Experiments with SP and CA approaches to mode choice

EXPERIMENTS WITH SP AND CA APPROACHES TO MODE CHOICE

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1 INTRODUCTION

Stated Preference-based survey techniques have become an accepted part of the transport planning tool kit, in spite of their known limitations and problems. In general these surveys are implemented as *Stated Choice*-experiments, in which respondents are asked to choose between the two or more alternatives described to them. The analysis of Stated-Preference data is decompositional in the sense, that one derives the part-worths of the different variables describing the alternatives from the one, joint judgement of the alternative as a whole (A was chosen, B not; A was ranked 5th and B 10th; A received a scale value of 6 out of 10). Logit or related utility-maximising models are used to derive those part-worths in the case of choice data.

The class of survey approaches based on such hypothetical markets/goods is called *Conjoint Analysis* in marketing. The approaches used, for example the very popular ACA-Software (Adaptive Conjoint Analysis) (Sawtooth, 1996), are hybrids of compositional and decompositional analysis methods. Compositional utility estimation is based on the isolated, independent ranking of the different variables for their importance and of their levels for desirability with the utility of a composite good calculated as the importance-weighted sum of the desirabilities.

Conjoint Analysis (CA) and *Stated Preferences* (SP) belong therefore to the same general class of techniques, where the respondents are offered hypothetical goods, mostly in the form of a written description, either individually or in sets, which they are asked to rate, or rank or choose between (Hensher, 1994 or Axhausen, 1996). Both approaches are in the general tradition of the social sciences, in particular psychology and microeconomics (Green and Rao, 1971; Louviere, Meyer, Stetzer and Beavers, 1971 etc.). They know that the true complexity of the decision is larger then the level presented to the respondent in the survey. This simplification is accepted as the price to obtain results of predictive value for those factors under the control of the authority or firm undertaking the study within an acceptable time frame (see Brög, 1997, for an opposing view).

The Stated-Preference or hybrid Conjoint-Analysis approach encompasses a wide variety of specific methodologies, which all share the aim of

- obtaining holistic statements of preference in a specified format
- for a series of (hypothetical) goods described by varying levels of a small number of attributes
- within a specified behavioural frame (overall context)

The decision problem is reduced for the respondent, as he has only the given response format, but he has both to imagine the stimuli and to adjust to the specified behavioural frame. The analyst looses the full behavioural context detail, but can focus on those aspects under management control. The control over the description of the hypothetical goods permits, in addition, the generation of well behaved statistical data for the estimation of appropriate decision models.

The development of Conjoint Analysis is well documented in a series of scholarly reviews in the marketing research literature (Green and Srinivasan, 1978; Böcker, 1986; Huber, 1987; Louviere, 1988). The growing usage of the methodology in marketing over the last two decades is equally well documented by three surveys of market research firms (Cattin and Wittink, 1982; Wittink and Cattin, 1989 and Wittink, Vriens and Burhenne, 1994). The development of the methodology in transport planning can only be reconstructed from a series of How-to-manuals, which have been published over the years (Kocur, Adler, Hyman and Aunet, 1982; Pearmain, Swanson, Kroes and Bradley, 1991; Axhausen, 1996 or Pearmain, Swanson and Ampt (forthcoming), but see also Bates, 1988 or Hensher, 1994). The usage of the methodology in transport planning has not been surveyed yet.

The current return of SP to the US, the coming together of professional market researchers and transport planners in the commercialized public transport firms (bus, rail and air) and the growing interest in market research in choice-based conjoint formats (Louviere and Woodworth, 1983 or Sawtooth, 1995) opens up new opportunities for the further development of both methodologies.

The purpose of this study is to compare two particular SP and CA methods with regards to the comparability of their results and with regards to the response behaviour of the respondents using the same issue, mode choice behaviour in the City of Innsbruck, reflecting the interests of the co-funders of the study.

The remainder of the paper is structured as follows. The next section describes the two approaches implemented in the survey, which are then described in detail. The survey administration and the response behaviour is analyzed in the following section, while the results from the modelling of the responses is the topic of the final substantive section. A summary and a discussion of further work concludes the paper.

2 SURVEY APPROACH

The methodological interest had to be balanced with the substantive interests, which required the drawing of a large sample of respondents. This requirement led to the choice of a combination of a telephone survey with a follow-on postal survey, which was based on the answers in the telephone survey (for the pioneering study see Polak, Jones, Vythoulkas, Meland and Tretvik, 1991), where ideally one would have wished to use a computer-based interview for the CA/SP elements of the work.

