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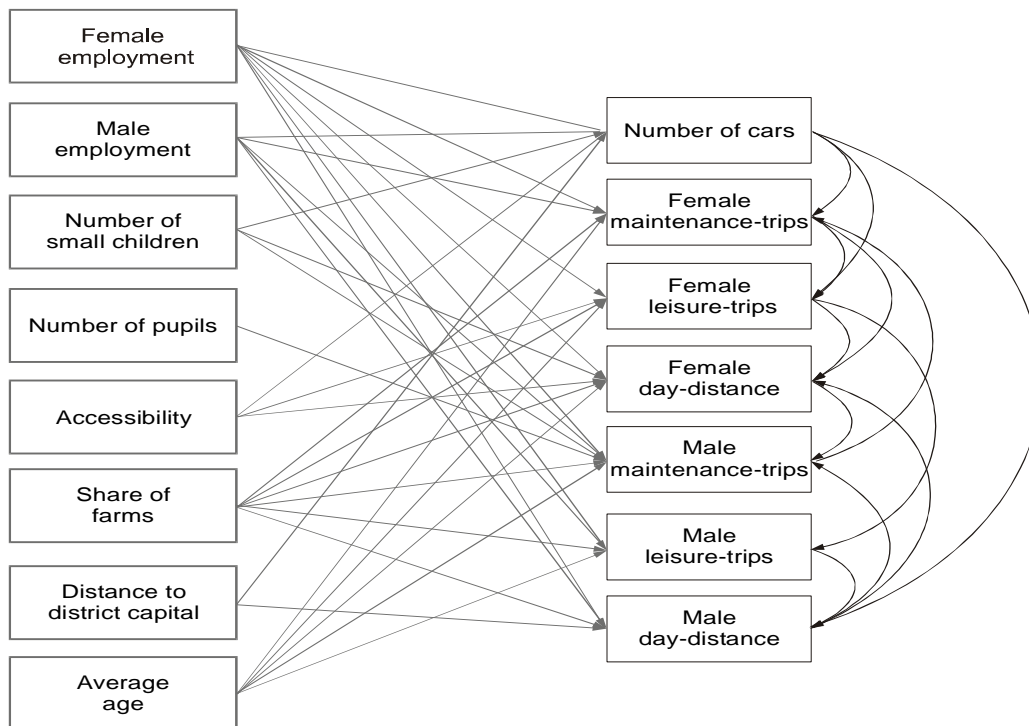
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## Within Household Allocation Of Travel – The Case Of Upper Austria

Paper submitted for presentation at the 80<sup>th</sup> Annual Meeting of the Transportation Research Board, Washington, D.C., January 2001

**A Simma und KW Axhausen**

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Paper

## **WITHIN-HOUSEHOLD ALLOCATION OF TRAVEL - THE CASE OF UPPER AUSTRIA**

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### **ABSTRACT**

This paper investigates the interactions between the heads of a household with regard to their out-of-home-activities and travel behaviour in Upper Austria. To answer the research questions a SEM-model (structural equation model) is developed. The data used in the modelling-process are from an extensive travel diary of over 100,000 households in the Land of Upper Austria, combined with extensive data on land use and local economic activities.

The main result of the model is that the sex-specific division of labour in nuclear families is still very common. If women are working, the number of their maintenance-trips is reduced, but this reduction is not compensated by men. Normally female employment is connected with a decrease of the number of other female activities and an increase of car-ownership and travelled distances. Additionally the model shows that out-of-home activities often are carried out together. The number of reachable infrastructure facilities is the most important spatial variable, whereby good access promotes the reduction of car-ownership and travelled distances.

### **KEYWORDS**

Upper Austria, structural equation model, nuclear family, interrelationships, travel behaviour

## 1 INTRODUCTION

The nuclear family with a sex-specific division of labour was the dominant family-type for several decades. This family-type was characterised by a father working outside and a mother staying at home doing the housework and bringing up their children. The importance of this family-type has decreased in the last four decades in Austria, as elsewhere. On the one hand other household-types have become more prominent, e.g. singles, one-parent-families, childless couples, unmarried couples or shared living arrangements (Spiegel, 1986; Peuckert, 1996). The single-household is the most common of these household-types. On the other hand, changes within the nuclear family have taken place, especially in regard to the role of the wives (Häußermann and Ostner, 1990; Nave-Herz, 1994).

