# STATED PREFERENCE AND CONJOINT ANALYSIS: A COMPARISON USING MODE CHOICE BEHAVIOUR

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## ABSTRACT

Stated Preference (SP) and Conjoint Analysis (CA) methods are both applied in transport to derive relative valuations for attributes and parameter estimates for choice models. While both are based on the idea of hypothetical markets, they derive their estimates in different ways: SP results are based on holistic assessments of goods in choice or rating situations. CA derives utility estimates from importance assessments of individual attributes and desirability ratings of their possible attribute levels.

In this paper a SP and a CA method are compared using the same topic: mode choice in the city of Innsbruck. Two sub-samples are drawn from a sample of respondents who had completed a telephone survey, which covered among other items a work, shopping or leisure trip which the respondents had recently undertaken. The respondents were sent either a stated-choice or a hybrid CA survey, which was customised using the information obtained in the telephone interview. The response rates were identical for both experiments (67%).

The variables tested, included among others the reliability of the travel times. While the results for variables such as travel time or access time were in the expected range, the results for reliability indicated, that the usual practice of ignoring it, might lead to wrong conclusions. The presence of a reliability variable in the utility function lowers the parameter estimates for weighting times substantially indicating that in a model without an explicit reliability measure weighting time can absorb the effects of reliability. This could lead policy makers to favour head time reductions over reliability improvements, which are actually preferred by customers.

## KEYWORDS

Stated Preference – Conjoint Analysis – Innsbruck – Mode choice – Reliability

# 1 INTRODUCTION

In spite of their known limitations and problems *Stated Preference*-based survey techniques have become an accepted part of the transport planning tool kit. In general they are implemented as *Stated Choice* experiments, in which respondents are asked to choose between 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 all attributes (A chosen over B; A ranked 5$^{th}$, B 10th; A received a scale value of 6 out of 10). In the case of choice data logit or related utility-maximising models are used to derive those part-worths.

In marketing surveys of hypothetical markets/goods is called *Conjoint Analysis*. 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 performed in two steps. In the first step variables are ranked one at a time for their importance and their attribute levels are ranked for their desirability. The total utility of an alternative (composite good) is 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 written descriptions, either individually or in sets, which they are asked to rate, or rank or choose between (Hensher, 1994; Axhausen, 1996). Both approaches are based on earlier work in psychology and microeconomics (Green and Rao, 1971; Louviere, Meyer, Stetzer and Beavers, 1971). Users of both techniques accept that the true complexity of the decision studied is higher then the level presented to the respondent in the survey. This simplification is accepted by the users 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 and the hybrid Conjoint-Analysis approach encompass 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 according to a well-designed experimental plan
- within a specified behavioural frame (overall context)

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 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 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; Pearmain, Swanson and Ampt (forthcoming), but see also Bates, 1988 or Hensher, 1994). The usage of the methodology in transport planning has not been reviewed yet.

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

The purpose of this paper is to compare two particular SP and CA methods with regards to the comparability of their results using mode choice behaviour in the City of Innsbruck to gain an insight into the potential of each of the approaches as a policy research tool.

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 analysed in the following section, while the results from the modelling of the responses is the topic of the final 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 of all parties involved in funding the survey, 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 nearest 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. See Table 1 for the variables obtained in the telephone survey, which were systematically varied for the SP/CA.

*Conjoint analysis survey*

CA 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. (See Figure 1, Figure 2  and Appendix A for a translation)

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

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

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

Each respondent was sent 14 tasks of the first type (5 pages with three each, including the reported mode from the reported target trip) (See Figure 1 for an example) and 14 tasks of the second type (5 pages with three each, including the reported mode) (See Figure 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 used. 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 of situations was checked for the extent of the correlation between the attributes and the absence of factorial structures The tasks related to the recorded work 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" without giving any details of attribute levels. The other two modes were varied systematically. In the second case, the descriptions of all three modes were 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 three trip purposes (work, shopping and evening leisure). Each respondent received 11 choice tasks, plus a description of the reference journey reported in the telephone interview (6 pages with 2 descriptions each) (see Figure 3 for an example and Appendix A for a translation).

Figure 3 SP experiments: Example of a choice task

# 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 person with the birthday closest to the date of the interview. The type of target trip purpose were 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 forms for the CA/SP experiments were sent in general within four (two working) days after the telephone interview. A reminder call was made, if no response was obtained within two weeks of sending the survey. The average respondent took 10 days return the forms.

## 3.2 Response behaviour

Table 2 summaries 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 for the SP/CA - experiments was identical: a satisfactory 65%. The response behaviour was analysed using probit models of the 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. The willingness to participate in such survey tasks seems therefore unrelated to the socio-demographic characteristics of the respondents. The commitment comes from other sources, which cannot be described with the socio-demographic variables available here.

