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## Objective and Subjective Socio-Spatial Inequalities in Activity Patterns

Joachim Scheiner\*

### 1 Introduction

The “classical” approaches to the explanation of travel demand are largely based on objective attributes of individuals and the built environment. These approaches are based on 1970s time geography and activity space research (Hägerstrand, 1970; Carlstein, Parkes and Thrift, 1978), which regarded travel demand as being derived from personal and external constraints. Individual constraints include financial, technical and time budgets, which again may be assigned to social roles. External constraints include social, spatial and temporal restrictions. While this line of argument has remained essential, the 1990s were characterised by increasing doubt as to whether it is sufficient to refer to constraints when studying activity patterns and travel demand.

In particular, the restrictive and cause-impact oriented understanding of human action inherent to time geography and travel behaviour research drew increasing criticism from sociologists and others (Scheiner, 2005). They argued that modernisation and individualisation has led to human action being self-dependent, individualised and based on freedom of choice rather than on structural constraints.

This criticism was supported empirically by studies finding the effects of the built environment on travel behaviour to be rather moderate, once subjective attitudes and lifestyles were controlled (Bagley and Mokhtarian, 2002). It became increasingly clear that there are much more complex mechanisms behind the seemingly spatial causes of distance behaviour and mode use. This also led to increasing doubt as to the potential success of attempts to achieve more sustainable transport demand by implementing land use and urban form concepts (see Marshall, 1999 and other contributions in the same issue). The complex interplay between social and spatial inequalities on the one hand and various forms of mobility on the other has been explored recently from a variety of perspectives in a number of studies related to the “new mobilities paradigm” (Ohnmacht, Maksim and Bergman, 2009).

In this situation, two lines of debate developed in interdisciplinary transportation research, both of which centre on the integration of subjective dimensions

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into explanation patterns for travel behaviour. These two lines of debate can be described as follows:

- 1 Firstly, the integration of lifestyles (Bagley and Mokhtarian, 2002; Handy, Cao and Mokhtarian, 2005). This approach is based on the increasing freedom of action of mobile individuals. It argues for travel demand to be explained in "cultural" terms by using subjective attitudes, aims and preferences rather than in terms of demographical and social structures<sup>1</sup> (Scheiner and Kasper, 2005).
- 2 Secondly, travel is increasingly interpreted as being related to residential mobility. It is assumed that spatial differences in travel demand are not so much related to differences in the built environment but to the selective immigration of certain population groups with specific location and travel preferences ("self-selection hypothesis", Handy, Cao and Mokhtarian, 2005; Schwanen and Mokhtarian, 2005; Scheiner, 2006a).

By integrating lifestyles and preferences as subjective explanatory variables without neglecting structural, objective aspects of life situation and the built environment, such models simultaneously refer to the objective and subjective side of travel demand. This is not meant to say that the dualism between objective and subjective exists in reality. For instance, ownership of a car is certainly an objective matter of fact. However, whether or not an individual owns a car, may be a matter of subjective preference as well as a matter of objective resources. Due to the complex interrelations studied, this calls for new methodological approaches. Structural equation models have been tested in a growing number of studies to cope with the increasing complexity of the theoretical approaches (e. g., Bagley and Mokhtarian, 2002; see also Golob, 2003 for a methodological overview).

In this contribution such interrelations are examined simultaneously by means of structural equation modelling. Travel behaviour is studied with respect to out-of-home activity patterns, which may have been significantly altered in recent decades by changing social roles. Other aspects of travel demand are not considered in this paper but can also be studied using the proposed model structures. Various other interrelations, such as the relevance of lifestyle and life situation for choice of housing location, are considered simultaneously. Despite the complexity of the approach, it should be noted that there are various determinants of travel behaviour that are not considered here, although their relevance is beyond doubt, for instance the economic and political context, technological innovations or ecological norms.

I turn now to a step-by-step explication of the basic concepts used in the chosen approach and the development of the model structure. Thereafter the methodology

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1 For the latter, I use the concept "life situation" instead of the usual "socio-demographics". "Socio-demographics" is just a formal term that fails to express anything about why underlying variables should influence travel behaviour, whereas "life situation" explicitly points to an individual's personal circumstances (e. g. social roles and resources) relevant for his or her travel.

and the data are described. The results are presented subsequently. The last section draws some conclusions.

## 2 Basic concepts

In the following the basic concepts and interrelations for the model structures presented below are developed. They are based on five key elements: life situation, lifestyle, location preferences, location choice/built environment, and travel behaviour.

The model structures are based on considerations developed in the context of two research projects: "StadtLeben" and "Intermobil Region Dresden". Details were developed and the analyses undertaken within the project "Choice of residential location, built environment and transport in the context of lifestyle and life situation"<sup>2</sup>. The theoretical basis was laid by Scheiner and Kasper (2005). The following summary is largely based on Scheiner and Holz-Rau (2007).

### 2.1 Lifestyle and life situation

Originating from market research, the theoretical background for research on lifestyles is provided by debates on modernisation (Giddens, 1990) and individualisation (Beck, 1992). These debates are largely based on the diagnosis of a growing "dis-embedding" of individual social relations from spatio-temporal contexts, the decreasing relevance of traditional structures of social inequality, and the change from materialist to hedonist, "post-materialist" values. As a consequence, "new" horizontal differences "beyond class and status" (Beck, 1992) are now assumed to be superimposed on (or complement or substitute) the "old" vertical inequalities. These horizontal inequalities are to be captured by the concept of lifestyle. Different study approaches use various definitions of lifestyles. According to Müller (1992), four dimensions of lifestyles may be differentiated:

2 "StadtLeben – Integrated approach to lifestyles, residential milieux, space and time for a sustainable concept of mobility and cities" (2001–2005). Project partners: RWTH Aachen, Institute for Urban and Transport Planning (coordination); FU Berlin, Institute of Geographical Sciences, Department of Urban Research; Ruhr-University of Bochum, Department of Cognition and Environmental Psychology; University of Dortmund, Department of Transport Planning (see <http://www.isb.rwth-aachen.de/stadt leben/>). – "Intermobil Region Dresden" (1999–2004) was a large cooperation project with many partners. The author was involved on behalf of the Büro für Integrierte Planung, Dortmund, in the project "Spatial and behavioural conditions of a sustainable provision of mobility", that was managed by the University of Technology Hamburg-Harburg, Department of Transport Systems and Logistics (see <http://www.vsl.tu-harburg.de/100>). Both projects were funded by the German Federal Ministry of Education and Research (BMBF). – "Choice of residential location, built environment and transport in the context of lifestyle and life situation" (2006–2008) was the author's exclusive responsibility. It was funded by the German Research Foundation (DFG).

- expressive dimension (e. g. leisure preferences/behaviour, everyday aesthetics, consuming behaviour)
- interactive dimension (e. g. social contact, communication)
- evaluative dimension (e. g. norms, values, perceptions)
- cognitive dimension (e. g. self-identification, affiliation).

Lifestyles always include an element of freedom of action and voluntarism (“stylism”). However, despite some voluntaristic approaches (mainly in Germany), which claim that lifestyles are independent of social structure (Beck, 1992), the dominant interpretation conceptualises lifestyles as being connected with life situations. This “structural approach” was mainly developed by Bourdieu (1984). It is empirically supported by, for instance, the continuous dependence of educational and occupational achievements on social and ethnic origin (Lampard, 1995; Kim and Tamborini, 2006).

