STATED ADAPTATION SURVEY OF ACTIVITY SCHEDULING REACTIONS TO CHANGING TRAVEL CONDITIONS: FIELD WORK AND PRELIMINARY RESULTS

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ABSTRACT

The paper reports on current research in a project aiming to explore new approaches for analysing and forecasting travel demand induced by changes in generalised costs of travel and activity participation. 250 respondents are administered a five-day travel diary. From the reported data one day is selected for further analysis. The conditions of that day are changed using pre-defined heuristics based on the household characteristics, to attain significant changes in the generalised costs of the reported trips. The households are faced with these changes in face-to-face interviews. All household members are asked to state how the implied changes would have affected their activity scheduling on the specified day, that is to adapt their reported schedule to the new conditions.

The data will allow the computation of detailed discrete choice models of activity scheduling. The results are expected to reflect the effects of the various changes in generalised costs on activity generation as well as destination and mode choice. The results will be applied in MATSim, an agent-based micro-simulation software developed at the Institute for Transport Planning and Systems (IVT) at ETH Zurich and the TU Berlin. The application will allow the validation of the model results and the evaluation of aggregated effects of measures changing generalised costs, as well as their repercussions on the transport system and the resulting feedback effects, thus allowing the assessment of total induced demand and a comparison to the results from earlier aggregated models.

This paper will focus on the description of the field work, which to our best knowledge is new in its approach, and will report preliminary results of the respondents' reactions to the implied changes.

Keywords: stated adaptation survey, activity scheduling, travel behaviour modelling

INTRODUCTION AND MOTIVATION

Induced traffic, a phenomenon that is here defined as demand for transport services generated by changes in travel conditions and thus in the generalised costs of participating in out-of-home activities, has been a topic of ongoing research for many years. The main focus was often the analysis of measures bringing about such changes. While previous studies have focused on specific and localised measures, such as the construction of new roads or rail lines in given corridors, and the assessment of their side effects, the research described in this paper deals with the effects of changing generalised costs of travel on traffic generation: the propensity of participating in out-of-home activities, or being mobile on a given day, the number of trips and activities carried out, and the resulting total time spent on activities outside of the home location on a given day.

The main focus of the research is on the trip generation side, with changes in destination choice being considered a consequence of having – or wanting – to re-allocate the time budget from travel to certain activity types. Mode choice is covered only marginally in the study and will not be directly included in the analysis, while route choice is left out altogether, as the study lacks the geographic information that would be necessary for its modelling.

The work described here is the second part of a research project funded by the Swiss Association of Transportation Engineers (SVI). In the first part (Weis, 2009; Weis and Axhausen, 2009), an analysis of the effects of historically changing accessibility values (on the municipality level) on the abovementioned mobility indicators was carried out with a pseudo-panel based structural equations model. Increases in accessibility, measured as the aggregate sum of inhabitants of all zones weighted by a negatively sloped function accounting for travel times from the origin zone, were found to have a positive effect on trip generation. Elasticities for various indicators of travel participation were calculated as a means to estimate induced travel effects.

In the second part of the study described here, the effects are being assessed on a disaggregate scale with a stated adaptation survey following in the tradition of the *Household Activity Travel Simulator (HATS;* Jones, 1979). A target sample of 250 respondents is being recruited for participation in a five-day travel diary. From the reported data, one day is selected for further analysis. The surrounding conditions of that day's travel are changed using pre-defined heuristics based on the household characteristics and the activities reported by the respondents, in order to attain significant changes in the generalised costs of the reported schedule and thus provide an impulse for changing travel behaviour. The households are faced with these changes in face-to-face interviews, where all household members are asked to state the likely effects of the implied changes on their activity scheduling on the specified day. The survey setting requires the respondents to adapt their reported schedules to the new conditions.

The data will allow the computation of detailed discrete choice models of activity scheduling. The results are expected to reflect the effects of the various changes in generalised costs on the indicators mentioned above. The model results will be applied to generate improved utility functions for daily schedules in *MATSim*, an agent-based micro-simulation software program developed at the Institute for Transport Planning and Systems (IVT) at ETH Zurich and the TU Berlin (Balmer *et al.*, 2008). The application will allow the validation of the model

results. Furthermore, using the software, aggregated effects of measures changing generalised costs, as well as their repercussions on the transport system and the resulting feedback effects, will be analysed, allowing the assessment of total induced demand and a comparison to the results from the earlier aggregated models.
The paper is structured as follows. First, a review is given of the few existing studies where the methodology has been applied. The heuristics that are used to determine the changes in generalised costs for the various households are then presented, followed by the description of the field work experience. A discussion of response behaviour follows, along with explorative analyses of the respondent sample as well as their current and stated mobility behaviour. A brief outlook to upcoming work concludes the paper.

METHODOLOGY

Literature review

When assessing the outcome of demand management policies on individuals' and households' travel behaviour, it is important to understand the underlying decision making process. A convenient means of recording such decisions are *stated preference* surveys, where participants are asked about their reaction to a given situation. In transport research, such surveys are often implemented as *stated choice* experiments, where respondents are faced with a destination, mode or route choice situation where the attributes of several pre-determined alternatives are varied. Such experiments, which are limited to a single trip, rarely comprise a trip generation component, thus the respondents are generally not given the choice of either not travelling or re-arranging their trip sequence in order to accommodate their needs. However, it has been recognised that travel decisions are made in a medium to long rather than a short term perspective, and that trip and activity sequences are scheduled not on-the-fly, but rather on a daily or even weekly basis. It seems therefore important to model decisions and also to conduct the underlying choice experiments in a context that can appropriately account for the complex scheduling process. An early attempt to conduct such experiments was the *Household Activity Travel Simulator (HATS)* developed by Jones (1979). The approach consists of a two-stage methodology where households are first asked to report their actual behaviour for a certain period of time (that is, to fill in a travel diary), around which choice experiments are then constructed. For the *HATS* interview, the setting for the household is modified by the hypothetical policy or other changes inducing a change to one or more generalised cost components, and the respondents are asked to adapt their schedules to the new situation. The survey tool used early on for these interviews consisted of a game-like display board, on which the respondents can visualise and test their adaptations. The approach thus ensures that the implications for all relevant decisions (activity and trip generation, scheduling and chaining; destination, mode and route choice) can be captured according to modelling needs. The recorded reactions to the scenarios relate to the whole schedule rather than to a specific trip, as often is the case in traditional *stated choice* surveys. At the end of the interview, the researcher has a set of "before and after" diaries at their disposal. The methodology combines the advantage of modelling entire days (as opposed to single trips or journeys, as is the case in traditional transport demand models) with the possibility to capture reactions to changes. These dynamic effects cannot be captured in *revealed preference* settings (that is, the use of diary data alone), which are often used as data sources for transport models. The research described here uses an approach similar to the *HATS*, but is based on computer software, which facilitates the data management process.

