VALUE OF DUTCH TRAVEL TIME SAVINGS IN 1997

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Abstract

Savings in travel time are almost always the major benefit that accrues from investment in the transport sector.

The paper describes a study to update current practice in The Netherlands, based on a 1997 study replicating the 1988 study on which current procedures are based.

INTRODUCTION

This paper describes the results of a study into "Value-of-Time" for car drivers and public transport passengers undertaken in 1997 in The Netherlands. It also compares the results with those from an earlier study, using data from 1988. Crucially, both studies used Stated Preference experiments with an identical experimental design.

On behalf of the Dutch Ministry of Transport and Public Works, between 1986 and 1990 a study team led by Hague Consulting Group (HCG) collected data and developed Values of Travel Time Savings or Losses (VOTs) for motorised travel in the Netherlands (including car and public transport, with walking and waiting components of public transport trips). These values were derived from models using data from Stated Preference and Revealed Preference (SP and RP) surveys, National Travel Survey (OVG) and official statistics such as price indices and wage rates (Bradley *et al* (1990), Gunn *et al* (1989)).

These references set out the choice of models used to relate VOT to potential explanatory variables suggested by economic theory, the choice of data base and the analytic methods used. These are not repeated in this paper

Below we describe a more recent study to update the Values of Time, using data from 1997. The study sets out to examine the evidence for model stability (whether or not factors explaining person-to-person differences were themselves stable over time) and the corresponding evidence for any remaining trends over time (unexplained differences in levels of VOT).

For the 1997 experiment, the surveys, methods and SP model specification from the original study are replicated as closely as possible, in order to avoid differences in the outcomes which could be confounded with changes in the methods used.

The update study discussed here basically consist of the following tasks:
1. Designing the survey
2. Conducting the survey
3. Data analysis and estimation of the SP models using the new data

The objectives of the study were twofold: firstly, to provide VOTs for passenger travel which are based on current information on trade-offs, person and household attributes, trip patterns, working hours and travel conditions, to be used in evaluation projects; secondly, to compare VOTs over time to improve predictive procedures.

SURVEY DESIGN AND CONDUCT

Target sample sizes

In an earlier study, reported in de Jong *et al* (1998), the variances of group average VOTs based on the 1988 SP survey were calculated. Subsequent work in the present study extended this approach to give sample sizes needed to measure in group average VOT estimates at an accuracy which would be adequate to detect a 10% change at the 95% confidence level.

The calculation indicated that an approximate doubling of the 1988 sample was needed.
Taking into account priorities in focus on different sectors, we have chosen for the current update survey to set target sample sizes using the following breakdown by purpose:

Commuting:	2,500
Other:	1,500
Business:	1,000

The questionnaires

For the design of the survey, the original concept of the VOT study in 1988 was followed closely, given that one of the research goals of this entire study was to allow comparability between the studies. The surveys, methods and SP model specification from the original study were therefore all repeated as closely as possible, in order to avoid confounding genuine changes over time with spurious effects due to the experimental methods used.

The experimental design of the 1988 SP experiment has been replicated without modifications. Therefore, in the SP questions, the attributes time and cost were varied according to the travel time class as reported during the recruitment survey. The amount of travel time variations presented to the respondent followed the replicated logic:

Table 1 - SP design variations

For trips of	*Travel time change presented*
45 minutes or less	5 and 10 minutes
46 to 90 minutes	10 and 20 minutes
91 to 135 minutes	15 and 30 minutes
136 minutes or longer	20 and 40 minutes

The variations in travel costs were based on an amount of Dutch cents per minute, which varied for each of the 12 choices.

Recruiting

In total 16000 recruiting forms were produced, of which 10817 were used. From these 10817 recruitment forms, 8738 follow-up questionnaires could be sent (81%). The difference was mainly due to refusal to participate and to partially or erroneously completed recruitment forms.

The main questionnaire

The number of responses on each phase in the data collection stage is graphically depicted in figure 1.

Detailed analysis on key variables of the survey were carried out in order to analyse whether serious biases could be expected due to non-response or inadequate data quality. Based on this analysis, we concluded that the data obtained were valid sound.

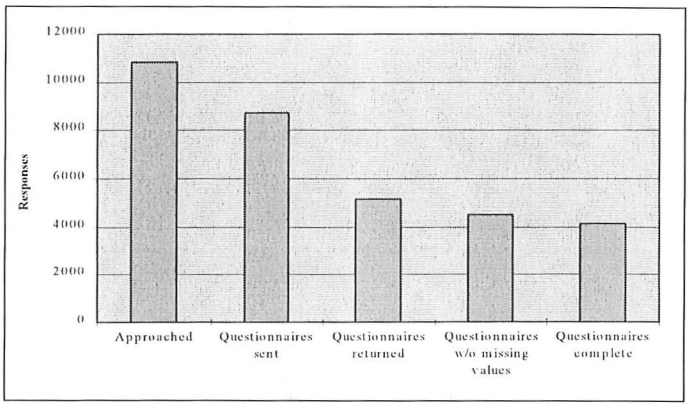

Figure 1 - Number of responses by data collection phase

MODEL ESTIMATION

Introduction

The SP data described about was used to estimate choice models of time-cost trade-offs. The parameters of these models provide the base for calculation of the VOT for individuals, samples, populations or segments of populations. This chapter describes the models that were estimated for further VOT calculations (see Bradley and Gunn (1990)).

