3. Other car ownership models for the Netherlands

3.1 The ‘Cramer’ model for forecasts of the car fleet

This model is described in Cramer and Vos (1985). It is based on an earlier model developed in 1973 at the University of Amsterdam by Cramer and Van der Vlis. In 1985 this model was revised and applied for forecasting the car fleet until the year 2010.

The model

The model describes the number of cars at the end of year t. Four sub fleets are distinguished: distinction is made between old and new cars and between first and second or next car of a household. The groups can also be summed to a (sub)total.

The model consists of 2 blocks:
1. The first block describes the car fleet at the end of year t.
2. The second block of the model describes the market process and the block also produces the number of cars purchased Q and the secondhand car price \( P_o \). Q and \( P_o \) are determined per year.

The dynamics of the model lay in the determination of the equilibrium between the number of purchased cars (defined by the number of people, the number of households, the average income and the distribution of incomes, and various prices) and the supply side of the market (defined by the number of scrapped cars, aging, new bought cars of the year before).

The two unknown endogenous variables in the model are \( Q_t \): the number of purchased cars (the supply-function) and \( P_o, t \): the price of a secondhand car (in the demand-function).

The dynamics of the car market is expressed by the adjustments in the demand for the existing number of old cars, via the price of secondhand cars, and through its effects on the demand for new cars. So if the price of a secondhand car decreases, the demand for new cars will also drop. The model describes the developments from year to year.

Block 1: the supply side of the car market

The first block contains equations for the size of the total car fleet at the end of year t. The total number of cars is computed by the number of cars sold (Q) in that year. For this, age-specific scrapping probabilities \( s(a) \) are used. Besides that, age-specific
transition probabilities \((r(a))\) are used. These define which fraction of new cars passes to the second owner. It is represented as a linear transition in the first 6 years. The import and export of used cars are also taken into account. This is done through an 'growth factor'. It is assumed that the import of used cars has the same distribution in age as the domestic car fleet.

### Block 2: de demand for cars

The second block contains demand equations for the desired size of the four subfleets (old versus new cars and first versus second and beyond cars). The starting point for these equations is that for the first, the second and others cars, there is a point of saturation. This point is similar to the number of potential car owners. The function for this point of saturation ranges between 0 and 1. The explanatory variables are income, prices, etc.

The desired size of the car fleet' is a function of \(M\) (the number of potential car owners) and the saturation level \(F\).

### The number of potential car owners

The number of potential car owners with a first car is set equal to the number of households. This also includes the 1-person household or singles. This series is derived from an interpolation process on figures of the CBS. The total amount of potential car owners (as needed to define the number of car owners with a second or even third car) is fixed at the adult population between 20 - 70 years.

### The function to compute the saturation level

The function to compute the saturation level \(F\) of a sub market is specified as a 'standard normal distribution function'. The saturation level is defined by the following exogenous variables:

- The income level \(Y_t\). \(Y_t\) is defined by the real disposable income (purchasing power) per head and the variance of this income distribution.
- The increase or decrease in the inequality in the distribution of incomes \(S_t\).
- The effect of all other variables \(\mu_{i,t}\).

The parameter \(\mu_{i,t}\) is defined by the following exogenous variables:

- A 'constant' which fixes the level of the demand-function. This differs for each of the four demand-functions.
- The generation-effect. This is connected to the gradual disappearance of generations that were too old at the beginning of the mass-motorization in the early sixties to accept a car or to pass a drivers license test. This effect is represented as a declining trend.
- The utility-effect or the spatial planning-effect. This is a rest-factor composed of a complexity of factors. The size over time of this rest-factor is connected to the values of other coefficients, like the coefficients of price indices.
- The price indices of old and new cars and the ratio between these two. There is no distinction between the first and the second car, because both would eventually be used in the same way. The price indices are determined as a linear combination of other price indices, namely: the variable car costs \(V\), fixed car costs \(F\), the price of new cars \(P_n\) and the price of secondhand cars \(P_o\). All these price indices have a fixed weight. The utility-effect maintains, because limitation of the utility-effect leads to unacceptable high elasticities.
A dummy variable. This dummy variable takes into account because the effect of the first oil crisis and the effect of that oil crisis on the demand of cars.