Early applications of the methodology suffered from the limited computational capacities which hampered the modelling applications. Recently though the trend has gone from traditional trip based models of the four-step type to activity based models, in the framework of which data from such *stated adaptation* surveys can be accommodated. The *MATSim* (Balmer *et al.*, 2008) and *Albatross* (Arentze and Timmermans, 2005) models are only two examples of the many activity based models that are currently under development.

As has been mentioned, applications of the *HATS* or similar methods in the literature are quite sparse. A few early successful examples can be found.

Jones (1980) describes various early research and policy applications of his approach, including worsening or improving rail and bus services in the UK (Martin and Vorhees Associates, 1978; Jones and Dix, 1978; Brown and Mawson, 1981). Jones *et al.* (1989) developed the *Computerised Activity-Based Stated Preference (CASP)* package; the field application that they describe is based on (hypothetically) forcing respondents to travel to work by public transport instead of car, and eliciting their reactions to such a constraint. The *Adelaide Travel and Activity Questioner (ATAQ)* described in the same paper faces households with parking pricing policies.

Van Knippenberg and Clarke (1984) (see also van Knippenberg and Lameijer, 1985) examine the effects of bus service reductions with pre-determined schedules from which the respondents have to choose. They recognize the need to analyse the behaviour of all household members jointly, as well as to consider all activities, not just those that give rise to the journeys affected by the policy measure.

Phifer *et al.* (1980) developed an interactive technique called *Response to Energy and Activity Constraints on Travel (REACT)*, and tested it with 12 households in the Albany, New York, area. They recognize that households often counteract travel constraints by modifying non-travel activities, a concept that is picked up in the present study.

Lee-Gosselin's (1989, 1990) works apply a methodology similar to the *HATS* surveys, named *Car-Use Patterns Interview-Game (CUPIG)*. 45 households were interviewed about their car use under various fuel shortage scenarios. Doherty and Lee-Gosselin (2000) and Doherty *et al.* (2002) apply the *CHASE* (*Computerized Household Activity Scheduling Elicitor*) framework, which is based on the *CUPIG* approach, to capture the effects of automobile use reduction scenarios. The three households they interviewed while testing their approach stated a substantial amount of rescheduling decisions, mainly the adaptation of activity (respectively trip) start and end times as well as mode choice decisions (the latter probably being caused to a large extent by the specific formulation of their experiment). Doherty and Miller (2000) use the same software program for a study where respondents' planned schedules are recorded in advance and can then be modified on the fly as changes occur in the real world. They argue that many adaptations to schedules are made at a very short notice, and that the *in situ* nature of their tool allows capturing those changes very effectively. Our approach is different in that it deals with s*tated preferences* rather than capturing reactions to real changes in a r*evealed preference* framework.

Arentze *et al.* (2005) conduct an internet based stated adaptation survey based on congestion pricing scenarios. They employ an activity based approach, in which various facets of the activity scheduling process can be changed by the respondents. Their survey is different from ours in that a discrete set of options is offered for the adaptation process, rather than the complete restructuring of a reported activity pattern that we aim to capture.

Implementation of the survey

Travel diaries

The diary that is administered to the respondents is similar to the trip based *MobiDrive* questionnaires that have previously been used in Switzerland (König *et al.*, 2000; Löchl *et al.*, 2005). An extract of a questionnaire page, allowing for two trips to be reported, is shown in Figure 1. Extensive instructions on how to fill the questionnaire are provided to the respondents. The complete diary has space for 40 trips that can be recorded over the 5 reporting days.

An analogous questionnaire was programmed with an internet based interface. Each participating household receives a user name and password and is assigned a period of five days over which to record their travel. On the web page, the visited locations for a given day are displayed on a map along with colour codes for the activity types (in the example, white for sojourns at home, blue for work activities, green for leisure activities), in an effort to make the survey more interactive and more attractive to the respondents (Figure 2).

On the same page, a graphical as well as a tabulated overview of the previously entered trips and activities is shown. Editing existing or adding new trips and activities can be done by clicking on the appropriate links in the table, while the navigation bar on the left of the screen takes the respondents to the other parts of the questionnaire (instruction page, socio-demographics, roster of frequently visited locations). The software used for the stated adaptation survey, which will be described in the next section, makes use of the same database as the online diary; therefore, data from the pen-and-paper questionnaires need to be entered into the web interface before being used in the interviews.

