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2000

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*Citation for published version (APA):*

Sjöstrand, H. (2000). *SP-studies among travel card holders - a methodological problem and test of alternative solutions*. Paper presented at PTRC Annual Meeting, European Transport Conference.

*Total number of authors:*

1

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## Paper 2

SP-studies among travel card holders –  
a methodological problem and test of  
alternative solutions

Helena Sjöstrand (2000)



# **SP-STUDIES AMONG TRAVEL CARD HOLDERS – A METHODOLOGICAL PROBLEM AND TEST OF ALTERNATIVE SOLUTIONS**

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## **1 INTRODUCTION**

Stated Preference studies are used to assess standard in public transport, based on passengers' willingness to pay. The studies are conducted under the condition that it's able to construct balanced hypothetical choices between standard and cost.

The monthly ticket holders have lower average costs per trip and no marginal cost per trip at all. Both their actual budget restrictions and their psychological situations are different from other passengers' situations as they have to make simultaneous decisions about larger expenses. This will affect both their actual assessments and how they react to hypothetical questions concerning fare changes.

Almost half of the bus passengers in local public transport, and in some cities even more, use monthly tickets. In SP-studies they often are treated together with cash paying passengers even though they travel under obvious different circumstances. For example has trip cost been used during evaluation of public transport systems in Norway even for monthly ticket users (see f i Kjörstad, 1995).

The easiest and most practical way making a survey would be to give identical questionnaires to all respondents. But previous research tells us that validity of results is violated if the respondents don't find the alternatives realistic (Widlert, 1994).

In a computerised survey it is easier to customise the alternatives to the traveller's present conditions than in printed questionnaires. Widlert (1992) has adapted the fare levels such that the monthly cost was presented to people using monthly period cards. The computer then calculated a cost per trip depending on how many trips the passenger said they did per month. The passenger then had the ability to change this trip cost, if they didn't agree. The results indicate that assessments of standard are proportionate to travel cost rather than to travel time.

## **2 AIM**

The aim of this paper is to investigate how the presentation of fare levels to monthly ticket holders in local public transport influences these passengers' estimated assessments. Three different ways of expressing the trip cost will



### **3.3 Response rate**

The next step was to see how many and which of the 1171 persons who sent in their answers. 624 persons did so, 53%. There was a significant difference in answering frequency between sexes. 59% of the women has answered, but only 49% of the men. There was no significant difference between different age groups.

Thus the sample available for analysis consists of  
too many women                                      too few men  
too many young persons                                      too few old persons

### **3.4 The Questionnaires**

Each questionnaire consisted of two sheets. The first one contained questions regarding the trip and the traveller, such as where did you start this trip, did you change buses, were seats available on bus, how many times do you go by bus per month and which year were you born. The second sheet consisted of a Stated Preference game with six binary choices. Each alternative described a bus trip with cost, in-vehicle time, walking time to bus stop and bus frequency. All attributes had three levels. The alternatives were created and paired by random. Pairs containing a dominant alternative were rejected. Each questionnaire thus had its own design and probably none looked exactly the same.

Three types of questionnaires regarding in which way cost was expressed were randomly distributed.

- MCCL (Monthly Cost, Card Level): cost expressed as cost per month. 300, 390, 500 SEK per month.
- TCCL (Trip Cost, Card Level): cost expressed as cost per trip. 5, 6.50, 8.50 SEK per trip. The levels were set such that they correspond to the cost in type MCCL divided by number of trips an average passenger does per month (according to the local transport authority).
- TCTL (Trip Cost, Ticket Level): cost expressed as cost per trip. 8, 10, 13 SEK per trip. The levels were set such that they correspond to the cost per trip when discount tickets are used.

Walking time to bus stop was either 2, 5, or 7 minutes.

In-vehicle time was as mentioned above customised to each passenger's conditions. Both faster and slower bus trips compared to the actual travel time were presented.