The telephone survey covered the following topics:

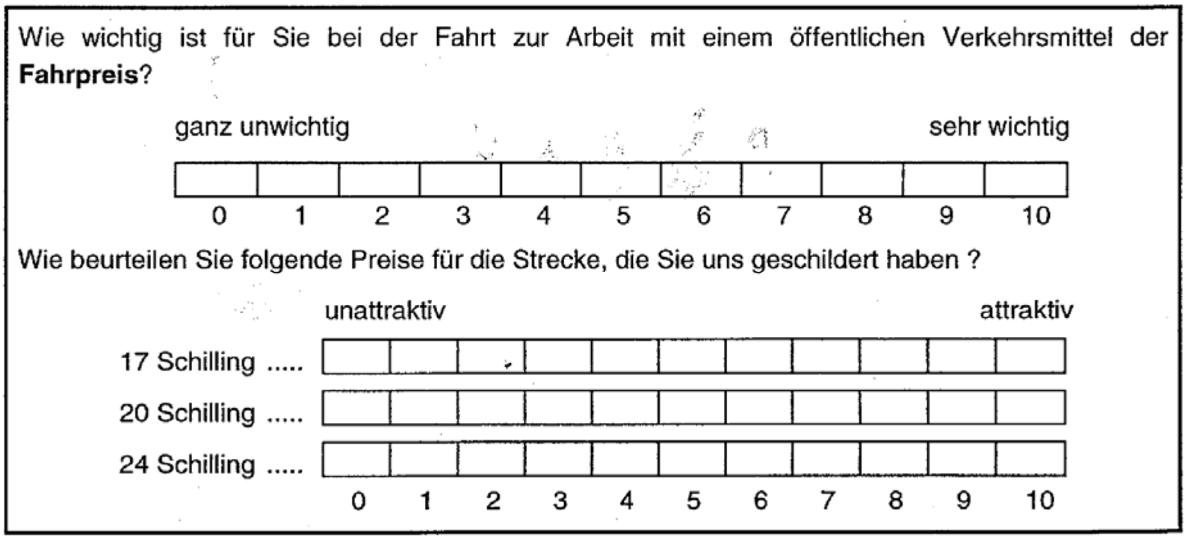
- Availability of public transport at home and at work, where relevant, in terms of distance to the most frequently used stop and number of lines available
- Availability of a car or of a season ticket
- Availability of parking at home and at work, in terms of distance to the parking space, its type and its costs.
- Socio-demographic description of the respondent, including the ownership of a driving licence
- a recent trip to either work, shopping or an evening leisure activity within the City of Innsbruck including destination, access-, wait-, in-vehicle, parking search and egress times, transfers, availability of seat, means of public transport (bus, trolley or tram), fare and parking fee (for the chosen and the competing modes)
- the number of trips undertaken by public transport during the past week and the usage of different ticket types (one half of the sample reported numbers and usage for the week as a whole, while the other half reported trips per and the ticket used on that day for each of the seven days)

The information was coded and the trip description was used to generate postal SP and CA surveys, which were sent to the respondents generally within four (two working) days.

Conjoint analysis survey

CA, as a term, covers a whole range of different approaches, which calculate individual utility part worths using both compositional and decompositional approaches (Schubert, 1991). The chosen hybrid approach combines both compositional and decompositional elements (Green and Krieger, 1996) by offering first a series of rating tasks, in which the respondent has to judge the importance of an attribute and the desirability of different levels of the attribute, and by then offering a set of alternatives, described with all relevant attributes, which the respondent has to rate as a whole. The first part allows the estimation of utility by adding (composing) it from the assessment of individual attributes and their levels. The second part allows the estimation of the part worths of the different attributes by decomposing the joint rating of the alternative offered.

Figure 1 Conjoint analysis survey: Example of attribute & levels rating task



Wie wichtig ist für Sie bei der Fahrt zur Arbeit mit einem öffentlichen Verkehrsmittel der **Fahrpreis**?

ganz unwichtig ... sehr wichtig

0 1 2 3 4 5 6 7 8 9 10

Wie beurteilen Sie folgende Preise für die Strecke, die Sie uns geschildert haben ?

unattraktiv ... attraktiv

17 Schilling .....

20 Schilling .....

24 Schilling .....

0 1 2 3 4 5 6 7 8 9 10

Figure 2 Conjoint analysis survey: Example of a full profile rating task

Nr.: 3064-102

Angenommen, es gäbe die folgende Möglichkeit:

Öffentlicher Verkehr:	Es fährt ein	O-Bus
	O-Bus fährt	alle 10 min
	O-Bus ist	in 5 von 10 Fällen unpünktlich
	Umsteigen	nein
	Fahrt dauert	insgesamt 22 min
	Fußwege von/zur Haltestelle dauern	insgesamt 12 min
	Fahrt mit dem O-Bus kostet	20 Schilling

Ihre Bewertung wäre:

unattraktiv ... attraktiv

0 1 2 3 4 5 6 7 8 9 10

Each respondent was sent 15 tasks of the first type (5 pages with three each, including the reported mode from the target trip) (See 1 for an example) and 14 tasks of the second type (5 pages with three each, including the reported mode) (See 2 for an example). The attribute values were varied consistently around those reported for the target journey. Depending on the availability of a car to the person, the modes presented were public transport and car or public transport, bicycle and walk.

Table 1 list the attributes. The experimental design was a random sample of the 2^{11} 3^{3} full factorial (44 situations, which were divided into four blocks with some overlap). The sample was checked for the extent of correlation between the attributes and the existence of factorial structures, in the factor analytical sense, and was found satisfactory in both respects. The tasks related to recorded work trips and shopping trips.

Stated Preference

The Stated Preference element of the survey was implemented as a *Stated Choice* experiment with respondents choosing between car, public transport, bicycle and walking, if a car was available and public transport, bicycle and walking, if no car was available. In the first case, bicycling and walking are described as "as today", while the other two modes are varied systematically. In the second case, the descriptions of all three modes are varied. In the case of public transport the access and egress walking times are presented as their sum, while the in-vehicle times, include any transfer times. The in-vehicle time for the car excludes any parking search time. Access times to the car are assumed to be constant at current values.

The experiments were conducted for all three trip purposes (work, shopping and evening leisure). Each respondent received 11 choice tasks, plus a description of the reference journey (6 pages with 2 descriptions each) (see 2 for an example).

Table 1 Variables used in the CA/SP tasks

Attribute (Number of levels)

Public transport	Car	Bicycle	Walking
Means of transport (3)			
Access time (2)	Access time[2] (-)	Access time[1] (2)	
Headway (2)			
Waiting time[1] (2)			
Transfer (2)			
In-vehicle (inclusive of transfer times) (2)	In-vehicle (without search) (2)	Riding time (2)	Walking time (2)
	Parking search time (2)	Parking search time [2] (-)	
Egress time[2] (-)	Egress time[1] (2)	Egress time (2)	
	Type of parking (3)	Type of parking (2)	
Reliability (probability of lateness) (2)	Reliability (probability of congestion) (2)		
Fare (3)	Parking fee (2)		
		Share of bicycle paths (3)	

[1] Only for the CA compositional tasks
[2] Not varied for the CA full profiles/SP tasks