Trip diary for:	Mon ☐ Tue ☐ Wed ☐ Thu ☐	Fri ☐ Sat ☐ Sun ☐
Trip Nr.	1	2
Start time	___ : ___	___ : ___
Modes	☐ walk ___ minutes ☐ bicycle ___ minutes ☐ motorcycle ___ minutes ☐ car ___ minutes ☐ tram / bus ___ minutes ☐ rail ___ minutes waiting time ___ minutes	☐ walk ___ minutes ☐ bicycle ___ minutes ☐ motorcycle ___ minutes ☐ car ___ minutes ☐ tram / bus ___ minutes ☐ rail ___ minutes waiting time ___ minutes
Arr. time	___ : ___	___ : ___
Distance	___ kilometres	___ kilometres
Dest. (Address)	Str. ___ Nr. ___ ZIP ___ City ___	Str. ___ Haus ___ PLZ ___ City ___
Purpose	☐ Return home ☐ Pick up / drop off someone ☐ Work / education ☐ Shopping / errand ☐ Business ☐ Leisure, namely: ___	☐ Return home ☐ Pick up / drop off someone ☐ Work / education ☐ Shopping / errand ☐ Business ☐ Leisure, namely: ___
Accomp. persons	Trip / Activity ___ Household members ___ ___ Other persons ___ ☐ Dog ☐	Trip / Activity ___ Household members ___ ___ Other persons ___ ☐ Dog ☐

Figure 1 – Pen-and-paper diary example (translated from German original)

Figure 2 – Online diary screenshot (German original)

Stated adaptation interview

Based on the day reported by the respondents and chosen for the *stated adaptation* interview, the modifications are implemented by the interviewer. Unlike former studies, the scenarios assigned to the respondents in the household interviews are not aimed at determining the effects of specific policies. They are formulated as generally as possible, in the following form: “Imagine your reported trip to [Activity] would now take [y] minutes instead of [x]. This may result from the facility where the activity is conducted relocating or closing, and you needing to choose a different location." The aim is for the household members to state their likely reactions to such a scenario, including the following possibilities:

- Choice of a different departure time for certain trips;
- Choice of a different travel mode for certain trips;
- Changing the order and/or duration of certain activities;
- Cancelling certain activities, or adding additional ones;
- Switching certain activities between household members;
- Combinations of the above.

The day for which the household interview is conducted is chosen by the researchers. Ideally, the chosen day should be one for which the household members have conducted a sufficiently large number of activities, so that changes to the schedule become visible and are substantial enough for the household to change its behaviour on one of the abovementioned levels. The assignment of scenarios to the household is carried out using heuristics, determining which trip is modified. The following rules are followed:

- If at least one household member is employed (or a student), check for commute trips (that is, trips that have either work or education as a purpose).
- If commute trips are present, change the travel time for the commute trips.
- Else, and if there are children in the household, check whether accompanying trips to or from the children's school(s) are present; if so, vary those trips.
- Else, check whether shopping trips are present, and modify one of them accordingly.
- Else, modify the longest leisure trip.

This procedure ensures that the priority is given to mandatory (that is, commute and to a certain extent shopping) trips, which are more routinely carried out and for which changing travel conditions represent a much larger modification to a person's schedule constraints than for leisure trips. However, as leisure trips account for a very large part of individuals' mobility (see below), they are kept in the sample and also accounted for in the modification process. Up to four scenarios are presented to each household member, in which travel times for the selected trip (and the return trip, if applicable) are progressively increased by 50, 100 and 200 per cent, then decreased by 50 per cent, thus creating four scenarios per household. The resulting times are rounded to the nearest 10 minute interval (that is, 20 instead of 18 minutes, et cetera). By default, the incurred time losses (or gains) are subtracted from (or added to) the final sojourn at home. The scenario thus created is saved to a separate file and then serves as a base for the interactive interview, where the household members progressively adapt their stated behaviour to reach convergence to a schedule that seems satisfying to them. The effects that the scenarios and the stated adaptations have on the respondents' schedules are directly visible to them. The same day that has served as an example above is displayed in Figure 3, based on the interview software. Here, the travel time for the public transport trip to work (marked by the yellow bar) would be gradually increased from the existing 20 minutes to 30, 45, and 60 minutes, and decreased to 10 minutes for the respective scenarios.

