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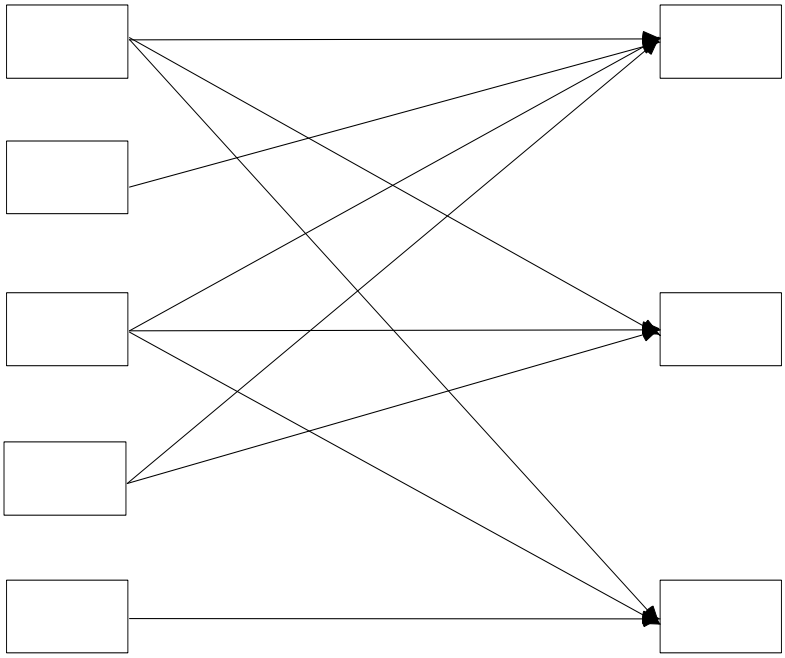

Successive days, related travel behaviour ?

Contribution to the Mobi*drive* final report

A Simma and KW Axhausen

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Abstract

This paper investigates the relationships between the travel behaviour on successive days of a week. It has an explorative character, because the Mobi*drive* data allow this analysis for the first time. The hypotheses and the structure of the models are based on the suggestions of the literature and on the descriptive analysis of the data.

Three different models are developed using the results of the continuous six-week travel diary and structural equation modelling (SEM). In the models person- and household-variables are exogenous and variables describing travel behaviour are endogenous. One model contains the number of trips per day (the days of one week and the following Monday) as endogenous variables, one model the distances travelled per day and one model the number of trips made by the female and male partner of a couple or family.

The results show that there are relationships between the days. The impact of the previous day and within limits the impact of the previous Monday on a given day, the differences between the weekdays and the weekend and the small influence of the socio-demographic variables on travel behaviour are the most important findings. Additionally dependencies between the partners in a household could be demonstrated.

Keywords

Weekly rhythms of travel behaviour – travel patterns – household-interdependencies – structural equation modelling – Mobidrive – six week travel diary

1. Introduction

The analysis of rhythmic patterns of travel behaviour has so far been restricted by the absence of surveys with reporting periods substantially longer than one week. With the implementation of a continuous six-week travel diary as part of the German research project Mobi*drive*, a current data set of long-term individual travel behaviour is now available for analysis (Axhausen, Zimmermann, Schönfelder, Rindsfüser and Haupt, 2000).

The survey was conducted in the cities of Halle/Saale and Karlsruhe in autumn 1999. A total of 317 persons over 6 years in 139 households participated in the main phase of the survey, after testing the survey instruments in a pre-test with a smaller sample in spring 1999 (44 persons). The paper-based travel-diary instrument was supplemented by further survey elements covering the socio-demographic characteristics of the households and their members, the details of the households' car fleet and of the transit season tickets owned and personal values as wells as attitudes towards the different modes of transport (see for details König, Schlich, Aschwanden, Kaufmann and Axhausen, 2000; König, Schlich and Axhausen, 2000).

This data base can be used to analyse temporal patterns in travel behaviour. Different methods have already been applied, for example survival analysis (Schönfelder and Axhausen, 2000), time series models (Fraschini and Axhausen, 2001) or sequence alignment methods (Schlich, 2001). Here a further method is presented and applied - Structural Equation Modelling. This method is suited to present the interrelationships between travel behaviour on successive days.