In the course of analysing the data, the following models have been estimated (for each of the three travel purposes):

1. a logit model on the 1997 SP data, with segmentation variables, using the same interaction terms with travel time and cost as in the model on the 1988 SP data (see HCG-report "The Netherlands' 'Value of Time' study: Final Report", 1990).

2. the same model on the pooled data of 1988 and 1997, both with and without a time trend term (defined as the multiplication of travel time and a dummy variable, which takes the value 0 in case of 1988 data and 1 in case of 1997 data) to analyse the evolution over time (ceteris paribus).

3. a logit model with less segmentation designed to ensure better efficiency in model estimation. In these models, only significant variables are maintained, with the intention of reducing the variance in VOT estimates. For comparison, these models were also estimated on the 1988 data.

4. the same model on the pooled data, both with and without a trend term.
These specifications have been chosen to highlight similarities and differences between the data sets.

For all models, T-values and ratio's for all parameters have been calculated using Jack-knife methods and using the results, confidence intervals for the VOT estimates have been derived by using draws from a joint Normal distribution (Daly *et al* (1996)).

In the following four sections the results of estimating each of these models are discussed. The last section of this Model estimation chapter contains the results of using the estimated model to derive

Estimation using the 1988 specification

First, models were estimated on 1997 data with the same specification as the 1988 models. Models with the original specification estimated on the 1988 data set have been estimated in a previous study (HCG-report "The Netherlands' 'Value of Time' study: Final Report", 1990).

For all three purposes, comparing the 1988 and the 1997 models, we find that a slightly smaller part of the variance in the data is explained by the model in 1997 as compared to 1988, showing that the 1988 specification fitted slightly better for that year than for 1997.

We found that the models estimated using the 1988 specification are quite comparable with respect to the time and cost parameters, and the effects of various socio-economic variables and travel circumstances.
Looking at the results by purpose, we find some changes in behaviour, which are given in some detail below. All results are given with respect to a 'base-group", consisting of medium income, males, aged 20-35 years with more than 50 hours of free time.

Commuting

For the commuting purpose, we have found that in 1988 part-timer workers were more time sensitive than the base group, while being less time sensitive in 1997. A possible explanation may be found in the composition of the part timers group: compared to 1988, our current sample includes less single workers, more women, more people older than 35 and more train, bus and tram travellers. Therefore, the group of part timers in 1997 contains more people with lower time sensitivity, possibly accounting for the shift in the sign.

Secondly, the effect of travel speed by car on highways has changed. Compared to the base situation of the models (urban traffic) car drivers on highways still have a higher time sensitivity. However, in 1997 there is some slight evidence that time sensitivity increases with increasing speed, whereas in 1988 time sensitivity was found to decrease with increasing speed.

Thirdly the effects of being in a double income household with no children (DINK) or having children have disappeared: In 1988 a higher time sensitivity for people with children and DINKs was found. In 1997, however, these categories do not have significantly higher time sensitivities anymore.

More details can be obtained from the table below giving the estimated coefficients for the Commuting purpose.

Table 2 - Commuting VOT

Sample	1988		1997		pooled (with time trend)		pooled (without time trend)	
Observations	5335		17787		23122		23122	
Final logL	-2995.2		-9790.3		-12834.1		-12843.7	
D.O.F.	22		22		23		22	
Rho2(0)	0.19		0.206		0.199		0.199	
Rho2(c)	0.183		0.180		0.179		0.178	
parameter	estimate	T-value	estimate	T-value	estimate	T-value	estimate	T-value
Cost	-0.0063	-19.90	-0.0070	-32.60	-0.0067	-38.20	-0.0066	-38.10
Time	-0.0815	-10.60	-0.1010	-18.20	-0.1029	-22.40	-0.0970	-22.10
Cost*Inc<3000	-0.0007	-1.60	0.0004	1.50	0.0001	0.30	0.0001	0.30
Cost*Inc5000-7500	0.0016	4.70	0.0008	3.40	0.0010	5.20	0.0009	4.90
Cost*Inc7500-10000	0.0016	4.50	0.0024	10.30	0.0022	11.30	0.0021	11.10
Cost*Inc>10000	0.0023	5.70	0.0037	15.50	0.0034	16.80	0.0033	16.50
Time*Kids	-0.0164	-2.60	-0.0001	0.00	-0.0027	-0.90	-0.0033	-1.20
Time*DINK	-0.0119	-2.00	0.0038	1.30	0.0011	0.40	0.0001	0.00
Time*Solo	-0.0175	-2.40	-0.0098	-2.80	-0.0108	-3.40	-0.0110	-3.50
Time*PTime	-0.0240	-3.50	0.0118	3.00	0.0035	1.00	0.0033	1.00
Time*Age16-20	-0.0352	-3.10	-0.0114	-1.30	-0.0162	-2.30	-0.0179	-2.60
Time*Age36-50	0.0120	2.30	0.0057	2.20	0.0064	2.80	0.0066	2.90
Time*Age51	0.0139	2.20	0.0240	6.70	0.0222	7.20	0.0221	7.20
Time*Female	0.0163	3.20	0.0086	3.50	0.0099	4.50	0.0106	4.80
Time*Free<=35	-0.0236	-2.70	-0.0080	-2.20	-0.0116	-3.50	-0.0095	-2.90
Time*Free<=49	-0.0179	-3.80	-0.0024	-1.00	-0.0051	-2.40	-0.0032	-1.50
Time*Train	-0.0049	-0.80	-0.0025	-0.50	-0.0054	-1.50	-0.0029	-0.80
Time*BTM	0.0073	1.10	0.0041	0.80	0.0033	0.80	0.0056	1.50
Time*Speed0-90	-0.0552	-5.00	-0.0113	-2.10	-0.0189	-4.20	-0.0165	-3.70
Time*Speed-100	-0.0433	-3.60	-0.0026	-0.30	-0.0146	-2.10	-0.0147	-2.10
Time*Speed-110	-0.0290	-4.20	-0.0178	-3.40	-0.0220	-5.30	-0.0209	-5.00
Time*Speed>110	-0.0078	-0.90	-0.0196	-3.90	-0.0212	-5.20	-0.0180	-4.50
Time*97					0.0106	4.30		