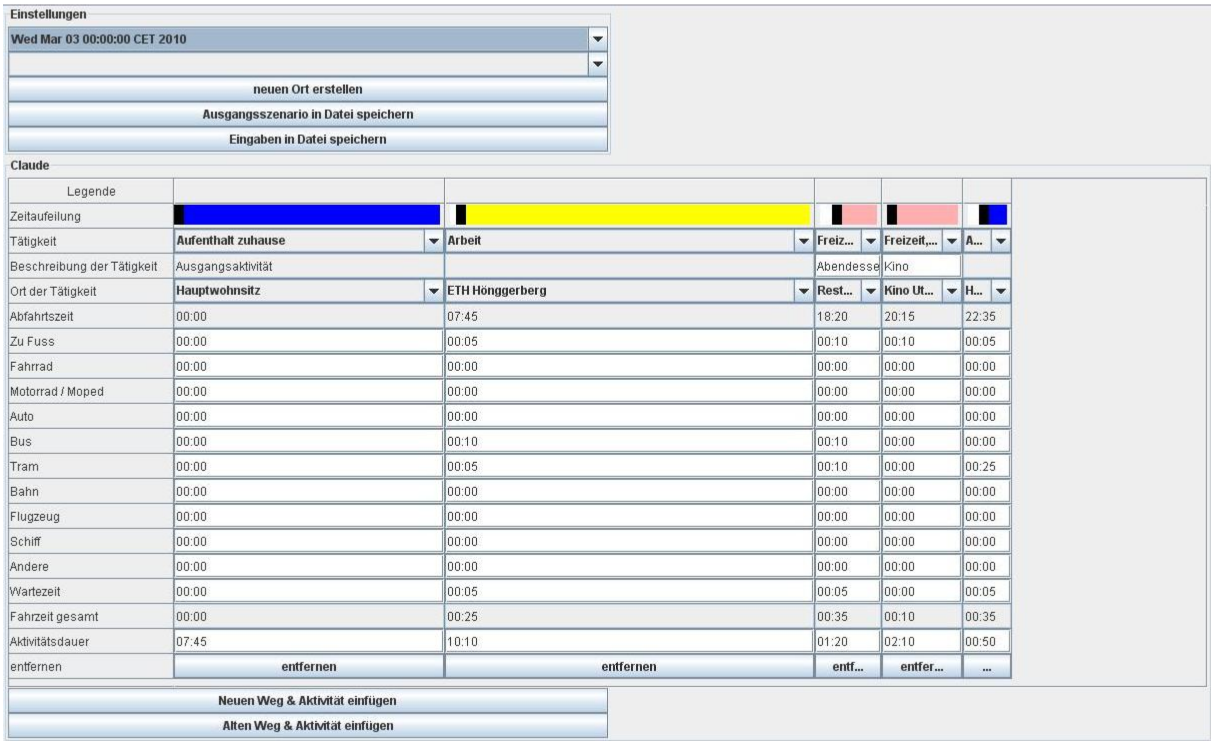

Figure 3 – Household interview software screenshot (German original)

FIELD WORK

Recruitment success and response rates

A sample of 1'500 household addresses was acquired from an address retailer, with the requirement that the distribution of household characteristics be representative for the canton of Zurich. Announcement letters are sent to the selected households. A few days after the introductory letter is dispatched, the interviewers call the potential respondents to establish the households' willingness to participate in the study and provide them with detailed information on the survey process. At the same time, they are informed about a 20.- Swiss Francs incentive given to each participating person (1.- Swiss Franc corresponds to about 0.90 US dollars in April 2010). The recruited respondents are assigned the online or paper questionnaire according to their preference. As of April 22nd, 2010, phone calls to 1'036 numbers have been made, 611 of which have been answered. Members of 158 households stated their willingness to participate in the survey, which corresponds to a recruitment rate of 25.9 per cent. 102 of the recruited households requested a paper questionnaire to be sent to them, while 56 preferred the internet survey. Of the 86 paper questionnaires that have been mailed out so far, 41 have been sent back and found valid (that is, none of the sections were left blank, and the data could be used for the construction of the stated adaptation experiments). 49 invitations to participate in the online survey have been sent via e-mail, 26 of which have been returned in useable form (a few households filled in their socio-demographic data, but aborted the survey at the diary stage – these cases were deleted from the sample, as they cannot be used for constructing choice experiments). Thus, the response rates for the online and paper questionnaires are currently at 53.1 and 47.7 per cent, respectively. The key figures are displayed in Table I.

Table I – Key recruitment and response figures (as of April 22nd, 2010)

	Total	Online	Paper
Numbers dialled	1'036		
Reached	611		
Recruited	158	56	102
Recruitment rate [%]	25.9		
Mailed (and reporting period ended)	135	49	86
Completed diary (households)	67	26	41
Completed diary (persons)	100	46	54
Response rate [%]	49.6	53.1	47.7

As Figure 4 shows, response rates are in line with expectations. They match the experiences with comparable studies at IVT, for which the ex-ante response was determined according to the scheme detailed in Axhausen and Weis (2010). The methodology assigns weighted scores to question types and sums them up to calculate the overall response burden of the survey. Response rates decrease approximately linearly with response burden, and the present study fits in the corresponding context for surveys with prior recruitment and/or incentive. In contrast to previous experience (Weis *et al.*, 2008), the online survey yields slightly higher response rates than the paper questionnaire.

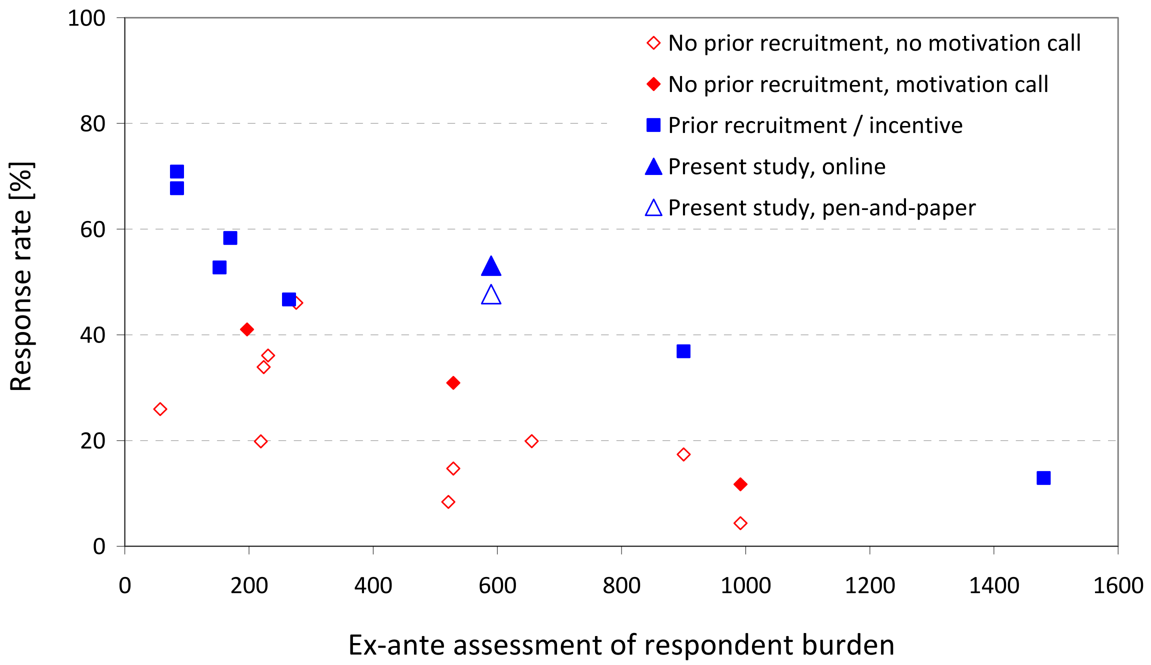

Figure 4 – Response rate in the context of comparable studies

Explorative analysis of the sample

Table II shows key descriptive figures for the respondent sample in comparison with values for the study area taken from the 2005 Swiss National Household Travel survey (called *Mikrozensus* or *Microcensus* and abbreviated *MZ'05*; see Swiss Federal Statistical Office and Swiss Federal Office of Spatial Development, 2007), a sample which is representative of the Swiss population. Household size and income distributions are given in percent of the households, the shares for the other variables in percent of the persons in the sample.