The confrontation between the two blocks
Eventually the two blocks have to be confronted in order to find the equilibrium. The final result is reached if the two blocks will have the same result and the differences between the numbers of new and the numbers of old cars will be zero. To reach this result an iterative process of adjustments is started, which reduces the deviation between the two estimations to less than 0.1%.

Usually no more than 7 iterations are sufficient to reach the above result. The result is reached in the following way: the old price \( P_{o,t-1} \) and the number of sold cars \( P_{o,t-1} \) of the year before are used as starting values. With these new exogenous variables this leads to two different estimations for the two subfleets. The differences between the estimations are reduced. To do so the number of sold \( Q \) cars is corrected with complete difference in the new fleet \( ?X_{nz}\). Also the price of secondhand cars \( P_o \) is adjusted. In practice this led to convergence quite quickly. To stop the iterative process a certain ratio value that indicates that the outcomes are sufficiently close to equilibrium was chosen.

3.2 The Van den Broecke car ownership model

A description of this model can be found in Van den Broecke (1987). This model was developed in 1986/1987 for the Projectbureau Integrale Verkeers- en Vervoersstudies (PbIVVS). The outcomes of the Van den Broecke car ownership model for 2010 (especially the prediction of 7.9 mln passenger cars in total for 2010) were used in applications of the Dutch National Model System for SVV-II and NMP in the second half of the eighties and early nineties. Later on this role has been taken over by FACTS.

The Van den Broecke car ownership model can be characterised as a combination of a cohort survival model and an econometric model. A cohort is defined here as a group of persons with the same birth year (and some other common characteristics, see below). The calculations in the model are done at a detailed level; population groups are distinguished by:

- Birth year
- Gender
- Education level
- Married/not married
- Employed/not employed.

The econometric component is used for producing the impact of changes in income on car ownership.

The Van den Broecke model start by relating car ownership to the number of owners of a driving licence in a population group (‘cohort’). The saturation level of licence holding and the income growth per cohort are determining factors for the future.
growth of car ownership in the model. Predictions of future licence holding (these can come from cohort models for licence holding also developed by Van den Broecke) and the income elasticities used in the model are therefore crucial factors in the model for forecasting car ownership. Both in predicting licence holding and car ownership, Van den Broecke assumes that the preferences of persons with regards to owning licences and cars remain unchanged. Only the numbers in the cohorts and the incomes that can be spent will change in the model.

The model gives total car ownership per cohort, without distinguishing between private and business cars. It also does not produce the distinction between first and second cars in the household (it is a model at the person not the household level) or car types by vintage, engine size or weight. Car costs or other policy levers are not included. The model is most suited for predicting the impact on car ownership of changes in the size and composition of the population.

3.3 The disaggregate car ownership model within the LMS

Within the LMS there is a car ownership model, which operates at the household level. The LMS car ownership model reproduces the car ownership model developed in an earlier project, the ‘Zuidvleugel Study’. The car ownership choices of the household are conditioned on household licence holding (which is also explained in the LMS by using disaggregate models):

- A household without licences will have zero cars
- A household with one licence can choose between two options: zero cars or one car.
- A household with two or more licences can choose between two options: one car or two more cars.

Figure 1. Structure of LMS: Household car ownership conditional on the number of driving licences in the household

These choices are modelled as binary logit models, estimated on disaggregate data from the Dutch National Mobility Survey (OVG). These models are based on random utility theory and can be interpreted within this behavioural framework.

An important explanatory variable in both the 0 or 1 cars choice-model as the 1 or 2+ cars choice-model is the monthly income that a household can freely spend; the monthly expenditures on food, clothing and housing have already been subtracted. If the household would chose to own a car it incurs fixed car cost; if there would be two cars, the household would have to pay fixed car cost for two cars.
So if the monthly incomes in the Netherlands rise, the probability of car ownership will rise as well. If the fixed car costs rise the car ownership probability will decrease. Other explanatory variables are age, gender, household size, number of workers in the household and region-specific variables.

