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It was twenty years ago today: revisiting time-of-day choice in The Netherlands

Gerard de Jong[a,b]*, Marco Kouwenhoven[a,c], Andrew Daly[b], Sebastiaan Thoen[a], Matthijs de Gier[d], Frank Hofman[e]

[a] *Significance, Grote Marktstraat 47, 2511 BH Den Haag, The Netherlands*
b Institute for Transport Studies, University of Leeds, University Road 36-40, Leeds LS2 9 JT, UK
[c] *Delft University of Technology, Faculty of Technology, Policy and Management, Jaffalaan 5, 2628 BX Delft, The Netherlands*
[d] *Kantar Public, Amsteldijk 166, 1079 LH Amsterdam, The Netherlands*
[e] *The Netherlands Ministry of Infrastructure and Water Management, Rijkswaterstaat, WVL, Lange Kleiweg 34, 2288 GK Rijswijk, NL*

Abstract

Time-of-day (TOD) choice can be considered as a fifth stage in the modelling of transport behaviour, additional to the conventional four stages. Twenty years ago in The Netherlands, a stated preference (SP) study was designed for investigating the choice of time-of-day (departure time) and transport mode. A nested logit time period and mode choice model, largely based on this SP data set, was included as one of the components of The Netherlands national transport model (LMS). A new TOD SP survey has now been developed to obtain up-to-date information for the next re-estimation round of the LMS. The fieldwork was carried out in in 2019, followed by the re-estimation of the nested logit model of period and mode choice on the new SP data. The context for the SP is that of a tour (round trip) carried out by the respondent as car driver or by train, also distinguishing by travel purpose (commuting, business, education and other). This means that we are asking questions both about the outward leg of the tour and the inward leg. Both car drivers and train users are asked to participate in two SP experiments on TOD and mode choice: the first focussing on the trade-off between congestion or crowding and the departure/arrival times; the second also with differentiation in costs between peak and off-peak. Our tentative conclusion is that TOD choice seems to have become (relatively to mode choice) more flexible in the past two decades, in line with the trends towards more flexibility in scheduling activities over the day and a 24 hours economy. Moreover, we now estimate nest coefficients for both car drivers and train users (until now the assumption that had to be made in the LMS was that the nest coefficients for train followed those for car).

Keywords: Time-of-day choice ; mode choice ; stated preference survey ; national transport model

* Corresponding author. Tel.:+31-6-53404000.
E-mail address: dejong@significance.nl

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1. Introduction

Twenty years ago in The Netherlands, a large stated preference (SP) study was designed for investigating simultaneously the time-of-day (TOD) choice and transport mode choice. Time-of-day choice can be considered as a fifth stage in the modelling of transport behaviour, additional to the conventional four stages. This is an important stage to add to a transport model in order to simulate all types of travellers' responses to increased congestion: will travellers avoid the congestion by shifting to another travel mode, or by shifting to another departure time, or will their travel behaviour remain unchanged? Including time-of-day choice is also important when simulating travellers' responses to a time-varying congestion charge, e.g. a peak charge. Again, the travellers can choose to change their travel mode, their departure time, or to pay the charge (and possibly benefit from reduced congestion).

The SP-survey was planned in 1999, the design was worked out in 2000 and the data collection took place in 2000-2001 among more than 1000 car drivers and train users travelling in the extended peak periods. The data were used to estimate error components models (de Jong et al., 2003) and nested logit models (Hess and Daly, 2007). A time period choice model, for an important part based on this SP data set and following the latter specification, was included as one of the components of The Netherlands' national transport model (LMS). All the other behavioural data that was used for estimation of the LMS is of a revealed preference (RP) nature. In the nested logit model structure of the LMS, TOD choice for commuting and non-home-based business trips is positioned below mode choice, implying that TOD choice is more sensitive to time and cost changes than mode choice. For the other travel purposes, both choices are at the same level. A key parameter that we need to estimate on the SP TOD data is the nest coefficient between TOD and mode choice, that influences the relative sensitivities of these choices.

The time-of-day SP questionnaire developed for the Netherlands in 2000 was later also used as a template for a similar SP survey in the West-Midlands (UK) which served for estimating the PRISM model. Furthermore, a comparison of various models, based on these two data sets and a TOD SP for London, was undertaken (Hess et al., 2007a, b), with a focus on finding the most appropriate way of nesting TOD and mode choice. The outcomes of this work, notably that TOD choice should be at the bottom of the choice hierarchy, were incorporated in WebTAG, the Department of Transport's guide to transport appraisal in the UK.