Table II – Sample descriptive statistics (in per cent)

Variable	Value	Sample	MZ'05
Household size	1	27.3	32.9
	2	45.5	37.1
	3	7.3	12.1
	4	10.9	13.2
	> 4	9.1	4.8
Household income (in CHF / month)	< 2000	0.0	3.2
	2000 – 4000	6.1	17.4
	4000 – 6000	24.5	26.5
	6000 – 8000	34.7	20.3
	8000 – 10000	16.3	13.3
	> 10000	18.4	19.4
Gender	Male	51.0	48.3
	Female	49.0	51.7
Age (in years)	18 – 35	8.5	28.6
	36 – 50	38.3	29.6
	51 – 65	27.7	23.1
	> 65	25.5	18.7
Education level	Primary or secondary school	11.5	11.2
	Professional school	43.8	60.1
	Baccalaureate	6.3	7.2
	Higher education	38.5	19.2
Transit pass	None	25.0	50.9
	Half-fare card	62.5	39.7
	Generalabonnement	12.5	9.4
Car availability	Always	69.8	72.7
	Sometimes	16.7	20.8
	Never	13.5	6.5

As can be seen, there is a strong bias towards the elderly population segment – almost a third of the respondents are over 65 years old, and very few are under the age of 35. This may in part be due to the fact that elderly people are more easily reachable by telephone (as they are often retired and thus at home for greater portions of the day than the working population) and, given a larger available time budget, might be more willing to participate in surveys such as the one described here. However, the bias is without any doubt also due to

the sampling, which was carried out by the address retailer. To counteract the described effect and to attain a more realistic age distribution, a second sample of 500 addresses (to add to the initial 1'000) was acquired, with the requirement to contain only individuals aged between 18 and 50 years. Thus it is hoped that with increasing sample size, the different age strata will be represented more representatively.
Apart from the skewed age distribution, a slight tendency towards rather wealthy households and well-educated, mostly male respondents can be seen. Single person households are under-represented. A high share of respondents own annual transit passes, as is common for transport surveys in Switzerland. In fact, public transport users tend to be more interested in transport policy issues, leading to a higher propensity to participate in the relevant surveys.

REPORTED TRAVEL BEHAVIOUR

General mobility figures

In this section, explorative analyses of the respondents' key mobility figures are presented. Table III shows the share of mobile persons and the average number of trips per day and compares the online and the pen-and-paper survey. As can be seen, reported weekday mobility is at par with the one in the *Microcensus*, while trip rates are slightly lower. This may be due to the fact that the national survey is carried out as a computer assisted telephone interview (CATI), and spans only one day for each respondent. Thus, attrition effects that lead to lower reported mobility as the survey period progresses are expected to be higher in the current study. We hypothesize that a similar effect causes part of the significant drop in reported mobility for Saturdays and Sundays in the online survey.

Table III – Key mobility figures

Characteristics	Sample: online	Sample: pen-and-paper	MZ'05
Working days (Monday – Friday)	n* = 147	n = 161	
Share of mobile persons [%]	91.8	90.1	91.0
Average number of trips (all persons)	3.57	3.24	3.67
Average number of trips (mobiles only)	3.89	3.59	4.03
Saturday	n = 41	n = 19	
Share of mobile persons [%]	68.3	89.5	89.4
Average number of trips (all persons)	2.95	3.37	3.26
Average number of trips (mobiles only)	4.32	3.76	3.64
Sunday	n = 24	n = 16	
Share of mobile persons [%]	66.7	81.3	79.3
Average number of trips (all persons)	1.92	2.44	2.11
Average number of trips (mobiles only)	2.88	3.00	2.66

* number of person days in the sample

Modal split

The distribution of the modal shares for the reported trips is displayed in Table IV, again along with the corresponding figures from the *Microcensus*. Here, significantly less walk trips are being reported, with public transport having a higher modal share than in the national survey. Two reasons can be brought forward for this effect: on the one hand, very short trips (where walking is the preferred mode) tend to be over-represented in the *Microcensus*. On the other hand, the elderly people that are over-represented in our study may more often tend to choose a bus or tram trip over walking, even for short distances. The higher share of season tickets also encourages more public transport use.

Table IV – Modal share distribution

Main mode	Sample	MZ’05
Walk	17.2	28.4
Bicycle	9.7	7.0
Car or motorcycle	48.1	51.5
Public transport	21.9	11.9
Other	3.1	1.2

Trip purposes

The trip purpose distribution for the reported trips and its comparison to the figures from the *Microcensus* are shown in Table V. Here, representativeness is reached quite exactly. Leisure accounts for about half of the reported out-of-home activities. Education trips are slightly under-represented, which is again due to the age distribution of the sample.

Table V – Trip purpose distribution

Trip purpose	Sample	MZ’05
Education	0.6	1.1
Work	15.1	16.0
Shopping / errand	14.5	16.0
Business	1.0	2.1
Leisure	27.7	25.7
Return home	41.2	39.1

REACTIONS TO CHANGES

Changing travel conditions

Of the 15 households that completed the diaries and have been re-contacted by telephone, 13 have agreed to participate in the interview, thus there have been only a few drop-outs at this point in the survey process. *Stated adaptation* interviews have been conducted with 10 households, amounting to a total of 17 persons. Data from these interviews form the basis for the analyses presented in this section.