Business

For the purpose business models, both in 1988 and in 1997, it is found that people in younger age categories are apparently more time sensitive. However, in 1997 it is also found that people older than 51 are less time sensitive. Although no difference between sexes was found in 1988, the 1997 model suggests that female business travellers are less time sensitive. As in 1988, people with less than 35 hours of free time are more time sensitive. The effect of having between 35 and 49 hours of free time is not significant in 1997. The effect of sub-purpose "other work", causing a lower time sensitivity in 1988, is not significant in the 1997 model. The effect of transport mode on time sensitivity has become more significant in the 1997 model. Bus and tram travellers are found to have a lower time sensitivity. Finally, the effect of travel speed by car on highways has changed. Compared to the base (urban traffic) car drivers on highways do not have a different time sensitivity in the 1997 model. Contrary to 1988, we do not find an effect of travel speed on time sensitivity in the 1997 data set.

More details can be obtained from the table below giving the estimated coefficients for the Business purpose.

Table 3 - Business (Own Time) VOT

Sample	1988		1997		pooled with time trend		pooled without time trend	
Observations	5159		12771		17930		17930	
Final logL	-2810.1		-6865.1		-9712.4		-9715.9	
D.O.F.	22		22		23		22	
Rho2(0)	0.214		0.224		0.219		0.218	
Rho2(c)	0.161		0.159		0.157		0.156	
Parameter	**estimate**	**T-value**	**estimate**	**T-value**	**estimate**	**T-value**	**estimate**	**T-value**
Cost	-0.0038	-14.70	-0.0045	-24.60	-0.0043	-28.80	-0.0043	-28.80
Time	-0.0765	-9.90	-0.0906	-15.70	-0.0886	-18.70	-0.0849	-18.80
Cost*Inc<3000	-0.0013	-3.00	-0.0019	-6.40	-0.0016	-6.80	-0.0016	-6.80
Cost*Inc5000-7500	0.0001	0.50	0.0007	3.30	0.0006	3.50	0.0006	3.60
Cost*Inc7500-10000	0.0006	1.90	0.0019	9.00	0.0015	8.70	0.0015	8.70
Cost*Inc>10000	0.0023	7.70	0.0029	13.00	0.0028	15.70	0.0028	15.80
Time*Kids	-0.0031	-0.60	-0.0030	-0.90	-0.0016	-0.60	-0.0022	-0.80
Time*DINK	-0.0061	-1.20	0.0001	0.00	-0.0003	-0.10	-0.0009	-0.30
Time*Solo	-0.0326	-4.60	-0.0075	-2.10	-0.0115	-3.60	-0.0117	-3.70
Time*PTime	0.0126	1.50	0.0062	1.40	0.0037	1.00	0.0042	1.10
Time*Age16-20	-0.0354	-2.10	-0.0269	-3.00	-0.0275	-3.50	-0.0274	-3.50
Time*Age36-50	0.0052	1.20	-0.0018	-0.60	0.0005	0.20	0.0003	0.10
Time*Age51	0.0022	0.40	0.0133	3.90	0.0107	3.70	0.0106	3.70
Time*Female	0.0011	0.20	0.0060	2.10	0.0043	1.70	0.0046	1.80
Time*Free<=35	-0.0287	-4.70	-0.0100	-2.80	-0.0167	-5.50	-0.0151	-5.10
Time*Free<=49	-0.0154	-3.70	0.0023	0.80	-0.0033	-1.40	-0.0020	-0.90
Time*OtherWork	0.0144	3.70	0.0043	1.70	0.0072	3.50	0.0073	3.50
Time*Train	0.0143	2.20	0.0142	2.90	0.0127	3.30	0.0136	3.50
Time*BTM	0.0175	1.90	0.0320	5.30	0.0262	5.40	0.0268	5.50
Time*Speed-100	-0.0254	-2.60	-0.0033	-0.60	-0.0087	-1.90	-0.0079	-1.70
Time*Speed-110	-0.0097	-1.50	-0.0036	-0.70	-0.0071	-1.80	-0.0072	-1.80
Time*Speed>110	-0.0027	-0.40	-0.0040	-0.80	-0.0046	-1.20	-0.0044	-1.10
Time*97					0.0058	2.60		

Other

Comparing the models for the 'Other' purpose between 1988 and 1997, we can conclude that they are quite similar. A few differences are listed in this section.