Since the collection of the time-of-day SP data in 2000-2001, the various components of the LMS have been re-estimated several times on more recent RP data. The TOD SP data however remained the same. The Netherlands Ministry of Infrastructure and Water Management, Rijkswaterstaat, WVL felt that the 2000-2001 data could no longer be used for the next re-estimation round of the LMS and that new data had to be collected. Therefore, a new TOD SP survey was developed to obtain up-to-date information. The fieldwork for this new survey was followed by the re-estimation of the nested logit model of period and mode choice on the new SP data.

The paper discusses the design of the new SP survey (section 2), the conduct of the survey, the preparatory analysis of the collected data (section 3) and the estimation results of the nested logit model of period and mode choice on the new SP data (section 4). In the final section (section 5), we will compare the survey and the estimated model to those of twenty years ago and discuss the implications of the findings.

2. Survey design

The LMS is a tour-based transport model. A tour is defined as a round trip: a series of trips that begins and end at the same place, such as the home or work location. It is therefore important for the SP survey to define experiments in the context of a tour. To increase realism of these experiments, this needs to be a tour that was actually carried out by the respondent, distinguishing different segments by mode used and travel purpose (commuting, business, education and other). This in turn implies that we are asking questions both about the outward leg of the tour and the inward (return) leg. Respondents are only in scope if at least one of these legs is in the period 6.00-10.00 or in the period 15.00-19.00 (the extended peak periods). The SP alternatives are based on the characteristics of both legs of the tour as given earlier in the interview by the respondent and reflect the legs of the tour as a whole (tour-based SP). Also, the LMS refers to a working day, and so should the SP survey. All of this applies to both the 2000 survey and the new one.

In the SP experiments we try to offer trade-offs between attractive departure times and short travel times (as in the scheduling model of Vickrey (1969) and Small (1982)), or between attractive departure times and low transport costs.

In the survey carried out in 2000-2001, we had two SP experiments, the first (SP1) without peak pricing, focussing on congestion in the peaks, and the second (SP2) with peak pricing. For both SP experiments each choice situation contained four choice alternatives:

- The first alternative had departure times close to the observed departure time (the same or a bit earlier/later);
- The second alternative had considerably earlier departure times;
- The third alternative had considerably later departure times;
- The fourth alternative referred to another mode than observed (public transport for car drivers, car for train users).

In the new survey, we again interview car drivers and train users, carrying out two SP experiments on TOD and mode choice. As in 2000, SP1 refers to situations with more congestion in the peaks and SP2 refers to situations with higher transport costs in the peaks. We still present four alternatives per choice situation (on one choice screen), but the philosophy behind these alternatives is somewhat different than in 2000:

Car drivers:

- SP1 with four alternatives (two for road and two for train or other public transport) focussing on the trade-off between congestion and the departure and arrival times of both legs of the tour;
- SP2 with the same four alternatives, but focussing on the trade-off between congestion, car cost differentiation between peak and off-peak and the departure and arrival times of both legs of the tour;

Train users:

- SP1 with four alternatives (two for rail and two for car driver or car passenger) focussing on the trade-off between the probability of a seat, train frequency and the departure and arrival times of both legs of the tour;
- SP2 with the same four alternatives, but focussing on the trade-off between probability of a seat, train frequency, rail fare differentiation between peak and off-peak and the departure and arrival times of both legs of the tour;

This setup is comparable to the setup that was used for SP experiments on TOD and route choice carried out recently in Copenhagen (Lu et al., 2018). We selected this presentation with two car and two public transport alternatives instead of the one with only a single other mode alternative because of the focus of this study on estimating the nest coefficient between mode and TOD choice for LMS. The new setup should provide more information on shifts to other modes and in this respect has a better balance between mode and TOD choice. Furthermore, whereas in the old survey we had an alternative that kept close to the observed departure time and two that were substantially earlier and later, we now have two alternatives for the observed mode with departure times that vary over the range of all possible departure times. We expect that this will provide more preference information and the risk that respondents in their choice-making just try to justify their observed choice will be avoided or at least reduced.