Table 2 Response behaviour

| 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 |

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 of the hybrid CA

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:

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

*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:

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

using the rating $r_{nk}$ as $y^0_{nk}$. In the first iteration assume the scaling parameters $\mu$ and $\tau$ 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 $\mu$ and $\tau$ as the intercept and slope of the simple linear regression of the model:

$$y_{nk}^{i} = \mu + \tau\, \hat{y}_{nk}^{i} + \varepsilon$$

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 of the SP

The data from the SP was analysed 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 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 for these modes. The SP data were merged with the available RP data, i.e. the trips reported, which formed the basis of the SP exercise, to improve the quality of the estimates. The required tree structure placed the RP-choices in one nest, while the SP-based alternatives were allocated to four different nests, one for each alternative (See Bradley and Daly, 1993). The SP data were reweighted, so that the RP data and all SP data together had equal weight in the analysis. The method scales the error variances of the SP-alternatives relative to the error variances of the RP-alternatives, while assuming that the parameters are the same in the SP and RP data set. The scaling parameter $\lambda$ indicates the strength of the scaling required.

## 4.3 Results

To gain an initial understanding of the data models were estimated for both the CA and the SP/RP data employing the relevant variables with linear terms only and including the available socio-demographic variables for each person (sex, age in decades (set of dummy variables), season ticket ownership, employment status, being in education, ownership of a high-school 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 and will therefore not be reported here. The CA models were estimated separately for each mode and trip purpose.

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 or serial correlation between answers).

The results of the analysis of the CA-data are presented in Table 3 for the car attributes, in Table 4 for the public transport attributes and in Table 5 for the bicycle attributes. A number of results are not consistent with expectations, as for example in the case of the car, the positive parameters for the walking and driving time, which are even in some cases significant. Equally surprising are the extremely high values for transferring and reliability in the case of public transport, which seem unrealistic.

Table 3 CA: Results for the car attributes by purpose

| Attribute | | Purpose<br>Work<br>Parameter | 1/2<br>Sig | 1/3<br>Sig | Shopping<br>Parameter | 1/2<br>Sig | 1/3<br>Sig | Leisure<br>Parameter | 1/2<br>Sig | 1/3<br>Sig |
|---|---|---|---|---|---|---|---|---|---|---|
| Walking times | [min] | 0,108 | | | 0,213 | * | * | | | |
| Travel time | [min] | 0,065 | | * | 0,022 | | | | | |
| Search time | [min] | -0,198 | | * | -0,181 | * | * | | | Not |
| available | | | | | | | | | | |
| Reliability | [] | -0,166 | | | -0,058 | * | * | | | for CA |
| Parking fee | [S] | -0,042 | * | * | -0,229 | | * | | | |
| Parking lot | [y/n] | 0,736 | | | 0,762 | | | | | |
| Garage | [y/n] | 0,892 | | | 0,484 | | | | | |
| | | | | | | | | | | |
| F | | 25,109 | | | 34,735 | | | | | |
| adj. $R^2$ | | 0,174 | | | 0,226 | | | | | |
| N | | 2066 | | | 2075 | | | | | |
| | | | | | | | | | | |
| VOT | [S/min] | -1,548 | | | -3,672 | | | | | |
| Walking/travel | [] | 1,662 | | | 9,682 | | | | | |
| Search/travel | [] | -3,046 | | | -8,227 | | | | | |
| Reliability/travel | [] | -0,646 | | | -10,409 | | | | | |

Initial analyses of the SP and RP data not reported here showed that the parameter estimates are in many cases rather similar across the modes. Therefore a joint SP/RP model using generic parameters where possible was estimated focusing on the modal parameters and using the same set of socio-demographic variables as before.

The estimation of the impacts of reliability proved problematic due to the RP data, which were unsatisfactory in their description of reliability (too little variance, a difficult to understand description of unreliability in the case of car transport). The parameters were therefore fixed a priori using the earlier SP-results.

Table 6 presents the results for the modal attributes and the summary statistics. The fits of the models are good. The highly significant scaling parameters $\lambda$ indicate the necessity of the estimation method used.