As has been mentioned above, the scenarios presented to the respondents in the household interviews consist of changing travel times to given activities. Figure 5 shows the distribution of the changes in total travel times implied by the modifications made in the various scenarios.

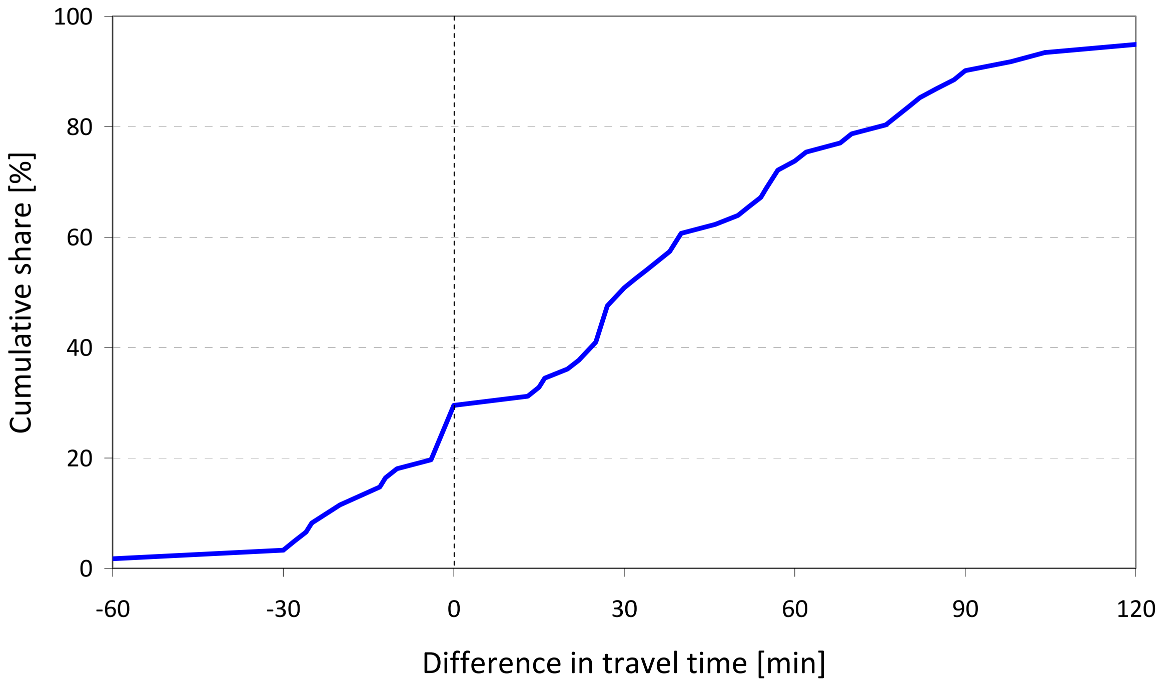

Figure 5 – Distribution of implied changes in travel times

As can be seen, about half of the implied changes are in the range between 30 minutes gained and 30 minutes lost on daily travel, where the scenarios are the most realistic. The remaining scenarios imply larger time losses (or, in few cases, gains) and impose stricter constraints on the scheduling decisions and thus are expected to yield adaptation decisions from the respondents.

Adaptations in travel patterns

Removal and addition of activities

The relationship between the implied changes in travel times and the number of added or removed out-of-home activities is shown in Figure 6, as a first indicator of how the respondents react to the changes.
It can be seen that on the one hand, the interviewees appear reluctant to make significant modifications to their schedules – a large number of them would not let time losses affect their schedules at all, or at least not to the degree of cancelling activities. However, as the implied travel times become larger, activities are more likely to become cancelled in order to make up for the time losses. In the same vein, time gains tend to increase the number of conducted activities, and less significant time gains appear to be necessary in order to

induce such a change. Moreover, there were no cases in which time gains led to activities being removed, or losses to additional ones being conducted; thus, the respondents' reactions are consistent with the assumption that more favourable travel conditions lead to more mobility and vice-versa (that is, that activities can be considered a normal good in the economic sense, for which reduced costs lead to increasing demand).