Also, we want to focus on alternatives that are evenly distributed over the extended peak periods, including departure and arrival times that fall outside of the possible period with a higher peak cost. More specifically, this means that a traveller, who currently departs long before the morning peak to avoid the queue, will not see choice alternatives that depart more than half an hour earlier than observed (and similarly for those that depart long after the morning peak). This is another deviation (improvement in our view) from the 2000 SP survey. For experiment SP1 we present eight choice situations, and also eight for SP2.

We ask each car driver which form of public transport he/she would use for the tour. If the answer is train or bus/tram/metro, then we use this mode for the two alternatives with another mode than observed for the tour. Should the respondent say that no public transport is available, we still offer hypothetical bus alternatives for the third and fourth alternatives, again because of our focus to get information on the nest coefficient between mode and TOD choice (and because we cannot present credible costs for walking or cycling).

Train users are asked whether car (as driver) would be available for the tour. In case this is not available (e.g. no driving licence, household without a car), we use for the third and fourth alternatives car passenger/carpool, where the traveller pays a contribution toward the travel cost of the tour.

The four alternatives that are presented to the respondents are described in terms of their attribute values, the attributes being:

- Departure time from home (or from work for *work-based tours*)

- Arrival time at the destination
- Departure time at the destination
- Arrival time at home (or work for *work-based tours*)
- Travel time for the tour (for public transport this includes access and egress)
- Duration of stay at the destination (activity time)
- Travel cost for the tour, not including the peak charge
- Peak charge for car or train (only in SP2)
- A simple measure of crowding in public transport: probability of getting a seat
- Frequency of the public transport.

In the travel cost, we distinguish several possibilities with regards to the compensation that travellers may receive from their employers and we take account of the fact that students can travel at a zero or reduced rate depending on the day and TOD. Respondents were asked to give both their first and second choice from the set of four alternatives. An example of the choice screens can be seen in Appendix A.

The design tables contain between 23 and 25 design attributes (depending on the experiment) that determine the values of the attributes mentioned above. These design attributes determine the size of the time shift, whether this shift applies to the departure or the arrival time, whether this shift applies to the outbound or the return journey, the amount of congestion/delay during the outbound and during the return journey, the change in the duration of the stay at the destination, the change in the travel cost, the amount of crowding and the frequency of the public transport alternative.

The design tables were generated by the Ngene software package (ChoiceMetrics 2018). We used a D-efficient design. Since it was not possible to find a prior for several of the design attributes, we treated all attributes as dummies and used dummy codes in Ngene (see Section 7.2.8. in the manual). By using a D-efficient SP design (a technique that we did not know of in 2000, where the design was adapted from an orthogonal one) we were able to reduce the required sample size to 900 interviews (500 for car drivers and 400 for train users). Different targets were set by mode and purpose, because we want to get enough observations for each mode, and enough observations to estimate separate models by travel purpose.

3. The data

For this survey, respondents were recruited from the NIPObase panel, the natural successor of the NIPO Capibus that was used for recruitment in 2000-2001. The NIPObase panel acquires its membership by invitation only (as opposed to panels that advertise to find members). First, a screening among the members was carried out to determine whether the head of the household or other household members had travelled in the extended peak periods on a working day and to determine the mode and travel purpose (which were separate strata with their own target numbers of interviews). After this screening, respondents that were in scope were invited to participate either for the pilot or the main survey.

The fieldwork took place in the period March - April (pilot) and May – June (full survey) 2019. The pilot was carried out to test the fieldwork procedures and questionnaire and improve the presented attribute levels, and led to some minor changes for the main survey. A large part of the pilot data could also be used in the main analysis. The questionnaire was programmed and the respondents accessed it and provided their answers through the internet (computer-assisted web interviewing, CAWI), either using their PC/laptop (63%), smartphone (35%) or tablet (2%). In 2000-2001, the internet penetration was much lower and one had to rely on computer-assisted personal (CAPI) interviews. The NIPObase panel members who participated received a reward, which they could keep for themselves or donate to a charity.

Table 1 presents the targets for the number of interviews as well as the numbers that were obtained, after filtering out respondents that always chose the same alternative, completed the interview in a very short time (i.e. within ten minutes) or had provided or seen clearly incorrect travel times, cost, duration of stay, arrival or departure times. It is clear from this table that all the targets were met. We aimed for 500 car driver interviews and 400 for train users, and obtained 593 and 501 interviews respectively (1094 in total). This slightly exceeds the number of interviews we obtained in 2000-2001 (1051, where the target was 964). The average interview time, after removing the ones below ten minutes, is 24 minutes.