The structural approach that conceptualises “subjective” lifestyles as being dependent on “objective” life situations is used here. This does not mean that structural differences are *part of* lifestyles. “Objective” and “subjective” differences (life situation and lifestyle) should be analytically separated so that interdependencies between them can be investigated. Otherwise, it is not possible to test the additional value that lifestyles, compared to life situation, have for the explanation of spatial mobility.

## 2.2 Lifestyles, location preferences and residential location choice

As lifestyles always include behavioural elements (leisure behaviour, consuming behaviour, social networks, etc.) the realisation of lifestyles relates individuals to the built environment, as for example, when activities take place in discos, pubs, sport facilities or other meeting places. Lifestyle specific needs and preferences with respect to the neighbourhood are therefore reflected by residential location choice. Self-realisation, adventure-oriented and hedonistic modern lifestyle groups, for instance, prefer urban neighbourhoods with a variety of cultural and leisure opportunities, whereas more traditional or reclusive lifestyle groups live predominantly in rural areas (Schneider and Spellerberg, 1999).

Differences in location choice between various lifestyle and/or life situation groups are subject to the specific housing, location and accessibility preferences of these groups. Such preferences may therefore be treated as intervening variables between life situation/lifestyle and location choice. The focus here is on preferences towards location attributes and accessibility rather than attributes of the residence itself (the house or the flat).

The bigger the leeway of a household willing to relocate on the housing market, the bigger is the practical relevance of location preferences for this household. When the housing market is mainly controlled by supply (e. g. in growth regions),

individual wishes on the demand side are hard to realise and of minor importance for the actual location decision. This depends mainly on individual financial and social resources.

### 2.3 Lifestyles and travel

The increase in travel distances and accessibility might also be interpreted in the light of individualisation and modernisation (Kesselring, 2006). As symbols of flexible mobility, mass motorisation and cars are regarded as central conditions for the realisation of modern, individual lifestyles (Sheller and Urry, 2003). Activity patterns may possibly be increasingly less determined by life situations due to the dissolving of social roles. A similar decline of determination over time has already been found for travel participation and mode choice (Scheiner, 2006c).

Consequently, the lifestyle concept is increasingly used in transportation science and translated into "mobility styles" that are mainly based on preferences towards transport modes, corresponding to the evaluative and cognitive dimensions of lifestyles. A differentiated, subject oriented approach to travel demand thus emerges (Ohnmacht, Götz and Schad, 2009). Attributes of "mobility styles" which refer to travel modes or residential location type are also studied using the terms attitudes or preferences (e.g. "pro-drive alone", "pro-high density", Bagley and Mokhtarian, 2002; see also Handy, Cao and Mokhtarian, 2005).

### 2.4 Residential mobility, travel and the built environment

Choice of housing location and travel behaviour are not only two variables dependent on lifestyles, but are also connected with one another. On the one hand, choice of housing location may be assumed to be a preliminary decision about travel behaviour that is centred at the location of residence. On the other hand, choice of housing location is influenced by life situation and lifestyle. Thus, choice of housing location as an intervening variable cannot be regarded as exogenous (Boarnet and Crane, 2001; Scheiner, 2006a).

As far as the effects of residential location decisions are concerned, there is a large body of research into the interrelations between housing and travel based on comparison of travel demand of populations in different types of spatial settings. The results may be summarised in the key statement that the inhabitants of dense, compact cities with mixed land-use undertake comparatively short trips and use public transport or non-motorised travel modes for many of their trips (Boarnet and Crane, 2001; Ewing and Cervero, 2001). This may be explained firstly by the high density and variety of activity opportunities in these urban structures, and secondly by the transport system serving these compact structures, which includes restrictions for car travel (low travel speed, lack of parking space), high quality public transport service and close-by destinations for non-motorised transport (should the latter part of the transport system be considered).

It is as yet unclear to what extent observed spatial variation in travel behaviour is spatially determined and to what extent it results from individual location preferences (self-selection hypothesis, Schwanen and Mokhtarian, 2005; Scheiner, 2006a). Travel behaviour might be an effect of selective location decisions of individuals or households who decide in favour of a certain location type that matches their needs and their behaviour (Boarnet and Crane, 2001; Scheiner, 2006a). This question is currently being investigated by comparing population groups characterised by specific forms of housing mobility or by specific travel and location preferences within a certain location type. These comparisons reveal the necessity of considerably modifying the key statement concerning the effects of the built environment on travel behaviour.

One might expect travel and location preferences to affect travel distances and mode choice, first of all. For instance, individuals with a preference for proximity to the workplace are likely to live close to their workplace and, accordingly, undertake short job trips, while individuals with a preference for public transport should use public transport more often than average. However, associations with activity patterns are also likely. For instance, one could expect individuals who bear domestic responsibilities and undertake much shopping to rate proximity to shopping facilities as being more important than others.

## 2.5 Study approach – model structures

Model structures with various degrees of complexity can be derived from the considerations above. Within the basic structures numerous issues may be analysed, each of which can be specified in different ways. The models can be applied to all aspects of travel. The general term travel behaviour is thus used here. Empirically this contribution is limited to activity patterns.

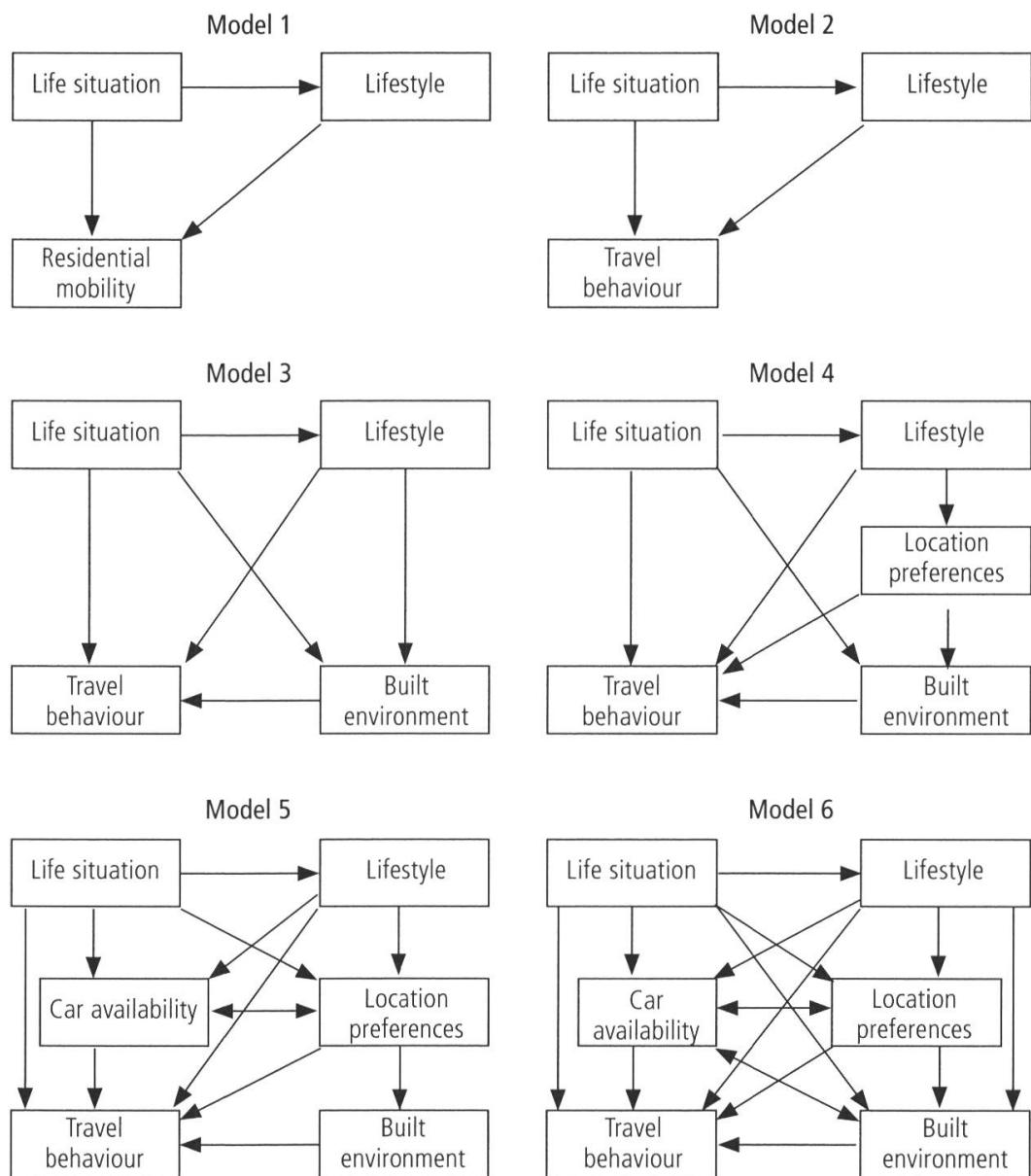
The approach used here claims that lifestyle influences spatial mobility. In accordance with many sociological studies it is further argued that lifestyles are dependent on life situations (Schneider and Spellerberg, 1999). The structures shown in Models 1 and 2 can be derived from this (Figure 1).