3 SURVEY ADMINISTRATION AND RESPONSE BEHAVIOUR

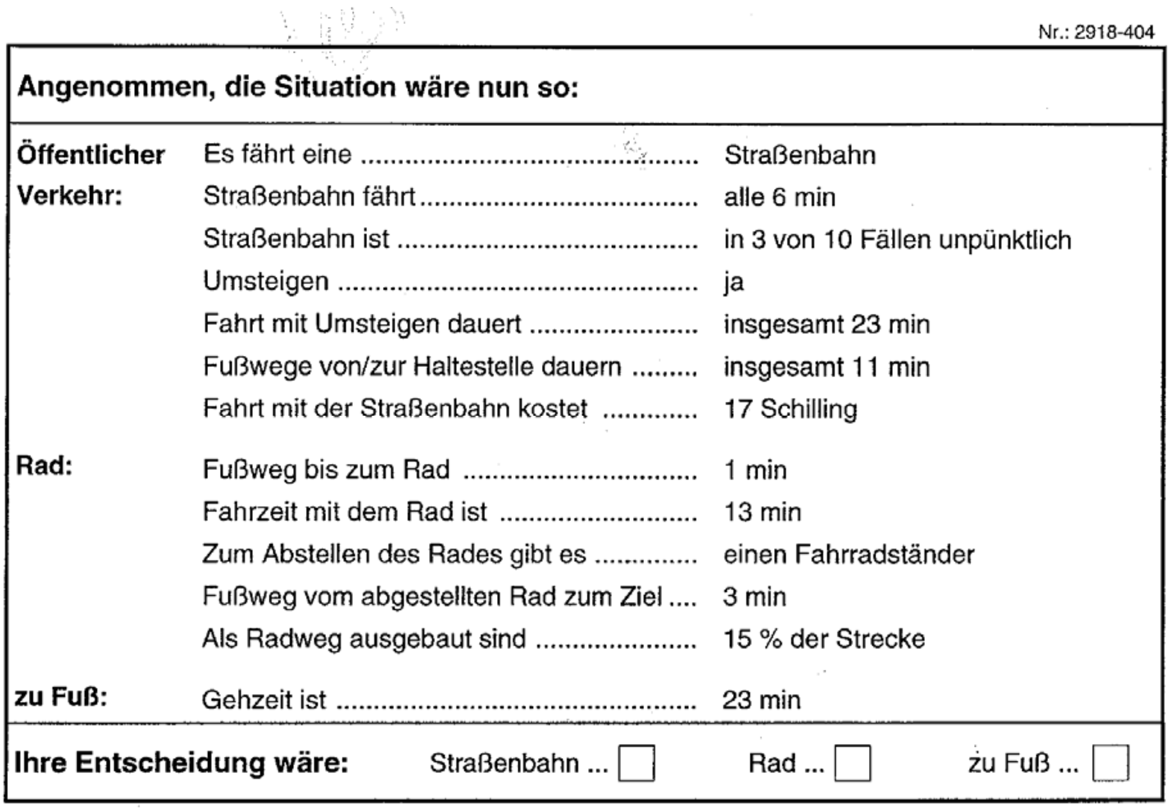
3.1 Survey administration

The survey work was conducted in two parts during the Winter of 1997 (November/December 1997 and February/March 1998) to avoid the clash with the Christmas holidays and the local school holidays at the beginning of February.

The sample addresses of households in the City of Innsbruck were obtained from an address dealer (addresses and current telephone numbers). The numbers were screened against the current post office CD of telephone numbers and any erroneous addresses were discarded. Every address/telephone number was tried five times at different times of the day over a number of days before it was classified as unreachable. To obtain a random sample of persons we asked to speak to the adult person with the birthday closest to the date of the interview. The type of target trip purpose was allocated randomly to the person, but so as to maintain a balance between the trip purposes. The same applies to the allocation between the SP or CA experiments.

The data relating to the target trip was coded and used to generate customized SP/CA experiments, which took the reported values as starting points for the systematic variation according to the experimental design. The forms were sent in general within four (two working) days. A reminder call was made, if no response was obtained within two weeks of sending the survey. The average respondent took 10 days to return the forms.

Figure 3 SP experiments: example of a choice task



Nr.: 2918-404

Angenommen, die Situation wäre nun so:

Öffentlicher Verkehr:	Es fährt eine	Straßenbahn
	Straßenbahn fährt	alle 6 min
	Straßenbahn ist	in 3 von 10 Fällen unpünktlich
	Umsteigen	ja
	Fahrt mit Umsteigen dauert	insgesamt 23 min
	Fußwege von/zur Haltestelle dauern	insgesamt 11 min
	Fahrt mit der Straßenbahn kostet	17 Schilling
Rad:	Fußweg bis zum Rad	1 min
	Fahrzeit mit dem Rad ist	13 min
	Zum Abstellen des Rades gibt es	einen Fahrradständer
	Fußweg vom abgestellten Rad zum Ziel	3 min
	Als Radweg ausgebaut sind	15 % der Strecke
zu Fuß:	Gehzeit ist	23 min

Ihre Entscheidung wäre: Straßenbahn ... ☐ Rad ... ☐ zu Fuß ... ☐

3.2 Response behaviour

2 summarizes the overall response behaviour. The share of unreachables is typical for the City of Innsbruck, reflecting the substantial share of second homes in the City. The share of those reached, who completed the interview was satisfactory with 66%, of which nearly all had a suitable target trip to report.

The response rate to the SP/CA - experiments was identical in the aggregate with a satisfactory 65%. The response behaviour was analyzed using probit models of response probability using the available set of socio-demographic variables contrasting those who had participated in the telephone interview, but not returned the forms with those, who did. The equations estimated were not significant overall and only a small set of variables had a significant impact, but there was no overlap between those significant in the CA response model and those in the SP response model. A high share of correct classifications overstated the quality of the models, as they misclassified nearly all of the non-respondents as respondents. The willingness to participate in this task seems therefore unrelated to the socio-demographic description of the respondents. The commitment comes from other sources, which cannot be described with the socio-demographic variables available here.

