2. Description of FACTS: Forecasting Air pollution by Car Traffic Simulation

In this chapter, we shall first describe the predecessors of the present FACTS3.0 model: the GEBAK-model and FACTS 2.0. After that, we shall describe the FACTS 3.0 model. This review mainly describes the car ownership model in FACTS and the modules that are closely related to the car ownership model. Not very much attention is paid to the air pollution module of FACTS.

2.1 Brief history: from GEBAK to FACTS 2.0

About the GEBAK-model

The GEBAK-model predicts car ownership and car use. It can also compute the emissions of pollutants by car traffic through a set of emission factors. The starting point of model is a base year 'reference variant'.

GEBAK computes car ownership for a number of car types and combinations of car types: 18 classes of passenger cars, divided into private car ownership and business car ownership. The 18 classes are:

- fuel type:
  - petrol
  - diesel
  - LPG,

- weight (here we give the classification of FACTS 3.0):
  - 950 kg or less
  - 951-1149 kg
  - 1150 kg or more

- and age of the car:
  - 5 years old or less
  - more than 5 years old.

The GEBAK-model strictly distinguishes between the private and the business car. The costs of a business car are fully paid by the company who 'owns' the car. Market segmentation is used within the segments private car and business car. In GEBAK, a certain private car is considered to coincide with a certain way of living with a certain expenditure pattern and mobility pattern. This way of living is determined by income,
age and household structure. A classification in homogenous groups as this influences car ownership and car use was developed. The level of expenditure and the mobility pattern of the business car is treated as depending on profession or function within the company.

The two basic assumptions of the model are:

- The budget share (of the income) spent on the ownership and use of the private car is assumed to be constant for homogenous groups of households. It is supposed that households allocate their budget, given their mobility needs, in a way that they get the maximum utility out of their car(s). This utility also depends on the comfort of the car. The latter is assumed to be a derivative of the price of the car and the weight of the car. The households are classified by age, household income and family composition. The cars are classified by fuel type, age and weight class. Different national and international research studies have shown that the budget share within homogenous household segments is approximately constant. However there is also evidence pointing in other directions (see discussion on fixed travel budgets later on).

- Households aim at retaining (car) mobility. The level of (car) mobility depends on the way of living of a household. The households are not only segmented by age and composition of the household but also by (net) household income. This hypothesis is used as valid for a period of time in which a household can adapt its car use to a change in the costs of car ownership and use. A possible way to do this is to buy a different car type. The supply of different car types is sufficiently heterogeneous to make it possible to substitute between fixed and variable costs in order to maintain the level of mobility. It is also assumed that the supply of infrastructure follows the demand for infrastructure. This implies that the average speed or travel time stays constant.

About FACTS 2.0

FACTS 2.0 predicts car ownership, car use and car emissions using alternative economic, demographic and emission scenarios as well as car cost policy measures of the government. The model does not compute the car fleet from year to year, although computations can be made for different future years. The number of trips made by car is not computed. The total traffic flow is not assigned to the network (this is being done in the LMS, using the car ownership predicted by FACTS).

The structure of the FACTS-model

The FACTS-model consists of various modules. FACTS 2.0 contains the following modules:

- Input module A, parameters which are independent of environmental and policy scenarios. This module contains input data like budget share per household type on car ownership and car use and the distribution of a car trip in different classes with a different average speed.

- Input module B, parameters which depend on environmental scenarios, but not on policy scenarios. This module contains data that depend on the chosen environmental scenario, like the average fuel use per car type.

- Input module C, parameters that depend on environmental and policy scenarios. This module gives the possibility to compute different kinds of policy measures, directed at influencing car costs.
Simulation module, in which a household, depending on its class and mobility needs, will choose a car from a given number of car types. Every car type has its own cost specification.

- Output module car ownership, car use and emissions.
- Output module energy consumption.
- Output module revenues of the government.