Model 3 is intended to uncover the interdependencies between residential mobility and travel behaviour. Thus, unidirectional cause-impact relationships are assumed, as the effects of residential mobility as a long-term decision affecting travel behaviour gain priority over the reverse relationship<sup>3</sup>. The most important aspect of residential mobility in this context is residential location choice.

3 The data suggest this direction of causality as well, as in the data set residential mobility precedes travel. Information on residential mobility is recorded retrospectively, whereas all travel information is recorded for the present (or the near past). – The decision on the direction of causality had also to be made with respect to the relations between car availability and the built environment as well as car availability and location preferences (see Model 5). Location preferences and the built environment might both influence car availability as well as the other way round (Model 6). However, models allowing for bi-directional causality between either two of them turned

Figure 1

Model structures to describe the interrelations between life situation, lifestyle, location requirements, location choice and travel behaviour



Source: Author's concept.

Moreover, we can assume that location decisions are affected by certain location preferences. These preferences are partly influenced by life situation, for instance by the presence of children in the household. But they might also be induced by

out to be unidentifiable. A decision was therefore made in favour of the respective, presumably stronger, relationship. A series of models with reverse (unidirectional) relationships were tested for control reasons (see below).

lifestyle. Location preferences are therefore incorporated as further intervening variables between life situation and lifestyle on the one hand and location choice on the other hand (Model 4).

At this point another piece of information is important. Location choice is reflected by the fact that individuals live in certain types of built environment. The actual location decision can therefore be described by attributes of this environment. Seen in this way, residential location choice is here tantamount to the built environment (at the place of residence). This means that the influence these attributes have on travel behaviour can be interpreted in two distinct ways: as an effect of the built environment, or as an effect of certain location behaviour that reflects subjective location preferences.

These two interpretations can indeed be separated in the model. Whenever preferences are crucial, the location choice should definitely reflect them. Moreover, travel behaviour is likely to be strongly affected by location preferences. Where the built environment is crucial, travel behaviour should rather be influenced by (objective) attributes of this environment than by (subjective) location preferences. The length of the work trip, for example, probabilistically depends on the number of workplaces within a certain radius around the place of residence (an attribute of the built environment). At the same time, it also depends on how important proximity to the workplace is for the individual (individual location preference). Even in areas with few jobs, the work trip might be short, as long as the employee likes to have his or her workplace close by and is prepared to move closer, if necessary. Thus, an attribute of spatial structure (density of workplaces) is modified by an attribute of individual activity space.

In a further step, car availability is integrated (Model 5) as it is – like location choice – an important pre-decision for travel behaviour. Car availability depends on the material resources of a person or household and might therefore be regarded as an intervening variable between life situation and travel behaviour. Potentially, car availability also depends on lifestyle. The spatio-temporal accessibility increased by the car results in the car influencing an individual's location preferences as well (e.g. proximity to shopping centres being less important for car-owning households). Therefore, the car might have indirect effects on travel behaviour. Conversely, the likelihood of car purchase might also be affected by location choice and even by location preferences. In practice, one has to decide on the directions of causality and on whether or not to include bi-directional relationships on the basis of theoretical, conceptual or practical reasoning (see footnote 3).

In a final step (Model 6), direct effects of life situation, lifestyle and car availability on location choice can be investigated, as it cannot be assumed that location choice is completely determined by individual location preferences. Firstly, location preferences (and indeed any other model components), can only partially be included in the models in order to keep complexity under control. Secondly, location deci-

sions are household decisions that do not necessarily reflect the location preferences of every person in the household<sup>4</sup>.

Before presenting the results of the model estimations, the methodology applied and the data used are briefly outlined.

### 3 Methodology

#### 3.1 Methodology of structural equation modelling

The interrelations discussed above can be studied with structural equation modelling. This method is being increasingly used in transportation studies (Golob, 2003). Structural equation modelling can be described as a combination of factor analysis and a generalised form of regression analysis. The technique used is not described in detail here due to lack of space (see Scheiner, 2009 for more details).

There is much debate about under which conditions the classical Maximum Likelihood (ML) approach can be regarded as superior to non-parametric procedures even when the normality assumption is violated (e.g., Hoogland and Boomsma, 1998, see also Golob, 2003 for transport applications). The available sample of about  $n = 2,000$  seems well appropriate for a robust application of the ML procedure, even if the sample is split into two halves (see below). The asymptotically distribution-free (ADF) procedure then reaches the limit of reliability, but seems still to be acceptable. Ultimately, a rather rigorous approach was applied. First, the sample was split into two halves by a random procedure. Then each model was estimated in four versions:

- 1 ML estimation of a theoretical model with the main sample
- 2 Empirical fitting of the model to the data
- 3 ADF estimation of the theoretical model
- 4 ML estimation of the theoretical model with the second sample for validation.

Version 2 only serves to verify the coefficients in the theoretical model version when fitted to the data, while my substantial interest lies in the theoretical models. Each of the four model versions was compared to the others with respect to the strength and sign of the effects. The results show considerable variations between each of the four versions in the direct effects of one variable on another. However, once the total effects are investigated more closely, the results turn out to be fairly stable and may clearly be interpreted in terms of the sign and strength of the effects. Taking total effects over and above direct effects into account allows for a more thorough

<sup>4</sup> Note that the empirical models presented in this paper do not allow for direct effects of gender on location choice, as the “fuller” models allowing for this interrelation were not identifiable. However, some control analyses showed rather limited effects of gender on location choice.