While there is range of papers and articles investigating the influence of person- and household-variables on travel behaviour (for example Simma, 2000; Jones, 1990; Kitamura, 1988), there is no literature about the relationships between days – at least to the knowledge of the authors. The literature on between-day variability does not shed light on the dependencies between days (see for example Pas and Sundar, 1995; Hanson and Huff, 1988; Jones and Clarke, 1986). Therefore the model hypotheses and the structures of the models cannot be based on prior consensus, but have to be based on the observation of the data at hand. The idea behind the models is that the behaviour on one day influences the behaviour on the next day and the following days.

2. Method - Structural Equation Modelling (SEM)

The SEM modelling is a method to simultaneously analyse the relationships between several variables (Bollen, 1989; Maruyama, 1998; Mueller, 1996). It is particularly suitable for examining complex questions. The method possesses two outstanding characteristics. On the one hand the covariances or correlations between the variables are used, on the other hand this model is so general that many other methods can be considered as special cases of SEM – for example the confirmatory factor analysis or regression analysis.

A SEM model consists of three parts – two measurement models and a structural equation model. The measurement models represent the relationships between the latent and the observed variables, while the structural equation model represents the relationships between the latent variables or if no latent variables are specified, the relationships between the observed variables. In this paper only structural equation models are used, because the behaviour of each day is the focus of interest. The structural equation model is defined as follows:

$$\eta = B\eta + \Gamma\xi + \zeta$$

Variables

η (eta)	m*1 vector of the (latent) endogenous variables
ξ (ksi)	n*1 vector of the (latent) exogenous variables
ζ (zeta)	m*1 vector of the residuals

Coefficients

B (beta)	m*m matrix of the relationships between the endogenous variables
Γ (gamma)	m*n matrix of the relationships between the exogenous variables

Matrices

Φ (phi)	n*n matrix of ξ
ψ (psi)	m*m matrix of ζ

The endogenous variables are a function of the (m) endogenous variables (B-matrix) and the (n) exogenous variables (Γ-matrix). The elements of the main diagonal in the B-matrix are zero, because no variable can cause itself. A model is called recursive, if B is lower triangular and if Φ is diagonal.

The user defines, which elements of the three matrices B, Γ and Φ are free, i.e. free to be estimated. The free parameters are simultaneously estimated. Different estimation methods are available – for example maximum likelihood, unweighted least squares or generally weighted least squares with arbitrary distribution functions. The direct and the total effects among the variables are one result of the estimation, whereby the parameters of the matrices B and Γ correspond to direct effects among the different variables. Additionally SEM provides criteria for the evaluation of the model quality. The multiple coefficients of correlation,

the Chi square test, the (adjusted) goodness of fit index, the (non)normed fit index, the comparative fit index and the critical N are the most important criteria.

Covariance matrices and the maximum likelihood method are used in the models developed in this paper. The advantage of a covariance matrix is that it also gives information about the size of the variability of variables, while the advantages of the maximum likelihood method are that this method provides the most precise estimators and is relatively robust against violations of the normal distribution assumption. The parameter estimates can be interpreted as analogous to the unstandardised coefficients of a linear regression.

3. Structure of the models

A SEM model consists of two model parts – the exogenous part contains variables, which explain the endogenous variables, the endogenous part contains variables, which are explained by the exogenous and sometimes by other endogenous variables. In the models of this paper it is postulated that variables describing travel behaviour are endogenous and that the person- and household-variables are exogenous. Models, which describe the behaviour of a single person, as well as models, which describe the relationships among couples as well as the behaviour of each partner, are developed.

The behaviour of one week and the following Monday are regarded as one observation. This structure is based on model technical considerations (number of variables and size of the sample) and on theoretical considerations. Other investigations in the context of the project Mobi*drive*, as well as many other studies, have shown that there is a strong weekly rhythm as long as no special events intervene, such as legal holidays etc. The reference to the next week is included by adding one day of the following week in the person models. This is not possible in the couple model because of the small sample size and the large number of variables.

3.1 Hypotheses

The following hypotheses form the starting point of the modelling process. In Table 1 the hypotheses for the endogenous model part are specified.

