childraising and associated trip-making (Hanson and Johnston, 1985; McDonald, 2008 for a US perspective, Lee and McDonald, 2003 for Korea; Zwerts et al., 2010 for Belgium; see Schwanen, 2007, for a detailed analysis of parents' chauffeuring of children to/from school and childcare, and Barker, 2008 as a rare example of studying fathers' child-escort trips in the UK). This may not only differently affect mothers' and fathers' activity patterns and trip generation, but also their mode use. Scheiner and Holz-Rau (2012) find that having small children decreases men's but

² The difficulty of interpreting travel behaviour as either constraint or choice may be further underlined by the study of Kawase (2004) in Tokyo. Typically, women's short commutes are interpreted as reflecting constrained access to the labour market. Kawase (2004) shows that actually Japanese adult daughters' *long* commutes are a reflection of constraints. Whereas adult sons typically move close to their workplaces when they enter the labour market, daughters are forced to stay in their parental home, which results in long commutes.

increases women's car use in Germany. In a qualitative study among twenty German parents Lanzendorf (2010) finds that the birth of a child may not only foster car dependency, but also induce mode choice changes in favour of public transport or cycling³. Schwanen (2011) reports from another qualitative study in The Netherlands, where the birth and development of children as they grow older tend to have more effect on mothers' than fathers' car use and home-work arrangements. Specifically, mothers' car dependence tends to increase, and they tend to reduce complexity in daily activity and trip patterns by reducing the hours of employment or by shortening their commute – or at least contemplate about doing so more than men.

Generally the car is considered best when mothers have to juggle multiple duties (Schwanen, 2011). Multiple care, household, and employment obligations impose more spatial and temporal fixity constraints on women than on men because they participate more in these duties (Kwan et al., 2009), and the car is better suited than other modes to link the required variety of destinations together in a relatively short time and with more reliability. What is more, unpaid care work, as compared to marketed work, has little potential for productivity or efficiency gains, as it is tied to the devotion of time, emotions and human presence at particular places and times – "it cannot be separated from the person doing it" (McDowell et al., 2006, p. 146). In effect, women are disproportionately affected by fixity constraints that result in reduced access levels (Hanson and Pratt, 1995; Kwan, 2000; Kwan et al, 2009), although one may object to some extent that the above-average fixity experienced by women includes personal needs and pleasure rather than being solely based on obligations (Kwan, 2000, p. 151-2).

Hence, the reasoning behind expecting gender differences in mode choice is, first, motivated by differences in activity patterns – specifically the types of work involved – and, thus, trip purposes. A second reason is the link between mode choice and trip distances. Some researchers argue that women's jobs tend to be concentrated in female-dominated occupations that are geographically more evenly distributed than male-dominated occupations (Hanson and Pratt, 1995; Sandow, 2008), which results in women's shorter commutes. This in turn may lead to lower levels of car dependence. A third key aspect is that travel modes themselves may reflect different symbolic meanings to men and women. Polk (1998) found rich evidence that the car tends to be stereotypically perceived as a masculine technology in terms of driving ability, driving experience, technological skills, interest and taking responsibility for the car

It is difficult to derive clearly defined hypotheses on travel mode use changes from this framework (see Schwanen's, 2011, p. 153, discussion of contradictory effects of gender differences on car use). In line with feminist research, it has to be assumed that in change situations women may act and negotiate from a weaker position than men and, hence, be *grosso modo* less able to realise their needs. The car is typically supposed to be a favourable mode from a user perspective due to its speed, flexibility and individual availability, and, hence, feminist studies argue "that the husband has the 'first choice' in families with only one car" (Hjorthol, 2000, p. 219 for Norway; similarly: Naess, 2008, p. 190 for Denmark). This would imply that increases in driving after life course events tend to be stronger for men than women, while decreases in driving are stronger for women than men. On the other hand, one may suspect that women's less habitual approach to travel (Matthies et al., 2002 for Germany) generally implies a stronger tendency for change. Besides, taking on household tasks strengthens an individual's negotiating position with relation to the car. This is probably the reason why women's car use increases when children are present (Scheiner and Holz-Rau, 2012 for Germany; Hjorthol, 2000, for Norway).

³ In fact, *having* a child is what fosters car dependency, if any. But the *birth* of a child is the key event that normally results in having a child.

Because of such ambivalent expectations, I refrain from detailed hypotheses on magnitudes and signs of expected effects. Hence, the empirical study presented here is more exploratory in nature. Its unique contribution is that it links two strands of research together in both of which geographers play a major role: the gender/travel debate on the one hand, which employs more static empirical approaches, and the dynamic approach of mobility biographies on the other hand, which has little relationship to gender issues to date.

3 Methodology

3.1 Data

The data used is the German Mobility Panel (GMP) 1994 to 2010⁴. The GMP is a household survey with the sample organised in overlapping waves. Every household is surveyed three times over a period of three consecutive years (Chlond and Kuhnimhof, 2005), e.g. from 1994-1996, before being excluded from the survey. A trip diary is used to collect information on trips over a whole week from all household members aged ten years or over. Sociodemographic attributes for the household and its members are collected as well as spatial context attributes at the residence and at the household members' places of work or education.

An important limitation is that household income has only been recorded since 2002. Income is thus excluded from the analysis, rendering it impossible to investigate the effects of income changes. Education level and employment status are used as rough proxies for income. Coding multiple life course events results in missing values in many cases (see Scheiner, 2011 for details). As life course events are relatively rare events in an individual's life, no event in cases of uncertainty is assumed. The coefficients estimated are thus based on changes among those for whom it is relatively certain an event occurred, while some of those for whom no event is assumed may in fact have experienced one.

The data include a total of 26,918 individual report weeks. Among these, 12,868 weeks are last-time-reports for which no change to the next year can be detected. For 12,555 weeks complete information (other than that discussed above) is available, and these are used for the regression models (n=5,951 men's, 6,604 women's weeks). This sample is composed of 7,740 individuals (3,660 men and 4,080 women), for 4,815 of whom two observations of change are available (from the first to the second and from the second to the third year of report).

3.2 Analysis approach

While most mobility biography studies to date focus on a particular life event, this paper uses regression modelling to detect the effects of a comprehensive set of life course events, cohort and period effects on travel mode use. Descriptive analysis of selected life course events that turned out significant is presented as well.

The paper draws upon a companion paper (Scheiner and Holz-Rau, 2013) but takes gender specific effects of life course events into account. The natural way to do this would be to use the main effects of a variable plus its interaction terms with gender. However, this procedure resulted in exorbitant multicollinearity, most pronouncedly between the variables cohort and cohort

⁴ 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).

squared, and their respective gender interactions, with variance inflation factors⁵ (VIF) exceeding VIF=100. As gender specifics in cohort effects are clearly of interest in this paper, separate models for men and women are estimated. In the resulting models all VIF are <4, which is well below the usual threshold of acceptance (VIF<10, Schendera, 2008, p. 105), with the exception of cohort (VIF≤68.1, depending on the model) and cohort squared (VIF≤73.9) which are naturally correlated but retained in the model due to the recent debate on gender specific decreasing car use among young adults (Kuhnimhof et al., 2012). The results of significance tests of interaction terms are included in Table 4 for convenient additional interpretation.

The panel nature of the data results in non-independent (clustered) observations, thus violating a most basic assumption of statistical analysis. The use of OLS regression with such data may result in the 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).

Hence, a cluster-robust estimation method based on pooled data is used. This method controls for autocorrelation within subjects emerging from the temporal order (sequence) of records. As the analysis is at the person level, this means that the correlation matrix of within-subject dependencies is estimated as part of the model. The estimates lack efficiency 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 estimator converges to the true standard error as the number of clusters (not the number of observations) approaches infinity (Kézdi, 2004; Nichols and Schaffer, 2007). Given the large sample and cluster number, neither of these issues should raise serious concern.

Concerning model specification (see Garson, 2010 for details), the autoregressive correlation type is used, 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. The dependent variables used are continuous in nature, and normal distribution is assumed. A graphical inspection reveals that this assumption holds true, which is not surprising as behavioural change from one year to the next is scattered around zero.

Unlike OLS regression, there is no determination coefficient available for cluster-robust regression. The SPSS procedure GEE (generalised estimating equations) is used for the analysis, and 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. This is reported for the final models as well as for the intercept models. However, there is no formal test of significance in model improvement available.