Table 4  CA: Results for the public transport attributes by purpose

| Attribute | | Purpose Work Parameter | 1/2 Sig | 1/3 Sig | Shopping Parameter | 1/2 Sig | 1/3 Sig | Leisure Parameter | 1/2 Sig | 1/3 Sig |
|---|---|---|---|---|---|---|---|---|---|---|
| Walking times | [min] | -0,064 | | | -0,071 | | * | | | |
| Travel time | [min] | -0,034 | | * | -0,009 | | | | | |
| Headway | [min] | -0,027 | | | -0,023 | | | | Not | |
| available | | | | | | | | | | |
| Reliability | [] | -0,271 | | * | -0,233 | | * | | for CA | |
| Fare | [S] | -0,004 | | | -0,031 | | | | | |
| Transfer | [y/n] | -2,341 | * | * | -1,857 | * | * | | | |
| Trolley bus | [y/n] | -0,301 | | | 0,043 | | | | | |
| Street car | [y/n] | -0,121 | | | -0,033 | | | | | |
| F | | 24,222 | | | 29,750 | | | | | |
| adj. $R^2$ | | 0,125 | | | 0,135 | | | | | |
| N | | 3242 | | | 3487 | | | | | |
| VOT | [S/min] | 8,500 | | | 0,287 | | | | | |
| Walking/travel | [] | 1,882 | | | 7,978 | | | | | |
| Wait/travel | [] | 1,588 | | | 5,169 | | | | | |
| Transfer/travel | [] | 68,853 | | | 208,652 | | | | | |
| Reliability/travel | [] | 7,971 | | | 26,180 | | | | | |

The core modal attributes are all significant, with the exception of headway/waiting time, which is only (weakly) significant in the case of work. The introduction of the reliability variable has to be the reason for this, as the headway variable normally captures the both aspects of the wait (waiting time and the unreliability of the service). The transfer variable captures the inconvenience of the transfer plus the chance for additional unreliability. The importance of cycle paths to cycling is visible in the joint estimation.

The relative valuations and the values of time are shown in Table 7. The values of travel time savings are in a realistic range of about 2,0-2,5 Schilling/min for work and shopping, while the value is considerable lower, as expected, for leisure. The relative valuations for walking show a reasonable pattern, although the value for shopping seems low in comparison with many other studies. The separate estimation of waiting time and unreliability results in by comparison low valuations for waiting time, which are in turn balanced by substantial valuations for unreliability, especially for the work trip.

Table 5 CA: Results for the bicycle attributes by purpose

| Attribute | | Purpose Work Parameter | 1/2 Sig | 1/3 Sig | Shopping Parameter | 1/2 Sig | 1/3 Sig | Leisure Parameter | 1/2 Sig | 1/3 Sig |
|---|---|---|---|---|---|---|---|---|---|---|
| Walking times | [min] | -0,258 | | | 0,042 | | | | | |
| Travel time | [min] | -0,020 | | | 0,023 | | | | | |
| Search time | [min] | 1,511 | | | -0,407 | | | | | Not |
| available | | | | | | | | | | |
| Cycle paths | [%] | 0,019 | | | 0,034 | * | * | | | for CA |
| Cycle stand | [y/n] | 2,580 | * | * | 1,686 | | * | | | |
| F | | 13,356 | | | 15,331 | | | | | |
| adj. $R^2$ | | 0,305 | | | 0,263 | | | | | |
| N | | 450 | | | 521 | | | | | |
| Walking/travel | [] | 12,900 | | | 1,826 | | | | | |
| Search/travel | [] | -75,550 | | | -17,696 | | | | | |
| Cycle path/travel | [] | -0,950 | | | 1,478 | | | | | |
| Stand/travel | [] | 129,000 | | | 73,304 | | | | | |

The search time valuations for car travel are in the expected range, while the valuations for cycling seem high, but which have to be accepted in the absence of comparable results as the expression of the ardent wish to park one's bicycle in front of the destination, in particular during shopping and at night. The transfer penalty of about 10-15 minutes during the day (work and shopping) is within the range of earlier studies, while the value for leisure (22 minutes) seems reasonable given the associated loss of comfort, especially during the evening and night.

The results for the different types of public transport vehicle are more conclusive for the joint estimation indicating in comparison with the normal bus a preference for the trolley bus to work, the trolley bus and the street car to shopping and for the street car to a leisure activity. Similarly, there are significant preferences for off-street parking during work and shopping.