Although no difference between sexes was found in 1988, the 1997 model suggests that female 'other' travellers are less time sensitive.

As in 1988, people with less than 49 hours of free time are significantly more time sensitive in the 1997 model. The effect of having between 49 and 63 hours of free time, however, has also became significant now. Remarkably, this category has a lower time sensitivity as compared to the base group that has even more free time.

Finally, the effect of travel speed by car on highways, which did not show a clear pattern in 1988, is not significant anymore.

More details can be obtained from the table below giving the estimated coefficients for the 'Other' purpose.

Table 4 - Other purpose VOT

Sample	1988		1997		pooled with time trend		pooled without time trend	
Observations	12166		14630		26796		26796	
Final logL	-6577.6		-8158.1		-14777.9		-14797.1	
D.O.F.	26		26		27		26	
Rho2(0)	0.22		0.196		0.204		0.203	
Rho2(c)	0.207		0.193		0.198		0.197	
Parameter	**estimate**	**T-value**	**estimate**	**T-value**	**estimate**	**T-value**	**estimate**	**T-value**
Cost	-0.0068	-33.70	-0.0067	-36.10	-0.0067	-49.50	-0.0066	-49.30
Time	-0.0916	-17.80	-0.0921	-18.50	-0.0978	-27.10	-0.0920	-26.50
Cost*Inc<2000	-0.0017	-6.00	-0.0010	-4.00	-0.0012	-6.80	-0.0012	-6.80
Cost*Inc2000-3000	-0.0004	-1.70	0.0001	0.50	-0.0001	-0.60	-0.0001	-0.40
Cost*Inc5000-7500	0.0008	3.60	0.0006	2.60	0.0006	4.20	0.0007	4.30
Cost*Inc7500-10000	0.0017	6.40	0.0012	4.60	0.0014	7.80	0.0014	7.80
Cost*Inc>10000	0.0024	9.50	0.0026	10.10	0.0025	13.70	0.0025	13.80
Time*Kids	-0.0020	-0.60	0.0013	0.40	0.0002	0.10	0.0004	0.20
Time*DINK	-0.0063	-1.70	-0.0027	-1.00	-0.0032	-1.50	-0.0019	-0.90
Time*Solo	-0.0082	-2.10	-0.0057	-1.90	-0.0074	-3.20	-0.0061	-2.60
Time*PartTime	0.0055	1.20	0.0005	0.10	0.0025	0.90	0.0031	1.20
Time*HouseWife	0.0163	3.60	0.0140	3.40	0.0137	4.60	0.0125	4.20
Time*Pensioner	0.0154	3.10	0.0081	1.90	0.0098	3.10	0.0095	3.00
Time*Age16-20	0.0103	2.80	0.0107	3.90	0.0098	4.50	0.0100	4.60
Time*Age36-50	0.0027	0.90	0.0014	0.50	0.0020	0.90	0.0013	0.60
Time*Age51	0.0200	5.30	0.0221	6.40	0.0221	8.90	0.0220	8.80
Time*Female	-0.0033	-1.30	0.0102	5.40	0.0053	3.50	0.0061	4.10
Time*Free<=49	-0.0137	-4.10	-0.0057	-2.00	-0.0080	-3.90	-0.0083	-4.00
Time*Free<=63	-0.0010	-0.40	0.0061	2.00	0.0027	1.40	-0.0007	-0.40
Time*Education	-0.0171	-4.90	-0.0140	-5.50	-0.0166	-8.20	-0.0163	-8.00
Time*Shop/PB	0.0083	2.50	0.0129	4.20	0.0097	4.30	0.0091	4.10
Time*Train	0.0013	0.30	0.0050	1.20	0.0045	1.60	0.0056	2.00
Time*BTM	0.0222	5.20	0.0135	3.00	0.0186	6.10	0.0190	6.20
Time*Speed-100	0.0063	0.60	0.0070	1.00	0.0074	1.40	0.0100	1.80
Time*Speed-110	0.0102	2.30	0.0031	0.70	0.0076	2.40	0.0079	2.50
Time*Speed>110	-0.0216	-3.80	0.0039	0.80	-0.0025	-0.70	-0.0006	-0.20
Time*97					0.0093	6.20		

1988 specification using pooled data

In addition, using the pooled data set, another two models were estimated. Firstly, a model was estimated with exactly the same specification as the 1988 model. Secondly, a model was estimated that included a time-trend variable. Both models were estimated using the specification as used in the previous study.