For comparison OLS regressions with a random subsample of one observation per individual are estimated. The results are available upon request from the author. OLS regressions are known to be relatively robust against mild violations of assumptions. A comparison of the cluster-robust regressions with the OLS regressions shows different levels of significance and effect magnitudes in some cases. However, the two modelling approaches generally yield very similar results both

⁵ Variance inflation factors indicate multicollinearity, i.e. correlations between multiple explanatory variables. Such correlations increase the variance and, hence, decrease the reliability, of coefficient estimates (Schendera, 2008, p. 104).

for the signs and the magnitudes of the coefficient estimations, supporting the robustness of the findings.

3.3 Dependent variables

The variables studied are changes in travel mode specific trip rates from one year to the next on the person level, including five modes: car as a driver, car as a passenger, public transport, bicycle and walking. The variables are computed using mean trip frequencies per day over the week of report, taking the difference between the value in the year of interest and that in the preceding year. Due to lack of space the regression models are limited to three modes: driving, PT use, and walking.

3.4 Explanatory variables I – baseline values

Various state and change variables in sociodemographics and spatial context at the residence and at the place of work or education (for the sake of brevity: workplace) are considered as explanatory variables. Change variables reflect life course events or changes in context (see next section). State variables reflect the baseline value observed in the year prior to change. Some of the variables used are explained in the following, as required (see Table 1 and Table 2 for the full set along with the descriptive statistics).

With respect to cohort effects, cohort plus cohort squared divided by 100 are considered simultaneously in order to capture non-linear effects. Those born in 1900 are coded as cohort zero while those born in 1901 are coded as cohort one and so forth⁶. To capture period effects, the year of survey (1994 equals zero) is considered.

The parking situation at the workplace, as subjectively reported by the respondents, is included as a measure of access to the workplace. It is recorded in four categories, of which the two 'better' categories ('more good than difficult' and 'good') are associated with similar modal splits. Hence they are summarised into one reference category.

The data include information on walking access in the neighbourhood to various facilities (groceries, other shopping facilities, restaurants/pubs, evening leisure facilities, sports facilities). This information is used to calculate the number of different facilities accessible on foot, which reflects the degree of urbanity at the residence, i.e. here the variety of neighbourhood facilities. Additionally, a self-reported variable of living at a central or remote location within the city is included. This information is only available for medium sized towns and cities. Small towns and villages are coded as remote.

Finally, the respective baseline value of the mode use under study in the year prior to change is included, as those with a high level of use of a particular mode may be expected to reduce it more than those who hardly use it anyway (Krizek, 2003).

The analysis started with a set of 61 variables, including 29 baseline and 32 change variables. 29 of 61 variables were retained in the final analysis (16 baseline and 13 change variables). Variables that did not pass a very moderate significance level of $p=0.08$ in any model were

⁶ Models including age plus age squared, but excluding cohort, were run for comparison. These models turned out as virtually identical to those including cohort. However, we assume age effects to be captured to some extent by using life course changes (such as founding a family, starting a job, retiring etc.). Thus, cohort is used for further analysis. It should be noted that cohort does not perfectly correlate with age here, as cohort depends exclusively on year of birth, while age also depends on year of observation.

excluded in a stepwise process, except for categories logically related to other categories. The following variables were excluded:

- Living with partner (as opposed to living without a partner)
- an interaction term between year of survey and a dummy taking the value one for years from 2000 and zero for years to 1999, which was tested because mode choice trends in the aggregate tended to change from this year
- walking distance from the nearest PT stop to work or education
- PT quality in the neighbourhood, calculated from the number of different systems accessible on foot.

Some categories were merged in the following variables:

- Children aged 10-13 and 14-17 (two categories in the data) were merged
- Education level was recorded in five categories, but only the highest level (university entrance qualification or higher) was retained in the analysis
- Parking situation at the workplace is difficult or very difficult (two categories in the data) were merged
- Part-time employed and full-time employed were merged into a reference category
- The population size of the municipality of residence was recorded in six categories but only the uppermost category (more than 500,000 inh) was retained in the analysis.

		Men				Women			
	type*	min	max	mean	SD	min	max	mean	SD
Dependent variables: change in number of trips per day made...									
... by car as a driver	C	-6.29	5.94	-0.03	1.12	-6.71	6.69	-0.01	0.99
... by car as a passenger	C	-2.91	3.34	-0.01	0.47	-4.29	3.25	-0.01	0.65
... by PT	C	-3.14	2.71	-0.01	0.40	-2.99	3.33	-0.01	0.42
... by bicycle	C	-5.14	3.71	0.00	0.55	-4.43	5.24	0.01	0.56
... on foot	C	-4.17	4.43	-0.01	0.71	-6.57	4.75	-0.01	0.78
Explanatory variables									
Gender, household, family biography									
No. of children in household (< 10 yrs)	B	0	4	0.26	0.62	0	4	0.26	0.61
No. of children in household (10-17 yrs)	B	0	4	0.32	0.67	0	4	0.32	0.66
Spatial context at residence, residential moves									
Urbanity (variety of facilities in neighbourhood accessible on foot)	B	0	5	3.06	1.41	0	5	3.06	1.41
Change in urbanity	C	-5	5	-0.02	1.11	-5	5	-0.02	1.13
Cohort and period									
Cohort (born in 1900 = 0)	B	6	96	54.41	18.27	5	96	54.78	17.67
Cohort, squared, div. by 100	B	0.36	92.16	32.94	20.83	0.25	92.16	33.13	20.08
Year of survey (1994 = 0)	B	0	14	7.44	3.89	0	14	7.56	3.88
Baseline values of mode choice									
Number of trips per day made...									
... by car as a driver	B	0	10.75	1.97	1.52	0	10.55	1.38	1.52
... by car as a passenger	B	0	4.22	0.30	0.47	0	10.43	0.65	0.70
... by PT	B	0	4.57	0.27	0.55	0	4.35	0.31	0.60
... by bicycle	B	0	8	0.71	0.86	0	9.43	0.86	0.94
... on foot	B	0	7.43	0.36	0.75	0	7.29	0.36	0.76

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

* B = baseline variable; C = change variable.

	type*	per cent 'yes'	
		men	women
Gender, household, family biography			
Child's birth	C	2.1%	2.0%
Social status, employment and educational biography			
Employed (reference)	B		
Apprenticeship, trainee, education	B	13.7%	12.1%
Not employed	B	33.2%	43.0%
Education level: university entrance qualification or higher	B	36.9%	28.7%
Entry into labour market	C	3.1%	4.2%
Leaving labour market (no retirement)	C	1.5%	2.7%
Access to place of work or education and associated changes			
Walking distance PT stop to place of work or education...			
... decreases	C	4.9%	4.2%
... increases	C	4.7%	4.3%
Parking situation at place of work or education is very difficult	B	13.4%	14.6%
Parking situation at place of work or education gets...			
... much worse	C	1.9%	1.6%
... much better	C	2.1%	1.8%
License holding, car availability and associated changes			
Driving license holding	B	85.6%	76.4%
Gaining driving license	C	2.1%	2.3%
Car availability (reference: not available)			
Occasionally / after agreement	B	10.0%	13.0%
Regularly	B	66.4%	53.0%
Loss in car availability	C	5.2%	5.5%
Increase in car availability	C	5.6%	6.4%
Spatial context at residence, residential moves			
Municipality with > 500,000 inh	B	13.3%	14.7%
Central residential location within city	B	14.9%	16.1%
Move to periphery	C	2.7%	2.8%
Move to centre	C	2.7%	3.0%
N		5,951	6,604

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

All variables are coded as yes=1, no=0.

* B = baseline variable; C = change variable.

3.5 Explanatory variables II – life course events and access changes

A rather comprehensive set of life course events and changes in spatial context and accessibility is considered. These are coded as dummies taking the value one for individuals who experienced a particular event, and zero for those who did not. Separate dummies for changes in opposite directions permit the detection of asymmetrical effects. It should be noted that some events are experienced only by relatively few individuals, which may result in non-significance even when associated changes in mode use are relatively pronounced. The rarest event in the final analysis is that the parking situation at the workplace gets worse from one year to the next. This change is experienced by 216 respondents (113 = 1.9% of all men, 103 = 1.6% of all women) (Table 2). Hence, the interpretation is not purely based on statistical significance, but also on significance or importance as regards content.