- **Monday**: The Monday is the first day of the week considered and represents thus the starting point. Therefore it is postulated that the Monday influences all other days with decreasing influence in the course of the week.

- **Previous day**: Besides Monday, the previous day plays an important role in the behaviour of the next day. The ideas behind this are that on the one hand, relations between the activities of two consecutive days exist, and that on the other hand type-specific behaviour is passed on in this way, whereby this fact is handled by the help of the covariances between the residuals.

- **Weekend – working-day**: Other investigations in the context of the project Mobi*drive* have shown that there are differences in the behaviour on weekdays and weekends – regardless of whether a person is employed or not. Therefore it is expected that the relationships between the weekdays are closer than the relationships between a weekday and a Saturday or a Sunday.

- **Socio-demography and travel behaviour**: It is generally assumed that the influence of the socio-demography on travel behaviour is rather small. Kind and directions of the relationships should correspond to the other results obtained by investigations of the Mobi*drive*-data set.

- **Dependencies within a household**: It is assumed that the behaviour of a family member is not independent of the behaviour of the other family members. Especially the weekend is characterised by common activities.

Table 1 Postulated direct effects between the endogenous variables (travel behaviour)

To	From Monday	Tuesday	Wednes-day	Thurs-day	Friday	Saturday	Sunday	Next Monday
Monday								
Tuesday	β							
Wednesday	β	β						
Thursday	β		β					
Friday	β			β				
Saturday	β							
Sunday	β					β		
Next Monday	β				β		β	

3.2 Choice of variables

The variables describing travel behaviour are the focus of interest. The number of trips per day and the distances travelled per day are chosen, because these two variables reflect two important dimensions of travel behaviour: the number of trips is a measure of the mobility level, the distances travelled is a measure of the mobility intensity. Since other investigations have shown that close relationships exist between the number of trips and the travelled distances (see Simma, 2000), only one of these dimensions is treated in each model. The limitation to one dimension per model leads to a far higher model stability and is a technical necessity, particularly for the couple model because of the relatively small sample size.

The choice of the person- and household variables is based on other findings in the course of the project Mobi*drive* (König, Schlich and Axhausen, 2000). An analysis of variance used there has shown that the variables sex, age, employment, location of the household (city) and the number of cars have the greatest influence on the endogenous variables. These variables are also used here. Since these variables can however explain only a small part of the variability of behaviour, it is expected that their explanatory power is rather small in the SEM models as well.

3.3 The endogenous variables

Three different models which contain different endogenous variables are considered for estimation. The descriptive statistics of these variables and the correlations between these variables (see Table 2) give first hints about the possible model results.

- **Number of trips**: Nearly four trips per day are undertaken on average. The Sunday is the day with the smallest average trip number (2.45 trips per day), the Friday is the day with the greatest average trip number (4.12 trips per day). The other days are very similar with regard to the average number of trips (around 3.8 trips per weekday, 3.32 trips per Saturday).

  The correlations between the weekdays (correlation coefficient of around 0.4) are higher than the correlations between a weekday and a Sunday respectively a Saturday (correlation coefficient of around 0.25).

- **Distances travelled**: Around 27 km are travelled per day on average – but there are two exceptions: Friday (29 km) and especially Saturday (35 km) are the days with higher distances. Because the standard deviations are twice as large as the means, the outliers have been considered in greater detail. Omitting the outliers (distances over 200 km per day) decreases the average distances to around 22 km and equalises the differences between the days. The day with the longest distances travelled is then Friday (24 km), the day with the lowest distances travelled is Sunday (20 km).

  Omitting the outliers affects not only the means, but also the correlations between the days. Generally it can be stated that the correlations are stronger, if the outliers are not included, for example the correlation coefficient between Tuesday and Wednesday decreases form 0.60 (correlation without outliers) to 0.34 (correlation with outliers). Additionally it can be stated that the weekday and the weekend are different.

  It was decided to estimate two different models because of these great differences.

- **Number of trips for couples**: The results are very similar to the results including all persons. Friday is the day with the highest number of trips, Sunday the day with the smallest number of trips. The differences within couples are rather small. Husbands are a bit more mobile than their wives, especially during the weekend.