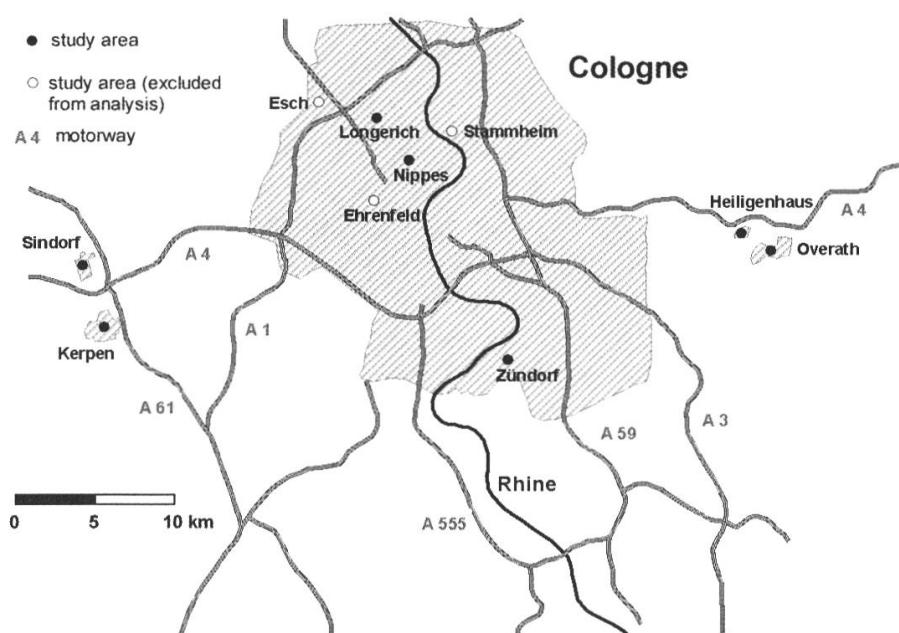
interpretation of interrelations, as direct effects may be mediated by intervening variables. An example for the calculation of total effects can be found in the text below Figure 3.

The analyses were undertaken with the programme AMOS 5.0 to 7.0 (Analysis of Moment Structures).

### 3.2 Data and study areas

The analyses are based on data from a standardised household survey within the scope of the project *StadtLeben* (see footnote 2). The survey was undertaken in ten study areas in the region of Cologne in 2002 and 2003. 2 691 inhabitants took part in extensive face-to-face interviews about their travel behaviour, housing mobility, life situation, lifestyle, location preferences and residential satisfaction. The response rate was 27 percent of those asked.

Figure 2 Location of the study areas in the region of Cologne



Source: Author's concept of project group *StadtLeben*

The study areas represent five area types, each type is represented by two areas (Figure 2): high density inner-city quarters of the 19<sup>th</sup> century ("Wilhelminian style": Ehrenfeld, Nippes); medium density neighbourhoods dating from the 1960s ("modern functionalism") with flats in three- or four-story row houses (Stammheim, Longerich); former villages located at the periphery of Cologne which since the 1950s have experienced ongoing expansion with single-family row houses or

(semi-) detached single occupancy houses (Esch, Zündorf); small town centres in the suburban periphery of Cologne (Kerpen-Stadt, Overath-Stadt); and suburban neighbourhoods with detached single occupancy houses (Kerpen-Sindorf, Overath-Heiligenhaus). The four suburban neighbourhoods are all about 30 km away from Cologne.

As each of the two areas belonging to one type is clearly different, the areas are very varied with regard to spatial location, transport infrastructure, central place facilities and socio-demographic structure. Nonetheless it has to be noted that spatially or socially "extreme" areas were not purposely targeted. There are no obvious high income areas, and only one distinct low income area (Stammheim). In any case Stammheim along with Ehrenfeld and Esch are excluded from the analysis because the location preferences of the inhabitants of these areas could not be investigated due to reasons of project flow. The analysis is therefore based on the seven remaining study areas only. Depending on the model, the resulting net samples have a value of about  $n=2\,000$ . The working samples have a size of about  $n=1,000$  due to the split of the sample.

One has to keep in mind that even the peripheral areas are located within the outskirts of the city of Cologne. They are thus not particularly remote when seen in the context of the spatial variety of the whole of Germany.

The region of Cologne is a polycentric agglomeration with the clearly dominating centre of Cologne. The population trend is slightly positive, and the housing market is largely supply dominated. The opportunities for different population groups as defined by lifestyle or life situation to realise a specific location choice that meets their needs and wishes are thus limited. This is an important condition for the interpretation of the results.

### 3.3 Variables

A large variety of questions can be dealt with within the scope of the model structures outlined above. For instance, travel behaviour may be examined with respect to activity patterns, travel distances or mode choice. Furthermore, the basic concepts can be specified with a low or high degree of complexity. Because of the many interdependencies, an attempt is made to keep the degree of complexity in the model components as low as possible. This is achieved by using dimensions of lifestyle, preferences and the built environment that seem relevant for activity demand from a theoretical point of view, rather than including all available dimensions. The following components are used:

*Life situation* was measured by a set of seven observed variables, namely gender, age, number of children in the household, total household size, education level, per capita household income (with children counting as 0.8 persons) and employment. Some transformations of the ordinal-level variables education level and employment were undertaken in order to achieve metric variables. Education

level was transformed into an estimated number of years in school. Employment (full-time, part-time, marginal, none) was similarly transformed into an estimated number of working hours per week.

In extensive attempts, a measurement model of life situation was developed<sup>5</sup> in which household size, number of children, age and income were allowed to load on one latent variable, which was called "family". It should be noted that this variable refers to individuals living in a certain household type (family) rather than to households as units, as all analyses are based on individuals. Education level, employment, income and age are allowed to load on a second latent variable called "social status". Gender operates as an exogenous variable and rendering its binary scale unproblematic.

*Lifestyles* are presented in the data by four domains: leisure preferences, values and life aims, aesthetic taste, and frequency of social contacts. In order to keep the models as simple as possible, only a few items are selected for each model to represent lifestyle. As some questionees are more inclined than others to generally agree with items, the answers were normed by subtracting a respondent's mean answer to all the items from the respective value. This results in normalised variables that take any individual tendency to generally agree or disagree into account.

In the work trip model, lifestyle is measured by a latent variable called "self-realisation". It is based on the items "importance of societal engagement" and "importance of achieving a leading job position". This latent variable is primarily job-oriented and is assumed to go along with frequent job trips. In the maintenance trip model, the "familial leisure preference" is based on the two items "play with children" and "engage with my family". Although this orientation does not have an obvious link to shopping, it is hypothesised to be associated with a female role model and feelings of responsibility for the family and, thus, with frequent maintenance trips. In the leisure model, lifestyle is represented by the strength of out-of-home leisure preferences, a latent variable based on the items "going to the movies/theatre/concerts" and "attending training/education courses". This latent variable is assumed to be related to a large variety of out-of-home leisure needs and frequent activities<sup>6</sup>.

5 In earlier analyses of the same data set (Scheiner, 2006b; Scheiner and Holz-Rau, 2007), latent variables were excluded from the model estimations by using scores derived from preceding factor analyses. The models with latent variables had very poor fit values (likewise: Simma, 2000 in similar studies). However, using factor scores for life situation or lifestyle as "observed variables" assumes that there are no measurement errors in such highly theoretical constructs – an assumption which appears to be unsatisfactory. Measurement models for life situation, lifestyle and location attitudes were therefore re-introduced into the analyses. The results were validated as far as possible with the rigorous approach described above. One should also note that far more models than those presented here were estimated. As the measurement model for life situation should be consistent for all models, some interrelations between manifest variables and latent variables were maintained even if the loadings do not reach acceptable standards (e. g. the loadings of income on social status in Figure 3 to Figure 5).

6 It should be noted that the two leisure preference indicators (out-of-home and familial) are not

Individual *location preferences* were operationalised using subjective importance ratings of neighbourhood and location attributes, for instance “accessibility of the city centre” or “access to public transport”. The five-point Likert-type answer scales ranged from “not important” to “very important” and were constructed so that they came as close to an interval scale as possible (see Rohrmann, 1978). Again, the scales are normalised (see above). Specifically, when examining job trips, the importance of access to the workplace is used as an indicator of location preferences, while in the maintenance activity model, the importance of proximity to shopping is used. This was measured by a latent variable based on two observed variables: “proximity to shops” and “proximity to services”. In the leisure model, the importance of proximity to leisure facilities for adults is used.