The basic assumptions of FACTS 2.0
Time and money are important constraints for car ownership and car use. Key notions for the factor time are the average travel speed and available time. Controlling factors for the factor money are the costs of car ownership and car use as well as disposable household income. The only constraint implemented in FACTS 2.0 is about money (budget constraint), there is no time constraint. The basic hypotheses remained the same as in the GEBAK-model (see the above text).

Input and simulation
In FACTS 2.0 there is no sequential dependency: all modules together give the information to the simulation process within the model. But there are differences in the way and degree different environmental and/or policy scenarios affect the input data.

Growth of income: the economic growth is translated into disposable household income. A growth in this income will lead to a growth of the number of cars and a growth of the number of kilometers driven.

Model structure FACTS 2.0
FACTS is composed of a number of blocks:

Main blocks:
- The 'computed' base year: in this block the number of cars, kilometers driven and emissions are computed for the base year. This is the first test on the outcome of FACTS. The results of the simulation of the base year are compared with the results of the computed base year. The computed base year is not used anymore as a reference for the forecasts for future years.
- The Simulation Model Car Choice (SMAK): in this block the choice process of households is simulated using the basic hypotheses. The output contains the following variables:
  - The future allocation of the number of car types per household class;
  - The share of Dutch households per household class who own a car in the year the forecast is made;
  - The average number of kilometers driven in a future year, split by household class and car type;
  - The share of household classes for the future number of households in the Netherlands.
  These variables are used in the next sub-block:
- The simulated base year and the forecast year are produced.

Other blocks:
- Business car fleet; the following variables are used as input in SMAK:
  - The total number of business cars, summed by car type and production sector;
The share per car type in the total number of business cars;
- The average number of kilometers driven per year per business car type.
- Fixed and variable car costs;
- Fuel consumption and emission.

The main similarities and differences between GEBAK en FACTS 2.0
- The basic hypotheses in FACTS 2.0 remained the same as in the GEBAK-model.
- In GEBAK it was assumed that business cars were not sensitive to car costs. This assumption is not used anymore. The following solution was chosen:
  - Restriction of the category business cars. The cars in this category are only the cars registered on the companies name or lease cars.
  - In line with the first restriction, drivers who have a business car are not sensitive to costs, because the employer pays for ownership, use, repairs, fuel consumption etc.
- Because of this there was a reduction in the number of cars that can be marked as business cars compared to GEBAK. This led to an increase in the number of car kilometers that can be influenced by policy measures on car costs.
- FACTS takes the ownership of a second car into account: households who have sufficient budget and want to drive enough private kilometers can own two private cars. Households with a company car can't own two private cars.
- In FACTS the two blocks (private cars and business cars) are integrated. In GEBAK the blocks were handled separately. The total amount of business cars is still determined by sector-specific developments, but after this these cars are divided among the Dutch households, based on a probability distribution function. Business cars can be used for both private and business kilometers. A private car can also be used for business kilometers.
- FACTS 2.0 includes a mechanism which makes it possible for a household to own no car, even if it can afford a car.
- In FACTS links were established between prices of new and old cars. This link assures that prices of dd cars develop in a same way as prices for new cars. This link was missing in the GEBAK-model.

An acknowledged shortcoming of FACTS 2.0 was that it is the missing an adequate car supply model.

2.2 FACTS 3.0

Introduction to FACTS 3.0
With FACTS 3.0 forecasts can be made of car ownership, car use and emissions under alternative economic and demographic scenarios, emission targets, developments in fuel efficiency as well as policy measures in the area of traffic and transport.

The structure of FACTS 3.0 shows the effects of car ownership and use due to (changes in) costs of ownership and use, as well as the total number of households and composition of these households and their incomes. Effects of car ownership and car use due to not explicitly modeled variables like travel time, spatial planning effects and public transport service levels are all included in a single factor.
Model description
The heart of the model contains the simulation of the choice process on private car ownership of households. This behaviour is influenced by fixed and variable car costs per car type, whether a household has a company car, and a number of exogenous variables (like the level of household income and the share of that income that is available for the private car), along with the two basic hypotheses (as already mentioned).