Table 2 Correlations between the endogenous variables (number of trips lower triangular, distances without outliers in italic)

To	From Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Next Monday
Monday	1.000	*0.564*	*0.499*	*0.454*	*0.461*	*0.189*	*0.106*	*0.523*
Tuesday	0.379	1.000	*0.599*	*0.480*	*0.439*	*0.198*	*0.140*	*0.518*
Wednesday	0.415	0.436	1.000	*0.443*	*0.395*	*0.142*	*0.141*	*0.474*
Thursday	0.415	0.445	0.426	1.000	*0.440*	*0.180*	*0.092*	*0.523*
Friday	0.378	0.405	0.407	0.421	1.000	*0.225*	*0.120*	*0.464*
Saturday	0.287	0.293	0.293	0.326	0.325	1.000	*0.224*	*0.221*
Sunday	0.224	0.259	0.277	0.283	0.296	0.341	1.000	*0.134*
Next Monday	0.431	0.372	0.396	0.387	0.386	0.284	0.250	1.000

In the SEM models all variables are centred (centred variable = value of the variable j for k – mean of the variable j). That means that only the differences between the days and the mean are considered.

4. Results

Four different models were estimated – three person models and one couple model. The person models differ in the choice of the endogenous variables (distances with and without outliers versus number of trips). The couple model is restricted to persons who are married and live together with their partner. Therefore the sample size of the couple model is rather small.

The explanation and interpretation of the results within the endogenous part is not as straightforward as within the exogenous part because of the lack of previous investigations and the lack of a widespread knowledge about the relationships. Instead of using SEM as confirmatory method an interactive process was selected. The results based on the hypotheses were judged and modified based on theoretical considerations and the first model results. All direct effects shown in the tables below are highly significant – at least at the 0.001 level.

4.1 Model fit

The initial models had to be modified to explain the structures better. The different fit-indices show that the modified person models possess a relatively high quality (see Table 3). The descriptive fit indices (GFI, AGFI, NFI, NNFI, CFI) nearly have optimal values (optimal value = 1). The fit of the couple model is rather bad, the model was nevertheless included because of a research interest in the within-household allocation of travel. Additionally it can be stated that all shown direct effects are highly significant – at least at the 0.001 level.

Additionally to the overall measures SEM provides squared multiple correlation-coefficients (comparable to the R^2 of a regression analysis) to show how much variance of the endogenous variables can be explained by the model. Problems occurred with this measure. Some of the R^2 were negative, the R^2 of the reduced form were very small (between 0.00 and 0.09, see detailed model results). Negative R^2s are by definition possible – namely if the diagonal elements in Φ are greater than the corresponding variances of the endogenous variables. Therefore the R^2s of the reduced form are recommended in the literature (Cudeck, Du Toit and Sörbom, 2000).

The reduced form is defined as follows (Jöreskog and Sörbom, 1996, 144):

$$y = A\Gamma x + A\zeta$$

where $A = (I - B)^{-1}$. This equation is obtained by solving the original equation of the structural equation model for y. The reduced form equation is equivalent to the regression of y on x. Because the R^2s of the reduced form only consider the influence of the exogenous variables, it is not surprising that the R^2 are so

small in the three estimated models. This result shows once again that the person- and household-variables cannot explain much of the variability in travel behaviour.

Table 3 Fit indices of the models

	Person trip model	Person distance model (with outliers)	Person distance model	Married couple model (number of trips)
Sample size (weeks)	1 407	1 407	1 263	433
Number of iterations	17	12	37	16
Degrees of freedom	37	46	42	127
Chi²-value (63/44 degrees of freedom)	53.61	55.94	54.72	204.97
Probability (P)	0.04	0.15	0.09	0.00
Goodness-of-Fit Index (GFI)	0.99	0.99	0.99	0.95
Adjusted Goodness-of-Fit Index (AGFI)	0.99	0.99	0.99	0.93
Critical N (CN)	1 572	1 791	1 528	345
Normed Fit Index (NFI)	0.98	0.97	0.98	0.92
Nonnormed Fit Index (NNFI)	0.99	0.99	0.99	0.95
Comparative Fit Index (CFI)	0.99	1.00	1.00	0.96