While the majority of married women stayed at home in the 50's and 60's, today most women, even mothers, are working – at least part-time. Women are no longer only responsible for the household, they also take part in the working world. The consequence of this development is often a double burden or a triple burden for mothers (Höpflinger, Charles and Debrunner, 1991; Blau and Ferber, 1992; Rossmann, 1996). In contrast to women the life of men has hardly changed. They are still mainly working and do not participate in the domestic sphere (Coltrane, 1996; Born, 1987; Davies and Joshi, 1994).

The general assumption is that the sex specific division of labour is still dominant in spite of the increasing share of working women. Few studies have tested empirically how families really manage everyday life and how these arrangements affect travel behaviour. In this paper an attempt is undertaken to analyse the interrelationships between heads-of-households with regards to out-of-home activities and travel behaviour. The analysis is limited to parents, because the question of the division of labour becomes decisive if children live in a household. Additionally spatial differences between the home locations are taken into consideration.

## **2 REVIEW**

The unit of analysis in this paper is the individual within the household, interacting with the social and spatial environment, as well as the household as a whole. Understandings developed from activity-based travel demand models form the basis of the analysis.

The activity-based approach to the analysis of travel behaviour and travel demand originated in the UK, the US and Germany in the 1970's to overcome the limitations of the standard four-stage approaches. The starting point of the approach was the switch of focus from aggregate trip making to individual activity participation and the identification of travel as a derived demand. The work was stimulated by developments in geography (Hägerstrand) and urban planning (Chapin). Both had analysed the activity patterns of individuals and groups of individuals. While the unit of analysis was the same, the two approaches had different basic assumptions. Chapin (1974) saw travel primarily as a result of individual preferences and unconstrained choices, whereas Hägerstrand (1970) saw it as the outcome of fulfilling a complex set of constraints (capability constraints, coupling constraints and authority constraints). The activity approach recognises both and analyses travel and activity behaviour as "choice in the context of constraints" (Jones, Dix, Clarke and Heggie, 1983, p. 266). It is this fuller understanding which allows the activity-based approach to offer more comprehensive and insightful analyses of travel behaviour.

The initial studies of the activity-based approach showed that travel behaviour is strongly influenced by socio-demographic characteristics (Kutter, 1972; Schmiedel, 1984). This finding was investigated in greater detail during the 80's and 90's, e.g., the life-cycle, person-characteristics, the impacts of income and available time, gender differences, household-structure and interactions (Kitamura, 1988; Jones 1990). In the last kind of models the focus was on the household-heads and their interactions (Golob and McNally, 1997; Golob, 1998).

## **3 UPPER AUSTRIA**

Upper Austria is one of the nine Austrian provinces located to the west of Vienna, to the east of Munich and to the south of Prague. It has a size of 12.000 km<sup>2</sup> and about 1.3 million inhabitants. At a very general level Upper Austria can be divided into three parts.

- **Böhmisches Massiv** in the north of Upper Austria
- **Alpenvorland** in the middle of Upper Austria
- **Alps** in the south of Upper Austria

The northern part of Upper Austria is disadvantaged in several ways. This area is neither well suited for agriculture nor for tourism. Additionally the border to Czech Republic was closed for the five decades of the Cold War. As a result the possibilities for industrial development after World War II were limited. Typical for this area are widely dispersed settlements and large, isolated farm houses and very traditional household-forms.

The situation is different in the other parts of Upper Austria. The Alpenvorland is the centre of agriculture and industry, including a number of large scale factory complexes in the main cities. Especially the western parts of its central area (*Zentralraum*) are important for agriculture. Half of the population lives in the Alpenvorland and 13 of the 15 largest towns are situated here. The Alps, especially the *Salzkammergut* with its lakes (e.g. location of “*Sounds of Music*”) and the skiing areas, are dependent on tourism, including second-home ownership.