Again, some variables require brief explanations (for details see Scheiner, 2011). An increase (or decrease) in walking distance from the nearest PT stop to the workplace means a change into the next category, measured in three 10-minute intervals (< 10 min, 10-20 min, > 20 min). A change variable is also computed for the measure of urbanity at the residence described above. This

variable may reflect residential moves or a change in urban form at the place of residence. A change report in the dummy 'central location of residence within the city' is also used to capture the direction of a move (towards a more central or a more remote location). Changes in the parking situation at the workplace are only considered in cases of severe change (much better or much worse according to the respondent's report) while slight changes are categorised together with the reference category of 'no change' due to lack of significance.

Making a distinction between the birth of a first child versus that of a further child in a family is clearly of interest as the effects on household organisation and travel patterns may differ (Schulze, 2009 and Lanzendorf, 2010 for Germany; Schwanen, 2011, for The Netherlands). A descriptive analysis including this distinction is presented below, but it was abandoned in the regression modelling due to lack of significance. Only one test out of 20 (five modes by two genders by two child 'categories') was close to significance ($p=0.055$). All effects had the same signs for the first and for further children with the notable exception of driving. However, none of the effects tested in the driving models was significant (neither in separate models nor in models for both genders taken together including interaction terms).

The following variables have also been excluded due to lack of significant effects:

- Forming a household with a partner
- Separation from partner
- Child moving out
- Change in workplace
- Finished school or apprenticeship
- Start of apprenticeship
- Retirement
- Change in the PT connection to work (details of measurement in Scheiner, 2011)
- Change in PT quality in neighbourhood, calculated from the number of different systems accessible on foot
- Loss of driving license.

4 Results

4.1 Mean value comparisons of change

The modal changes associated with key events are relatively moderate in most cases (see state variables of mode specific trip frequencies in Table 3 for comparison). Just 25 of 160 tests (32 events by five modes) turn out significant ($p=0.05$). Comparing the mean values of mode use change between men and women reveals even more modest differences. Only nine tests suggest significant differences, all of which are included in Table 3.

With respect to family biography, the birth of a child has the most notable effects on mode use. While trips made as a car passenger, by public transport and by bicycle decrease, walking and driving tend to increase (albeit non-significantly). Mothers decrease their cycling considerably more than fathers, which is likely to reflect their responsibility for the baby. Distinguishing between the first child and further children in a family is interesting, even though this distinction leaves even less chance for statistical significance due to small numbers. Firstly, in both groups mothers change modes considerably more than fathers. Secondly, mothers' modal changes differ considerably according to whether their first or a further child is born. After the birth of their first child, mothers tend to increase their walking at the expense of all other modes. The magnitudes of all changes taken together suggest that the birth of the first child tends to constrain mothers' total trip rates, i.e. they go out less often than before. After the birth of a further child mothers tend

to drive more rather than less. This may reflect the more complex organisation of a family with two or more children, which may also help explain the strong decrease in cycling.

With respect to education and employment biography, two events show significant effects. The completion of school or apprenticeship tends to increase women's driving, but not men's, at the expense of women's cycling. Entry into the labour market is associated with a significant increase in driving at the expense of walking for both genders, and with significant gender differences in PT and bicycle use: men tend to decrease their cycling and PT use when they enter the labour market while women use PT more than before. These changes reflect the more constrained time budget after labour market entry and gendered mode choices in commuting.

Gaining a driving license and an increase in car availability exhibit 'natural' effects on mode use: more driving, less use of other modes, except for walking. For decreasing car availability it is the other way round, albeit with less pronounced effects. The only significant gender difference is that gaining a driving license leads to fewer trips made as a car passenger among women, but not (or less so) among men, who are known to make fewer trips as car passengers than women anyway (Hjorthol, 2008; Rosenbloom, 2006).

Other significant changes are related to the spatial environment in which a person lives. A decrease in walking distance between the workplace and the next PT stop results in less driving. When the walking distance increases, women tend to reduce their PT use more than men. On the other hand, when the PT connection to work gets worse, men tend to decrease PT use more than women. Perhaps men are more ready to walk, but less willing to tolerate a poor connection than women. Finally, an increase in urbanity – the variety of facilities accessible on foot – is associated with slightly less driving and fewer trips made as a car passenger.

Taken overall, the findings are reasonable in terms of the direction of changes. However, in terms of magnitude and significance, most events appear to have only limited effects on mode use, given particularly that many other events that have been studied are not even reported here due to lack of significance. This is also true for the hypothesised gender differences in modal changes. It is difficult to compare this general finding to other studies, as most studies focus on a limited set of events. What is more, overarching judgements of the significance of associations are impeded by the general problem of publication bias (overreport of significant results) (Card and Krueger, 1995).

		Car (driver)	Car (pass)	PT	On foot	Bicycle	n
Birth of a child	M	0.03	-0.03	-0.10	0.01	-0.06	134
	F	0.11	-0.16	-0.09	0.18	-0.25	140
	All	0.07	-0.09	-0.09	0.09	-0.15	274
Birth of first child	M	-0.01	-0.03	-0.13	0.00	0.05	49
	F	-0.15	-0.16	-0.13	0.14	-0.13	52
	All	-0.07	-0.09	-0.13	0.07	-0.04	101
Birth of further child	M	0.05	-0.04	-0.08	0.01	-0.12	85
	F	0.25	-0.16	-0.07	0.20	-0.32	88
	All	0.15	-0.10	-0.07	0.10	-0.22	173
Household size decrease	M	-0.13	0.03	0.04	0.03	-0.02	278
	F	-0.06	-0.12	0.02	0.01	0.00	336
	All	-0.09	-0.05	0.03	0.02	-0.01	614
Household size increase	M	0.09	-0.03	-0.06	-0.03	-0.03	236
	F	0.05	-0.11	-0.01	0.04	-0.13	241
	All	0.07	-0.07	-0.03	0.01	-0.08	477
Completion of school or apprenticeship	M	-0.02	-0.07	-0.05	0.00	0.04	416

	F	<i>0.07</i>	0.03	-0.03	0.01	-0.07	418
	All	0.03	-0.02	-0.04	0.01	-0.02	834
Entry into labour market	M	0.27	0.01	-0.07	-0.08	-0.10	210
	F	0.14	-0.06	0.08	-0.15	0.04	303
	All	0.20	-0.03	0.01	-0.12	-0.02	513
Gaining a driving license	M	0.82	-0.21	-0.22	-0.04	-0.19	139
	F	0.57	-0.05	-0.06	-0.05	-0.10	169
	All	0.68	-0.13	-0.13	-0.05	-0.14	308
Decrease in car availability	M	-0.24	0.05	0.05	-0.02	0.03	339
	F	-0.17	0.01	0.05	0.02	-0.01	393
	All	-0.21	0.03	0.05	0.00	0.01	732
Increase in car availability	M	0.27	-0.07	-0.10	-0.03	-0.02	357
	F	0.27	-0.11	-0.07	-0.05	-0.06	462
	All	0.27	-0.09	-0.08	-0.04	-0.04	819
Walking distance from PT stop to workplace							
... decreases	M	0.03	-0.05	0.04	-0.01	0.00	310
	F	-0.17	-0.02	0.02	0.05	0.03	316
	All	-0.06	-0.04	0.03	0.02	0.02	626
... increases	M	0.00	-0.02	-0.01	-0.04	-0.03	309
	F	0.01	-0.05	-0.05	-0.09	0.00	316
	All	0.01	-0.04	-0.03	-0.07	-0.01	625
PT connection to workplace							
... gets worse	M	0.00	-0.03	-0.04	-0.05	-0.05	654
	F	-0.05	0.04	0.00	0.01	0.01	687
	All	-0.02	0.01	-0.02	-0.02	-0.02	1,341
... gets better	M	-0.05	-0.02	-0.02	0.03	0.01	684
	F	0.01	-0.05	0.02	-0.05	-0.05	652
	All	-0.02	-0.03	0.00	-0.01	-0.02	1,336
Decrease in urbanity	M	-0.01	-0.02	-0.01	-0.01	0.02	1,590
	F	0.01	0.01	0.00	-0.04	0.01	1,744
	All	0.00	0.00	0.00	-0.03	0.01	3,334
Increase in urbanity	M	-0.03	-0.02	-0.04	-0.02	0.00	1,532
	F	-0.02	-0.03	0.00	-0.04	0.00	1,686
	All	-0.02	-0.02	-0.02	-0.03	0.00	3,218
None of the key events identifiable in the data occurred	M	-0.03	-0.01	0.00	-0.05	0.02	1,115
	F	-0.02	-0.01	0.00	-0.02	-0.01	1,274
	All	-0.02	-0.01	0.00	-0.03	0.01	2,389
State variables (daily trip frequencies) (total sample)	M	1.83	0.31	0.31	0.72	0.39	6,640
	F	1.20	0.61	0.36	0.90	0.36	7,387
	All	1.50	0.47	0.34	0.81	0.37	14,027