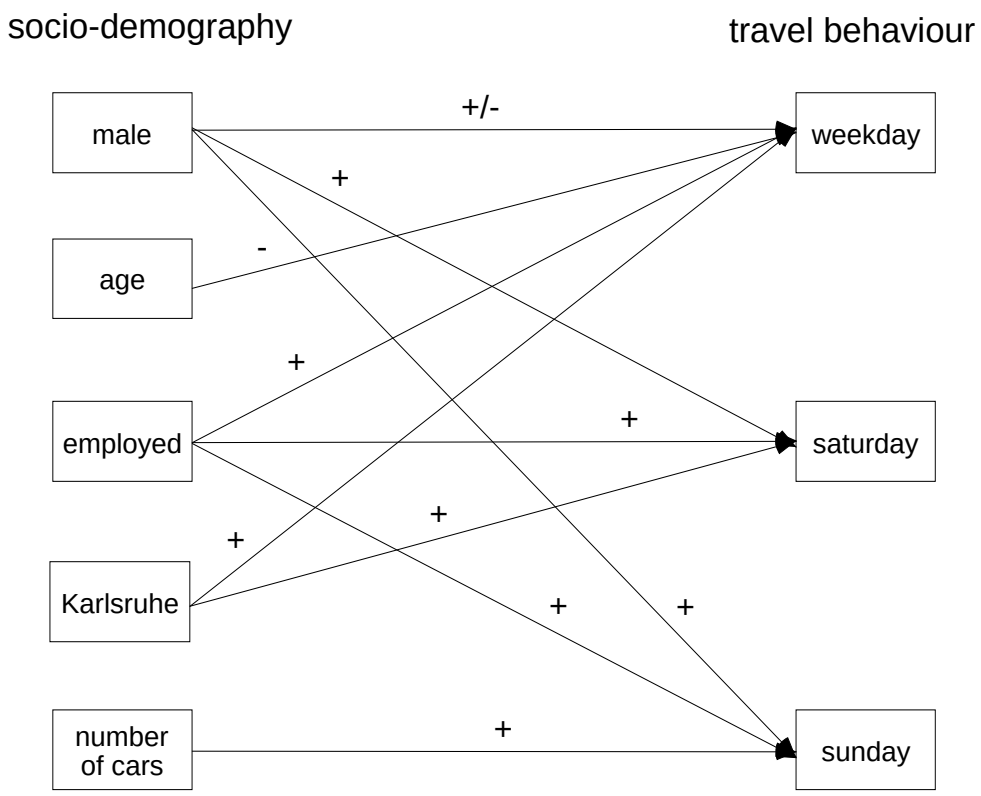
4.2 Effects of the exogenous variables

The exogenous variables which are normally expected to influence travel behaviour in a substantive way were used in the models. But the impacts of the variables sex, age, employment, location of the household (city) and the number of cars on the daily behaviour are rather small. On the hand only few parameters are freed, on the other hand the R^2s of the reduced form are very small. Those parameters which have been freed in the person models are shown in the following path diagram (see Figure 1), which generalises the results of the estimated person models.

The influence of the person- and household variables are very similar in the person models. Similar parameters are free and most of the parameters have the same direction – with only one exception. Employment and sex are the most influential exogenous variables. To be employed is connected with longer distances and more trips. To be male has positive effects on the travelled distances and on the number of trips during the weekend, but a negative effect on the number of trips on weekdays. The results also show that the respondents in Karlsruhe have on average a different behaviour compared to the respondents in Halle. The number of cars has a stimulating effect on travel behaviour, but this relationship is not as close as the relationship between employment and behaviour.

The results of the couple model confirms the results of the person models. Older couples, couples without cars and couples living in Halle make fewer trips and travel shorter distances than younger couples respectively couples with cars respectively couples in Karlsruhe. All described effects are consistent with the expectations. Therefore it can be concluded that the structure of the models is right – at least for the exogenous model part.