Table 2 Response behaviour (Telephone interviews)

Response							Share of all
Unreachable	391			(18%)			18%
Reached	1832			(82%)			
Refused		487			(27%)		22%
Aborted		130			(7%)		6%
Full interview		1215			(66%)		
With trip			1161			(96%)	52%
Without trip			54			(4%)	2%
Sum	2223	1832	1215				2223

3.3 Socio-demographics

The telephone interview technique led to an overrepresentation of older and female respondents. The sample was therefore weighted to reproduce the known distribution of residents with regards to age (3 age categories), sex and season ticket ownership.

4 RESULTS FROM THE CA/SP EXERCISES

4.1 Analysis procedure for the hybrid CA exercise

The hybrid approach chosen here requires that the compositional and the decompositional elements of the exercise are brought together in one uniform analysis framework. Adapting the procedure suggested by Green and Krieger (1996) the following algorithm was implemented:

1. Calculate the ratings y_{ijk} for each level i of each attribute j for each person k from the compositional questions as:

$$y_{ijk} = d_{ijk}\, w_{jk}$$

$$\textit{with}$$

$$\sum_{\forall j} w_{jk} = 1.0$$

   using the desirability ratings d_{ijk} of the levels and the scaled importance rating w_{jk} of each attribute.

2. Calculate the scaled ratings y_{nk} for each full profile n for each person k from the decompositional tasks as:

$$y^{i+1}_{nk} = \frac{y^{i}_{nk} - \mu}{\tau}$$

   using the rating r_{nk} as y^0_{nk}. In the first iteration assume the scaling parameters μ and τ to be zero and one.

3. Construct a joint data matrix from steps 1 and 2 as:

$$\begin{bmatrix} y_{ijk} \\ y_{nk} \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix} + \begin{bmatrix} V_{jk} \\ V_{rk} \end{bmatrix}$$

with the vector y's of the ratings and a vector 0 of zeros, a vector 1 of ones and the vector V describing the values of the levels of the attributes. V_{jk} consists of zeros for the non-rated attributes j and of the rated value of the level of the attributed rated. V_{nk} consists of the values of levels of the attributes X_{jnk} in the full profile.

4. Estimate with multiple linear regression the ß's for the attributes:

$$\hat{y} = \beta_j X_j + \varepsilon$$

5. Reestimate μ and τ as the intercept and slope of the simple linear regression of the model:

$$y^i_{nk} = \mu + \tau \hat{y}^i_{nk} + \varepsilon$$

6. Repeat steps 2 to 4 until the sum of the squares of the errors of the regression in step 3 changes less then a predetermined amount between iterations.

This procedure, which essentially scales the ratings from the decompositional tasks to the mean and variance of the ratings from the compositional task, converged well in this application (3-5 iterations with a stopping criterion of 3% change between iterations). The calculations were performed with the linear regression procedure of SAS.

4.2 Analysis procedure for the SP exercise

The data from the SP exercise was analyzed using the procedure NLOGIT of LIMDEP 7.0 (Econometric Software, 1998). Persons, who chose one mode only across all eleven choice tasks, were removed from the estimation of the simple multinominal logit models reported below. The travel times of the "as is"-condition for the cyclists and pedestrians were estimated from the zone-to-zone car travel times of an available assignment model for the City of Innsbruck, which were scaled using the reported travel times.

4.3 Comparison of the results

To gain an initial understanding of the results simple initial models were estimated for both the CA and the SP data employing linear models of the levels of the relevant variables and of the available sociodemographic variables for each person (sex, age in decades (set of dummy variables), season ticket ownership, employment status, participation in education, ownership of a highschool diploma). More complex forms (logistic transformation of the desirabilities for the CA or quadratic terms of the independent variables) did not increase the explanatory value of the models. The CA models were estimated separately for each mode and trip purpose. The SP models were estimated for each trip purpose. 3, 4, 5 and 6 show the results for public transport and car for both shopping and work. The results of the logit models from the available RP-data are shown as well.

The significance levels of the parameters were corrected by either the square root of the number of cases or the third root of the number of cases per person to account for the repeated measures problem in both the CA and the SP exercises (Bates and Terzis, 1997). The first correction (Columns marked 1/2) is deemed in general to be too conservative, while the second correction (Columns marked 1/3) is deemed to be more appropriate in the absence of a more rigorous estimation procedure (e.g. models allowing for taste variation).