When all households have made their choice from the 18 car types distinguished, the next step follows: the confrontation of demand and supply of different car types. After this confrontation the total number of cars per car type is known, and together with that the number of kilometers driven per car type. With the help of the fuel consumption- and emission module the total amount of fuel consumption and emissions can be computed.

SMAK (simulation car choice)
The starting point is the computation of the fixed and variable costs per car type. These costs depend on the chosen scenario. Also the total size and composition of the business car fleet are - depending on the chosen scenario - determined. These business cars, distinguished by type, are allocated to households based on a probability distribution function per household class. This probability depends on a household class specific probability and the share of this household class in the total number of households in The Netherlands. People who are 65 and older can not own a business car.

In the next step the available budget for private car ownership and private car use (for one or two cars) is determined. This net income might be altered by a travel cost reimbursement per household type. In the business car module the number of business cars per car type is determined.

The next step is the determination of the number of kilometers driven per household. This variable is determined by drawing from a specific probability distribution per household class. Based on this the number of driven kilometers can be adjusted to the variable 'mobility needs'. This variable takes care of the changes in mobility needs due to measures that can not be modeled explicitly within FACTS. After the determination of the mobility needs a first selection of households takes place to see whether they are considered to own a private car or not. At least they need to have:
- A mobility need at or above a exogenous minimum determined value, AND
- An available car budget sufficient to buy the car with the minimum total annual costs at the mobility threshold.

If one of the rules is not fulfilled, it is not possible for this household to own a private car. The household can still own a business car.

The next selection a household has to go through is a procedure that determines whether a household will have no private car at all, even if it can afford one. The remaining households go to the next procedure. In this procedure it is determined whether the household is a single-person household or not. This has certain consequences for the next steps. There are four possible routes from here:
1. A single-person household - business car. It is assumed that it is not possible to own more than one car. When this kind of household owns a business car, this household can not own a private car.

2. A single-person household - no business car.

3. A more-than-one-person household - business car. If the private need is smaller than an exogenous minimum limit, a private car can not be owned. If the need is bigger than this minimum limit, the household will own a car. This household can also have a business car. The mobility need is diminished with the number of private kilometers that is driven with the business car.

4. A more-than-one-person household - no business car. In this situation it is possible that a household will have the disposal of two private cars (more than two cars is not possible). This does not include the group of people who are 65 and older. To own two cars the following requirements must be taken into account:
   - The private-mobility need must be above an exogenously determined minimum for the owning two cars.
   - If the remaining budget is smaller than the minimum needed to own a first car with a mobility need that is equal to a minimum limit, the second car is taken from the household.

First it is determined if it is possible to own a second car; otherwise the budget would all be spent on the first car.

Every household that is 'allowed' to own a first private car, may 'choose' a car type in the next step. A household can choose from a set of cars. These cars all fit within the available budget (or within some user-defined excess budget).

In somewhat more detail this means that the first step in this car type selection process is the comparison of the at random selected number of kilometers driven per year with the kilometer threshold in the choice between petrol and diesel or the threshold for a petrol versus LPG. When this random selected number of kilometers driven is smaller than both minimum levels a household can only 'choose' from petrol cars (6 types). When the random picked number of kilometers driven is bigger than both minimum levels a household can 'choose' from all 18 distinguished car types. In both other situations a household can 'choose' from 12 car types.

After restricting the households car choice to 6, 12 or 18 car types, the costs of the relevant car types are raised with the psychological car costs. This –multiplicative-factor is put in, because otherwise it leads to an overestimation of the share of certain car types, notably diesel and LPG. The idea behind this variable is that it should represent (perceived) disadvantages of LPG (reduced luggage space, sometimes seen as dangerous) and diesel (noise, slow).