We checked the composition of the resulting sample in terms of education level, occupation, age and gender, comparing this to statistics on the Dutch population. We found that there is some overrepresentation of persons with a higher education and older people. We expect this is caused not so much by the composition of the NIPObase panel or selective response from it, but a result of our targets which overrepresent commuting and especially business tours. For the estimation of the discrete choice models this overrepresentation is not problematic (consistent coefficients can be estimated on samples that are selective in exogenous variables), but in application we need to make sure that we properly expand to the population (as happens as part of the application within the LMS).

Table 1. The target numbers of interviews and the numbers achieved (pilot plus main survey), after applying filters.

Travel purpose (car)	Target	Achieved	Travel purpose (train)	Target	Achieved
Commuting, flexible working hours	95	108	Commuting	150	210
Commuting, non-flexible working hours	95	97			
Business, home-based	85	94	Business	70	83
Business, work-based	65	80			
			Education	85	109
Other, incl. education	160	214	Other, excl. education	95	99
Total	500	593	Total	400	501

We also checked whether there is sufficient trading in the SP responses. We found that the shares of respondents that change mode in the SP experiments is between 37% and 61% (depending on SP1 and SP2 and on whether we include the second choice answers or only the first choices). This is a quite reasonable outcome for an SP experiment with mode choice. The fraction of respondents that always chooses the fastest alternative is 5-7% and it's 6-8% for always choosing the cheapest alternative.

4. Model estimation

After this, we re-estimated the nested logit models for mode and TOD choice by purpose from Hess and Daly (2007). We could have estimated mixed logit models, but these are impractical in the context of the larger LMS. Estimation and application of mixed logit models requires a large number of random draws and repeated calculations for each of these. In the LMS, with very many choice alternatives, these mixed logit calculations would take far too long. The nested logit estimation results by travel purpose, distinguishing commuting, business and other, are in Table 2. This is not necessarily the final use that we will make of the new SP data, since a project to re-estimate the entire LMS travel demand model has started recently, that will try to estimate joint models for mode, destination and TOD choice on a combination of RP and SP data, including the new TOD and mode choice SP data. A fall-back option would be to use in the LMS only the new nesting coefficients from an SP-only model.

What we now do is that, in as far as possible, we use the best model specification from the previous investigation to estimate an SP-only model. By doing this we can also see which coefficients are not significant this time. Even though we also asked the respondents to give their second choice, we only use the first choices in estimation, as we found that the second choices contain considerably more illogical effects and impair the accuracy of estimation. In 2000-2001, we only asked for the first choice, so this selection also makes the data from 2000-2001 and 2019 more comparable.

Within each of the three purposes, we combine the data for car users and train users, as well as the SP1 and SP2 data in a simultaneous model, but we do estimate a scaling factor for train relative to car and another for SP2 relative to SP1 to account for the possible difference in unobserved variance between these modes and experiments.

The first block of estimated coefficients in Table 2 refers to the attributes that were shown in the SP experiments (cost, time, frequency and probability of a seat). These coefficients all have the expected sign, and except for train cost in the commuting model and car and train cost and frequency for business they are also significant at the 90% confidence level. It is worth noting that the t-ratios in Table 2 fully correct for the fact that our data are a form of panel data with multiple observations from the same person. The software used for estimation, Biogeme (Bierlaire, 2013, 2018), routinely produces standard and robust t-ratios for models without mixed-logit effects. For a proper estimation of the t-ratios in the presence of panel effects, one needs to use the Sandwich estimator, Jack-knife or Bootstrap methods (as were applied in de Jong et al., 2003) or (preferably) a model that explicitly includes correlation between the unobserved components per individual (as can be done in mixed logit models). We estimated nested logit models forcing Biogeme to use the Sandwich estimator and all results in Table 2 come from these estimations (earlier estimations that did not correct for the panel effect had standard t-ratios that were higher by a factor of about two). For commuting by car, we find a distinct negative influence of time in congested conditions, on top of the negative influence of total travel time, but for the other purposes this is not significant.