The total number of cars in a future year in the LMS is usually imported from an external model (initially the van den Broecke model, later FACTS). This has been done to be able to compare different policy variants (e.g. changes to the networks) on the same basis. The role of the disaggregate model then is to subdivide the national total supplied by an external model over zones and households.

LMS car ownership without external totals
In a project called ‘Cost sensitivity of car ownership and car use in the LMS without adjustments to the control-total for future car ownership’ that Hague Consulting Group carried out in 1990 for the Dienst Verkeerskunde (now AVV), the effects of not using the 7.9 mln cars in 2010 from the Van den Broecke model were investigated (Hague Consulting Group, 1990).

In the LMS changes in variable car costs (esp. fuel costs) influence the mode choice and the destination choice for a journey. At the time of this project, the disaggregate model for car ownership in the LMS was adjusted to the forecast of the national car ownership from the Van den Broecke model (later FACTS was used for this). Adjusting the car ownership will make it impossible to examine the effect on car ownership and use of changes made in the fixed car costs, since these cost only appear in the disaggregate car ownership model. If one would not use the adjustment procedure the LMS could compute the influence of changes in the fixed costs on car ownership and use. Changes in car ownership influence the mobility predictions of the LMS, e.g. the total amount of car kilometers driven.

Key questions of the research project were:
- What effect do changes in the fixed car costs have on car ownership, in the LMS, in a situation where future car ownership is not a fixed number?
- What effect do changes in the fixed car costs have on the mobility forecasts in the LMS, and especially on the number of car kilometers?

The only change to the LMS that was made in the ‘Main variant’ of this project, was the removal of the fixation of the national number of cars to the control-total of 7.9 mln cars (Main variant) in the year 2010. The remaining control-totals in the Main variant (car ownership in the base-year, licence holding) remained unchanged.

The ‘Dienst Verkeerskunde’ suggested an other variant: in this variant not only the control-total of future car ownership is dropped but also the control-total of car ownership in the base year is abandoned. This variant (Variant A) was computed subsequently.

In the research three ‘exercises’ were done: predictions of car ownership, deriving a fixed costs elasticity of car ownership and the effect of fixed costs via car ownership on mobility. The forecasts on car ownership and the fixed cost elasticity were computed for the Main variant as well as in the Variant A.
Information about income is used while making the car ownership forecasts. In current practice the classification of the personal net income of the OVG (onderzoek verplaatsingsgedrag) is maintained. In the OVG there are 5 income classes and 3 classes for a no or unknown income. But it turned out that for the car ownership effects it was preferable to use more spread in household income. In this project, this was accomplished by Monte Carlo simulation (drawing incomes within the classes, similar to FACTS).

To get the information about incomes for a future year, the real growth of the net household income was used. Next, assumptions had to be made about the expenditure on a house, the daily expenditure and the fixed car costs in a future year.

The outcome was 7.6 mln cars in 2010 (the Van den Broecke control-total being 7.9 mln).

**Fixed costs elasticity of car ownership**
The effect of a change in fixed costs on car ownership was examined. It appeared that a rise of the fixed costs with different percentages mostly affected the choice of households with 2+ drivers license between 1 or 2 cars. The fixed cost elasticity of car ownership was –0.1. This was also published in Klooster and de Jong (1991).

**Effect of cost changes working through car ownership on mobility**
The probabilities on driving license ownership and car ownership, as computed for households, were transformed into probabilities per person. The latter form the input for the travel frequency models and the mode and destination models. The combination of both of these models produces several outputs. On the one hand the output contains origin- and destination tables for journeys per travel purpose. These tables are part of the input for the information that is used in the assignment module.

- On the other hand a combination of travel frequency tables and the mode and destination models provides a more aggregated mobility forecast: the number of kilometers (and journeys) in of persons in the Netherlands by mode and purpose. In this study attention was paid to the effect of fixed costs on national mobility predictions. This effect is working through car ownership probabilities. These form the input for travel frequency models and also affect the choice of mode and the choice for a destination. Two applications were done with the travel frequency models and mode choice and destination choice models.