The *built environment* at the place of residence is studied with regard to specific attributes of the neighbourhood that are selected in accordance with the location preferences. In the maintenance activities model, the supply of retail and services is used. Similarly, the supply of leisure opportunities is used in the leisure trip model. Both indicators are measured as the number of opportunities within a straight-line distance of 650 m around the place of residence. These indicators are calculated separately for all individuals<sup>7</sup>.

For the work trip model, access to workplaces (“jobs supply quality”) was estimated by a gravity model based on transport zone and community level data (see Scheiner, 2009 for details).

*Car availability* is measured in the data as an ordinal variable which can take on four values ranging from “no car in the household” to “car available at any time”. This ordinal variable can by and large be interpreted as metric as the distances between the four values are approximately equal in terms of actual car use (see Scheiner, 2007).

*Activity frequencies* were examined on the basis of sum values for selected activities an individual reported having made. Work obviously includes only trips to the workplace(s). Maintenance activities include daily grocery shopping, weekly shopping, event shopping and administrative transactions at public authorities. Leisure trips include private visits, sports, visits to restaurants or pubs, cultural events and sport events, disco and concert, walks, and excursions.

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two ends of the same scale, but two different dimensions. Hence, a respondent may have high scores on both variables. In a control analysis for leisure activities lifestyle was measured using the two leisure indicators simultaneously. The result showed that out-of-home leisure preference was clearly superior to familial leisure in explaining leisure activities. For the sake of parsimony, familial leisure was excluded from the leisure model.

<sup>7</sup> The mapping of opportunities was undertaken by the RWTH Aachen and the Ruhr Universität Bochum. Leisure opportunities include sites of informal activity, such as chance meeting points in public space. I extended this survey beyond the borders of the study areas to meet the full radius of 650 m even for respondents living close to the border of an area.

## 4 Results

### 4.1 Model fit

There are a number of heuristic indicators to assess the goodness-of-fit of structural equation models. For most of these indicators there are decision rules available and they have been tested in methodological studies. The indicators are based on different principles, for instance on discrepancies between theoretical and empirical covariance matrices, or on mean differences between expected and estimated values of various parameters. Two of these indicators, along with the corresponding decision rule, are given in Table 1 for the models shown in the figures below and for the respective best model version (i.e. the ones that have been empirically fitted to the data). The fit values of the theoretical models fail to meet a satisfactory level, but the values of the fitted models are satisfactory to close.

Table 1 Indicators of goodness-of-fit of the models

Model	indicator of goodness-of-fit				df	
	RMSEA		Hoelter (p=0,05)			
	decision rule		< 0.05 good		≥ 200 good	
Work	figure	best	figure	best	figure	best
Work	0.116	0.048	96	446	46	30
Maintenance	0.103	0.042	115	509	57	43
Leisure	0.106	0.035	112	682	46	30

The table gives values for two goodness-of-fit indicators as well as the degrees of freedom (df) for the model shown in the following figures and for the empirically fitted "best" model version. RMSEA (Root Mean Square Error of Approximation) approaches zero in case of a close fit. The Hoelter statistics specifies the required sample size (critical n) to reject the model at a given significance level. Large values indicate a close fit. The table gives decision rules for the two indices.

Source: Author's analysis. Data: Project StadtLeben.

### 4.2 Some notes on car availability

Before highlighting the determinants of travel behaviour, the role of car availability shall be outlined briefly. Other interrelations examined in the model framework, such as effects of life situation on lifestyle, are excluded from interpretation due to lack of space (see Scheiner, 2009).

Car availability shows powerful association with the built environment: car owners tend to live in suburban rather than in urban locations (see Figure 3, Figure 4, Figure 5). However, as noted above, there is no unidirectional relationship between location choice and car availability. The same is true for location attitudes and car availability. Therefore, further models were estimated in which the direc-

tion of causality between the said constructs went the other way. The results were almost identical to the models presented here. From these results, it is not possible to conclude whether there is a causal direction between location attitudes/choice and car availability that fits the data better than the other direction<sup>8</sup>.

Car availability is above all determined by social status, suggesting substantial vertical inequality in travel opportunities. Individuals with high social status have increased access to a car. The same is true for people in family households and for men. What is more, familial leisure preferences are positively associated with access to a car, and the same is true (albeit not significantly) for out-of-home leisure preferences. Further analyses show that lifestyle effects on car availability are generally relatively weak (Scheiner, 2009). For instance, one might expect a distinct positive effect of self-realisation on car availability. This is not confirmed by the results. Furthermore, one would expect the effect of out-of-home leisure on car availability to be stronger than the effect of familial leisure. Again, the evidence does not confirm this. These findings cast some doubt on the relevance of lifestyle for motorisation, despite the effects found.

#### 4.3 Activity Patterns

The job activity model is largely dominated by social status (Figure 3), which is primarily determined by the extent of employment. Social status is positively correlated with job trip distance as well. Consequently, the amount of job travel, measured as the product of trip frequency and trip distance, strongly increases with social status (Scheiner, 2009). This indicates remarkable vertical inequalities in activity demand.

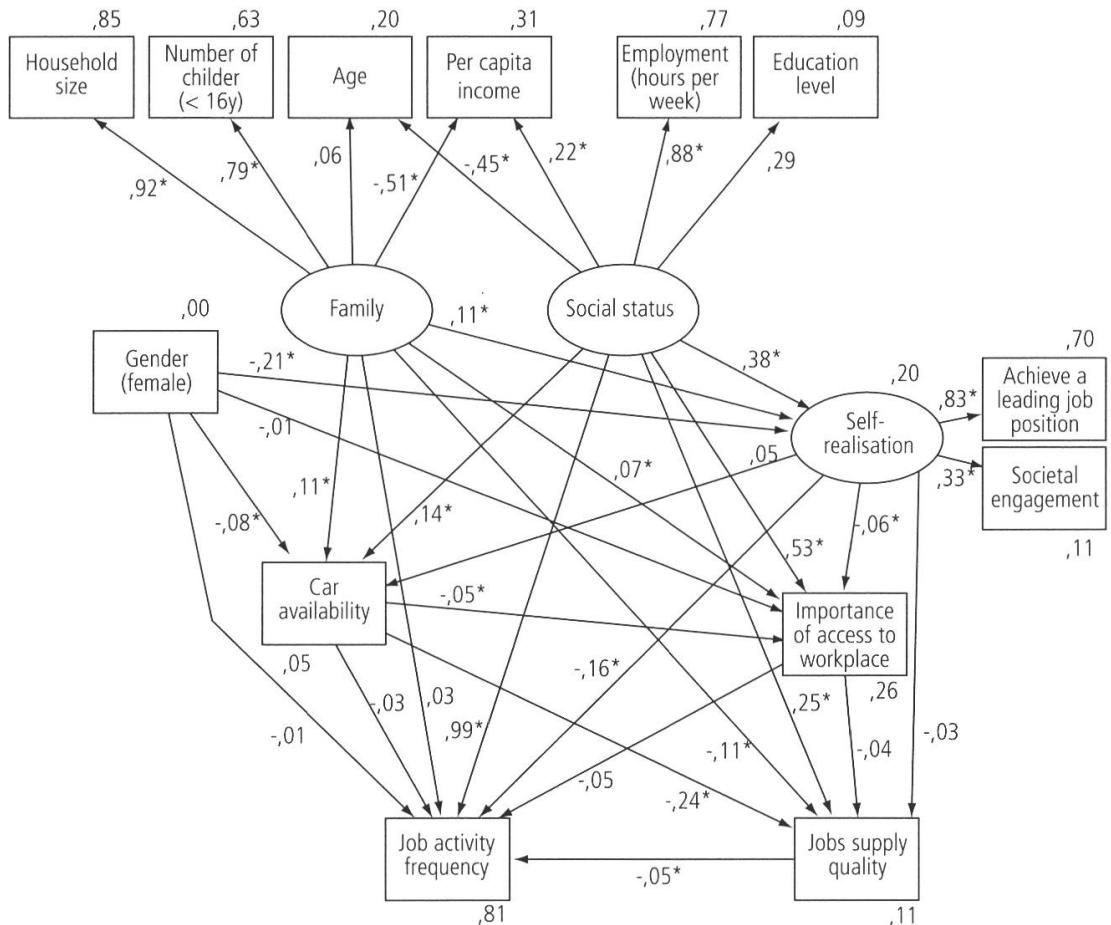
Other life situation variables are considerably less important than social status. Both gender and the household type family do not play much of a role for the frequency of job trips. Scheiner (2006c) found a marked decline over time of the relevance of gender. The effect of the private car is not worth mentioning either.