Table 2. Estimation results for nested logit models, by travel purpose

	Commuting		Business		Other		t-ratio is relative to 0 or 1
Number of observations	4824		3054		5271		
Loglikelihood	-5324.9		-3140.3		-5794.3		
Rho-square	0.204		0.258		0.207		
	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	
Car cost [€]	-0.039	-3.4	-0.0066	-1.0	-0.014	-2.8	0
Train cost [€]	-0.010	-1.2	-0.0089	-1.5	-0.025	-3.4	0
Car time [min]	-0.0063	-1.9	-0.0045	-2.1	-0.0060	-2.3	0
Congested car time [min]	-0.013	-2.9	-0.0038	-1.2	-0.0025	-1.0	0
Train time [min]	-0.011	-4.1	-0.0049	-2.1	-0.0031	-2.3	0
Frequency [per hr]	0.028	2.1	0.0066	0.6	0.015	2.1	0
Probability of a seat	0.022	1.8	0.036	1.9	0.032	2.6	0
Nest TOD for car	1.680	2.2	2.070	1.3	2.780	1.9	1
Nest TOD for train	1.520	1.7	1.960	1.7	1.920	2.5	1
Scale SP2 vs SP1	1.130	1.2	1.290	1.9	1.240	2.0	1
Scale train vs car	0.986	-0.1	1.160	0.4	1.560	1.0	1

And many other dummy coefficients not shown here

If we divide the time coefficient by the cost coefficient and multiply the outcomes (still in minutes) by 60, we get the implied Values of Time (VoT) per hour. These can be found in Table 3 (by mode and purpose). The VoTs, especially for commuting-train and for business and other by car, are quite high, as the official VoTs for cost-benefit analysis are about 9-13, 23-32 and 8-9 euro at the moment for commuting, business and other respectively (Kouwenhoven et al., 2014; Rijkswaterstaat, 2018). In these cases, the precision is also lower (larger standard deviations). In the models that were estimated on the 2000-2001 TOD SP data, the implied VoTs were also high, and by about the same factor as we find now. The error components models in de Jong et al. (2004) give, after conversion from guilders to euros and correcting for inflation, VoTs of 15-49 euro (of 2019) for commuting, 47-59 for business and 6-71 for other (including education). A possible explanation is that the focus in this research is not so much on the trade-off between travel time and cost, but of the trade-off between departure time and travel time (and/or cost).

As an aside, the finding that the VoTs from this kind of study ((TOD) have not increased in the period 2000-2019, whereas real income in this period has increased, is remarkable. Other research into changes in the VoTs over time also found that the change in VoTs in The Netherlands over time is smaller than the income change over the same period. (Kouwenhoven et al., 2017). However, we have to be careful in drawing our conclusions on the VoT, since this survey was not designed as a VoT survey. Also, the sample used is not yet (made) representative for journey distances and socio-economic characteristics of the travellers, as has been done in the national VoT study (Kouwenhoven et al., 2014). Moreover, Kouwenhoven et al. (2014) also take account of unobserved heterogeneity, unlike the nested logit models that were estimated in this new study.

Table 3. The resulting Values of Time (VoT) by mode and purpose. The confidence intervals given refer to plus or minus one standard deviation

VoT (€/hr)	Commuting	Business	Other
Car	10 ± 6	41 ± 43	26 ± 15
Train	65 ± 53	33 ± 26	7 ± 4

The second block of estimated coefficients in Table 2 contains the nest coefficients, one for TOD choice alternatives within the car mode and one for TOD alternatives within the train mode. All nest coefficients but one (business – car) are significantly (at 90%) different from 1. In the estimated nesting structure TOD choice comes below mode choice, making TOD the most sensitive of the two choices (more substitution between periods than between modes). This outcome is in line with Hess and Daly (2007), who also found either this nesting structure or MNL, depending on the travel purpose. In the Biogeme software that we used for estimation, the nesting coefficients have a different normalisation than in Alogit, which was used in 2007. In order to obtain nesting coefficients that can be compared to those from Alogit, we have to take the reciproke: 1/(nest coefficient). The nest coefficients from Table 2 then become 0.60 (car) and 0.66 (train) for commuting, 0.48 (car) and 0.51 (train) for business and 0.36 (car) en 0.52 (train) for other purposes. These values are all between 0 and 1, as required for global consistency with stochastic utility maximisation.

In Table 4, these nesting coefficient values are compared to those from Hess and Daly (2007), which are still used in the current version of LMS.