The CA models produce fewer significant parameter estimates and more estimates, which seem unrealistic in comparison with prior knowledge. The signs of the estimates are in general the same and the rank order of the sizes is also normally identical, but the relative sizes can vary considerably raising doubts about the consistency of either set of results.

The goodness of fit for the shopping models is worse than for the models for work. The SP and CA estimates of the value of time for in-vehicle time are low, but not unreasonable. It is interesting to note, that for work the estimates for the public transport fare are not significantly different from zero, reflecting on the one hand the long-term commitment of a season ticket and one the other the necessity to use public transport for the other users. The parking fee estimates are consistently significant for work (CA, SP and RP models).

The relative valuations for the different time elements vary considerably, but for the SP and RP case they do not deviate massively from prior expectations, but for walking time relative to travel time, which in a number of cases seems to low reflecting the lack of variability in the data. The CA estimates are in a fair number of cases excessive.

It is difficult to judge to what extent this unexpected patterns are due to the presence of the reliability variable, which does not produce convincing results. For the RP models it has twice the wrong sign and is significant and twice it is insignificant. This might be due to the lack of range and variability in the rather non-congested Innsbruck. For the CA and SP car models the estimates are either not significant or only marginally so, maybe again reflecting either too little variability in the data or a lack of understanding of the description of the variable, which might have been misunderstood by the respondents (Some respondents might have included the congested time with the travel time specified for the CA/SP description). The reliability estimates for the SP public transport models are significant and have the right signs (less significant for the CA models) reflecting an easier to understand formulation of reliability (x out of 10 late for 5 minutes) and more range in the observed data.

Both methods agree, that there is no difference between offering a bus, trolley bus or tram to the traveller.

Table 3 Estimation results for the public transport attributes for shopping (linear model forms)

Term	Form	Unit	CA Beta	1/2 Sig	1/3 Sig.		SP Beta	1/2 Sig	1/3 Sig.	RP Beta	Sig
Walking time	L	[min]	-0,071		*		-0,050	*	*	-0,021	
Travel time	L	[min]	-0,009				-0,027	*	*	-0,084	**
Headway	L	[min]	-0,023				-0,041	*	*	-0,010	
Reliability	L	[]	-0,233		*		-0,183	*	*	0,007	
Fare	L	[S/trip]	-0,031				-0,077	*	*	-0,065	**
Transfer		[y,n]	-1,857	*	*		-0,271		*	0,023	
Trolley		[y,n]	0,043				0,049			0,493	**
Tram		[y,n]	-0,033				-0,127			0,695	**
Summary statistics											
F			29,750	***		Pred.	0,374			0,721	
R(2) adjusted			0,135			rho2(0)	0,205			0,626	
						rho2(C)	0,105			0,355	
N			3487				1253			494	
VOT (Travel)		[S/min]	0,287				0,351			1,292	
Walking/Travel		[]	7,978				1,852			0,250	
Wait/Travel		[]	5,169				3,037			0,238	
Transfer/Travel		[]	208,652				10,037			-0,274	
Reliability/Travel		[]	26,180				6,778			-0,083	

CA, SP: * Significant at the alpha = 0,05 level, when corrected for the degrees of freedom
F, RP: * Significant at the alpha = 0,01 level; ** alpha = 0,01; *** alpha = 0,001

Table 4 Estimation results for the public transport attributes for work (linear model forms)

Term	Form	Unit	CA Beta	CA 1/2 Sig.	CA 1/3 Sig.		SP Beta	SP 1/2 Sig.	SP 1/3 Sig.	RP Beta	RP Sig.
Access time	L	[min]	-0,064				-0,133	*	*	-0,140	**
Travel time	L	[min]	-0,034		*		-0,048	*	*	-0,018	**
Headway	L	[min]	-0,027				-0,010			-0,014	*
Reliability	L	[]	-0,271		*		-0,108	*	*	*0,132*	**
Fare	L	[S/trip]	-0,004				-0,019			0,006	
Transfer		[y,n]	-2,341	*	*		-0,466	*	*	-0,766	**
Trolley		[y,n]	-0,301				0,568		*	0,116	
Tram		[y,n]	-0,121				0,208			-0,323	
Summary statistics											
F			24,222	***		Pred.	0,516			0,696	
R(2) adjusted			0,125			rho2(0)	0,398			0,551	
						rho2(C)	0,344			0,438	
N			3242				752			392	
VOT (Travel)		[S/min]	8,500				2,526			-3,000	
Walking/Travel		[]	1,882				2,771			7,778	
Wait/Travel		[]	1,588				0,417			1,556	
Transfer/Travel		[]	68,853				9,708			42,556	
Reliability/Travel		[]	7,971				2,250			-7,333	