Lifestyle has a certain impact in terms of less frequent job trips for individuals with a distinct orientation towards self-realisation. As self-realisation mainly refers to vocational/career aims here (“achieve a leading job position”), the explanation for this manifestation of the lifestyle effect is not obvious. One might expect more frequent job trips for individuals with ambitious career aims. Even if the analysis is limited to full-time employees, the negative effect of the self-realisation orientation remains stable. It therefore does not seem to be an effect caused by students with career goals who are in part-time employment.

Perhaps there is an inverse U-shaped interrelation between the frequency of job trips and social status which is mediated by lifestyle: the frequency of job trips possibly

<sup>8</sup> To shed more light on this question, models were tested that allowed for bi-directional causality between (1) location attitudes and car availability, and (2) location choice and car availability. Unfortunately, these models turned out to be unidentifiable.

Figure 3 Frequency of work model (trips to the workplace)



#### Theoretical model (ML estimation)

This and the following figures show the estimated standardised path coefficients and the proportion of explained variance of the endogenous variables, the latter being indicated next to the variable boxes. Significant coefficients ( $p=0.05$ ) are marked with an asterisk. The total effect a variable has on another variable is calculated as the sum of direct and indirect effects. For instance, the total effect of "importance of access to the workplace" on "job activity frequency" equals  $-0.05 + -0.04 \times -0.05 = -0.048$ . The rectangles are observed variables, the ovals are latent constructs.

Source: Author's analysis. Data: StadtLeben.

increases with social status (with a greater extent of employment, specifically), but slightly decreases at the top level of the status spectrum where self-realisation is most pronounced. The slight decrease at this level may be due to teleworking or other forms of flexible working organisation, business trips (which do not count as job trips), and/or a higher proportion of weekly commuters. At the same time, the share of employees living in precarious employment situations with two or more jobs and, accordingly, frequent job trips, may be above average among individuals with low scores in self-realisation.

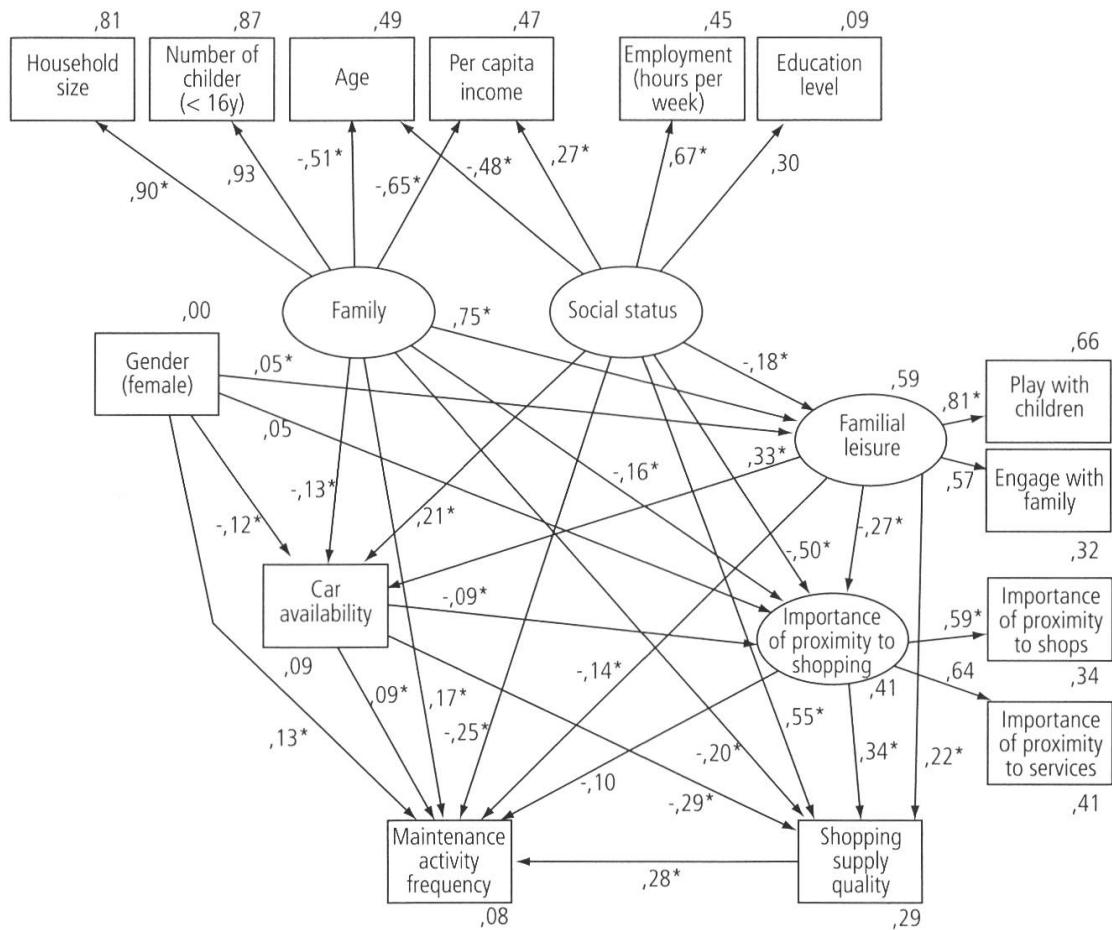
High subjective importance ratings of access to the workplace are negatively associated with the frequency of job trips, although the effect is not significant. Again

this may reflect part-time employees who visit their workplaces less frequently but for whom access to the workplace is relatively important for economic reasons.

Actual employment opportunities (job supply side) are negatively associated with the frequency of job trips. This effect is weak, but nevertheless significant. At locations with high scores in job accessibility, job trips are somewhat less frequent. This may be due to higher shares of part-time employees or other forms of flexible working schedules such as telework in urban locations.

Generally, the job trip model is largely dominated by social status. Lifestyle plays a certain role, but a definitive interpretation is difficult. At urban locations, job trips are undertaken somewhat less frequently.

Figure 4 Frequency of maintenance activities model



Theoretical model (ML estimation).

Source: Author's analysis. Data: StadtLeben.

Maintenance trips are largely determined by shopping in the data used. 68 percent of reported maintenance activities are due to daily grocery shopping. Including

weekly shopping and event shopping, shopping activities make up 88 percent of all maintenance activities.