Upper Austria consists of 15 districts, three cities with district status (Linz, Steyr and Wels) and 445 incorporated communities. The respective district capitals are both centre of the local administration, as well as of shopping and industrial activity of their area. Linz is the capital of the province and by far its largest city.

#### **4 THE 1992 UPPER AUSTRIAN TRAVEL SURVEY**

The government of Upper Austria conducted a travel survey during the autumn of 1992 renewing its data base for the first time since early 1980’s (Amt der Oberösterreichischen Landesregierung, 1995). It mostly followed in design and protocol the well known example of the German KONTIV survey (Axhausen, 1995). A postal questionnaire was used to collect the information. Every third household was sampled from the official and mandatory local registers of residents and households.

Each of the households was contacted up to four times. The survey pack included one questionnaire for the household as a whole and six individual trip diaries for the different

household members. Responses were expected from persons aged older than five years. The return rate was relatively high. On average 70% of the households returned the questionnaires. The result of the 1992 Survey was a database with 898.552 trip records, 328.242 person records and 123.628 household records. Additional variables were created, mostly aggregates, such as e.g. the distances travelled on a given day or the number of pupils living in a household. This database was complemented with further community-based spatial variables.

## 5 MODELLING APPROACH – STRUCTURAL EQUATION MODELLING (SEM)

A precondition for the analysis of the complex questions posed in this paper is a method which can handle relationships between several dependent and independent variables at the same time. SEM-Modelling meets these requirements. SEM-Modelling is a confirmatory method which should be guided by prior theories about the structures to be modelled.

A SEM-model is simply a set of simultaneous equations specified by direct links between variables. A SEM-model with latent variables has at most three components: a measurement submodel for the endogenous variables, a similar measurement submodel for the exogenous variables, and a structural submodel. Here we develop only the structural submodel, because travel behaviour is not well suited to be handled by hypothetical constructs (latent variables).

The structural submodel captures the relationships between the exogenous and endogenous variables and between the endogenous variables themselves. It is defined by

$$\eta = \mathbf{B}\eta + \mathbf{\Gamma}x + \xi$$

in which the (m) endogenous variables are a function of each other and of the (q) exogenous variables (denoted by the q-dimensional column vector x). The unexplained portions of the endogenous variables (the errors in equations), have a variance-covariance matrix defined by  $\mathbf{\Psi} = E[\xi\xi']$ .

The modeller specifies which elements of the  $\mathbf{B}$ ,  $\mathbf{\Gamma}$  and  $\mathbf{\Psi}$  matrices are free parameters, and these parameters are estimated simultaneously, together with their standard errors. Identification requires, among other conditions, that the matrix  $(\mathbf{I} - \mathbf{B})$  must be non-singular. The total effects of various variables on the endogenous variables are given by the so-called reduced-form equations:

$$\eta = (I - B)^{-1} \Gamma x$$

Estimation of a SEM-model can be accomplished in several ways. The methods (described in detail in Bollen, 1989) are based on matching model-replicated variance-covariances with the observed variance-covariances. Here we use the ADF-WLS-method (arbitrary distribution function weighted least squares) in conjunction with a PM-matrix (matrix of product moment (Pearson), polychoric, and polyserial correlations), because several variables are not normally distributed. SEM-models have been used in travel demand modelling by e.g. Golob (1998), Golob, Bradley and Polak (1995), Lu and Pas (1996), Golob (1999) or Kuppam and Pendyala (1999).

## **6 ANALYSIS**

The aim of the analysis is to model the interactions between parents with regards to their out-of-home activities, as well as their impacts on travel behaviour. The focus is on everyday life and not on the weekend. Because detailed hypotheses are necessary to conduct a SEM-model, it is postulated that mothers are responsible for the housework – regardless of whether they work or not. Consequently they make more maintenance trips and fewer leisure trips – because of the limited time-budget – than their male partners. The behaviour of men is independent of domestic responsibilities. There are not only sex-specific differences with regards to the activities, but also with regards to car-ownership and distances travelled. Particularly housewives are less likely in the possession of a car and travel fewer kilometres. Additionally it is postulated that travel behaviour is affected by the spatial environment. Especially the location of a household (accessibility, distances to towns) is important.