Table 3: Changes in mean trip frequencies per day after experiencing various life course events, categorised by gender

M: Male, F: Female

Rows M+F italic: gender difference significant (5%, two-tailed t-test)

Row 'all' bold: effect of life course event significantly different from zero (5%, two-tailed t-test)

Oakil et al. (forthcoming) study changes in household car ownership in The Netherlands. They find significant effects of all events studied, but consider a set of just six events (as compared to 32 change variables in the present paper) plus baseline variables. Prillwitz et al. (2006) study car ownership changes on the household level in Germany, finding significant effects for four out of 14 events (residential move from one regional core area to another, change in number of adults in household, birth of first child, income change). Goodwin (1989) in an early panel study investigates the effects of changes in family cycle, occupational status and income on changes in

car ownership and public transport use from one year to the next in The Netherlands. His results generally show limited changes in car ownership. The benefits of public transport when individuals switch to being 'captive riders' were less than expected as well.

4.2 Multiple regression analysis

Baseline variables effects

It may sound surprising that a number of baseline variables significantly affect changes in mode use (rather than mode use per se). This means that modal changes are to some extent systematically associated with certain life situations and circumstances (rather than changes in circumstances).

1. Women tend to increase their driving over time with the number of children in the household, particularly those aged below 10, less so with older children. Younger children also tend to increase their mothers' walking, while older children reduce fathers' walking.
2. Being in education or apprenticeship (or not being in employment at all) reduces women's driving, compared to employed women.
3. Spatial context effects match expectations. Living in a large city, living at a central location within a city and the level of urbanity at the residence are associated with a decrease in driving and/or an increase in PT use or walking. Women also reduce their driving and increase their use of PT when parking at the workplace is difficult; the association with PT use is also significant for men.
4. Driving license holders increase their driving from one year to the next, but only licensed men reduce their use of PT. Having a car available has likewise but even stronger effects for both genders, and also reduces walking.

While these associations are generally in line with what one would expect for travel mode use at a given point in time, the interpretation of their effects on modal changes is less obvious. The most suggestive interpretation is that learning processes over time strengthen beneficial behaviour even when no key event occurs. Also, habits may intensify in such periods exactly because there is no key event. Seeming baseline effects may in fact also be delayed effects induced by key events that happened much earlier.

The composition of cohort and period effects in driving is different for men and women. For men, cohort is positively associated with driving, but the effect of cohort squared is negative. That is to say, subsequent cohorts drive more than their predecessors but the increase flattens out over time and turns negative at some point. Taken together, the two effects suggest that the maximum in driving is among those born in the 1960s, while later generations tend to drive less. This supports recent studies that found a decline in driving among young male adults (Frändberg and Vilhelmson, 2011; Kuhnimhof et al., 2012), but suggests that this decline may have started earlier than previously known. Women, on the other hand, show a negative period effect that suggests that driving among women steadily declines over the study period independent of cohort. The magnitude suggests that the decline is slightly less steep than that for men in the study period, which again is roughly in line with previous findings (Kuhnimhof et al., 2012) and which suggests gender convergence over time, as known from the literature (Rosenbloom, 2006; Scheiner et al., 2011). Various reasons have been proposed in the literature for this decline in car travel. Transnationalisation/globalisation may result in the substitution of car travel by long-distance (air) travel (Frändberg and Vilhelmson, 2011). A shift from suburbanisation to the renaissance of cities (Kabisch et al., 2010), increasing travel costs, socio-economic changes (longer education,

decreases in income) and possibly a shift in status symbols among young adults may further contribute to the decline in car travel (Kuhnimhof et al., 2012).

Finally, strong negative effects of baseline values in mode use suggest that increases in the use of a particular mode are relatively weak among those who already used this mode frequently in the baseline year.

Change variables effects – life course events and access changes

Only few key events of sociodemographic nature affect travel mode use significantly. First, a child's birth makes mothers walk considerably more often than they did before, probably due to strolls and a generally more neighbourhood-oriented activity space and social networking (Kalmijn, 2012). In any case, this behavioural change does not go along with a significant shift towards father's car use. Concerning the distinction between the birth of the first versus a further child, an additional model (not documented here, see above) suggests that mothers decrease their driving after the first child's birth while there is little change after a further child's birth. None of the effects is significant due to small numbers.

Secondly, both men's and women's driving increases to roughly the same extent when they enter the labour market, suggesting a trade-off of time against money (increased income and time constraints). On the other hand, leaving the labour market results in decreased PT use, but only among women, suggesting that the number of women who commute by PT is relatively high (which is supported by an (albeit non-significant) increase in PT use when women enter the labour market).

Other significant events are related to accessibility. A decrease in walking distance between the workplace and the next PT stop makes both men and women use PT more often, and it reduces women's driving. Conversely, an increase in walking distance tends to make men and women walk less, but both effects just fail to meet significance. A worsening parking situation at the workplace makes men drive less. Easing of the parking situation increases driving for women, and reduces their PT use. Moving to a more peripheral residence negatively affects both genders' walking, while for increases in urbanity it is the other way round. Moving towards central locations also increases women's PT use. All these effects meet expectations.

Gaining a driving license has the expected effects on both genders: more driving, and less PT use. The same is true for an increase in car availability, while a decrease has the opposite effects. Additionally, increases in car availability reduce walking frequency, and vice versa.