The estimation results were, as expected, very similar to the separate 1988 and the 1997 models. We found plausible results such as cost sensitivity decreases with increasing income; time sensitivity decreases with age, more hours of free time and a higher time sensitivity for single workers. No significant effects of being a DINK, having kids or working part time were found. The latter is caused by the fact that the opposite effects of the two models are now neutralised by each other.

In estimating the models using a time-trend variable, we found a significant increase of the goodness-of-fit of the model. The significant positive parameter suggests that travellers in 1997 are, ceteris paribus, less time sensitive than they were in 1988. Note however that the impact on the average VOT of many other factors has already been accounted for by the other variables in the model and their coefficient values. For more details see tables 2 – 4.

Estimation using a new specification

In this section we discuss a set of new models, that were subsequently used to estimate all three purposes. The aim of the new specification has been to derive a more efficient model, which uses less, but more significant variables to describe the variance in the travel time valuation. An outcome of the use of a more efficient model is that the confidence intervals of VOT estimates will become smaller; validation of the new specification must avoid subsequent experiments.

The strategy that was followed in deriving the new models entailed removing variables that proved not to be significant in the previous models. Occasionally, new variables were added or existing variables were redefined into new categories. The new models were estimated on the 1988 sample, the 1997 sample and on the pooled data set. In the latter case (as described in the next section) the model was estimated with and without a time trend variable.

In all three purposes, variables representing the effect of having kids and being a DINK have been removed from the model.

In Commuting and Other segments the variables representing the effect of low income and travelling by public transport have been removed from the model.

In Business and Other segments variables representing the effect of working part time, being between 36 and 50 years old, and various speeds on the highway have been removed from the model.

In Commuting and Business segments having between 35 and 49 hours of free time is removed. For commuting only being between 16 and 21 years old is removed as explanatory variable in the model. For the commuting purpose, the variables representing the effect of highway travel speeds have been combined into one variable, indicating whether or not one travels on a highway. This variable has a significant and negative parameter, suggesting that travellers using the highway have a higher VOT than travellers in urban areas. In addition, the effect of travelling in the morning peak has been introduced into the model. These travellers were found to have a significantly higher value of time.

For the models in the "Other" segment, two variables were added: Firstly a variable indicating whether or not the household contains two or more workers were added. This variable is not significant in the 1988 model, but is significant and negative in 1997, indicating that travellers from households with two or more workers have a higher value of time. This finding reflects the higher time pressure in double income families, as one would expect. Secondly, the train and BT variables were combined into one variable representing the effect of travelling by public transport. This variable is significant in 1988 and almost significant in 1997. The positive sign suggests that public transport travellers have a lower VOT.

In estimating the models using the new specification, we found for each of the purposes that the effect of variables that were already in the old model remained unchanged in this model, apart from small changes in the size of parameters. More details can be obtained from the three tables below giving the estimated coefficients for each of the purposes.

Table 5 - Commuting

Sample	1988		1997		pooled with time trend		pooled without time trend	
Observations	5335		17787		23122		23122	
Final logL	-3014		-9797.3		-12839.5		-12847.3	
D.O.F.	13		13		14		13	
Rho2(0)	0.185		0.205		0.199		0.198	
Rho2(c)	0.178		0.179		0.178		0.178	
Parameter	**estimate**	**T-value**	**estimate**	**T-value**	**estimate**	**T-value**	**estimate**	**T-value**
Cost	-0.0065	-22.30	-0.0068	-35.30	-0.0067	-41.80	-0.0066	-41.80
Time	-0.0990	-19.90	-0.1010	-35.90	-0.1071	-34.80	-0.0999	-40.90
C-Inc6	0.0018	5.80	0.0006	3.10	0.0009	5.50	0.0009	5.20
C-Inc7	0.0019	5.80	0.0022	10.70	0.0022	12.30	0.0021	12.00
C-Inc8	0.0027	7.30	0.0036	16.30	0.0034	17.80	0.0033	17.60
T-Solo	-0.0027	-0.50	-0.0127	-4.30	-0.0108	-4.20	-0.0102	-3.90
T-PTime	-0.0162	-2.50	0.0115	3.10	0.0047	1.40	0.0039	1.20
T-Age36-50	0.0103	2.20	0.0057	2.40	0.0067	3.10	0.0071	3.30
T-Age51	0.0231	3.80	0.0244	7.20	0.0241	8.20	0.0243	8.30
T-Female	0.0124	2.60	0.0093	3.90	0.0102	4.80	0.0107	5.00
T-Free<=35	-0.0158	-1.90	-0.0065	-2.00	-0.0086	-2.90	-0.0079	-2.70
T-Highway	-0.0211	-4.20	-0.0140	-5.80	-0.0157	-7.20	-0.0153	-7.10
T-AMPeak	-0.0224	-3.40	-0.0064	-2.00	-0.0100	-3.50	-0.0106	-3.70
T-97					0.0090	3.90		