### **6.1 Modelling-process**

A data-set with observations containing information about the female and male head of a nuclear family was necessary to investigate the interactions within a household. The first condition for being considered in the data-set consequently was being a parent in a nuclear family. These parents formed the sample for the modelling-process. The second condition for being considered in the data-set was being mobile on the given diary-day, since the focus of this investigation was on out-of-home activities and travel behaviour. The data-set had a size



of 19.280 observations (19.280 nuclear families with information about the male and the female head).

In the second modelling step the variables were chosen. On the exogenous side there are variables describing the person (female employment (0=no, 1=yes), male employment (0=no, 1=yes), average age of the parents, age difference between the partners), the composition of a household (number of small children, number of pupils in a household) and the spatial environment. The following spatial variables are used.

- **Location of the communities:** The location of a community can be described by two distance-variables – the distance to the relevant district capital and the distance to Linz. In Upper Austria the distance to the district-capital is more relevant, because the communities are orientated towards their district-capital.
- **Number of reachable facilities (accessibility):** The number of reachable facilities is a measure for the supply of activity opportunities to a household. It is high, if a household can reach a shop, a supermarket, a bank, a post-office, a kindergarten, school, a pharmacy and a doctor within walking-distance (ten minutes). It equals zero, if a household cannot reach any facility within this time. Only three communities are without all of these facilities, but in every community there are at least some households which cannot reach any facility within a reasonable walking time.
- **Share of working women:** This variable characterises the importance of the traditional nuclear family and the sex-specific division of labour within the communities. Between 25 and 50% of all women are working.
- **Share of commuters:** Because workplaces are concentrated in Linz and the district capitals, people in the small villages often have to commute. In some communities more than 80% of the working adults are commuters.
- **Share of farms:** The importance of the agriculture is not only captured by its share of employees, but also by the share of farms among all buildings. This second variable is especially interesting, because many farms are operated by part-time farmers, which combine industrial and agricultural employment. Up to 69% of the buildings are farms.

The endogenous variables describe the mobility-chances, the out-of-home activities and travel behaviour. The choice of variables was dependent on the available database.

- **Number of cars in a household:** Most households with more than one person own at least one car. The acquisition of a second car is often combined with a higher need for this mobility chance.

- **Activity Participation:** The activity participation is defined by the number of trips undertaken for a specific activity type, whereby the activities are divided into three categories – work, maintenance, leisure. The number of work-trips is not considered in the model, because it is assumed that people who work make normally two work-trips per day. The number of maintenance-trips conveys the engagement in the housework, the number of leisure-trips conveys the possibility to participate in leisure-activities.
- **Day-distances:** This variable describes the mobility-intensity. It is affected by car-ownership, the location of the household and activity-structure.

Effects were postulated between the exogenous respectively endogenous and endogenous variables (see Table 1).

Table 1 Postulated direct effects

	To						
	Number of cars	Female Maintenance-trips	Leisure-trips	Day-distance	Male Maintenance-trips	Leisure-trips	Day-distance
<b>From</b>							
Number of cars		$\beta$	$\beta$	$\beta$			$\beta$
Maintenance-trips – female			$\beta$		$-\beta$		
Leisure-trips – female				$\beta$		$\beta$	
Day-distance – female							$\beta$
Maintenance-trips – male			$\beta$				$-\beta$
Leisure-trips – male							$\beta$
Day-distance – male							
Employment – female	$\gamma$	$\gamma$	$\gamma$	$\gamma$	$-\gamma$		
Employment – male						$-\gamma$	$\gamma$
Average age		$\gamma$			$-\gamma$		
Age-difference		$\gamma$			$-\gamma$		
Number of small children	$-\gamma$	$\gamma$	$\gamma$	$-\gamma$			
Number of pupils	$-\gamma$	$\gamma$	$\gamma$	$-\gamma$			
Distance to district-capital	$\gamma$			$\gamma$			$\gamma$
Accessibility	$-\gamma$	$\gamma$	$\gamma$	$-\gamma$			
Share of commuters	$\gamma$			$\gamma$			$\gamma$
Share of farms	$\gamma$	$-\gamma$		$\gamma$			$\gamma$
Share of working women	$\gamma$						