	Car driver						Public transport						Walking						
	Men			Women			Men			Women			Men			Women			
	B	Exp(B)	Sig.	B	Exp(B)	Sig.	B	Exp(B)	Sig.	B	Exp(B)	Sig.	B	Exp(B)	Sig.	B	Exp(B)	Sig.	
Intercept	-0.320	0.726	0.020	0.060	1.062	0.524	0.264	1.302	0.000	0.185	1.203	0.000	0.285	1.329	0.010	0.155	1.168	0.078	
Household, family biography																			
No. of children in household (< 10 yrs)	B*	0.040	1.041	0.070	0.102	1.108	0.000	0.001	1.001	0.895	-0.001	0.999	0.921	-0.003	0.997	0.788	0.036	1.037	0.022
No. of children in household (10-17 yrs)	B*	0.039	1.040	0.075	0.044	1.045	0.040	0.002	1.002	0.791	-0.005	0.995	0.436	-0.025	0.975	0.031	-0.011	0.989	0.422
Child's birth	C*	-0.006	0.994	0.956	-0.023	0.977	0.817	-0.056	0.945	0.108	-0.047	0.954	0.151	0.017	1.017	0.743	0.249	1.283	0.002
Social status, employment and educational biography																			
Employment (reference: employed)																			
Apprenticeship, trainee, education	B*	-0.024	0.976	0.728	-0.325	0.722	0.000	0.012	1.012	0.702	0.030	1.031	0.361	0.046	1.047	0.309	0.007	1.007	0.876
Not employed	B*	-0.031	0.970	0.473	-0.098	0.907	0.002	-0.011	0.989	0.444	-0.002	0.998	0.855	0.043	1.044	0.165	0.028	1.028	0.230
University entrance qualification or higher	B*	0.010	1.010	0.707	0.001	1.001	0.955	0.018	1.018	0.039	0.010	1.010	0.306	0.033	1.034	0.055	0.021	1.021	0.236
Entry into labour market	C*	0.223	1.250	0.020	0.232	1.262	0.001	-0.015	0.985	0.640	0.048	1.049	0.075	-0.057	0.945	0.358	-0.072	0.930	0.156
Leaving labour market (no retirement)	C*	0.203	1.225	0.194	-0.114	0.892	0.198	-0.042	0.959	0.255	-0.076	0.927	0.001	0.120	1.127	0.100	0.089	1.093	0.115
Access to place of work or education and associated changes																			
Walking distance PT stop to place of work or education...																			
... decreases	C*	-0.025	0.975	0.706	-0.155	0.856	0.004	0.059	1.061	0.028	0.057	1.058	0.074	-0.031	0.970	0.355	0.003	1.003	0.943
... increases	C*	-0.074	0.929	0.227	0.003	1.003	0.952	0.044	1.045	0.100	-0.013	0.987	0.601	-0.068	0.934	0.063	-0.065	0.937	0.063
Parking situation at place of work or education																			
... is difficult	B*	-0.055	0.946	0.163	-0.095	0.909	0.008	0.050	1.052	0.007	0.064	1.066	0.000	-0.046	0.955	0.071	0.023	1.023	0.404
...gets much worse	C*	-0.207	0.813	0.036	-0.106	0.899	0.294	0.013	1.013	0.779	0.095	1.100	0.056	0.023	1.023	0.649	0.011	1.011	0.857
...gets much better	C*	-0.050	0.952	0.648	0.306	1.358	0.008	-0.064	0.938	0.214	-0.123	0.884	0.000	-0.036	0.964	0.532	-0.130	0.878	0.073
License holding and car availability and associated changes																			
Driving license holding	B*	0.242	1.274	0.000	0.122	1.130	0.000	-0.075	0.928	0.021	0.013	1.013	0.547	-0.071	0.932	0.092	-0.022	0.978	0.474
Gaining driving license	C*	0.878	2.405	0.000	0.663	1.940	0.000	-0.212	0.809	0.000	-0.113	0.893	0.002	-0.056	0.945	0.430	-0.088	0.916	0.197
Car availability (reference: no)																			
Occasionally / after agreement	B*	0.097	1.102	0.091	0.101	1.106	0.009	-0.031	0.969	0.197	-0.087	0.916	0.000	-0.042	0.959	0.261	-0.030	0.970	0.362
Regularly	B*	0.405	1.500	0.000	0.400	1.491	0.000	-0.116	0.890	0.000	-0.125	0.883	0.000	-0.087	0.917	0.004	-0.093	0.912	0.001

Loss in car availability	C*	-0.285	0.752	0.000	-0.347	0.707	0.000	0.086	1.089	0.000	0.055	1.057	0.003	0.035	1.036	0.344	0.065	1.067	0.070
Increase in car availability	C*	0.333	1.396	0.000	0.329	1.390	0.000	-0.107	0.899	0.000	-0.085	0.919	0.000	-0.058	0.943	0.152	-0.089	0.915	0.020
Spatial context at residence, residential moves																			
Municipality > 500,000 inh	B*	-0.080	0.923	0.013	-0.063	0.939	0.010	0.106	1.111	0.000	0.077	1.080	0.000	0.021	1.021	0.419	-0.017	0.983	0.444
Central residential location within city	B*	-0.008	0.992	0.824	-0.029	0.972	0.344	-0.017	0.983	0.321	0.024	1.025	0.116	0.173	1.189	0.000	0.091	1.095	0.001
Urbanity (variety of facilities in neighbourhood accessible on foot)	B*	-0.023	0.978	0.021	-0.023	0.977	0.005	0.001	1.001	0.664	-0.005	0.995	0.113	0.031	1.032	0.000	0.045	1.046	0.000
Move to periphery	C*	0.027	1.027	0.731	0.113	1.120	0.083	-0.005	0.995	0.889	-0.032	0.968	0.398	-0.197	0.821	0.001	-0.147	0.864	0.019
Move to centre	C*	0.004	1.004	0.955	0.001	1.001	0.992	-0.018	0.982	0.546	0.077	1.080	0.043	-0.065	0.937	0.170	-0.092	0.912	0.067
Change in urbanity	C*	-0.013	0.988	0.328	-0.019	0.981	0.072	-0.006	0.994	0.233	0.003	1.003	0.528	0.023	1.023	0.004	0.034	1.035	0.000
Cohort and period																			
Cohort (born in 1900 = 0)	B*	0.019	1.020	0.000	0.003	1.003	0.412	-0.003	0.997	0.115	-0.003	0.997	0.104	0.001	1.001	0.738	0.000	1.000	0.947
Cohort, squared, div. by 100	B*	-0.016	0.984	0.000	0.003	1.003	0.453	0.003	1.003	0.109	0.004	1.004	0.061	-0.003	0.997	0.297	-0.001	0.999	0.733
Year of survey (1994 = 0)	B*	-0.005	0.995	0.163	-0.012	0.988	0.000	0.000	1.000	0.666	0.001	1.001	0.325	0.000	1.000	0.856	0.005	1.005	0.015
Baseline values of mode use																			
Number of trips made by the respective mode under study	B*	-0.323	0.724	0.000	-0.311	0.733	0.000	-0.303	0.739	0.000	-0.252	0.777	0.000	-0.354	0.702	0.000	-0.320	0.726	0.000
(Scale)		1.004			0.780			0.134			0.150			0.407			0.489		
QICC		6,007			5,190			851			1,047			2,468			3,273		
QICC (intercept model)		7,467			6,422			975			1,187			2,998			3,977		
n (observations)		5,951			6,604			5,951			6,604			5,951			6,604		
n (individuals)		3,660			4,080			3,660			4,080			3,660			4,080		
R ² adj (OLS regression)		22.4			19.3			15.7			18.9			15.4			19.1		

Table 4: Cluster-robust regression models of changes in daily trip rates

B* = baseline variable; C* = change variable.

Italics: Interaction term with gender is significant ($p=0.05$) in models including both men and women.

5 Conclusions

This paper has studied changes in travel mode use after life course (and accessibility) related key events from a gender perspective. Significant effects were found for some key events, and some effects differed distinctly between men and women, suggesting that men and women are differently affected by life course events. Such effects are also reflected in interaction terms between key events and gender which have not been documented in this paper due to severe multicollinearity occurring in the models concerned.

	Effect on...		
	driving	PT use	walking
Child's birth			+W
Entry into labour market	+		
Leaving labour market (no retirement)		-W	
Walking distance PT stop to workplace decreases	-W	+	
Parking situation at workplace gets much worse / better	-M / +W	0 / -W	
Gaining driving license	+	-	
Loss / increase in car availability	- / +	+ / -	0 / -W
Move to periphery / centre		0 / +W	- / 0
Increase / decrease in urbanity			+ / -
Cohort	*M		
Period	-W		+W
Baseline behaviour	-	-	-

Table 5: Summary table of important results

+ positive effect, - negative effect, 0 no effect. M: effect only for men, W: effect only for women.

* positive effect turning into negative from one cohort to the next.

Given the comprehensive set of variables used and tests performed, Table 5 aims to summarise key results. Without repeating the findings in detail here, the following shall be highlighted. The birth of a child makes mothers walk considerably more often than they did before. Mean value comparisons suggest that parents – mothers in particular – also decrease their trip-making as car passengers, by public transport and bicycle. Interestingly, mothers tend to drive less after the birth of their first child, but more often after the birth of a further child. These findings are based on non-significant results from only a few cases and, thus, further research is required here. Entry into the labour market is associated with a significant increase in driving among both genders, and leaving the labour market reduces women's PT use, which may be due to women's more prevalent commuting by PT. Other significant key events are related to changes in spatial context, accessibility and mobility, including the PT connection to work, the parking situation at the workplace, urbanity, residential moves, license holding and car availability.

Some baseline variables have been found to show significant effects on mode use changes which is not an obvious finding, as certain states within a life course or in a spatial setting (without an associated change in state) do not naturally lead to adaptations or other changes in travel. Possible explanations include, first, that habits tend to intensify over time just because there is no

change in circumstances. Secondly, seeming baseline effects may in fact be delayed effects of earlier key events. Hence, adaptation or learning processes over time may be at play. More research is needed to clarify this issue, and the mobility biography approach may be used as a valuable guiding framework.