Table 6 - Business

Sample	1988		1997		pooled with time trend		pooled without time trend	
Observations	5159		12771		17930		17930	
Final logL	-2825		-6867.4		-9717.0		-9719.8	
D.O.F.	14		14		15		14	
Rho2(0)	0.21		0.224		0.218		0.218	
Rho2(c)	0.156		0.159		0.156		0.156	
Parameter	**estimate**	**T-value**	**estimate**	**T-value**	**estimate**	**T-value**	**estimate**	**T-value**
Cost	-0.0038	-15.00	-0.0045	-24.70	-0.0043	-28.90	-0.0043	-28.90
Time	-0.0911	-23.50	-0.0941	-35.80	-0.0962	-36.00	-0.0926	-42.70
C-Inc3	-0.0013	-3.10	-0.0019	-6.50	-0.0017	-7.20	-0.0017	-7.20
C-Inc6	0.0002	0.90	0.0007	3.40	0.0006	3.60	0.0006	3.60
C-Inc7	0.0007	2.20	0.0019	9.10	0.0015	8.80	0.0015	8.80
C-Inc8	0.0024	8.50	0.0029	13.20	0.0027	15.90	0.0028	16.00
T-Solo	-0.0278	-4.70	-0.0062	-2.00	-0.0109	-4.10	-0.0107	-4.00
T-Age16-20	-0.0292	-1.80	-0.0265	-3.00	-0.0269	-3.50	-0.0269	-3.50
T-Age51	0.0044	0.90	0.0146	4.80	0.0118	4.60	0.0118	4.60
T-Female	0.0034	0.60	0.0068	2.40	0.0052	2.10	0.0055	2.20
T-Free<=35	-0.0235	-4.10	-0.0123	-4.20	-0.0152	-5.80	-0.0145	-5.60
T-OthWork	0.0144	3.80	0.0047	2.00	0.0073	3.60	0.0074	3.60
T-Train	0.0227	5.00	0.0178	6.60	0.0193	8.40	0.0198	8.60
T-BTM	0.0264	3.30	0.0349	8.10	0.0325	8.70	0.0328	8.80
T-97					0.0050	2.30		

Table 7 - Other

Sample	1988		1997		pooled with time trend		pooled without time trend	
Observations	12166		14630		26796		26796	
Final logL	-6634.6		-8172.3		-14830.2		-14845.9	
D.O.F.	18		18		19		18	
Rho2(0)	0.213		0.194		0.202		0.201	
Rho2(c)	0.2		0.192		0.195		0.195	
Parameter	estimate	T-value	estimate	T-value	estimate	T-value	estimate	T-value
Cost	-0.0067	-33.60	-0.0067	-36.20	-0.0067	-49.60	-0.0066	-49.40
Time	-0.0883	-25.00	-0.0866	-27.00	-0.0915	-35.80	-0.0855	-37.10
C-Inc3	-0.0009	-4.20	-0.0004	-2.00	-0.0006	-4.20	-0.0006	-4.00
C-Inc6	0.0007	3.30	0.0005	2.40	0.0006	4.30	0.0007	4.30
C-Inc7	0.0017	6.50	0.0011	4.50	0.0014	8.10	0.0014	8.10
C-Inc8	0.0024	9.50	0.0026	10.20	0.0025	14.10	0.0025	14.10
T-2wrkrs	-0.0032	-1.10	-0.0054	-2.20	-0.0041	-2.30	-0.0039	-2.10
T-Solo	-0.0101	-2.70	-0.0059	-2.10	-0.0080	-3.60	-0.0070	-3.20
T-HWife	0.0172	4.10	0.0144	3.70	0.0141	5.00	0.0125	4.50
T-Pens	0.0156	3.30	0.0077	1.90	0.0095	3.10	0.0088	2.90
T-Age16-20	0.0096	2.80	0.0111	4.20	0.0100	4.90	0.0100	4.90
T-Age51	0.0182	5.40	0.0200	6.40	0.0204	9.00	0.0205	9.10
T-Female	-0.0025	-1.00	0.0106	5.70	0.0058	4.00	0.0066	4.50
T-Free<=49	-0.0129	-4.00	-0.0061	-2.20	-0.0087	-4.40	-0.0091	-4.50
T-Free<=63	-0.0007	-0.30	0.0054	1.90	0.0019	1.00	-0.0011	-0.60
T-Educatn	-0.0206	-6.00	-0.0133	-5.30	-0.0166	-8.30	-0.0163	-8.20
T-Shop/PB	0.0060	2.00	0.0125	4.30	0.0085	4.10	0.0077	3.70
T-OV	0.0091	3.60	0.0036	1.60	0.0055	3.40	0.0057	3.50
T-97					0.0082	5.60		

New specification using pooled data

The models with the new specification were also estimated on the combined 1988 and 1997 data set. The models were estimated both with and without a time trend variable. We found that these 'pooled' models show the same behaviour as already found in the models described before.

For commuting travel we find, as with the old model, that the coefficient denoting part-time working practices has a negative sign in the 1988 model, a positive sign in the 1997 model, and is insignificant in the pooled model. As explained before, this is probably due to a shift in the characteristics of part time workers.

As in the case where pooled data was used in the 1988 model specification, we find that the time trend variable still has a positive sign, indicating that travellers in 1997, ceteris paribus, have a lower VOT than in 1988. However, this may be outweighed by the distribution of other variables and their coefficient values, and the effect is in any case small.