In the next step, after the restriction process, households choose from a set of (maximum) 4 cars. These cars cost nearly the same as the 'best' car (probability procedure, see below). These 4 cars get a probability based on the distances of the car cost (at the kilometrage selected) to the budget.

The probability procedure contains the following three steps:
1. Determine the budget deficit (variable plus fixed car cost bigger or smaller than car budget) for the car types that households can choose (6,12 or 18 car types);
2. Determine the 1-4 car types for which a probability will be calculated. These are the cars closest to the budget, under the restriction that it is not allowed that the budget deficit of these selected car types is bigger than a user-defined excess budget (the budget can only be over-spent by some margin).

3. Compute the probabilities for each of the 1-4 car types. The probability differences depend on the distances between the budget deficits of each of the car types to the budget: the car type closest to the budget gets the highest probability.

FACTS assumes that every household chooses that car that fits best within the budget (all the budget will be used, and if an excess budget is allowed, possibly a bit more).

After the probabilities for the 1-4 car types have been determined, a random number generator is used to choose one car type from the set of up to four car types. FACTS does not work with sample enumeration (adding probabilities over the sample), but assigns a specific car type for every car owned.

When a household can own two cars but the budget deficit is bigger than allowed a household can loose the probability to the second car. When a household can not own two cars the budget deficit is checked a second time. When the budget shortage is bigger than approved, the randomly selected number of kilometers is adjusted. If the household still has a bigger budget than allowed, the household is not permitted to own a car.

SMAK defines the following output variables:
- The division of the number of car types per household class;
- The share of the Dutch households who own a car per household class;
- The average number of kilometers driven per household class and car type;
- The share of each household class within the total number of households in the Netherlands.

These variables are used in the next block: the simulated base and forecast year.

Simulated base and forecast year
In this module predictions are made for the total number of cars per type and household class. This number can be seen as the demand for the most preferable car type per household. This demand will be confronted with the number of cars supplied. The number of cars that is the result of the equilibrium process is the total number of cars per car type and per household class. In the next step, the VRAAGJ-procedure, the result is distributed by vintage (year of construction). By shifting this result over time (taking account of vehicle scrappage), the supply for next forecast year can be determined (see below).

Business car fleet
The size of the business car fleet is directly related to the production structure of the economy. The following output variables are used as input in the SMAK-procedure:
- The total number of business cars, summed by type and production sector;
- The share per car type in the total amount of business cars;
- The average number of kilometers driven per year per business car type.
The supply side of the car market
In FACTS 3.0 some attention is paid to the supply side of the market. Now it is possible to let demand and supply interact. A distinction is made between old cars (>5 years) and young cars (≤ 5 years).

The supply of young cars is assumed to be equal to the demand of young cars. The supply of old cars is computed by FACTS. To determine the number of old cars supplied, information is needed about the ‘administrative’ car fleet (this is the fleet in use plus the car stock of the dealers) in the base year specified by fuel, weight and construction year of the car. FACTS determines the number of cars that will survive (the opposite of scrappage) on to the next forecast year (t+5), using a survival function. The size of the computed car fleet can be influenced by the number of imported and exported cars (>5 years). The result is used in the demand-supply confrontation procedure.

Demand-supply confrontation procedure (de RAS-procedure)
It is possible that an Excess Supply or an Excess Demand will develop. The price mechanism takes ensures that an equilibrium is found by changing the demand of young cars and the number of non car owners. Adding this result to the number of business cars and second cars determined earlier gives the ‘active’ fleet (not including the car stock of the dealers).

It might seem odd that the demand supply confrontation only takes into account the first private owned car, this is done because in the RAS-procedure the non-car-owners are taken into account. These non-car-owners can not be compared with the total number of cars demanded per household. That is why, before the demand supply confrontation procedure starts, the simulated demand of cars and the number of a second car and business cars are subtracted. This results in a total number of households with one private car.

VRAAGJ-procedure
In this procedure the active car fleet by type and household class, as determined after the demand supply confrontation, is divided over vintage categories, using the result of this, the number of cars supplied in the next forecast year can be computed.