Interestingly, the composition of cohort and period effects in driving is different for men and women. While cohort effects are significant for men, with a maximum in driving reached by those born in the 1960s, driving among women tends to decline over the study period in general (period effect). Cohort and period effects taken together suggest declining car use, accompanied by gender convergence over time. Both gender convergence (Rosenbloom, 2006; Scheiner et al., 2011) and declining (car) travel in daily trips (Frändberg and Vilhelmson, 2011, Kuhnimhof et al., 2012) support existing literature. These trends reflect a number of recent developments including a move towards more gender equity, the renaissance of cities, socio-economic changes, increasing travel costs, and a shift towards long-distance (air) travel.

An even more distinct finding is that taken together the associations found, as well as their gender specifics are rather limited. The modelling process upon which this paper is based started with 61 explanatory variables, including ten sociodemographic life course events and 22 spatial / accessibility-related changes. The final regressions presented include a mere 29 variables, including three sociodemographic life course events and ten spatial / accessibility-related changes. The majority of variables have thus been excluded from analysis in a stepwise process. Hence, many life course events seem to be only loosely associated with travel mode specific trip rates, and the same is true for gender structures in the life course (see test results for interaction terms, descriptive gender comparisons in models and mean value comparisons).

Six reasons may be offered for interpretation. Firstly, the period of observation of any household is relatively short, and – as outlined above – changes in mode use triggered by key events may be delayed (Oakil, forthcoming). Secondly, mode choice is known to involve strongly habitual elements that results in strong path dependency and may prevent behavioural changes even when circumstances alter, as long as the utility outcome is still acceptable. What is more, even if the outcome does not seem to be acceptable changes may be prevented by inertia.

Thirdly, weak effects and low levels of variance explanation suggest high levels of freedom of choice which may result in changes in various and unexpected directions, if any. Hence, the trajectories in individuals' mobility biographies may be more complex than that which can be captured in modelling. Even if the associations between events and modal changes are quite strong, they may result in mean values close to zero and weak correlations if they take various directions. Qualitative in-depth studies could shed more light on this issue. For instance, Lanzendorf (2010) found evidence for such variety in parents' modal changes after the birth of a child.

Fourthly, past studies on the effects of key events on travel behaviour focused on either just one or at least a more limited set of events than this paper. The set of events considered here is rather comprehensive, which may help explain why many events turned out insignificant and also contribute to focusing future research on those events which are likely to exhibit substantial impact.

Fifthly, changing attitudes, values and preferences may be more important drivers for behavioural changes than key events. Attitudes were not recorded in the data, and they are known to be important predictors of travel behaviour (Bohte, 2010). Personality traits may play an important role in the experience of time and, hence, in the use of fast v. slow travel modes. Even if relatively little is known about changes of attitudes and personality traits over the life course, change may well occur. The role of gender relationships for behaviour may vary over the life course as well (Jarvis et al., 2011). However, these interpretations presuppose that attitudes and personality

traits are exogeneous to key events and other circumstances that were controlled in the analysis, because otherwise their effects should have been captured by the variables used. The cause-impact relationship between such subjective attributes of individuals and more objective circumstances of living cannot be clarified here, but for attitudes and behaviour one can say that there seems to be a mutual interdependency between the two (Bohte, 2010).

Sixthly and finally, it is tempting to connect the overall moderate changes found to the German context. Germany is described in the introduction as a relatively conservative regime, which may explain some reluctance to change even when circumstances change. The finding that women's mode use (in terms of walking) changes more than men's after the birth of a child, and that leaving the labour market has a significant effect on women's, but not on men's PT use, may support the idea of gendered key events in a conservative regime. On the other hand, many sociodemographic key events including those as important as forming a household with a partner, separation from one's partner, and retirement, did not exhibit significant gendered effects.

One may question the value of such a complex analysis if the findings appear relatively modest, given that much of the practical – e.g. predictive – value of statistical analysis is to establish associations between explanatory variables and an outcome of interest. However, research has benefits beyond practical applications. Precisely the bias of published research towards significant results (Card and Krueger, 1995) distorts a realistic view of the world. The analysis has rendered some interesting and significant results concerning gendered key events, while, in addition, the five interpretations offered above may stimulate further research.

Various directions for future research are indicated. Firstly, the life course effects found are relatively minor. However, the idea of mobility biographies includes a much broader spectrum of topics and methodological approaches than those examined in this paper. Hence it is too early at this stage to draw general conclusions for this approach.

Secondly, studying other measures of travel behaviour, such as travel distances, trip durations, trip chain complexity and the like could yield different results. For instance, women have been found to have substantially more complex daily trip and activity patterns than men (Wegmann and Jang, 1998; Rosenbloom, 2006), which would render a gendered analysis of changes in complexity in activity/travel patterns over the life course worthwhile.

Thirdly, it would be valuable to extend the analysis of change to longer periods to capture delayed effects (e.g., Dargay, 2001). People may react to changing circumstances slowly, and they may react in very different ways, because changes in some respects are superimposed on the steady habits of daily life in other respects.

Fourthly, in-depth comparisons of mobility biographies and their gendered structures between different societal contexts would be a worthwhile strand of research that may enhance understanding of the role of societal norms and policy impacts.

Fifthly and finally, an important issue is to tackle interpretation of such empirical results in terms of sustainability, particularly with respect to its gender equity dimension. Gender specific travel behaviour changes over the life course may suggest gendered worksharing in childraising, housework or employment (see effect of childbirth), they may show gendered adaptations to spatial context (as in the effects of residential moves), or they may be the outcome of powered negotiations between two partners over access to the car (Polk, 1998; Scheiner and Holz-Rau, 2012). However, they may also be the outcome of gender specific preferences deliberately developed by individuals rather than power relations (Hakim, 2003). If this were ascertained, then there would be no point in claiming inequality just because there is difference. Gender/travel

studies are to a certain extent caught in the trails of feminist perspectives that generally interpret findings from a notion of women's weakness, whatever the findings may look like. Other interpretations are practically non-existent, although gender studies have claimed a relational rather than a women's perspective for a long time (see Law, 1999 for transport studies).

Thus, in future research the main question should not (only) be whether and how the travel behaviour of men and women (including any changes) is different or similar. Rather, the focus should be on the emergence of such differences or similarities, specifically on the extent to which unequal power relations are at play. This should involve rigorous testing of the extent to which preferences are at play, if ever possible, including the complex interrelationship between preferences and constraints. In a late-modern, liberal democratic regime it is not reasonable to assume that preference is nothing but a reflection of unequal power and constraint, as such a notion would neglect people's autonomy. Only if the possibility of preference playing a role in differences can be ruled out in methodologically rigorous studies would there be reason to criticise a deficit in sustainability in terms of gender inequality.

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6 Literature

Apps, P., Rees, R., 2005. Gender, time use, and public policy over the life cycle. *Oxford Review of Economic Policy* 21(3), 439-461.

Axhausen, K. W., Frei, A., Ohnmacht, T., 2006. Networks, biographies and travel: First empirical and methodological results. Paper presented at the 11th International Conference on Travel Behaviour Research, Kyoto, 16-20 August 2006.

Babcock, L., Laschever, S., 2003. *Women Don't Ask: Negotiation and the Gender Divide*. Princeton: Princeton University Press.

Barker, J., 2008. Men and motors? Fathers' involvement in children's travel. *Early Child Development and Care* 178(7-8), 853-866.

Best, H., Lanzendorf, M., 2005. Division of labour and gender differences in metropolitan car use. An empirical study in Cologne, Germany. *Journal of Transport Geography* 13(2), 109-121.

Bianchi, S. M., Milkie, M. A., Sayer, L. C., Robinson, J. P., 2000. Is anyone doing the housework? Trends in the gender division of household labor. *Social Forces* 79(1), 191-228.

Blau, F. D., Ferber, M. A., Winkler, A. E., 2010. *The Economics of Women, Men, and Work*. 6th edition. Englewood Cliffs, NJ: Prentice-Hall.

Blumen, O., 2000. Dissonance in women's commuting? The experience of exurban employed mothers in Israel. *Urban Studies* 37(4), 731-748.

Bohte, W., 2010. Residential self-selection and travel. The relationship between travel-related attitudes, built environment characteristics and travel behaviour. PhD thesis, TU Delft, Delft Centre for Sustainable Urban Areas.