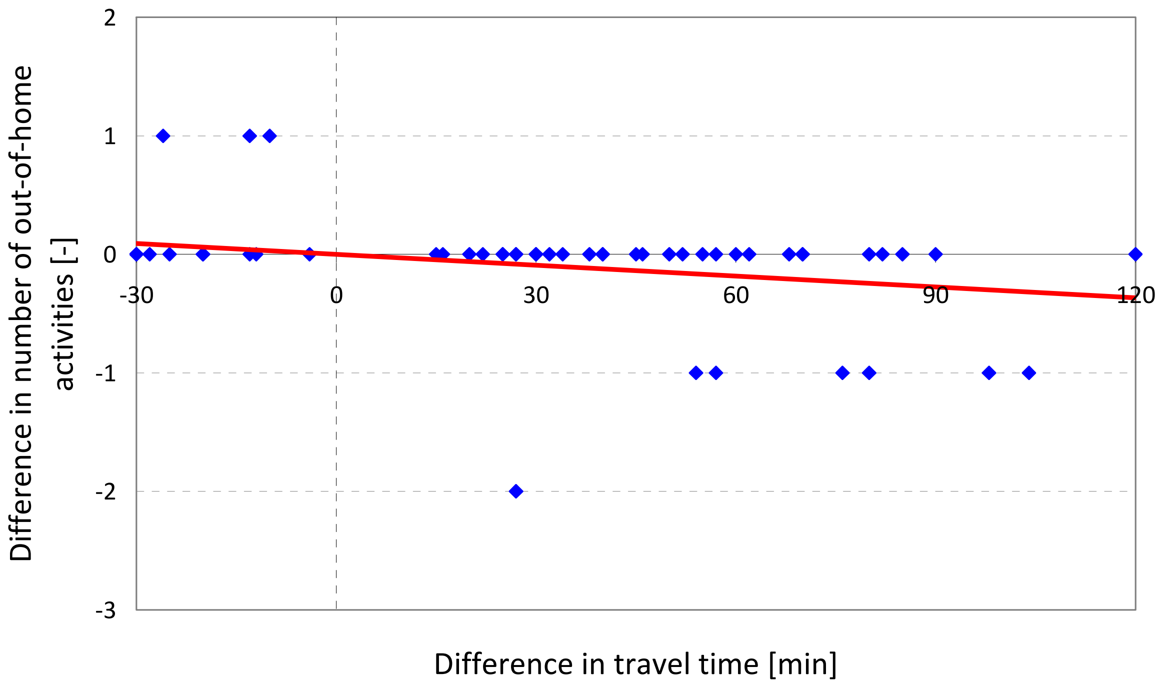

Figure 6 – Changes in activity rates motivated by changing travel times

The regression line displayed in Figure 6 corresponds to the linear regression results shown in Table VI. The regression was estimated using the ordinary least squares (OLS) method. It is thus to be seen as merely diagnostic, while more appropriate methods for the data at hand (Poisson regression, logistic regression, structural equations models) will be applied at a later stage, when the sample size permits their consistent estimation. As the sample is still quite small, so is the regression's overall goodness-of-fit, indicated by the small adjusted R^2 value. However, the result is a valuable first test for the consistency of the collected data and is expected to stabilize as the sample grows. The negative sign for the time difference variable implies the abovementioned interrelation, and the parameter is significant at the 5 per cent level (as indicated by the t-statistic). The model constant proved to be statistically insignificant and was thus set to zero. This corresponds to the obvious assumption that a "no change" scenario would not be expected to induce any changes in travel behaviour.

Table VI – Results of linear regression – dependent variable: change in number of activities

Independent variable	Parameter value	t-statistic
Constant	(fixed) 0.000	-
Change in total daily travel time	-0.003	-2.83
		Adjusted R^2 = 0.103

Another important question that arises is which type of activities are the most likely to be affected by the modifications implied here. The number of cases in which any of the activity types has been chosen for addition to or removal from an individual's schedule is shown in Table VII.

Here, the most frequent activity type to be removed is the sojourn at home. This results from the fact that, as travel conditions worsen, cancelling an intermittent return to the home location (for example, a lunch break between two work activities) is often the most easily doable option. This behaviour implicitly leads to less home-to-home tours (that is, sequences of trips starting and ending at the home location).

Other activity types frequently selected for removal are leisure and, quite surprisingly, work. However, the latter is likely to be a side effect of the abovementioned removal of intermittent home trips, often leading to two separate work activities being merged into a single, and longer, one. An analysis of the times spent at the various activity types should substantiate the assumption that the total work duration is not actually shortened in order to compensate travel time losses.

The frequent removal and addition of leisure activities is consistent with expectations, as these are the activities that can be planned the most flexibly.

Table VII – Types Summary of activity type additions and removals

Type of activity	Number of removals	Number of additions
Work	4	0
Education	0	0
Shopping / errand	2	1
Business	0	0
Leisure	5	2
Home	12	2

Changes in activity durations

As has been mentioned above, when analysing activity schedules, it appears important to consider the changes in the total durations spent at activities in addition to the number of activities carried out. Figure 7 shows the changes in durations spent at home inferred by the scenarios. As can be seen, these durations tend to decrease as the time lost travelling becomes larger. Thus, the time loss is compensated by shortening the duration spent at home, a tendency which is also shown by the regression line. In certain cases though, the home duration increases by virtue of removing out-of-home activities.

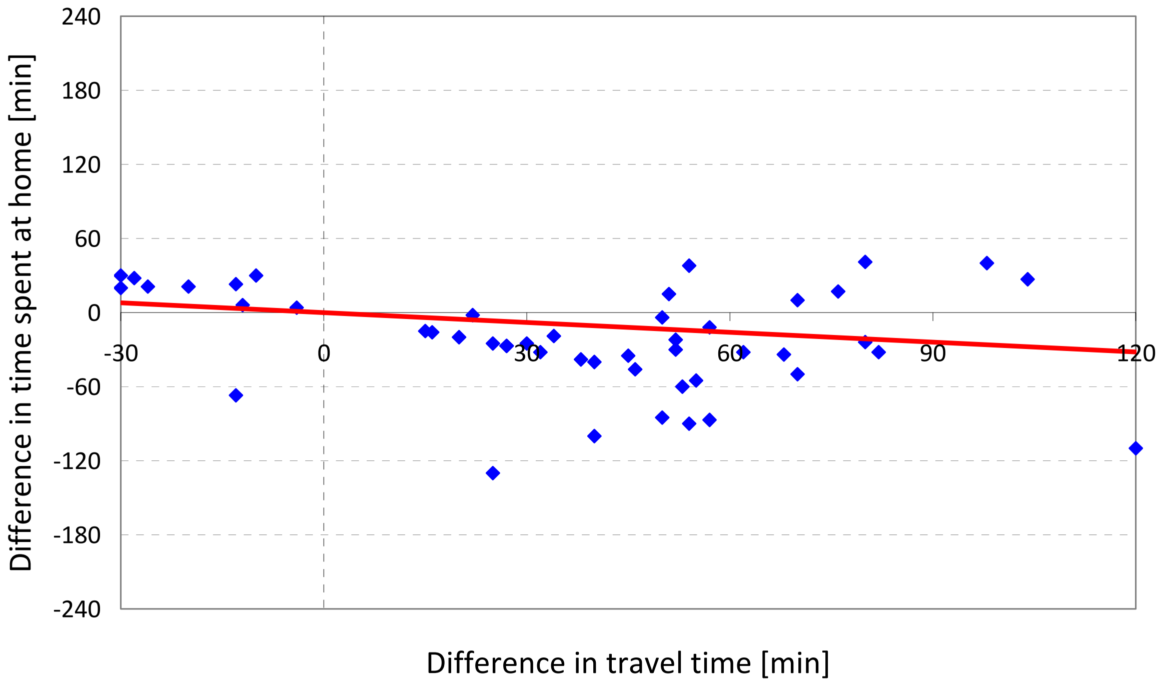

Figure 7 – Changes in durations spent at home motivated by changing travel times

The analogous distribution of changes in times spent at out-of-home activities induced by the changing travel times is shown in Figure 8. Here again, it becomes obvious that in most cases, the respondents are unwilling to change their activity patterns, as most duration changes are equal to zero. There is however a slight tendency towards reducing activity times to compensate for the travel time losses, but it is less prominent than in the home durations' case above.