CA, SP: * Significant at the alpha = 0,05 level, when corrected for the degrees of freedom
F, RP: * Significant at the alpha = 0,01 level; ** alpha = 0,01; *** alpha = 0,001

Table 5 Estimation results for the car attributes for shopping (linear model forms)

Term	Form	Unit	CA Beta	1/2 Sig.	1/3 Sig.		SP Beta	1/2 Sig.	1/3 Sig.	RP Beta	Sig.
Walking time	L	[min]	0,213	*	*		-0,003			-0,009	
Travel time	L	[min]	0,022				-0,034	*	*	-0,057	**
Search time	L	[min]	-0,181	*	*		-0,071	*	*	-0,280	**
Parking fee	L	[S/trip]	-0,058	*	*		-0,017	*	*	-0,046	**
Reliability	L	[]	-0,229		*		*0,068*		*	*0,124*	*
Parking lot		[n,y]	0,762		*		-0,054			2,296	**
Garage		[n,y]	0,484				0,176			1,078	**
Summary statistics											
F			34,735	***		Pred.	0,385			0,721	
R(2) adjusted			0,226			rho2(0)	0,205			0,626	
						rho2(C)	0,105			0,355	
N			2075				1253			494	
VOT (Travel)		[S/min]	-0,379				2,000			1,239	
Walking/Travel		[]	9,682				0,088			0,158	
Searching/Travel		[]	-8,227				2,088			4,912	
Reliability/Travel		[]	-10,409				-2,000			-2,175	

CA, SP: * Significant at the alpha = 0,05 level, when corrected for the degrees of freedom
F, RP: * Significant at the alpha = 0,01 level; ** alpha = 0,01; *** alpha = 0,001

Table 6 Estimation results for the car attributes for work (linear model forms)

Term	Form	Unit	CA Beta	1/2 Sig	1/3 Sig.		SP Beta	1/2 Sig	1/3 Sig.	RP Beta	Sig
Walking time	L	[min]	0,108				-0,277	*	*	0,021	
Travel time	L	[min]	0,065		*		-0,033			-0,091	**
Search time	L	[min]	-0,198		*		-0,023			-0,179	**
Reliability	L	[]	-0,166				-0,106		*	-0,025	
Parking fee	L	[S/trip]	-0,042	*	*		-0,056	*	*	-0,026	*
Parking lot		[n,y]	0,736				0,317			0,845	**
Garage		[n,y]	0,892				-0,176			0,710	**
Summary statistics											
F			25,109	***		Pred.	0,516			0,696	
R(2) adjusted			0,174			rho2(0)	0,398			0,551	
						rho2(C)	0,344			0,438	
N			2066				752			392	
VOT (Travel)		[S/min]	-1,548				0,589			3,500	
Walking/Travel		[]	1,662				8,394			-0,231	
Search/Travel		[]	-3,046				0,697			1,967	
Reliability/Travel		[]	-0,646				3,212			0,275	

CA, SP: * Significant at the alpha = 0,05 level, when corrected for the degrees of freedom
F, RP: * Significant at the alpha = 0,01 level; ** alpha = 0,01; *** alpha = 0,001

5 CONCLUSIONS AND FUTURE WORK

The initial simple results indicate that the two approaches produce results consistent in their trends, but not necessarily in their exact valuations. Further work is needed to identify to reasons for those differences.

The further work planned will address these challenges. In particular, it is planned to crossvalidate the CA rating-based results against the SP choice-based results by building a choice simulator, which uses the utility part-worth estimates to predict choices for the SP choice tasks. Consistency at this level would be useful, even if consistency at the relative parameter estimates cannot be established.

A second important direction is the estimation of individual parameter estimates from the CA exercise, which should shed new light into the distribution of the valuations of the modal attributes, in particular of reliability, of waiting time and of the transfer penalty.

In terms of survey administration and response behaviour no important differences can be found between the two methods. This makes the choice between the methods one solely of the required results.

6 ACKNOWLEDGEMENTS

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7 LITERATURE

Axhausen, K.W. (1996) *Hinweise zur Messung von Präferenzstrukturen - die Methoden der "Stated Preferences"* (Stated Preference Guidelines), with contributions from W. Bogner, M. Herry, H. Verron, H. Volkmar and W. Wichmann, Forschungsgesellschaft für das Straßen- und Verkehrswesen, Köln.