- Card, D., Krueger, A. B., 1995. Time-series minimum-wage studies: a meta-analysis. *The American Economic Review* 85(2), 238-243.
- Chlond, B., Kuhnimhof, T., 2005. *Panelhandbuch. Das Deutsche Mobilitätspanel: Informationen sowie Anleitung und Anregungen zur Datennutzung*. Karlsruhe: Universität.
- Clark, W. A. V., Wang, W. W., 2005. Job access and commute penalties: Balancing work and residence in Los Angeles. *Urban Geography* 26(7), 610-626.
- Cooke, L. P., 2006. Policy, preferences, and patriarchy: the division of domestic labor in East Germany, West Germany, and the United States. *Social Politics* 13(1), 117-143.
- Corna, L. M., 2013. A life course perspective on socioeconomic inequalities in health: A critical review of conceptual frameworks. *Advances in Life Course Research* (In Press, <http://dx.doi.org/10.1016/j.alcr.2013.01.002>)
- Crane, R., 2007. Is there a quiet revolution in women's travel? Revisiting the gender gap in commuting. *Journal of the American Planning Association* 73(3), 298-316.
- Dargay, J. M., 2001. The effect of income on car ownership: evidence of asymmetry. *Transportation Research A* 35(9), 807-821.
- Davis, S. N., Moore, S. B., 2010. Bearing children, becoming mothers: The influence of childbearing on unmarried women's gender ideology. *International Journal of Sociology of the Family* 36(2), 77-91.
- Dieleman, F. M., Mulder, C. H., 2002. The geography of residential choice. In: Aragonés, J. I., Francescato, G., Gärling, T. (Eds), *Residential Environments: Choice, Satisfaction, and Behavior*. Westport, CT and London: Bergin & Garvey, pp. 35-54.
- Diewald, M., Mayer, K. U., 2009. The sociology of the life course and life span psychology: Integrated paradigm or complementing pathways? *Advances in Life Course Research* 14(1-2), 5-14.
- Dobbs, L., 2005. Wedded to the car: women, employment and the importance of private transport. *Transport Policy* 12(3), 266-278.
- Dustmann, C., 2005. The assessment: gender and the life cycle. *Oxford Review of Economic Policy* 21(3), 1-16.
- Elder Jr., G. H., Johnson, M. K., Crosnoe, R., 2006. The emergence and development of life course theory. In: Mortimer, J. T., Shanahan, M. J. (Eds): *Handbook of the Life Course*. Berlin: Springer, pp. 3-19.
- Fortin, N. M., 2005. Gender role attitudes and the labour-market outcomes of women across OECD countries. *Oxford Review of Economic Policy* 21(3), 416-438.
- Frändberg, L., Vilhelmson, B., 2011. More or less travel: personal mobility trends in the Swedish population focusing gender and cohort. *Journal of Transport Geography* 19(6), 1235-1244.
- Garson, G. D., 2010. *Generalized Linear Models and Generalized Estimating Equations*. Accessed 15/03/2011. http://faculty.chass.ncsu.edu/garson/PA765/gzlm_gee.htm
- Geisler, E., Kreyenfeld, M., 2012. How policy matters: Germany's parental leave benefit reform and fathers' behavior, 1999-2009. MPIDR Working paper WP 2012-021. Rostock: Max Planck Institute for Demographic Research.
- Gil Solá, A. 2013. På väg mot jämställda arbetsresor? Vardagens mobilitet i förändring och förhandling (Towards gender equality? Women's and men's commuting under transformation and

negotiation, English summary). Gothenburg: University, Department of Economy and Society, School of Business, Economics and Law.

Goodwin, P. B., 1989. Family changes and public transport use 1984-1987. *Transportation* 16(2), 121-154.

Grieco, M., 2008. Gendered accessibilities, gendered mobilities? Engaging the transport academy in repairing a traditional neglect. In: Becker, U., Böhmer, J., Gerike, R. (Eds), *How to Define and Measure Access and Need Satisfaction in Transport*. Series of Dresden Institute for Transportation and Environment (DIVU), Issue 7/2008. Dresden: University, pp. 151-163.

Grieco, M., McQuaid, R. W., 2012. Gender and transport: An editorial introduction. *Research in Transportation Economics* 34, 1-2.

Grunow, D., Hofmeister, H., Buchholz, S., 2006. Late 20th century persistence and decline of the female homemaker in Germany and the United States. *International Sociology* 21(1), 101-131.

Grunow, D., Schulz, F., Blossfeld, H.-P., 2012. What determines change in the division of housework over the course of marriage? *International Sociology* 27(3), 289-307.

Hägerstrand, T., 1970. What about people in regional science? *Papers in Regional Science* 24(1), 7-21.

Hakim, C., 2003. Lifestyle preferences versus patriarchal values: causal and non-causal attitudes. *Advances in Life Course Research* 8, 69-91.

Hamilton, K., Jenkins, L., 2000. A gender audit for public transport: a new policy tool in the tackling of social exclusion. *Urban Studies* 37(10), 1793-1800.

Hanson, S., Johnston, I., 1985. Gender differences in work-trip length: explanations and implications. *Urban Geography* 6(3), 193-219.

Hanson, S., Pratt, G., 1995. *Gender, Work and Space*. London: Routledge.

Harms, S., 2007. From university to working life: Impact of a critical life event on travel mode choice. Paper presented at the 7th Biennial Conference on Environmental Psychology, Bayreuth, 12 September 2007.

Haustein, S., Klöckner, C. A., Blöbaum, A., 2009. Car use of young adults: the role of travel socialization. *Transportation Research Part F* 12(2), 168-178.

Hedeker, D., Gibbons, R. D., Flay, B. R., 1994. Random-effects regression models for clustered data with an example from smoking prevention research. *Journal of Consulting and Clinical Psychology* 62(4), 757-765.

Hillmert, S., 2005. From old to new structures: a long-term comparison of the transition to adulthood in West and East Germany. *Advances in Life Course Research* 9, 151-173.

Hjorthol, R. J., 2000. Same city-different options – An analysis of the work trips of married couples in the metropolitan area of Oslo. *Journal of Transport Geography* 8(3), 213-220.

Hjorthol, R., 2008. Daily mobility of men and women – a barometer of gender equality? In: Uteng, T. P., Cresswell, T. (Eds): *Gendered Mobilities*. Aldershot: Ashgate, pp. 193-210.

Jarvis, H., Pain, R., Pooley, C., 2011. Multiple scales of time-space and life course. *Environment and Planning A* 43(3), 519-524.

Kalmijn, M., 2012. Longitudinal analyses of the effects of age, marriage, and parenthood on social contacts and support. *Advances in Life Course Research* 17(4), 177-190.

- Kabisch, N., Haase, D., Haase, A., 2010. Evolving reurbanisation? Spatio-temporal dynamics as exemplified by the east German city of Leipzig. *Urban Studies* 47(5), 967-990.
- Kan, M. Y., Sullivan, O., Gershuny, J., 2011. Gender convergence in domestic work: discerning the effects of interactional and institutional barriers from large-scale data. *Sociology* 45(2), 234-251.
- Kawase, M., 2004. Changing gender differences in commuting in the Tokyo metropolitan suburbs. *GeoJournal* 61(3), 247-253.
- Kézdi, G., 2004. Robust standard error estimation in fixed-effects panel models. *Hungarian Statistical Review, Special* (9), pp. 96-116.
- Kohli, M., 2007. The institutionalization of the life course: Looking back to look ahead. *Research in Human Development* 4(3-4), 253-271.
- Krizek, K. J., 2003. Residential relocation and changes in urban travel. Does neighborhood-scale urban form matter? *Journal of the American Planning Association* 69(3), 265-281.
- Kuhnimhof, T., Armoogum, J., Buehler, R., Dargay, J., Denstadli, J. M., Yamamoto, T., 2012. Men shape a downward trend in car use among young adults – evidence from six industrialized countries. *Transport Reviews* 32(6), 761-779.
- Kwan, M-P., 2000. Gender differences in space-time constraints. *Area – Transactions of the Institute of British Geographers* 32(2), 145-156.
- Kwan, M.-P., Schwanen, T., Ren, F., 2009. Gendered rigidity of space-time constraints and human activity patterns: An activity-based approach. In: Wang, D., Li, S.-M. (Eds), *Transportation and Geography*. Hong Kong: Hong Kong Society for Transportation Studies, pp. 951-959.
- Lanzendorf, M., 2003. Mobility biographies. A new perspective for understanding travel behaviour. Paper presented at the 10th International Conference on Travel Behaviour Research (IATBR), Lucerne, 10-15 August 2003.
- Lanzendorf, M., 2010. Key events and their effect on mobility biographies: the case of childbirth. *International Journal of Sustainable Transportation* 4(5), 272-292.
- Law, R., 1999. Beyond 'women and transport': towards new geographies of gender and daily mobility. *Progress in Human Geography* 23(4), 567-588.
- Lee, B. S., McDonald, J. F., 2003. Determinants of commuting time and distance for Seoul residents: The impact of family status on the commuting of women. *Urban studies* 40(7), 1283-1302.
- Liefbroer, A. C., Elzinga, C. H., 2012. Intergenerational transmission of behavioural patterns: How similar are parents' and children's demographic trajectories? *Advances in Life Course Research* 17(1), 1-10.
- MacDonald, H. I., 1999. Women's employment and commuting: explaining the links. *Journal of Planning Literature* 13(3), 267-283.
- Martensson, S., 1979. *On the Formation of Biographies in Space-Time Environments*. Lund Studies in Geography, Series B, Human Geography, 47. Lund: University, Department of Geography.
- Matthies, E., Kuhn, S., Klöckner, C. A., 2002. Travel mode choice of women: the result of limitation, ecological norm or weak habit? *Environment and Behavior* 34(2), 163-177.