## 6.2 Results

The initial model had to be revised according to prior theoretical considerations to improve the explain the structures more fully. The different fit-indexes (Bollen, 1989; Mueller, 1996) show that the modified model possesses a high quality (see Table 2). Compared to the postulated model the chi<sup>2</sup>-value and the critical number could be substantially improved. The high chi<sup>2</sup>-value is not a sign for a model-misspecification. Because the chi<sup>2</sup>-value is dependent on sample-size, the big sample used in this model leads to this high value. The squared multiple correlation-coefficients lie between 0,07 and 0,25. This means, that the independent variables can only explain a small part of the variance. The explanatory power is especially low for the number of cars, the number of female leisure-trips and the male day-distance, especially high for the number of female maintenance-trips and female day-distance.

Table 2 Fit indexes of the postulated and the modified model

	Fit of the postulated model	Fit of the modified model
Sample size	19.280	19.280
Chi <sup>2</sup> -value (63/44 degrees of freedom)	3127,66 (P = 0,0)	398,00 (P = 0,0)
Goodness-of-Fit Index (GFI)	1,00	1,00
Adjusted Goodness-of-Fit Index (AGFI)	1,00	1,00
Critical N (CN)	568	3.329
Normed Fit Index (NFI)	1,00	1,00
Nonnormed Fit Index (NNFI)	1,00	1,00
Comparative Fit Index (CFI)	1,00	1,00

The direct effects of the modified model are shown in the path-diagram (Figure 1) and in Table 3. The total effects only in Table 3. Because one estimator above the diagonal within the B-matrix is free, the modified model is a non-recursive model. No parameter has been freed within the  $\Psi$ -matrix. The  $\Gamma$ -matrix contains fewer exogenous variables than postulated. The age difference as well as the spatial variables “share of commuters” and “share of working women” do not have significant effects on the endogenous variables. This result indicates that the person-variables are more important than the corresponding spatial variables.