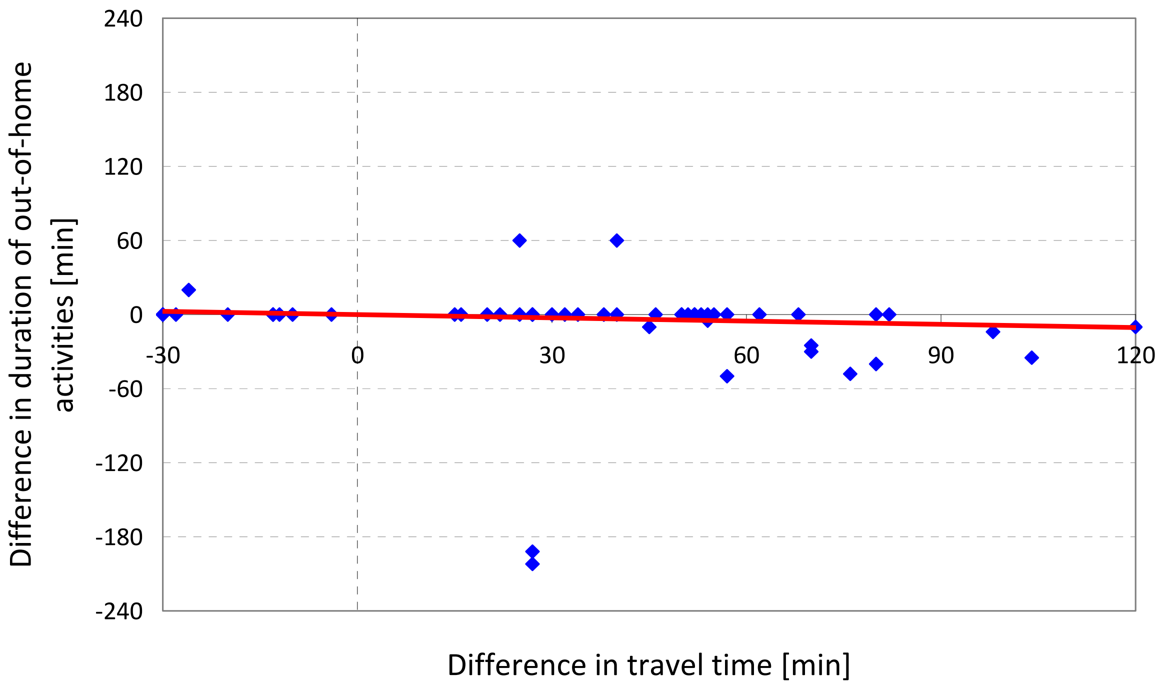

Figure 8 – Changes in durations of out-of-home activities motivated by changing travel times

Table VIII shows the number of cases in which the durations spent at the respective activity types were shortened or extended. Again, the activity type that is the most frequently affected is the duration spent at home, and in some cases that of leisure activities. In all cases where work activities are cancelled, the total duration spent at work is also shortened, which at least in part disproves the assumption made above. As all four such cases relate to the same person, it is assumed that this is to be considered a special case (perhaps the person has a flexible work schedule and/or is able to work at home). It is expected that as the sample grows, the patterns described in the previous section will prevail.

Table VIII – Summary of activity type duration changes

Type of activity	Shorter duration	Longer duration
Work	4	0
Education	0	0
Shopping / errand	2	1
Business	0	0
Leisure	5	0
Home	35	21

CONCLUSION AND OUTLOOK

Field work experiences and preliminary results of a stated adaptation survey of travel and activity planning have been presented. Based on reported five day travel diaries, the respondents are faced with changing travel conditions and asked to state their likely reactions to these scenarios on a daily schedule level.

As postulated, an induced travel effect is observed, in that the modifications to the generalised costs of travel affect the respondents' travel patterns in general, and the number and durations of conducted out-of-home activities in particular. Although the sample is still quite small, first indicators of the mentioned effects have been shown, and are assumed to be consolidated as the survey sample grows. The activities most likely to be re-planned are leisure activities and sojourns at the home location, as is consistent with expectations.

Further work in the research project will consist of additional survey work, until the target sample of 250 respondents is reached. Based on the collected data, models of activity scheduling will be estimated, which on the one hand should confirm the presence of the abovementioned induced travel effect, and on the other hand will provide the parameters for an improved model of activity generation to be implemented in the micro-simulation software MATSim (Balmer *et al.*, 2008). The approach described in Feil *et al.* (2010) will be used for generating the choice sets to be used in the discrete choice models. The models will include generalised cost variables such as travel times as well as control for the effects of the various socio-economic factors influencing travel behaviour. Through the better understanding of the decision process provided *stated adaptation* data, which have the advantage of covering dynamic effects, an improvement of the scheduling models is expected.

The model parameters will then be applied in MATSim. The application will allow the validation of the model results and the evaluation of aggregated effects of changing generalised costs, as well as their repercussions on a large scale, thus allowing the assessment of total induced demand effects and a comparison to the results from the earlier aggregated models, where trip generation was estimated as a function of accessibility values on the municipality level.

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