- McDonald, N. C., 2008. Household interactions and children's school travel: the effect of parental work patterns on walking and biking to school. *Journal of Transport Geography* 16(5), 324-331.
- McDowell, L., Ward, K., Fagan, C., Perrons, D., Ray, K., 2006. Connecting time and space: The significance of transformations in women's work in the city. *International Journal of Urban and Regional Research* 30(1), 141-158.
- Mortimer, J. T., Shanahan, M. J. (Eds), 2006. *Handbook of the Life Course*. Berlin: Springer.
- Naess, P., 2008. Gender differences in the influences of urban structure on daily travel. In: Uteng, T.P., Cresswell, T. (Eds), *Gendered Mobilities*. Aldershot: Ashgate, pp. 173-192.
- Nichols, A., Schaffer, M., 2007. Clustered Errors in Stata (www.docstoc.com, 18.01.2011)
- Oakil, A. T. M., Ettema, D., Arentze, T., Timmermans, H., forthcoming. Changing household car ownership level and life cycle events: an action in anticipation or an action on occurrence. *Transportation*
- Ortoleva, S., Brenman, M., 2004. Women's issues in transportation. In: Lucas, K. (Ed): *Running on Empty. Transport, Social Exclusion and Environmental Justice*. Bristol: Policy Press, pp. 257-279.
- Ottmann, P., 2007. Critical life events in the German Mobility Panel. Paper presented at the 7th Biennial Conference on Environmental Psychology, Bayreuth, 12 September 2007.
- Polk, M., 1998. *Gendered Mobility: A Study of Women's and Men's Relations to Automobility in Sweden*. Göteborg: University, Department for Interdisciplinary Studies of the Human Condition.
- Prillwitz, J., Harms, S., Lanzendorf, M., 2006. Impact of life-course events on car ownership. *Transportation Research Record* 1985, 71-77.
- Rosenbloom, S., 1993. Women's Travel Patterns at Various Stages of Their Lives. In: Katz, C., Monk, J. (Eds), *Full Circles. Geographies of Women over the Life Course*. London and New York: Routledge, pp. 208-242.
- Rosenbloom, S., 2006. Understanding women's and men's travel patterns: the research challenge. In: *Transportation Research Board (Ed): Research on Women's Issues in Transportation Vol. 1: Conference Overview and Plenary Papers. Transportation Research Board Conference Proceedings 35*. Washington, D.C.: National Research Council, pp. 7-28.
- Rossi, A. S., 1980. Life-span theories and women's lives. *Signs – Journal of Women in Culture and Society* 6(1), 4-32.
- Rossi, A. S., Ed., 1985. *Gender and the Life Course*. Hawthorne/New York: Aldine.
- Ruppanner, L., 2010. Conflict and housework: does country context matter? *European Sociological Review* 26(5), 557-570.
- Sackmann, R., 2007. *Lebenslaufanalyse und Biografieforchung*. Wiesbaden: VS Verlag.
- Sandow, E., 2008. Commuting behaviour in sparsely populated areas: evidence from northern Sweden. *Journal of Transport Geography* 16(1), 14-27.
- Schäfer, D., 2004. Unbezahlte Arbeit und Haushaltsproduktion im Zeitvergleich. In: *Statistisches Bundesamt (Ed): Alltag in Deutschland. Analysen zur Zeitverwendung*. Wiesbaden, pp. 247-273.
- Scheiner, J., 2003. Housing mobility and travel behaviour: a process-oriented approach to spatial mobility. Evidence from a new research field in Germany. Paper presented at the RGS-IBG International Annual Conference, London, 3-5 September 2003.

- Scheiner, J., 2007. Mobility biographies: elements of a biographical theory of travel demand. *Erdkunde* 61(2), 161-173.
- Scheiner, J., 2011. Changes in travel mode choice: the impact of period, cohort, and life-course effects: a comprehensive approach. *Raum und Mobilität – Arbeitspapiere des Fachgebiets Verkehrswesen und Verkehrsplanung* 24. Dortmund: Technische Universität.
- Scheiner, J., Sicks, K., Holz-Rau, C., 2011. Gendered activity spaces: trends over three decades in Germany. *Erdkunde* 65(4), 371-387.
- Scheiner, J., Holz-Rau, C., 2012. Gendered travel mode choice: a focus on car deficient households. *Journal of Transport Geography* 24, 250-261.
- Scheiner, J., Holz-Rau, C., 2013. A comprehensive study of life course, cohort, and period effects on changes in travel mode use. *Transportation Research Part A* 47, 167-181.
- Schendera, C., 2008. *Regressionsanalyse mit SPSS*. Oldenbourg, München.
- Scherger, S., 2009. Social change and the timing of family transitions in West Germany. Evidence from cohort comparisons. *Time & Society* 18(1), 106-129.
- Schulze, A., 2009. Sozioökonomische Konsequenzen der Fertilität. Folgen der Geburt von Kindern für den Wohlstand von Paarhaushalten. Wiesbaden: VS Verlag für Sozialwissenschaften.
- Schwanen, T., Kwan, M.-P., Ren, F., 2014. The Internet and the gender division of household labour. *The Geographical Journal* 180(1), 52-64.
- Schwanen, T., 2007. Gender Differences in Chauffeuring Children among Dual-Earner Families. *The Professional Geographer* 59(4), 447-462.
- Schwanen, T., 2011. Car use and gender: the case of dual-earner families in Utrecht, The Netherlands. In: Lucas, K., Blumenberg, E., Weinberger, R. (Eds): *Auto Motives: Understanding Car Use Behaviours*. Bingley: Emerald, pp. 151-171.
- Thakuriah, P., Menchu, S., Tang, L., 2010. Car ownership among young adults: generational and period-specific perspective. *Transportation Research Record* 2156, 1-8.
- van der Lippe, T., de Ruijter, J., de Ruijter, E., Raub, W., 2011. Persistent inequalities in time use between men and women: a detailed look at the influence of economic circumstances, policies and culture. *European Sociological Review* 27(2), 164-179.
- Van der Waerden, P., Timmermans, H., Borgers, A., 2003. The influence of key events and critical incidents on transport mode choice switching behaviour: a descriptive analysis. Paper presented at the 10th International Conference on Travel Behaviour Research, Lucerne, 10-15 August 2003.
- Wegmann, F. J., Jang, T. Y., 1998. Trip linkage patterns for workers. *Journal of Transportation Engineering* 124(3), 264-270.
- Widmer, E. D., Ritschard, G., 2009. The de-standardization of the life course: Are men and women equal? *Advances in Life Course Research* 14, 28-39.
- Wooldridge, J. M., 2003. Cluster-sample methods in applied econometrics. *The American Economic Review* 93(2), 133-138.
- Zwerts, E., Allaert, G., Janssens, D., Wets, G., Witlox, F., 2010. How children view their travel behaviour: a case study from Flanders (Belgium). *Journal of Transport Geography* 18(6), 702-710.