Figure 1 Exogenous effects in the person models



4.3 Effects within the person trip model

The direct and the total effects within the B-matrix are shown in Table 4. Additionally, effects within the Φ-matrix were freed, whereby the relationships between the residuals of two consecutive weekdays are

negative (see Table 5). All β-effects are positive as they should be (number of trips must not become negative). Direct effects normally exist between two consecutive days. Whereas the effects between two consecutive days are rather large at the beginning of the week, the relationships are smaller with regards to the weekend. The weekend generally seems different to the rest of the week. Additionally it is noticeable at the end of the week and for the following Monday that the number of trips is influenced by the previous days with decreasing strength with increasing intervals between the days.

The differences in the magnitude of effects between the total and direct effects and the different progress of the estimator magnitude can be explained by the accumulation of effects which leads to the total effects. The total effects within the B-matrix are defined as follows, if B is lower triangular.

$$T_{yy} = B + B^2 + B^3 + ...$$

The total effects correspond to the sum of the direct (multiplied) effects. Because many effects are greater than one, the value of the total effects is greater than the value of the direct effects.

Table 4 Direct and total (in italic) endogenous effects of the person trip model as well as the R^2s of the reduced form

To	From Monday	Tuesday	Wednes-day	Thurs-day	Friday	Saturday	Sunday	Next Monday
Tuesday	1.29							
	1.29							
Wednesday		0.99						
	1.27	*0.99*						
Thursday			1.05					
	1.33	*1.04*	*1.05*					
Friday				0.97				
	1.29	*1.00*	*1.01*	*0.97*				
Saturday	0,11		0.11	0.16	0.17			
	0.68	*0.44*	*0.45*	*0.32*	*0.17*			
Sunday			0.08	0.08	0.10	0.16		
	0.45	*0.34*	*0.34*	*0.23*	*0.13*	*0.16*		
Next Monday	0.23	0.11	0.15	0.13	0.14			
	0.91	*0,54*	*0.43*	*0.27*	*0.14*			
R^2 of the reduced form	0.03	0.04	0.05	0.05	0.04	0.05	0.09	0.02

Table 5 Covariances between the residuals of the endogenous variables (person trip model)

To	From Monday	Tuesday	Wednes-day	Thurs-day	Friday	Saturday	Sunday	Next Monday
Monday	4.72							
Tuesday	-4.83	8.08						
Wednesday		-2.86	5.28					
Thursday			-2.71	5.42				
Friday				-2.46	5.49			
Saturday						4.23		
Sunday							2.53	
Next Monday								3.47

4.4 Endogenous effects within the person distance model

The direct effects of the two person distance models (with and without outliers) and the covariances among the residuals are presented in Table 6 and Table 7. The results show that the behaviour of one day is mainly affected by the behaviour of the previous day, whereby the influence of the previous decreases in the course of the week. Days later in the week are influenced by more days than the first days of the week which is logical because of the model structure. Especially the Monday of the second week is a product of the weekdays of the previous week.

The relationships between the weekdays are free within the Φ-matrix in both distance models, the relationship between Tuesday – Friday only in the model without outliers. All these parameters are negative – with one exception: the relationship between Monday and Tuesday in the model with outliers. This finding and the impossibility to estimate the effect of the Monday distances on the Tuesday distances or the effect between their residuals (if one of these effects was freed, the model did not converge) give hints of some modelling problems. Since likely issues inherent in such model structures were checked (sample size, estimation method, starting values) and found to be correctly specified, theoretical reasons are likely. It is not clear in the model which of the two days can be regarded as the origin situation.

The differences between the two models are also interesting. The differences occur not so much in the choice of the free parameters, but in the magnitude of the coefficient estimators. Especially the estimators of those variables with high standard deviations (if outliers are included) are different. The first two days of a week are characterised by their similarity and by comparably low distances. The travelled distances increases between Tuesday and Wednesday whereby this is especially the case in the model with outliers. A gap between the estimators of the models also occurs between Thursday and Friday marking the beginning of the weekend, when some people make longer trips.