Unexpanded VOTs

In this section the use of the estimated models is described in order to calculate average sample VOTs and their confidence intervals.

The calculation of average VOTs and their confidence intervals consists of the following steps:

1. Estimation of the models using the Jack-knife approach described below, to account for the effect of repeated measurements.

2. Simulation of parameter values for each individual by drawing them from a multivariate normal (MVN) distribution defined by the parameter values and the variance/covariance matrix and calculation of the VOT based on the drawn parameters. This is repeated a large number of times (1000 in this case).
3. Calculation of the average sample VOT expanded to national represetativity using exogenous data from the Dutch National Travel Survey.

The results of the application of these steps are discussed below.

Jack-knife

A potential source of bias in the estimation of confidence intervals of parameters in SP studies stems from the fact that multiple responses are obtained from individual respondents (Daly *et al 1996).* Although the parameter estimates themselves may not be seriously biased, significance levels tend to be overestimated, as treating all observations as independent overstates the information content of the data. A way to obtain reliable estimates of the confidence interval of parameters is the use of Jack-knife estimation procedures.

The estimation results of the original and the Jack-knife models are displayed in the following tables. In addition, the ratio of the Jack-knife T-value and the original T-value is displayed, which gives an impression of the relative decrease of the T-values. The tables only display the Jack-knife results of the 1997 models following the 1988 model specification.

Table 8 - Commuting

Variables	Jack-knife estimates		Original estimates		
	estimate	T-value	estimate	T-value	Ratio
Cost	-0.0069	-17.44	-0.007	-32.57	0.54
Time	-0.0999	-10.21	-0.101	-18.16	0.56
C-Inc3	0.0005	0.76	0.0004	1.51	0.50
C-Inc6	0.0008	1.64	0.0008	3.42	0.48
C-Inc7	0.0023	4.55	0.0024	10.27	0.44
C-Inc8	0.0037	8.56	0.0037	15.52	0.55
T-Kids	-0.0001	-0.02	-0.0001	-0.02	1 *
T-DINK	0.0038	0.61	0.0038	1.25	0.49
T-Solo	-0.0098	-1.75	-0.0098	-2.76	0.63
T-PTime	0.0117	1.8	0.0118	2.99	0.60
T-Age16-20	-0.0116	-0.8	-0.0114	-1.29	0.62
T-Age36-50	0.0057	1.34	0.0057	2.24	0.60
T-Age51	0.024	3.64	0.024	6.74	0.54
T-Female	0.0085	1.57	0.0086	3.49	0.45
T-Free<=35	-0.008	-1.55	-0.008	-2.17	0.71
T-Free<=49	-0.0026	-0.68	-0.0024	-0.96	0.71
T-Train	-0.0025	-0.24	-0.0025	-0.53	0.45
T-BTM	0.0038	0.38	0.0041	0.84	0.45
T-Spd0-90	-0.0115	-1.04	-0.0113	-2.11	0.49
T-Spd-100	-0.0025	-0.19	-0.0026	-0.29	0.66
T-Spd-110	-0.0176	-1.5	-0.0178	-3.35	0.45
T-Spd>110	-0.0196	-1.82	-0.0196	-3.92	0.46

- Due to the small size of the T-value, the ratio cannot be adequately calculated.

Table 9 - Business

Business					
Variables	Jack-knife estimates		Original estimates		
	estimate	T-value	estimate	T-value	Ratio
Cost	-0.0045	-10.05	-0.0045	-24.56	0.41
Time	-0.0891	-9.98	-0.0906	-15.7	0.64
C-Inc1	-0.0019	-2.84	-0.0019	-6.39	0.44
C-Inc3	0.0007	1.2	0.0007	3.33	0.36
C-Inc6	0.0019	4.36	0.0019	9.03	0.48
C-Inc7	0.0029	6.96	0.0029	12.98	0.54
C-Inc8	-0.0032	-0.44	-0.003	-0.87	0.51
T-Kids	0	0.01	0.0001	0.02	0.50
T-DINK	-0.0076	-1.11	-0.0075	-2.07	0.54
T-Solo	0.0068	0.65	0.0062	1.37	0.47
T-PTime	-0.0278	-1.89	-0.0269	-3.01	0.63
T-HWife	-0.0015	-0.26	-0.0018	-0.64	0.41
T-Pens	0.0136	2.2	0.0132	3.89	0.57
T-Age16-20	0.0057	1.62	0.006	2.09	0.78
T-Age36-50	-0.0102	-1.3	-0.01	-2.76	0.47
T-Age51	0.0024	0.47	0.0023	0.8	0.59
T-Female	0.0041	1.25	0.0043	1.72	0.73
T-Free<=49	0.0138	2.22	0.0142	2.86	0.78
T-Free<=63	0.0309	4.29	0.032	5.34	0.80
T-Educatn	-0.0028	-0.35	-0.0033	-0.59	0.59
T-Shop/PB	-0.0038	-0.51	-0.0036	-0.73	0.70
T-Train	-0.0041	-0.47	-0.004	-0.81	0.58
T-BTM	0.0309	4.29	0.032	5.34	0.80
T-Spd-100	-0.0028	-0.35	-0.0033	-0.59	0.59
T-Spd-110	-0.0038	-0.51	-0.0036	-0.73	0.70
T-Spd>110	-0.0041	-0.47	-0.004	-0.81	0.58