The effect of a change in the fixed costs on the total amount of tours (also per purpose) is so small that it can be neglected. The effect of lower car ownership probabilities on mobility goes not via travel frequency, but via mode choice and destination choice.

In terms of kilometers, there is some substitution from the car (esp. car driver) to public transport and slow modes. The fixed cost elasticity of car kilometers on average was –0.1 (the variable cost elasticity of car kilometers was on average –0.4).
3.4 The joint car ownership and use models of De Jong

In his Ph.D. thesis (supervisor: Professor Cramer of the University of Amsterdam, mentioned in section 3.1), De Jong developed two different disaggregate models (De Jong, 1989a) each of which simultaneously explains:

- Whether a household will own a private car or not
- Conditional on car ownership: the number of kilometers driven per year (private car use).

The basis idea for both models is that decisions of households on car ownership and car use are strongly interrelated and should be studied together. Both models are joint discrete-continuous models (variants of the Tobit model), and were estimated on data from the Dutch Budget Survey.

The first model can be used for demand predictions in a situation without major policy changes. It is not directly based on economic theory and was called the ‘statistical model’. It assumes that a household has a structural desired annual kilometrage, which depends on attributes of the household. Only if this desired kilometrage exceeds a threshold, the household will own a car. The observed kilometrage can deviate from the desired kilometrage through a random disturbance term. Explanatory variables for car ownership and use in this model are household income, household size, age, gender and occupation of the head of the household.

The statistical model has not attracted much attention, unlike the second model, the ‘indirect utility model’, which can also be found in De Jong (1989b, 1991). This model is based on micro-economic theory, especially on the relationship this theory postulates between indirect utility functions and demand functions through Roy’s Identity. As a result, the relationship between car ownership and car use is included in the model in a way that is consistent with economic theory. The basic idea is that households compare combinations of car ownership and car use with each other and choose the combination that gives them the highest utility. The model also contains fixed car cost and variable car cost as explanatory variables (besides the variables that are in the statistical model). The fixed car cost influence both car ownership and use, and so does variable car cost, and the model has been used for simulating these changes and variabilisation of car cost in the Netherlands.

In the course of developing a national model for Norway, the indirect utility model was extended to include the option of two cars per household (see De Jong, 1987). The model has also been estimated in data for Israel. Attempts at estimating the indirect utility model for the UK, for use in the NRTF forecasts, have not produced stable results.
3.5 Car ownership models on the Dutch Longitudinal Mobility Survey (LVO) 1984-1989

In Kitamura (1987) a model is developed for the simultaneous determination of car ownership (0, 1, 2 or more) and the total (all modes together) number of trips in a week. The discrete choice is estimated using normal probabilities and the estimation of the continuous choice is done using Heckman's method. The data set is a panel and the model contains lagged effects. All equations are linear.

In the paper by Golob and van Wissen (1989) an ordered-response probit model for car ownership in the household (0, 1, 2+) is combined with a standard tobit model for the continuous variables, which are the distances travelled per week by four modes. The overall framework is that of structural equations, with direct synchronous, indirect synchronous and lagged effects. The structural equations system is estimated with the LISCOMP procedure on panel data. Within this the tobit-model is estimated with Maximum Likelihood.

The model in Golob (1989) is similar to the above model in formulation and estimation, but it explain car ownership and travel time per week for three modes.

The Ph.D. thesis of Meurs (1991) also contains car ownership models estimated on the panel data of the LVO. These models explicitly take account of the panel nature of the data. The car ownership models in the thesis include linear simultaneous equations models of car ownership and use, discrete choice car ownership models, estimated through mass point estimation, and joint car ownership and mobility models (also in Meurs, 1993). These models focus on the effect of income on car ownership; car cost variables are not included.

3.6 Car ownership in the ScenarioExplorer, version 1.2

This model was developed by TNO-Inro afdeling Vervoer for AVV (TNO, 1999). The ScenarioExplorer is an instrument that enables the analysis of long term developments in transport demand. The model combines scenario building, system dynamics and strategic transport modelling. Segmentation of transport demand is realised by means of an aggregated strategic transport demand model. Projections aim at the Dutch national level with a time horizon of 15 to 60 years in the future. The base year for all calculations still is 1990.