Figure 1 Path-diagram of the modified model

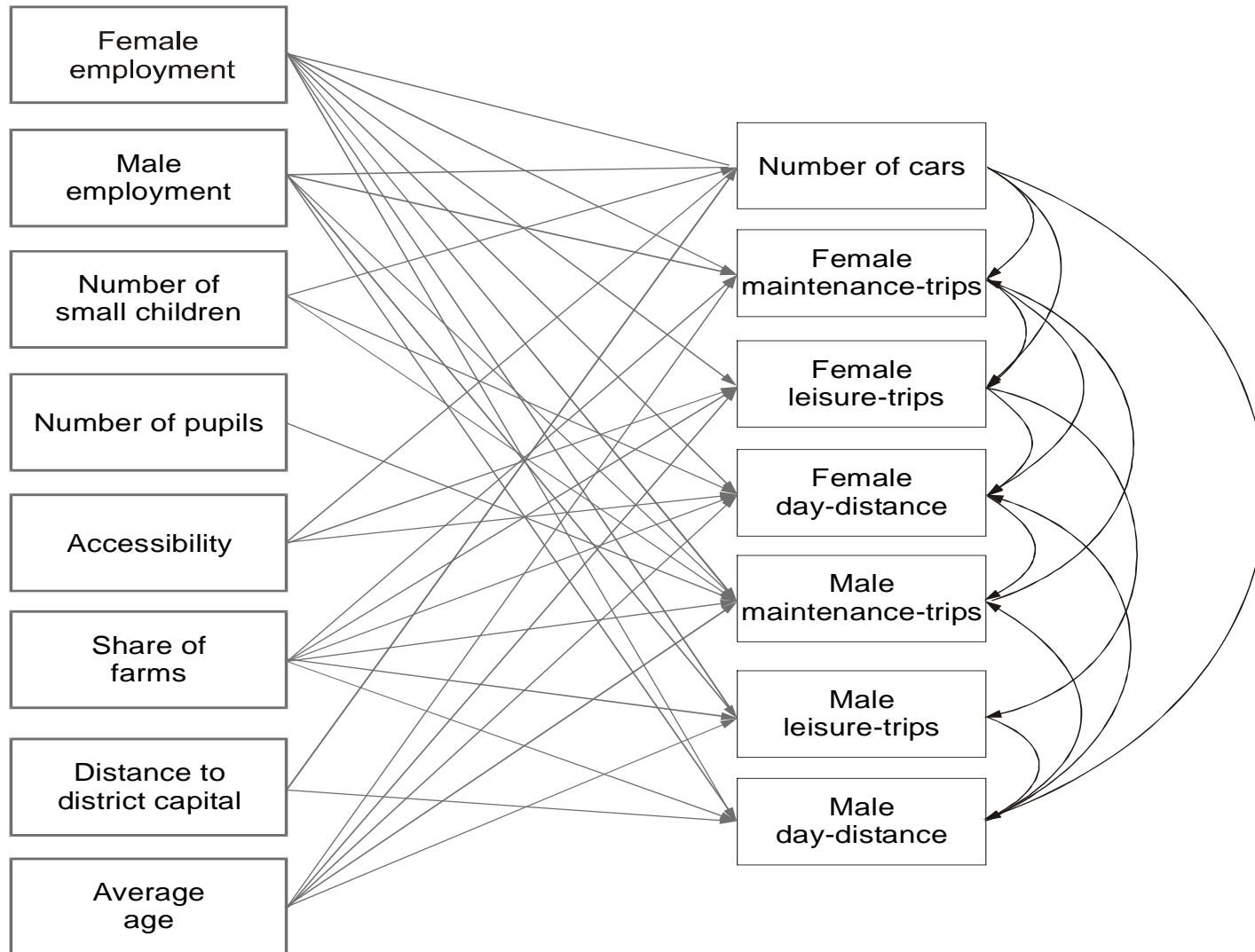


Table 3 Direct and total effects of the modified model (effects without a number are significant at the 0,0001-level)

From	to						
	Number of cars	Female Maintenance trips	Leisure-trips	Day-distance	Male Maintenance trips	Leisure-trips	Day-distance
Number of cars		0,11	0,08				0,07
Maintenance-trips – female		0,11	0,06	0,06	0,01	0,02	0,07
Leisure-trips – female			-0,21	0,28	0,01	-0,07	
Day-distance – female			-0,21	0,23		0,35	0,02
Maintenance-trips – male		0,01			0,02	0,35	0,02
Leisure-trips – male		0,01			0,05		
Day-distance - male		0,18	-0,04	0,04		-0,01	0,07
Employment – female	0,27	-0,52	-0,28	0,47	0,12	0,05	-0,10
Employment – male	0,08	-0,47	-0,16	0,28	0,12	-0,08	-0,08
Average age	0,08	0,13		0,06	-0,57	-0,08	0,18
Average age <sup>2</sup>		0,05 <sup>1</sup>		0,06	-0,55	-0,08	0,19
Number of small children	0,10	0,57	-0,14 <sup>1</sup>	-0,49	-0,58	-0,11 <sup>2</sup>	-0,01 <sup>1</sup>
Number of pupils	0,10	0,46	-0,23 <sup>1</sup>	-0,42	-0,60	-0,19 <sup>1</sup>	-0,01 <sup>1</sup>
Distance to district-capital	-0,07	-0,57	0,06 <sup>2</sup>	0,53	0,40	0,08 <sup>2</sup>	0,01 <sup>2</sup>
Accessibility	-0,07	-0,49	0,16 <sup>2</sup>	0,43	0,42	0,13 <sup>2</sup>	0,01 <sup>2</sup>
Share of farms	-0,07	0,03		0,06	0,10		0,01
		0,03	-0,01	0,01	0,18		0,18
	-0,07			0,02			0,09
	-0,07	-0,01		0,02	0,01		0,08
	-0,07		0,03 <sup>1</sup>	-0,09			
	-0,07	-0,01	0,03 <sup>1</sup>	-0,09	-0,01	0,01 <sup>1</sup>	
		-0,10	-0,08	0,09	-0,11	-0,03 <sup>1</sup>	0,15
		-0,12	-0,05	0,08	-0,09	-0,05	0,14