Axhausen, K.W., H. Köll and M. Bader (1998) Stated Preferences and Conjoint Analysis: A comparison using mode choice, paper presented at the 4th NECTAR conference, Kibbutz Shefajim, April 1998.

Bates, J.J. (ed.) (1988) Stated Preference Methods in Transport Research, *Journal of Transport Economics and Policy*, **22** (1).

Bates, J.J and G. Terzis (1997) Stated preference and the 'Ecological Fallacy', *Proceedings of the 25th European Transport Forum*, **F2**, 155-170, PTRC, London.

Böcker, F. (1986) Präferenzforschung als Mittel marktorientierter Unternehmensführung, *Zeitschrift für betriebswissenschaftliche Forschung*, **38** (7/8) 543-574.

Brög, W. (1997) Raising the standard: transport survey quality and innovation, paper presented at the *International Conference on Transport Surveys: Raising the Standard*, Grainau, May 1997.

Cattin, P. and Wittnik, D.R. (1982) Commercial use of Conjoint Analysis: A survey, *Journal of Marketing Research*, **16** (1) 44-53.

Econometric Software (1998) *LIMDEP 7.0 for Windows*, Econometric Software, Sidney.

Green, P.E. and A.M. Krieger (1996) Individualized hybrid models for conjoint analysis, *Management Science*, **42** (6) 850-867.

Green, P.E. and V.R. Rao (1971) Conjoint measurement for quantifying judgmental data, *Journal of Marketing Research*, **8** (8) 355-363.

Green, P.E. and V. Srivasan (1978) Conjoint analysis in consumer research: issues and outlook, *Journal of Consumer Research*, **5** (September) 103-123.
Hensher, D.A. (1994) Stated preference analysis of travel choices: The state of practice, *Transportation*, **21**, 107-133.
Huber, J. (1987) Conjoint analysis: how we got here and where we are, paper presented at the *Sawtooth Software Conference*, Sawtooth Software Inc., Evanston, 1997[1].
Kocur, G., T. Adler, W. Hyman and B. Aunet (1982) *Guide to Forecasting Travel Behavior with Direct Utility Assessment*, Bericht UMTA-NH-11-0001-82-1, US Department of Transportation, Urban Mass Transit Administration.
Louviere, J.J. (1988) Analyzing decision making: Metric Conjoint Analysis, *Sage University Papers*, **67**, Sage, Newbury Park.
Louviere, J.J., R.J. Meyer, F. Stetzer and L.L. Beaver (1973) Theory, methodology and findings in mode choice behaviour, *Working Paper*, **11**, Institute of Urban and Regional Research, University of Iowa, Iowa City.
Louviere, J.J. and G. Woodworth (1983) Design and analysis of simulated consumer choice and allocation experiments: An approach based on aggregate data, *Journal of Marketing Research*, **20**, 350-367.
Pearmain, D., J. Swanson and E. Ampt (Forthcoming) *Stated Preference Explained*, SDG, London.
Pearmain, D., J. Swanson, E. Kroes and M. Bradley (1991) *Stated Preference Techniques: A Guide to Practice*, Steer Davies and Gleave, London.
Polak, J.W., P.M. Jones, P. Vythoulkas, S. Meland und T. Tretvik (1991) The Trondheim toll ring: results of a stated preference study of travellers' response, *Working Paper*, **662**, Transport Studies Unit, University of Oxford, Oxford.
Sawtooth Inc. (1995) *The CBC System for choice-based Conjoint Analysis*, Sawtooth Software Inc., Evanston.[2]
Sawtooth Inc. (1996) *ACA System - Adaptive Conjoint Analysis - Version 4.0*, Sawtooth Software Inc., Evanston.[3]
Schubert, B. (1991) *Entwicklung von Konzepten für Produktinnovationen mittels Conjointanalyse*, Poeschel-Verlag, Stuttgart.
Wittnik, D.R. and P. Cattin (1989) Commercial use of conjoint analysis: An update, *Journal of Marketing*, **53** (7) 91-96.
Wittink, D.R., M. Vriens and W. Burhenne (1994) Commerical use of conjoint analysis Europe: results and critical reflections, *International Journal of Research in Marketing*, **11** (1) 41-52.

[1] Obtained as http://www.sawtoothsoftware.com/TechPap.htm/HowweW.zip

[2] Obtained as http://www.sawtoothsoftware.com/TechPap.htm/CBCTchWp.zip

[3] Obtained as http://www.sawtoothsoftware.com/TechPap.htm/ACATchWp.zip