The core of the ScenarioExplorer is the transport demand model. Given the model input variables as constructed by means of the Scenario Construction Module, developments in transport demand, travel times and car ownership are calculated simultaneously. Starting with a base situation, changes in the number of trips are calculated for each year and for each travel purpose, transport mode and type of traveller, using an incremental multiplicative model. Equilibrium mechanisms are strong determinants for the long term growth potential. To account for this, several direct and lagged feed-backs are distinguished in the transport model. The
Netherlands is divided into six functional zones, determined by the level of urbanisation.

The output of the model can be summarized in four groups: transport volume, car ownership, time and money expenditures on transport and accessibility. Below we describe the car ownership model.

**Car ownership model**

The development of the car ownership is endogenously determined within the ScenarioExplorer. The purpose of the car ownership model is to forecast the number of passenger cars in the Netherlands for three submarkets:

1. company cars
2. first cars in the household
3. second and further cars in the household.

The number of company cars largely depends on economic growth. After three years it is assumed that company cars will flow into the private market. The household income and the price of the car determine in great part the acquisition of the first household car (consumption), while the purchase of the second car (or more) depends on the user costs (production).

The number of cars per submarket in the observed year depends on the number of cars in the previous year multiplied by a growth factor. The calculation of the growth factor differs per submarket:

1. growth factor for company cars: based on the number of business trips and number of workplaces.
2. growth factor of first cars in the households: based on annual net personal income, the purchase price and the number of households.
3. second and further cars in the household: based on annual net personal income, purchase price, variable costs per kilometer and the number of persons per household.

The number of cars for the base year (1990) is exogenous.

Within the passenger car market, no distinction is made in age classes. Developments of the market due to demographic shifts or cohort effects can not be modelled in the ScenarioExplorer.

Two other models in the ScenarioExplorer produce feedback for the car ownership model:

1. Saturation levels (maximum number of persons that are able to possess one or more cars) per submarket. These levels have a negative feedback on the number of total cars.
2. (Lagged) feedback on the demand for cars. High car use will yield a high demand.

The input for the car ownership model is:

- population older than 18
- income and employment
The output generated by the car ownership model is categorized per submarket by the future size of the car fleet and saturation level. The number of cars is distributed over different population categories: three age groups (12-18, 18-65, 65+), male/female, unemployed/part-time/full-time, and low or high education.

3.7 The Dynamic vehicle transactions model

This is a model, developed and tested by Hague Consulting Group in the period 1993-1995 for AVV (HCG, 1993, 1995a,b, De Jong 1996). The data used in estimation originate from a project for Novem to measure the effectiveness of a government campaign to increase energy efficiency of passenger cars (‘Koop zuinig/Rij zuinig’).

The main objective of the modelling exercise was to extend the disaggregate modelling approach for the size and composition of the car market into the domain of dynamic models. Static disaggregate car ownership models (‘holding models’) can only give a time path for the car fleet if one is prepared to assume that in each period a household compares all vehicles (or vehicle combinations for multiple car ownership) and chooses the alternative with the highest utility. This static equilibrium assumption for every period considered will lead to an unrealistically high number of transactions, unless this is made unattractive by introducing dummies for not changing the household fleet. A more detailed critique on static holdings models can be found in De Jong and Kitamura (1992). In the Dynamic Vehicle Transactions Model (DVTM) each household will keep its vehicle holdings the same unless it explicitly decides to engage in a transaction.