The frequency of maintenance activities is more difficult to explain, as reflected in the low variance explanation rate of 8 percent in this model (Figure 4). Nevertheless, some relevant impact factors may be extracted from the analysis. In terms of social structures, the frequency of maintenance activities is mainly affected by gender: women shop more frequently and they cover shorter distances for shopping. The pronounced negative effect of social status is reduced by positive indirect effects. Nevertheless, shopping is less common among high status individuals than among low status persons. Again this suggests domestic division of labour, as well as differentiated forms of housework: employed individuals go shopping less frequently. This may be due to their non-employed partners bearing the shopping duties, or to single households organising their shopping more efficiently than others. Individuals living in families undertake somewhat more frequent maintenance activities as well.

Social status is more determined by demographic than by socio-economic elements here. Mainly young and employed individuals undertake maintenance trips less frequently than average. This may be interpreted in terms of efficiency gains, as the same associations, but with different signs, can be found with respect to the *distances* of maintenance trips. Young employees tend to shop less frequently, but with longer trips, and they tend to make use of large shopping centres rather than go shopping "around the corner". Among the elderly and non-employed, a pattern of frequent shopping in the neighbourhood is more common.

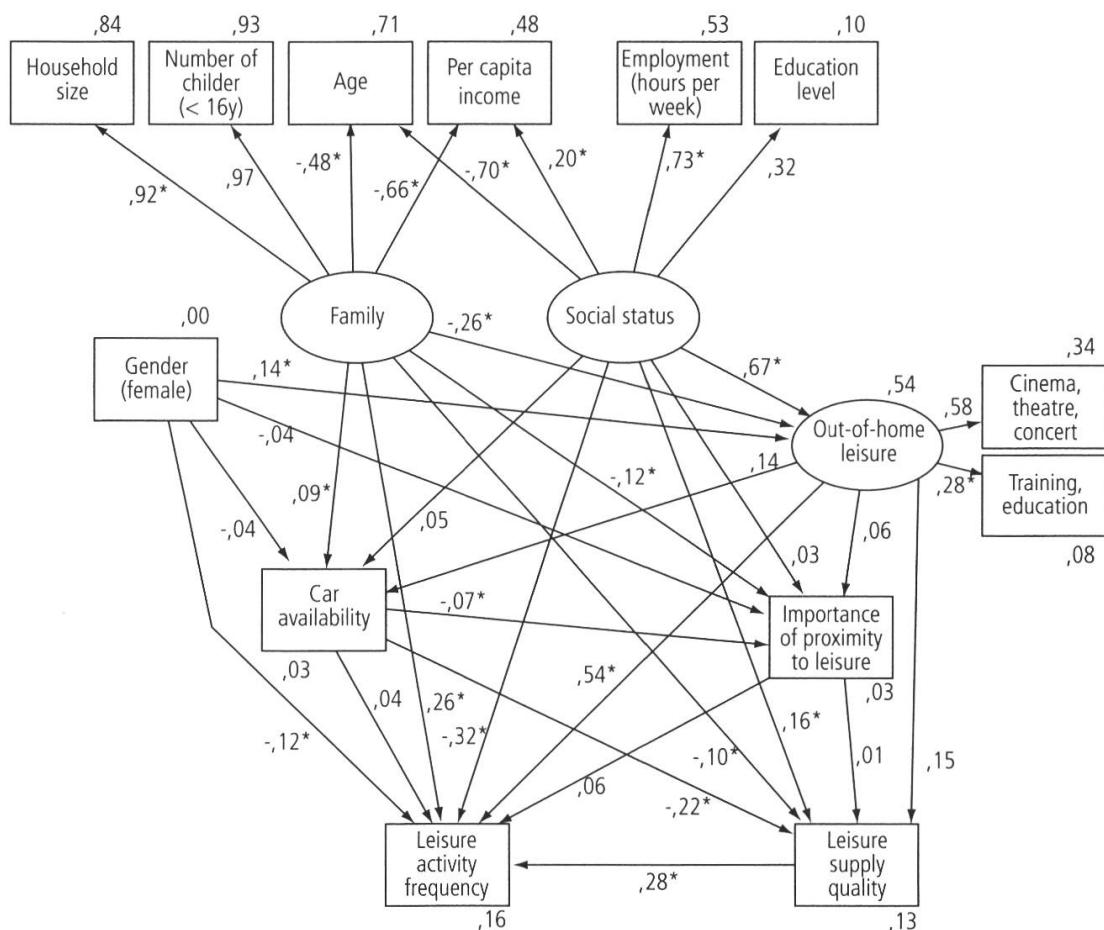
The spatial context at the place of residence has the strongest influence on the frequency of maintenance activities. A good quality and quantity of shopping facilities in the neighbourhood is associated with more frequent (and considerably shorter) maintenance trips. The effect of the built environment becomes even more distinct once indirect effects are taken into account. This confirms the higher frequency of shopping trips at urban locations found elsewhere (Scheiner, 2006c). It reflects a different way of organising daily life in cities compared to suburban settings. In urban neighbourhoods well supplied with shopping facilities, there is a tendency towards fitting shopping in between other activities. In suburban or peripheral locations, weekly shopping is more common. The contrary effects of the built environment on activity frequency and trip distance lead to total travel volumes decreasing with increasing supply quality. Mixed land-use is therefore indeed linked to less maintenance travel. However, it has to be highlighted that a surplus in centrality may *in total* lead to high travel volumes once incoming commuters are accounted for (Holz-Rau and Kutter, 1995), which the data used here do not allow for.

A strong familial leisure orientation is associated with somewhat less frequent, but longer shopping trips. Again this may be interpreted in terms of efficient shopping behaviour of individuals with a family-oriented lifestyle which counterbalances

the positive effect of the family (as a demographic structure) on shopping. It should be noted that the lifestyle effect is not statistically significant and should therefore not be overemphasised.

Finally, neither the subjective preference for proximity to shopping facilities nor car availability appears to play a role, once indirect effects are accounted for.

Figure 5 Frequency of leisure activities model



Theoretical model (ADF estimation).

Source: Author's analysis. Data: StadtLeben.

Recorded leisure trips again include only selected activities: private visits, sports, visits to restaurants or pubs, cultural events and sport spectating, discos and concerts, walks, and excursions.

Strikingly, the leisure activity frequency model performs better in terms of variance explanation than the shopping model (16 percent, see Figure 5). This is contrary to what one might expect from the hypothesis of diffuse, highly individualised, and barely explicable leisure travel behaviour, as confirmed in my own analysis (Scheiner, 2006c). The relatively high variance explanation rate is mainly

due to the consideration of lifestyle. This means that the factors influencing leisure activities strongly differ from those affecting maintenance or job activities. Distinct out-of-home leisure preferences are associated with a considerably higher frequency of leisure activities (and longer trips, see Scheiner, 2009). Lifestyle appears to be the strongest impact factor for leisure time, and this relates to activity frequency as well as to trip distances and travel volume. Accordingly, leisure activities are more related to horizontal (lifestyle oriented) than to vertical inequalities, in the terminology introduced above.

All other determinants are of minor relevance here. Social status is positively correlated with leisure activity frequency (as well as with trip distances). The direct status effect is negative, possibly due to the limited time budgets of employees. However, this negative effect is more than outweighed by positive indirect effects, leading to the positive correlation mentioned.

The direct effect of gender is negative as well. That is to say, women undertake fewer leisure activities than men. Again this is to a large extent counterbalanced by a positive indirect association, which is mediated by women's out-of-home leisure orientation. Individuals living in family households undertake many leisure activities. As this can hardly be interpreted in terms of parents having a large leisure budget two other interpretations may be helpful. Activities typical for families, such as private visits or strolls, may determine the result, or it may be an effect of adolescent or adult children with a high leisure activity level living in family households.