Table 6 Direct effects of the person distances models (the effects of the model without outliers in italic) as well as the R^2s (R^2s of the model without outliers in italic) of the reduced form

To	From Monday	Tuesday	Wednes-day	Thurs-day	Friday	Saturday	Sunday	Next Monday
Monday		0,35						
Tuesday								
Wednesday		1.22 *0.96*						
Thursday			0.69 *0.81*					
Friday		0.16		0.49 *1.05*				
Saturday	0.24				0.23 *0.14*			
Sunday			0.09			0.13 *0.20*		
Next Monday	*0,20*	0.15 *0,14*	0.15 *0.10*	*0.22*	0.42 *0.14*			
R^2 of the reduced form	0.02 *0.05*	0.08 *0.09*	0.05 *0.07*	0.06 *0.05*	0.02 *0.06*	0.02 *0.03*	0.02 *0.04*	0.01 *0.04*

Table 7 Covariances between the residuals (the covariances of the model without outliers in italic) (person distances travelled)

To	From Monday	Tuesday	Wednes-day	Thurs-day	Friday	Saturday	Sunday	Next Monday
Monday	3112.60							
	631.03							
Tuesday	246.48	1768.37						
		739.32						
Wednesday		-1390.74	4689.89					
		-10.14	*683.68*					
Thursday			-1418.11	1687.73				
			-344.42	*807.30*				
Friday				-364.96	2123.47			
		-65.98		*-470.02*	*1000.06*			
Saturday						3969.13		
						853.57		
Sunday							2923.84	
							880.04	
Next Monday								3271.89
								387.27

4.5 Endogenous effects within the couple model

The number of trips of each partner are used as endogenous variables. The effects between the days for each person, the residuals between two consecutive weekdays for each person and the effects between the partners are estimated and shown in Table 9 and Table 8.

Table 8 Covariances between the residuals (couple trip model)

To	From													
	Wife							**Husband**						
	Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su
Monday	5.39							4.66						
Tuesday	-2.42	5.72						1.97	4.74					
Wednesday		-3.72	6.32						1.01	3.23				
Thursday			-2.72	5.92						-2.46	4.95			
Friday				-2.89	6.02						0.68	3.61		
Saturday					-1.86	4.71							4.06	
Sunday							2.13							2.14

Table 9 Direct and total (in italic) effects of the couple model (person trips) as well as the covariances between the residuals (a bit smaller) as well as the R^2s of the reduced form

To	From													
	Wife							**Husband**						
	Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su
Wife														
Monday														
Tuesday	0.77													
	0.77													
Wednesday		1.09												
	0.83	*1.09*												
Thursday			1.04											
	0.87	*1.13*	*1.04*											
Friday				0.99										
	0.86	*1.12*	*1.03*	*0.99*										
Saturday					0.60									
	0.52	*0.67*	*0.62*	*0.59*	*0.60*									
Sunday			0.22											
	0.18	*0.24*	*0.22*											
Husband														
Monday	0.17													
	0.17													
Tuesday		0.19												
	0.14	*0.19*												
Wednesday				0.18				0.33						
	0.22	*0.21*	*0.19*	*0.18*				*0.33*						
Thursday										1.08				
	0.23	*0.22*	*0.21*	*0.20*				*0.36*		*1.08*				
Friday					0.18			0.16	0.20	0.22				
	0.25	*0.28*	*0.22*	*0.21*	*0.18*			*0.23*	*0.20*	*0.22*				
Saturday						0.28			0.17			0.20		
	0.22	*0.27*	*0.22*	*0.21*	*0.20*	*0.28*		*0.05*	*0.21*	*0.04*		*0.20*		
Sunday			0.12				0.52						0.22	
	0.25	*0.32*	*0.29*	*0.05*	*0.04*	*0.06*	*0.52*	*0.01*	*0.05*	*0.01*		*0.04*	*0.22*	
R^2 of the red. Form	0.15	0.10	0.13	0.12	0.12	0.05	0.12	0.01	0.00	0.01	0.01	0.01	0.01	0.05

Most of the results of the respective behaviours of a partner are consistent with the findings in the person trip model. But there are slight differences between the female and the male behaviour:

- The Monday has more effects on the following days for the husbands than for the wives.
- The day to day relationships are greater for the wives than for the husbands.
- The influence of the first weekdays on the weekend behaviour is greater for the wives than for the husbands.