**Table 1 Presented levels of in-vehicle time depending on actual travel time on bus in minutes.**

actual travel time according to interview on bus	travel time in SP alternatives		
	fast level	medium level	slow level
<15	5	10	15
15-25	15	20	25
25-35	25	30	40
35-50	35	40	50
>50	50	60	75

Bus frequency had three levels: one bus per 10, 15, or 30 minutes. Since all buses in the study had a frequency of either 15 or 20 minutes, these levels also involved both improvement and deterioration.

But of these only people travelling with a month ticket for Gothenburg costing 390 SEK were interesting in this study, which were 400 persons. The remaining were persons travelling with period tickets valid in a larger area, during specific time periods, or valid for a whole year and thus with another cost.

Among the interesting 400 answering persons  
140 got questionnaire MCCL (300, 390, 500)  
114 got questionnaire TCCL (5, 6.50, 8.50)  
146 got questionnaire TCTL (8, 10, 13)

These three groups were compared to avoid that differences in assessments actually depend on differences in group-characteristics. The only difference between groups found was the one between sexes. There is a significant difference ( $p=0.05$ ) regarding sex between the groups. The share of men is higher in TCTL than in the other types. Still there are more women than men also in this sub-sample.

This may effect the results so that the results from TCTL are coloured too much of men's preferences.

Other characteristics studied without finding any significant differences between the three groups are

- on which bus route the passenger was contacted
- passenger's age
- trip purpose
- number of interchanges the passenger has done during the trip
- passenger's availability of seating place on bus
- passenger's occupation
- in-vehicle travel time

## 4 COMPARING THE THREE TYPES

To compare the three different SP questionnaires various aspects of their performance were tested. Several tests were done to compare the different questionnaires' performance. Various tests give more information about how the different ways of expressing trip costs works in a Stated Preference survey.

The tests with results are described in this section.

### 4.1 Response rate

The response rate is the first test to see if the inquiry was interesting at all and possible to send in. If the response rate is high the answers represent the population in a better way than if only a few people have answered.

Unfortunately the response rate cannot be calculated for 390-card users only. The figures are based on answers from the short interview on the bus before handing out the questionnaires. It's only known if the person uses a period ticket, discount card or is paying this trip cash. Period tickets then in addition include monthly tickets valid in various areas, for specific age groups, only during off-peak hours, or for other periods than months.

**Table 2 Response rate (number of returned questionnaires divided by number of hand-outs).**

Type	Response rate
MCCL (300, 390, 500)	56%
TCCL (5, 6.50, 8.50)	54%
TCTL (8, 10, 13)	50%

There is no significant difference between the three ways of expressing the cost per trip. People using a period ticket seem just as willing to consider alternatives where the travel cost is described per month as described per trip.

### 4.2 Non-complete Answers

Even if the questionnaire was sent in the SP task was not always solved in the right way. A complete binary choice game gives 6 observations per game, but all choices may not be made. This can be due to misunderstanding or fatigue.

**Table 3 Number of non-complete answers depending on questionnaire type.**

	non-complete answers	complete answers
MCCL (300, 390, 500)	4	140
TCCL (5, 6.50, 8.50)	7	114
TCTL (8, 10, 13)	7	146

There is no significant difference between questionnaire types regarding number of non-complete answers.



### 4.3 Share of Lexicographical Answers

If the SP task is too difficult, the respondent tries to simplify it. One way to do this is to sort the alternatives according to only one factor. This is called lexicography. Lexicographically sorted answers are not always wrong (see e.g. Widlert, 1992). One parameter, for example the cost, could be extremely important to the respondent. The design of the game could be unbalanced so that one factor dominates the others. The alternatives could be lexicographically sorted by random.

Share of lexicography is still to be tested in a quality test because the factor that respondents have sorted according to will be overestimated in the analysis if the respondent has sorted lexicographically instead of assessing the alternatives in the right way. On the other hand if the design is unbalanced and hasn't be able to meet the respondents preferences, the attribute will be underestimated.