<sup>1</sup> only significant at the 0,01-level

<sup>2</sup> only significant at the 0,1-level

### 6.3 Interpretation of results

The B-matrix shows that the number of cars per household has a positive direct and total effect on the number of female trips and a positive total effect on the number of male trips. This means, that the car has an inducing effect on the mobility-level. Additionally car-ownership is connected with higher day-distances for both sexes.

The relationships between the activities are the second interesting result. On the one hand, there exists a negative effect from the number of female maintenance-trips to the number of female leisure-trips. This effect and the negative effect from the exogenous variable “female employment” on the number of female leisure-trips support the hypothesis that mothers – particularly working mothers – have very little time at their own disposal. On the other hand, the activities of the two heads are mutually dependent. The number of female leisure-trips has a positive effect on the number of male leisure-trips, the number of male maintenance-trips on the number of female maintenance-trips. Out-of-home activities which are undertaken together are most probably decisive for this result.

The main result in regard to the  $\Gamma$ -matrix is that the variables describing the person have the highest explanatory power. The importance of the household-variables is rather small – possibly, because only families are considered. The detailed results can be interpreted as follows:

- **Female employment:** Female employment possesses significant effects on all endogenous variables. The negative effect on the number of female maintenance- and leisure-trips can be explained by the fact that the employment leads to rationalisations of the housework and to restrictions of leisure-activities. This result conveys how large the burden of working is for mothers.

The effect of female employment on the male behaviour is higher than expected. The female employment is connected with an increase of the number of male maintenance-trips and a decrease of male day-distances. This means that the male partners take over some household-responsibilities from their female partners and compensate the increase of distances travelled by women.

- **Male employment:** The employment of a man mainly influences his own behaviour, especially his number of maintenance-trips and his travelled distances.
- **Average age:** The most important result in regard to age is that a higher age is connected with a more traditional sex-specific division of labour. Therefore the conclusion is possible that the importance of the traditional patterns decreases gradually.
- **Number of small children and of pupils:** These variables have positive effects on the number of female and male maintenance-trips. The increase of maintenance-trips can be explained by the fact that children induce a considerable rise in housework – different to the expectations is the significant effect on fathers.
- **Accessibility:** If the number of reachable facilities is high, the necessity to own a car and to travel long distances decreases. That means that a good provision with infrastructure-facilities is connected with a reduced trip-intensity.

- **Share of farms:** People in agricultural-dominated communities make fewer trips and travel longer distances than people in other communities. The often peripheral location and the rural structure of these communities are reasons for these results above and beyond their distance to the district capitals.
- **Distance to the district capital:** The positive effect of this variable on the day-distances corresponds with the expectations. Furthermore – a high distance to the district capital is connected with an increase in the number of male maintenance-trips. One explanation can be that men living in badly supplied communities have to take over maintenance-trips. This explanation is supported by the fact that high distances to the district capital lead also to a decrease in the number of female maintenance-trips.

## 7 CONCLUSIONS

The model has shown that the sex-specific division of labour still determines the every-day life of nuclear families, but there are signs for changes, e.g. the increasing participation of women in the labour-force, the similar effects of children on the behaviour of their parents or the take-over of maintenance-trips by men if the distance to the district-capital is high.

The increasing participation of women in the labour force and the decreasing importance of the traditional family are certainly connected with impacts on travel behaviour. Working women own more often a car, make more trips, but fewer maintenance-trips and travel longer distances than housewives. Consequently more working women are probably connected with more traffic.

Generally it can be assumed that the reduction of the number of female maintenance-trips is not fully compensated by their male partners. Rationalisations of the housework and weekly shopping will become more common.

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