A good quality of leisure supply in the neighbourhood does not appear to be associated with a high frequency of leisure activities, while a strong preference for proximity to leisure facilities is linked to slightly more frequent activities. Thus, preference is more important here than the built environment. However, the effect is very weak and fails to reach the significance level.

Over all, lifestyle turns out to be the crucial factor for leisure activity frequency. Within the scope of this paper, this is the first strong piece of evidence pointing to the relevance of lifestyle for travel behaviour. This is not surprising as the lifestyle dimension applied in the leisure activities model explicitly refers to leisure activities. By contrast, job and maintenance activities have been studied with reference to lifestyle dimensions, from which a more indirect association with the activities may be expected at best, even though the dimensions have been chosen deliberately.

The substantial proximity between the definition of the explanatory variable (lifestyle as leisure preferences) and the dependent variable (leisure activities) poses the question as to whether the strong impact of lifestyle might be the result of a tautology. However, the same lifestyle dimension significantly affects leisure trip *distances* as well (Scheiner, 2009). I therefore consider a tautology to be unlikely here.

## 5 Conclusions

This paper has presented structural equation models of travel behaviour focussing on objective as well as subjective determinants of activity patterns. The findings show complex interrelations, and the main factors relevant for activity demand vary greatly between different types of activity.

The frequency of job activities is mainly determined by social status, which is hardly surprising as social status itself is largely determined by the extent of employment. For other activities, social status plays a significant role as well. Accordingly, activity patterns are significantly affected by vertical social inequalities.

Maintenance activity behaviour generally is more difficult to explain, as reflected in the low variance explanation rate. The built environment appears to be the most important factor influencing maintenance activities, suggesting that spatial planning may impact on travel demand for shopping trips more than in other transport sectors. It is also notable that women take on more shopping responsibilities than men, although longitudinal analyses suggest that the differences may have declined in recent decades (Scheiner, 2006c).

With respect to leisure activities, lifestyle appears to be the major impact factor. While household type and social status show strong direct effects as well, these are counterbalanced by indirect effects. A related study in Switzerland (Ohnmacht, Götz and Schad, 2009) found only very moderate effects of leisure mobility styles on leisure activity participation. This is likely to be a result of the use of a discrete typology in the Swiss study, whereas in the present paper I employed a continuous preference dimension that may be more able to capture slight differences. Cultural differences might play a role as well, although I do not believe Switzerland to be less individualised than Germany. A comparison with related North American studies is difficult, as these mainly refer to mode choice or mode-specific travel distances, rather than activity patterns.

Comparing subjective and objective inequalities, the influence of objective life situations, and thus vertical social inequalities, on travel behaviour exceeds the influence of "subjective" lifestyles, although lifestyle shows a significant impact on job activities as well. The general finding that life situation is more important than lifestyle confirms earlier analyses of travel mode choice and trip distances (Scheiner and Holz-Rau, 2007, Scheiner, 2006b). However, the reverse is true for leisure activities. This points to some methodological reasoning, as the strength of the interrelation between lifestyle and travel behaviour is likely to depend on the measurement of lifestyle. Lifestyle appears to have a strong influence on travel when its substantial focus is on the element of travelling studied. This raises the question of possible tautological explanation patterns. In the context of this paper, I do not believe in tautology, because out-of-home leisure preferences significantly affect not only leisure activities, but also leisure trip distances (Scheiner, 2009), the

latter definitely not being part of the measured preferences. However, the question of tautology has to be considered carefully in related studies.

Effects of the built environment are most pronounced for maintenance activities, which are undertaken more often in central/urban locations with a good supply than in more peripheral settings. For other activities, spatial effects are very limited. Residential preferences appear to be of minor relevance for activity patterns as well. One might expect, for instance, that individuals who undertake many shopping activities rate proximity to shopping facilities as more important than others. Yet there is hardly any evidence for this.

Car availability does not play a major role for activity patterns, as opposed to mode choice (Scheiner, 2006c, 2007). This is perhaps unsurprising, as people's essential activities do not vary much, whether they own a car or not. Nonetheless, there is a longstanding myth about the positive impact the car may have on individual trip frequencies. This is based on the causal interpretation of the positive correlation between the two (see for critical discussion Apel and Ernst, 1980). According to the results presented in this paper, the total effect of the car on the frequencies of all studied activities is close to zero<sup>9</sup>.

However, the powerful role car availability plays for location choice has to be highlighted here. Individuals with access to a car tend to locate in peripheral settings. This can be interpreted in at least two ways. Firstly, the car may be seen as a structural impact on location choice, given that car availability itself is clearly unequally distributed among societal groups. Secondly, without neglecting such structural inequalities, the differing location decisions of individuals with and without access to a car may also be seen as an effect of residential self-selection spatially separating the population according to car availability, as car availability in itself may depend on travel mode preferences.

As far as the applied method and data are concerned, there are some limitations worth mentioning that make further research necessary.

Firstly, the requirement of working with metric variables in addition to using latent variables makes the effects of life situation somewhat "blurred". The results presented above indicate substantial vertical social stratification of activity patterns. However, the details of this determination are not entirely clear. They could be made clearer by using detailed, discrete indicators of life situation. On the other hand, the models could quickly become over-complex.

Second, travel behaviour was limited to activity patterns in this paper. Related papers focus on travel mode choice (Scheiner and Holz-Rau, 2007) and the interrelation between trip distance and mode choice (Scheiner, 2007). An important step further could be taken by the combined examination of different travel behaviour

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9 The positive direct effect on maintenance activities is outweighed by the negative effect mediated by location choice.

elements (e. g. activity frequency and trip distance, mode choice and trip chain complexity, etc.).

Third, the effects of location preferences on travel behaviour appear to be relatively limited in this analysis. This confirms other studies that found the objective built environment to have a substantial impact even when self-selection effects were controlled (Schwanen and Mokhtarian, 2005). However, it contradicts studies that found self-selection effects to be much stronger than the effects of the built environment (Bagley and Mokhtarian, 2002). I see several reasons for the limited effects of self-selection found here:

- 1 Self-selection may have less effect on activity frequencies than on trip distances and mode choice.
- 2 While the objective built environment was measured in great detail, location preferences were recorded using rather generalised items<sup>10</sup>.
- 3 The housing market in the region of Cologne is supply dominated. Thus, the opportunities of different population groups to realise a specific location choice that meets their needs and wishes are limited.
- 4 Location preferences might in some cases not have had any impact on actual location decisions, because the decisions were based on the partner's location needs (which were not recorded in the data).

Consequently, the true effect of residential self-selection on travel behaviour might be substantially larger than suggested by the empirical findings presented here.

Fourth, the definition of lifestyle should possibly be more focussed on dimensions relevant for activity patterns and travel behaviour. However, the challenge in appropriately defining lifestyle is to find dimensions that are theoretically relevant and focussed on activity/travel behaviour without being tautologically interrelated with the dependent variable.

Overall the results presented here point to a predominance of "objective" over "subjective" factors for the explanation of activity patterns. Nonetheless, we should not forget that lifestyles and preferences or, to put it more generally, the subjective side of travel demand, has long been neglected in transportation studies (Holz-Rau and Scheiner, 2009). Consequently, more theoretical reasoning and the development of empirical applications seem to be a worthwhile line of research for the future.

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10 The interviewees were asked about access or proximity to certain opportunities. Yet these concepts may be understood in different ways. Car owners might regard a shopping centre within 3 km distance as being close by, while for people without a car proximity probably means "within a range of some 500 m".

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