Table 10 - Other

Other					
Jack-knife estimates			Original estimates		
estimate	T-value		estimate	T-value	Ratio
-0.0067	-21.74		-0.0067	-36.15	0.60
-0.0911	-11.04		-0.0921	-18.55	0.60
-0.0009	-2.46		-0.001	-4.02	0.61
0.0002	0.31		0.0001	0.55	0.56
0.0006	1.19		0.0006	2.56	0.46
0.0012	2.29		0.0012	4.55	0.50
0.0026	7.38		0.0026	10.1	0.73
0.0011	0.23		0.0013	0.45	0.51
-0.0027	-0.54		-0.0027	-0.96	0.56
-0.0058	-1.23		-0.0057	-1.92	0.64
0.0006	0.11		0.0005	0.14	0.79
0.0147	3.15		0.014	3.37	0.93
0.0084	0.99		0.0081	1.86	0.53
0.0106	2.47		0.0107	3.87	0.64
0.0015	0.3		0.0014	0.46	0.65
0.0219	3.6		0.0221	6.37	0.57
0.0103	4.93		0.0102	5.38	0.92
-0.0056	-0.99		-0.0057	-1.99	0.50
0.0062	1.61		0.0061	2.04	0.79
-0.0139	-3.41		-0.014	-5.45	0.63
0.0123	2.61		0.0129	4.21	0.62
0.0046	0.56		0.005	1.21	0.46
0.0129	1.7		0.0135	3	0.57
0.0069	0.85		0.007	1.04	0.82
0.0031	0.28		0.0031	0.66	0.42
0.0036	0.38		0.0039	0.8	0.48

The tables show clearly that the application of the Jack-knife approach has resulted in the expected finding that the estimated parameters of the model were almost exactly equal to the estimates derived before, while (compared with the 'standard' estimation procedure) reducing the significance of these parameters. This leads us to conclude that the hypothesised effect of within person correlations does indeed exist and would lead to a too optimistic estimate of the confidence intervals of parameters and the VOT. Therefore, the Jack-knife estimation results provide a more credible base for reliably establishing the confidence interval of the VOT.

AVERAGE VOT RESULTS

We have concluded that the relationship between the VOTs in the two years, and the explanatory variables used in the models, has remained overall extremely stable. For the practitioners, of course, the important thing is now that stable aggregate values have remained.
The aggregate values are effected by the distribution of activities between population groups (distinguished by income, sex, etc.) and modes.
The main resulting values of time are given in the three tables below and are compared with the results as obtained in the 1988 study (corrected for inflation between 1988 and 1997).

The overall conclusion is that these are no major variations after corrected for inflation between the years. Such differences as can be seen are increases in commuting and business (4.9 % and 5.9 %) and a slight decrease in "Other" (8.9. %).

Table 11 - VOT by Income and Purpose and Travel Mode(in 1997 guilders)

Gross monthly hh income		commute		business		other		car		train		Bus/tram	
1988	1997	1988	1997	1988	1997	1988	1997	1988	1997	1988	1997	1988	1997
<2500	<3000	11.20	11.14	24.10	17.41	8.88	7.63	10.59	9.32	8.28	8.03	6.09	7.81
2500-4000	3000-5000	11.80	10.98	33.83	27.08	9.98	8.45	11.93	11.20	9.86	9.24	7.30	8.54
4000-6000	5000-7500	15.82	11.93	46.12	34.93	11.32	9.29	16.43	13.79	11.80	10.38	8.76	9.52
>6000	>7500	16.31	19.84	58.66	73.17	13.87	12.67	21.42	25.39	15.46	16.78	12.29	14.48
Total	Total	13.75	14.43	45.64	48.37	10.59	9.64	14.60	16.24	10.83	11.54	7.91	10.11

Table 12 - VOT by Travel Mode and Purpose (in 1997 guilders)

	commute		business		other	
	1988	1997	1988	1997	1988	1997
car	13.87	14.51	45.76	50.18	11.07	9.99
train	14.12	14.60	40.16	30.87	9.61	8.96
BT	11.56	13.55	40.04	23.69	6.82	8.61
Total	13.75	14.43	45.64	48.37	10.59	9.64

CONCLUSIONS

The most important conclusion that can be drawn from the results obtained is that, with a few exceptions, the valuation of travel time has remained stable between 1988 and 1997, keeping in mind autonomous developments over these last nine years.
The most important differences between 1988 and 1997 are found in the business segment. For car users a small increase in the travel time valuation has been found, while for train and bus/tram a substantial decrease is found. Given the high proportion of car trips in this segment, the net effect is that the total VOT in the Business segment has increased slightly.
Overall the conclusion must be that a fairly stable (if quite complex) set of relationships has been identified in the Netherlands Value of Time study, linking VOT by purpose to external variables.

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