Table 4. The resulting nesting coefficients by purpose and mode in the new study and in Hess and Daly (2007). The confidence intervals given refer to plus or minus one standard deviation

	commuting		Business		Other	
	Car	Train	Car	Train	Car	Train
This new study	0.60 ± 0.27	0.66 ± 0.39	0.48 ± 0.37	0.51 ± 0.30	0.36 ± 0.19	0.52 ± 0.21
Hess and Daly (2007)	0.40 ± 0.05	-	1.04 ± 0.2 (->MNL*)		1.36 ± 0.3 (->MNL*)	

* These nest coefficients are not significantly different from 1. Therefore, a nest coefficient of 1 is used in the LMS, which makes it equivalent to a MNL structure.

For commuting we now find a somewhat larger nesting coefficient than Hess and Daly (2007), though this is within the error margins. The only other acceptable nested logit model that Hess and Daly (2007) found was for non-home-based business trips, but in the new version of the LMS this will no longer be a separate travel purpose, so we did not collect data or estimate a separate model for this. For business tours we now obtain nesting coefficients between 0 and 1, but with large error margins. The nesting coefficients that we find now for other are significantly different from those of Hess and Daly (2007), which were not significantly different from 1. A possible reason for finding different nesting coefficients (for car) than in the previous study could be the decision to let two out of four alternatives on a screen refer to the other (not observed) mode instead of one out of four. Also the use of a D-efficient design in the new study can have played a role in obtaining significant coefficients (higher precision).

Moreover, this new study also yields nesting coefficients for train users. Hess and Daly (2007) did not include models for this, so in the current LMS the assumption was made that for train users the nesting coefficients for car drivers can be used as well. We do find now that, certainly for commuting and business, the nesting coefficients for car drivers and train users are not significantly different indeed.

The second block of estimated coefficients in Table 2 also contains the scale parameters that scale the unobserved variance for current train users to that of car users (who got slightly different SP experiments), and likewise for SP2 to that of SP1. In the planned estimation/application of TOD choice in the context of the LMS, these scale coefficients will no longer be necessary. However, it is good to see that their values are close to 1, which tells us that the unexplained variance does not differ much between car drivers and train users or SP experiments with and without higher cost in the peak.

Furthermore, we also estimated a large number of alternative-specific dummies for combinations of the four alternatives on each screen and whether the respondent was a car driver of train user, and dummies for combinations of the time periods for the outward journey and the return journey (not presented in Table 2). The time periods used here are the same as used in the LMS:

- Before 6 AM
- First shoulder of morning peak: 6-7 AM
- Morning peak: 7-9 AM
- Second shoulder of morning peak: 9-10 AM
- 10 AM – 3 PM
- First shoulder of afternoon peak: 3-4 PM
- Afternoon peak: 4-6 PM
- Second shoulder of afternoon peak: 6-7 AM
- After 7 PM.

As in Hess and Daly (2007), many of the estimated coefficients for TOD combinations are not significant, which is not surprising given the large number of these dummies that were estimated. Also their significance will depend on the choice of the reference alternative. In the new LMS, the TOD dummies will be based on RP data (the national travel survey), because this data source gives a representative pattern over the whole day. Nevertheless, we have to include these dummies here to get better (less biased) estimates for the other estimated coefficients.

5. Findings, comparison with 2000-2001 and conclusions

The SP data for the choice of time period that were available in The Netherlands for the re-estimation of the LMS national transport model date back to the years 2000-2001. A new SP survey was carried out (almost) twenty years later to obtain up-to-date data on this. As in 2000-2001, the choice that is investigated is the simultaneous choice of mode and time-of-day (TOD). Other similarities between the two studies are:

- Tour-based SP survey;
- Interviews with car drivers and train users, recruited from a panel;
- One SP experiment on travelling in the congested peaks or outside and another SP experiment including higher travel cost in the peak than off-peak, both with eight choice situations;
- Use of the data in a nested logit model for mode and TOD choice.

Differences between the old and the new study are the following:

- In 2000-2001 a CAPI survey was carried out and in 2019 a CAWI survey;
- In 2000-2001 we presented choice situations with three alternatives referring to the observed mode and one for another mode, in 2019 we present two alternatives for each of these modes;
- In 2019 a D-efficient design was used for generating the SP alternatives, which was not the case in 2000-2001.