The DVTM consists of the following submodels

- Hazard-based duration models for the time that will elapse between two household vehicle transactions. Initially there was only a model for the duration of ownership of a single vehicle until replacement; later on this was extended to transactions such as extending the household car fleet (e.g. from one to two cars) and disposal without replacement
- Vehicle type choice models, for households replacing or extending their fleet. Vehicle types are distinguished by brand and model (for instance Volkswagen Golf 1.6 diesel and Toyota Starlet 1.3) and by vintage. For each brand/model/vintage combination, the engine size, weight, average fuel efficiency, fuel type, type of catalytic converter (if any) and fixed and variable cost are known, which are used in this multinomial logit type choice model. The outputs can be aggregated over these categories. The most expensive car types were not included in the sample; company cars were not included either.
- A model for annual car use (similar to the indirect utility model)
- A model for style of driving determining a possible deviation from the average fuel efficiency.
The DVTM has been used to simulate the impact of changes in fixed and variable car cost and income on the size and composition of the Dutch car fleet for the short and medium run (1-5 years ahead). For application to the long run a car (type) supply component would have to be added. The outcomes of these simulation runs generally speaking were quite plausible.

3.8 A model for the effects of motivational factors on car use: a multidisciplinary modelling approach

This section is based on a paper by Linda Steg, Karst Geurs and Michiel Ras (2001). Although it is about a model of car use, not car ownership, it is included in this review because at the inception meeting of this audit project it was decided to consider car use as well.

Transport models are widely used for making long-term transport forecasts. Result of such models form an important input for policy making and planning. In general transport models forecast car use based on assumptions on socio-demographic, economic, price, technical, infrastructural / accessibility and spatial developments. Changes in motivation, e.g. attitudes and preferences related to transport mode choice and car use, are usually not taken into account at all, or at most, only through an implicit assumption being that motivations within homogenous population groups do not change over time and thus can be incorporated via constants.

For three reasons it would be preferable to include motivational factors in transport models:
- Psychological and sociological studies reveal that people's motivations form an important explanatory factor for car use.
- Several studies from outside the transport field show that motivations might change over time.
- Some policy measures are explicitly aimed at changing motivations of large-scale information campaigns.

The aim of the paper is to examine the effects of motivational factors on present and future car use. Via a multinomial regression model, using socio-demographic, socio-economic and motivational variables three things were examined:
- Whether car use can be better explained by taking motivational factors explicitly into account.
- Whether the level of car use forecast changes significantly if changes in people's motivations are assumed under different scenario conditions: Scenario 1: divided Europe, Scenario 2: European co-ordination, Scenario 3: global competition
- Clarification how motivational factors can be incorporated in existing transport models.

In current car-use models the level of car use depends on three determinant categories: (1) location of human activities, (2) needs and desires of people and (3) transport resistance. The three determinant categories are interdependent
Psychological models explain relationships between attitudes and other motivational factors on one hand and mode choice and/or car use on the other hand. Factors from other determinant categories such as land-use, technology, travel time and prices are usually taken into account. Golob and Hensher (1998) found relationships between attitudes and actual commuters’ mode choice. Steg found that the more people use their cars, the more positive their attitude is towards car use, the less serious they receive the problems of car use and the less favourable they evaluate policy measures aimed at reducing car use. A literature study revealed the following motivational factors to be related to car use and travel-mode choice: (1) attitudes towards different models of transport, (2) emotions evoked by car use, (3) social norms, personal norms, (4) awareness of problems caused by car use, and (5) perceived responsibility for and perceived control of problems caused by car use. Unfortunately, most studies don’t give a definite conclusion on the causal relationship between attitudes and car-use behaviour, for attitudes and car use are mostly assessed at one point in time. Mode choice may also influence attitudes, through experience and psychological phenomena such as cognitive dissonance reduction.

In a study of Kitamura, et al. (1997), variables from all three determinant categories were used to explain travel behavior, i.e., the effect of socio-economic, land-use and attitudinal variables on travel behavior were assessed. The highest proportion of de variation in the data could be explained by attitudinal variables.

A model for car-use simulation in the Netherlands

The model for car-use simulation in the Netherlands (MOCASIN) forecasts car use on an individual level on the basis of socio-economic, socio-demographic and motivational characteristics. To reduce complexity, contextual developments like changes in land-use, transport prices, travel time or technology are not taken into account. The MOCASIN assesses future car use on the basis of development in population characteristics and based on the relationship between these characteristics and car use. The development of MOCASIN involved three steps. First, the relationship between car mileage and socio-economic, socio-demographic and motivational determinants were examined by means of a multinomial regression analysis. Second, scenarios were constructed which differ in future development in these determinants. Third, a Population Model was constructed for estimating the size and composition of the Dutch population for the years 1995, 2010, 2020 according to these scenarios.