**Table 4 Lexicographically sorted answers by factor.**

	sorted by cost	sorted by walking time	sorted by in-vehicle time	sorted by bus frequency	lexicographically sorted games	total no of games
MCCL	42 (30%)	6 (4%)	7 (5%)	24 (17%)	68 (49%)	140
TCCL	19 (17%)	6 (5%)	13 (11%)	25 (22%)	58 (51%)	114
TCTL	17 (12%)	8 (5%)	19 (13%)	42 (29%)	74 (51%)	146

Total share of lexicography is the same for all three types, about 50%. Note that some answers could be sorted lexicographically according to more than one attribute at the same time. That's why the numbers in "lexicographically sorted games" are not the same as the sum of the four first columns.

Which attribute persons have sorted according to differs however between questionnaire types. Table 4 shows that lexicography according to cost is more common among MCCL questionnaires than in other types. Thus when cost is presented as a per month cost, that is with higher amounts, more people seem to sort according to cost.

In types TCCL and TCTL, where cost is expressed per trip, the factor most sorted according to is bus frequency.

### 4.4 Model

One model including all interesting data was created allowing the assessment of cost to vary with questionnaire type.

$$U = a_{c,MCCL} * c + a_{c,TCCL} * c + a_{c,TCTL} * c + a_w * w + a_v * v + a_f * f + \varepsilon$$

where

$a_i$  are the parameters for cost, walking time, in-vehicle time, and bus frequency

$c$ ,  $w$ ,  $v$ , and  $f$  are the cost, walking time, in-vehicle time, and frequency actually presented in the alternative

For each alternative only one  $a_c$  was present, the others were zero.

To make it possible to use the monthly ticket price questionnaires, MCCL, in the same model as types TCCL and TCTL, it was necessary to convert the cost per month to cost per trip. It was done by dividing the monthly cost by the answer on question “How many times do you use bus or tram during one month?” for each person respectively. For those people who hadn’t answered this question an average was used.

Since the number of trips per month varies a lot, even the cost per trip varies between travellers. Number of trips ranged from 4 to 100 in the present group. Excluding the outliers (trips per month fewer than 20 and more than 80) from the data didn’t make the model better. The size of the standard errors remained about the same and the rho-2 was even reduced. This decrease of the quality of the model is probably due to loss of observations. All observations are therefore kept in the modelling.

#### 4.5 The Estimated Parameters’ Precision

Alogit was used to estimate the model’s parameters ( $a_i$ ). Standard errors and t-values were also calculated. Each parameter’s t-value shows if the parameter has had any influence on the choice.

**Table 5 Estimated parameters with t-values.**

	parameter	t-value
cost, MCCL	-0.5742	-14.3
cost, TCCL	-0.3835	-8.7
cost, TCTL	-0.3199	-10.3
walking time to bus stop	-0.1068	-5.8
in-vehicle time	-0.0896	-13.9
bus frequency time	-0.1136	-20.2

Table 5 shows that all included attributes have parameters separated from 0.

#### 4.6 Assessments and their Precision

Valuations of each of the three assessed standard factors are calculated as the factors’ estimated parameter divided by the cost’s estimated parameter. In table 6 values of time of different parts of the bus trip are shown estimated from each questionnaire type.

**Table 6 Average value of time, SEK per hour. Standard error in parenthesis.**

	walking time to bus stop	in-vehicle time	bus frequency time
MCCL	11.16 (1.89)	9.36 (0.76)	11.87 (0.77)
TCCL	16.71 (3.15)	14.01 (1.69)	17.77 (1.96)
TCTL	20.03 (3.60)	16.80 (1.74)	21.31 (1.96)

As expected all valuations are positive meaning that longer time is less comfortable. The relationships between walking time, in-vehicle time, and bus frequency time are as expected i.e. in-vehicle time is least uncomfortable while walking time is about as uncomfortable as bus frequency time is.

If you want to compare the assessment of bus frequency time with the more often used assessment of waiting time, the bus frequency time should be multiplied by 2, if you assume the average waiting time to be half the bus interval.