In total, 1094 useable interviews were collected and all the targets in terms of numbers of interviews by mode and purpose were achieved. Nested logit models were estimated on the new SP data, using the same specifications as in the previous study for the LMS. The new estimation results are of a similar level of quality as were obtained on the SP data from 2000-2001. For the nesting coefficients between mode and TOD choice, which in the current LMS are the key results from the SP estimations, we get results that are significantly different from the outcomes on the old SP data for some of the travel purposes. We now obtain nest coefficients that are smaller than 1 for all three purposes commuting, business and other (though not always significantly different from 1), which goes with a model structure where TOD choice is more sensitive than mode choice. Our tentative conclusion is that TOD choice seems to have become (relatively to mode choice) more flexible in the past two decades, in line with the trends towards more flexibility in scheduling activities over the day and a 24 hours economy. Moreover, we now estimate nest coefficients for both car drivers and train users (until now the assumption that had to be made in the LMS was that the nest coefficients for train followed those for car).

The values of time (VoTs) that can be calculated from the new models are in most cases larger than the official CBA values, but of a similar order of magnitude as was found on the data from 2000-2001.

We conclude from the above findings that the new SP data provide a good new source for use in the new LMS re-estimation project, in combination with the RP data (national travel survey), and possibly also other SP data (such as the most recent national VoT survey; Kouwenhoven et al., 2014). In The Netherlands we now again have up-to-date information on mode and TOD choice which can be used in future joint SP/RP modelling. A fall-back option is also available, which entails only taking the nesting coefficients for TOD alternatives within the same mode (car driver or train) from models on the new SP data. The models reported here can form a good starting point for this, but further specification research (e.g. on linear or nonlinear time and cost variables, interaction with household and person attributes) would probably be worthwhile in this case.

Besides use of the new SP data in a joint RP/SP model in the context of the LMS re-estimation, one could also use the new SP estimation sample and the models estimated on it directly for policy simulations. A proper method for doing this would be sample enumeration, with expansion factors and recalibrated alternative-specific constants to make the application representative. In this way, the results of this study could be used (outside of the LMS) to investigate the impact of changes in transport time and cost (by TOD), frequency and probability of a seat on the modal split and the distribution over time periods of Dutch travellers.

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Appendix A. Examples of choice screens

SP1 (car drivers)

	Car 1	Car 2	Train 1	Train 2
Outward journey Return journey	07:15 - 08:00 17:20 - 18:16	08:20 - 09:16 14:32 - 15:28	08:12 - 09:10 17:30 - 18:29	07:36 - 08:28 16:48 - 17:40
Total travel time	1 hr and 41 min. of which 21 min. in traffic jam	1 hr and 52 min. of which 32 min. in traffic jam	1 hr and 57 min.	1 hr and 44 min.
Total duration of stay	9 hr and 20 min.	5 hr and 16 min.	8 hr and 20 min.	8 hr and 20 min.
Total cost	€ 3.80, of which € 0.00 for parking	€ 3.80 of which € 0.00 for parking	€ 6.40	€ 5.80
You can find a seat …			every 2 out of 10 trips	every 4 out of 10 trips
You can travel …			4 times per hr	4 times per hr

					None of these
First choice	o	o	o	o	o
Second choice	o	o	o	o	o

SP2 (car drivers):

	Car 1	Car 2	Train 1	Train 2
	Travelling outside the peak (7-9 hr, 16-18 hr) is 33% cheaper			
Outward journey Return journey	08:20 - 09:10 17:50 - 18:50	05:40 - 06:45 15:05 - 15:50	09:15 - 10:05 17:25 - 18:15	08:20 - 09:10 16:55 - 17:45
Total travel time	1 hr and 50 min. of which 30 min. in traffic jam	1 hr and 50 min. of which 30 min. in traffic jam	1 hr and 40 min.	1 hr and 40 min.
Total duration of stay	8 hr and 40 min.	8 hr and 20 min.	7 hr and 20 min.	7 hr and 45 min.
Total cost	€ 7.40 of which € 0.00 for parking)	€ 3.80 of which € 0.00 for parking)	€ 6.40	€ 6.40
You can find a seat …			every 10 out of 10 trips	Every 4 out of 10 trips
You can travel …			4 times per hr	4 times per hr

	Car 1	Car 2	Train 1	Train 2	None of these
First choice	o	o	o	o	o
Second choice	o	o	o	o	o