There are interrelationships between the male and female behaviour. Especially during the weekend the number of female and male trips influences each other.

4.6 Interpretation of results

Three different model types were developed and presented in this paper. Each model had a different focus – the number of trips was the focus of the first model, the distances travelled and the impact of outliers were the focus of the second model, the interactions in the number of trips within couples were the focus of the third model. All different models provided interesting results.

- **Person trip model**: The relationship between two consecutive weekdays are strong. The values of the coefficient estimates amount to around one indicating a constant trip number. This finding is consistent with the assumption of a stable behaviour during the working week.

  There is a gap between the behaviour on weekdays and on the weekend. The influence of the previous day decreases strongly. The behaviour on Saturday is mainly affected by the behaviour on Thursday and on Friday. This finding could be explained by the fact that the weekend is starting earlier for an increasing number of people.

- **Person distance model**: On the hand technical results for the two model are of interest. First - differences between the coefficient estimates in the two models (model with and without outliers) can be attributed to the magnitude of the standard deviations. Second – non-convergence can be caused be the similarity of two variables. This problem can only be solved by fixing the corresponding parameter.

  On the other hand some interesting theoretical findings could be obtained. Once again the influence of the previous day is obvious. In the model with all observations the difference between the weekdays and the weekend is not as strong as in the model without outliers or in the person trip model. Reason for this result is that the outliers distort the coefficient estimates.

  The Monday of the second week is a product of the previous weekdays, whereby the effects of the last Monday and the last Thursday are strongest. The relationship between the Mondays indicates that a specific day behaviour exists, the relationship between the Thursday and the following Monday indicates the begin and the end of the weekend which seem to be similar.

- **Couple model**: The effects of consecutive days are similar to those in the person trip model. Nevertheless one important finding could be made. The Monday affects strongly the behaviour of the husbands in the rest of the week, whereas wives seem more likely to plan from day to day. This result can be explained by the sex specific division of labour within families. Husbands go about their work. Wives have to make short time plans – often in order to synchronise their behaviour with the needs of other family members.

  The model also shows that there are relationships between the male and the female behaviour which are especially visible during the weekend. This finding can be explained by the fact that activities are undertaken together especially in times with fewer obligations.

The postulated hypotheses can be answered by these models.

- **Monday**: This hypothesis is partly true. Direct effects from Mondays to the other days exist between Monday and Tuesday, between Monday and Saturday and between Monday and the following Monday in the most models. The consecutive day effect is the main reason for the first finding, a typical daily behaviour is the main reason for the third finding. The second finding can perhaps be understood as mobility indicator.

  The couple model has shown that the husband behaviour is strongly influenced by the Monday indicating that employed people have a less variable behaviour during the work-week than people without employment.

- **Previous day**: This hypothesis was proved by all models. The parameters within the B-matrix as well as the parameters within the Φ-matrix show the importance of the previous day for the behaviour on a specific day. The limited validity for the weekend is also visible.

- **Weekend – working-day**: The result give evidence of the existence of a weekly rhythm with similar weekdays and differences between the weekdays and the weekend. However, it is important to consider the influence of outliers because of possible distortions.

- **Socio-demography and travel behaviour**: The hypotheses about the relationships between socio-demography and travel behaviour could be verified by the models. The influence of the person- and household variables on travel behaviour is rather small. Employment and sex are the most important exogenous variables.

- **Dependencies within a household**: The couple model shows that activities relate most strongly during the weekend.

5. Conclusions and further research

The presented results are a first attempt to analyse the relationships between different days. Two very rough variables describing travel behaviour and only a few socio-demographic characteristics were considered in the models estimated. Nevertheless it could be shown that interesting relationships exist between the different days, for example the differences between weekdays and weekends or the importance of the previous day and the Monday for the behaviour on a specific day.

These results should be regarded as starting point for further investigations. Future research should investigate other endogenous variables, especially a detailed investigation of the activities could be interesting. Additionally different model segmentations could improve the understanding of the individual behaviour. A prerequisite for these investigations are larger samples. Activity based models were not possible for this Mobi*drive* dataset because of many observations without activities of a specific kind, segmented models were not possible because of the small number of persons of a specific type.

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