In the 'basic' version, only the effects of changes in the composition of the population, classified according to age, level of educational attainment, gender, household composition, and household income were explicitly simulated.

Step 1: the relationship between car mileage and the three determinants

Assessment on the relation between various variables was done through regression analysis for nominal variables. Two regression analyses were performed. First, it was examined to what extent age, level of education, gender, household composition and household income contributed to the explanation of car use. Second, the relationship between car use and these personal background variables was studied, along with a motivational factor (viz., problem awareness) to examine whether the explanation of car use improved.
The result shows that 21% of the variation in the weekly car mileage was explained by age, level of education, gender, household type and household income. The result also shows that car use could be better explained when problem awareness was included in the regression analyses (+5% explained variance).

Step 2: scenario assumption
Three scenarios (as mentioned above) were used to study the effect on car use. The scenarios differ in the expected international economic and political developments, and in national demographic, socio-cultural, technological and economic developments.

Step 3: the Population Model
A Model Population is an expected classification of the population. It provides information on the size and the composition of the population for different points in time and different scenarios.

The results from MOCASIN indicate that current - more comprehensive - Dutch national transport models could possibly be improved by adding motivational factors, thus creating the possibility to simulate the effects of changes in motivations under different scenario conditions. This is especially relevant with regard to policy measures aimed at changing people's motivations.

3.9 A dynamic lifetime utility model of car purchase behaviour (Golounov, Dellaert and Timmermans, 2001)

In this paper submitted for presentation at the 2002 TRB annual meeting, the authors first develop a theoretical model for the purchases and consumption of cars, other durable goods and other day-to-day and long-term purchases. This is an explicit dynamic model, based on the concept of (remaining) lifetime utility from economic theory. They -correctly- state that most existing dynamic car ownership models (duration models, panel models, cohort models) do not have a strong theoretical underpinning (an exception is the work of Hensher et al. (1992), but here the link from theory to econometrics is not particularly strong). Golounov et al. then present a model for an individual (not a household as in most disaggregate car ownership models) is assumed to optimise the sum of discounted utilities for every period over the remaining lifetime. The utility in a period depends on the consumption in that period of four goods:

- Cars (internal to the model)
- Other optional durables (internal to the model)
- Long-term fixed purchases (external to the model)
- Fixed day-to-day purchases (external to the model).

Consumption in a period for the first three goods is defined as depreciation of the commodity. So car consumption (say in a year) is the decline in the value of the car (in the year). This definition of car consumption differs from that of De Jong (1989), where car consumption is defined in terms of car use (e.g. the annual number of kilometres). The model of Golounov et al. does not have a link to car use (except in
the interpretation of some of the coefficients found), but it has the advantage of being dynamic.

Besides the direct utility function to be maximised, the theoretical model also contains a number of restrictions, including a budget restriction with income, savings/loans, and purchases of the four types of goods. Consumption of durable goods (including cars) and expenditure on purchasing these goods can take place in different periods.

On the basis of the economic model, an econometric model for the purchases and consumption of cars and other optional durables is specified, which is estimated on seven waves (1993-1999) of data from a revealed preference consumer panel. This panel (CentER savings Survey) focusses on financial assets and liabilities of the persons. Additional assumptions had to be used to make this dataset suitable for estimation of the model. Also depreciation functions were adopted from the Dutch Automobile Association (ANWB/BOVAG). In estimation, parameters for the discounting function, the utility from cars and from other optional durables are estimated, as well as variance-covariance parameters. The model only contains 8 significant coefficients (besides the constants). Although the model used different brand-model-vintage combinations, it does not yield vehicle type choice probabilities. The major contribution is that car purchase behaviour over time has been formulated is an explicit dynamic theoretical model, and that this has been translated into an estimable econometric model. The authors have plans to collect new stated preference data and use this to develop and test the model further.