Table 6 SP/RP: Results for the modal attributes

| Attribute | | Purpose Work Parameter | 1/2 Sig | 1/3 Sig | Shopping Parameter | 1/2 Sig | 1/3 Sig | Leisure Parameter | 1/2 Sig | 1/3 Sig |
|---|---|---|---|---|---|---|---|---|---|---|
| Walking time | [min] | -0,090 | * | * | -0,070 | * | * | -0,101 | * | * |
| Travel time | [min] | -0,054 | * | * | -0,062 | * | * | -0,032 | * | * |
| Headway | [min] | -0,015 | | * | -0,004 | | | -0,007 | | |
| Search time (car) | [min] | -0,091 | * | * | -0,197 | * | * | -0,106 | * | * |
| Search time (cycle) | | -0,111 | | | -0,307 | | | -0,931 | | * |
| Transfer | [y,n] | -0,775 | * | * | -0,562 | * | * | -0,711 | * | * |
| Fare/Fee | [Schilling] | -0,021 | * | * | -0,026 | * | * | -0,048 | * | * |
| Reliability (PT) | [x/10] | **-0,540** | | | **-0,360** | | | **-0,270** | | |
| Reliability (Car) | | **-0,400** | | | | | | | | |
| Cycle paths | [%] | -0,004 | | | 0,013 | * | * | -0,005 | | |
| Trolley bus | [y,n] | 0,785 | * | * | 0,534 | * | * | -0,257 | | |
| Street car | [y,n] | -0,316 | | | 0,560 | * | * | 0,730 | * | * |
| Parking lot | [y,n] | 0,572 | * | * | 2,533 | * | * | -0,005 | | |
| Multi-storey | [y,n] | 0,609 | * | * | 1,256 | * | * | 0,822 | | * |
| Cycle rail | [y,n] | 0,213 | | | -0,596 | | | 0,648 | | |
| Summary statistics | | | | | | | | | | |
| $\lambda$ | | 0,956 | * | * | 0,312 | * | * | 0,384 | * | * |
| $\rho^2(0)$ | | 0,725 | | | 0,759 | | | 0,684 | | |
| $\rho^2(C)$ | | 0,279 | | | 0,223 | | | 0,162 | | |
| N | | 1095 | | | 1692 | | | 1312 | | |

The parameters in bold were fixed based on the earlier SP-results.

The significance levels are based on 1,96*Square root(2) (=1/2 Sig) and 1.96*Third root(2) (1/3 sig), as there are 2 observation per person given the weighting of the SP observations.

$\rho^2(0)$ = _(ß) - _(0) /_(0);$\rho^2(C)$ = _(ß) - _(C) /_(C);

Table 7 SP/RP: Relative valuations

| Relation | Purpose<br>Work | | | | Shopping | | | | Leisure | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All modes | PT | Car | Bike | All modes | PT | Car | Bike | All modes | PT | Car | Bike |
| VOT | 2,57 | | | | 2,38 | | | | 0,67 | | | |
| Walking/Travel | 1,67 | | | | 1,13 | | | | 3,16 | | | |
| Waiting/Travel | | 0,56 | | | | *0,13* | | | | *0,44* | | |
| Searching/Travel | | | 1,69 | 2,06 | | | 3,18 | 4,95 | | | 3,31 | 29,09 |
| Transfer/Travel | | 14,35 | | | | 9,06 | | | | 22,22 | | |
| Reliability/travel | | **10,00** | **7,41** | | | **5,81** | | | | **8,44** | | |
| Cycle path/Travel | | | | *-0,07* | | | | *-0,21* | | | | *0,16* |

Bold values were determined a priori
Italizied values are based on non-significant parameter estimates

## 5 CONCLUSIONS AND FUTURE WORK

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 weights is also normally identical, but the relative sizes can vary considerably raising doubts about the consistency of either set of results.

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 SP/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 seems 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 these unexpected patterns are due to the presence of the reliability variable, which does not produce convincing results other than in the SP context. For the RP models (not reported here) 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, again reflecting either too little variability in the data or an unclear 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 of out 10 late for 5 minutes) and more variability in the observed data.

The initial analyses 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 cross-validate 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 on the distribution of the valuations of the modal attributes, in particular of reliability, of waiting time and of the transfer penalty.

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## APPENDIX A TRANSLATION OF THE SP AND CA-FORMS

Conjoint analysis survey: Example of attribute & levels rating task

How important is the public transport fare for you for your work trip ?

Not important at all ............................................... Very important

How do you rate the following fares for the trip, you reported to us:

Unattractive .......................................................... Attractive

Conjoint analysis survey: Example of a full profile rating task

Assume, the following were available:

| | | |
|---|---|---|
| Car: | Driving time with the car | 13 min |
| | Congestion of 5 or more minutes | 3 out of 10 days |
| | Parking search normally takes | 8 min |
| | Parking at the destination | Curb |
| | Parking costs | 48 Schilling a day |

Your rating would be:

Unattractive .......................................................... Attractive

SP experiments: example of a choice task

Assume the following situation:

| | | |
|---|---|---|
| Public Transport | It is | a bus service |
| | The bus comes | every 20 min |
| | It is | not on time in 0 out of 10 cases |
| | Transfer | yes |
| | Riding time (inc. transfer) | 23 min total |
| | Access times | 14 min total |
| | Bus fare | 20 Schilling |
| Car | Driving time with the car | 8 min (without parking search) |
| | Congestion of 5 or more minutes | 0 out of 10 days |
| | Parking search normally takes | 7 min |
| | Parking at the destination | Curb |
| | Parking costs | 36 Schilling a day |
| Bicycle | As is | |
| Walking | As is | |