The assessments show a clear pattern; assessments from MCCL are lower than those from TCCL, which are lower than those from TCTL. All differences between MCCL and TCTL are significant (0.05), table 7.

**Table 7 Significance tests, differences between questionnaire types. p.**

	walking time to bus stop	in-vehicle time	bus frequency time
MCCL vs TCCL	0.20	0.05	0.05
MCCL vs TCTL	0.05	0.05	0.05
TCCL vs TCTL	-	-	-

The estimated assessments from TCCL and TCTL are not significantly different. In a way this is positive. It means that the actual size of the levels presented in the alternatives don't affect the estimated assessments.

Another way of measuring the quality of the answers is comparing the size of the standard errors. Of course the size of the standard errors not only depends on the type of SP questionnaire, but also on number of observations and homogeneity among respondents.

There's a clear pattern concerning size of standard errors as well. MCCL has the smallest and TCTL the largest standard errors. This difference cannot be explained only by the fact that the number of observations differs between segments. The ratios between standard errors are larger than the ratio between number of observations. Besides the number of observations per person is six for all respondents, so the "repeated measurement problem" is no problem in this comparison.

## **5 SUMMARY OF RESULTS: RELIABILITY AND VALIDITY**

The quality of the questionnaires' results can be discussed in terms of reliability and intern respective extern validity.

Reliability is poor if the results depend a lot on the survey's design and on when and where it is conducted. Poor reliability might show as insignificant estimations of parameters and large standard errors.

Even intern validity, if the estimated models can describe the choices made in the Stated Preference-experiment, can be explored when studying the parameters' t-values and the assessments' standard errors.

The response rate and occurrence of non-complete answers are together with share of lexicographical answers means to study the external validity. If loss of observations is low and lexicography not too high or uneven distributed the model is more likely to predict people's acting in the future. The assessed

valuations are also to be compared with earlier findings, to analyse reasonability.

When comparing the three questionnaire types' response rate and loss of observations no differences are found. People seem just as willing to make choices between costs expressed in monthly costs as in per trip costs.

Total amount of lexicographical answers is also equal in all three types. But TCCL is the type with most evenly spread lexicography. In MCCL there's a dominance of games sorted by cost and in TCTL there's a dominance of games sorted by bus frequency.

All assessed valuations of travel time in this study are reasonable. They have the right signs and are within common ranges. The assessments from MCCL are lower than the other ones, partly because of the lexicographical sorting by cost in this type. Because of other budget situations when comparing costs per month, the cost became more important which partly was shown through lexicographical sorting according to cost.

The assessments from types TCCL and TCTL cannot be significantly divorced from each other. They practically give the same results. Both trip costs of 5,6.50,8.50 SEK and 8,10,13 SEK seem just as realistic to this group paying 390 SEK per month for their ticket.

All assessments from MCCL have smaller standard errors and the cost parameter's t-value is higher than the ones from other questionnaire types. The high t-value can to some extent be assigned to the lexicographical sorting according to cost. But since the standard errors of the ratios ( $a_{\text{time}}/a_{\text{cost}}$ ) are small, meaning that the valuations of time are rather well estimated, there probably have been trade-offs when choosing between alternatives.

## 6 CONCLUSION

At least two conclusions can be drawn from this analysis

- 1) the estimated assessments are different depending on how trip cost is expressed
- 2) quality of results increases when attributes are expressed in a way that respondents recognise

The two main ways expressing the cost, per month and per trip, give different assessments. Which assessments that are the correct ones depend on what is to be investigated and on where the findings shall be used.

If valuations of travel time shall be assessed, it's probably most appropriate to use per trip cost. It's convenient because in that case the same questionnaire design can be used for both monthly ticket users and for passengers travelling with discount cards or paying cash.

When results are used for predicting the local transport authority's incomes caused by traffic changes it is probably more right to use the monthly ticket cost.

It seems like passengers paying per month find it more realistic to state their preferences when cost is expressed per month.

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