The distribution by construction year for young cars is not known for the future years. The supply of these cars is simulated within FACTS. But FACTS does not distinguish cars by construction year, but by construction year class (≤ 5 year en >5 year). The distribution of young cars therefore is determined in the VRAAGJ-procedure. The annual growth of the car fleet between t and t+5 is determined through interpolation.

The last step to determine the administrative number of cars is the adjustment of the demand for young cars per year of construction to the maximum potential supply of young cars. The demand for young cars is raised by a factor to get the administrative car fleet.

Finally the administrative fleet of old cars is added to the number of young cars supplied. This results in a total maximum potential supply of cars per construction
year, fuel type and weight in the year t+5. This outcome is the starting point for the
determination of the size of the car fleet in the year t+10.

The output variables are:
- The total number of cars supplied by fuel type, weight and year of construction for
  the year t+5.
- The total number of cars scrapped by fuel type, weight and construction year
  created in a 5-years period.

The main differences between FACTS 2.0 en FACTS 3.0

- By activating the variable 'mobility needs' the consequences of an increase in
  congestion or changes in driving behaviour can be simulated. The changes in the
  mobility needs can be differentiated by household class and simulation year.
  Altering this variable will result in a proportional change in private kilometers of
  the household. By changing the annual number of kilometers driven the
  probability of private car ownership of a household also changes. In FACTS 3.0
  the variable 'mobility needs' has been simplified by dropping the differentiation
  between household classes. It is very difficult to measure the effect of a prolonged
  travel time per household class. Also, boundary values have been specified within
  which the mobility needs are allowed to vary. When there would be too much
  freedom to increase or decrease the mobility needs, this would undermine the
  ‘normal’ operation of the model and lead to incredible model results.
- 18 household classes are distinguished:
  - Disposable income. This category was changed in FACTS 3.0.
  - Age of the head of the household. This category was not changed compared to
    FACTS 2.0.
  - Household structure (one-person or multi-person household). This category
    was not changed compared to FACTS 2.0.
- The number of sectors of the business car module was reduced from 7 (FACTS 2.0) to 5 (FACTS 3.0).
- The basic hypotheses remained the same.
- FACTS 3.0 has a supply function to bring about the interaction between the
  demand and supply side of the car market. The previous models did not have this
  mechanism.

2.3 Advantages and disadvantages of FACTS

In this subsection we list the advantages and disadvantages of the FACTS model.
FACTS has been reviewed before: some of the advantages and disadvantages listed
below (or rather of GEBAK) have already been mentioned in De Jong (1989).

Advantages of FACTS:
- FACTS has an excellent track record; it has been used in many applications, and
  has also been regularly updated and extended to account for changed
circumstances and to remedy things that were not modelled satisfactorily or were
missing. On the other hand we have not seen a validation of FACTS forecasts
against observed future year data. Comparisons for a base-year are available for
all versions, and in 1989 FACTS was used in a backcasting exercise to predict
1981 car ownership. The outcomes were compared with observations from the CBS car panel PAP. The main outcome was that total car ownership was predicted well, but the distribution over car types, especially fuel types deviated considerably from what was observed. The introduction of the ‘psychological car cost’ in later versions of FACTS might have reduced this problem. For the present FACTS 3.0 we have not seen such a backcasting exercise.

- FACTS is flexible, rather fast and easy in use.
- FACTS can produce outputs in many dimensions: number of cars owned, fixed and variable car cost, composition of car fleet in terms of 18 car types (fuel type, weight, vintage), impacts on households distinguished by income, age of head and household size, and car use; together with the emissions module it can also predict fuel consumption and emissions.
- FACTS contains a special treatment of business cars (leased cars, company-owned cars). This is related to production structure of the Dutch economy. The decisions of households on private car ownership are made conditional on the presence of a business car.
- FACTS contains a confrontation of car demand and supply (for cars older than 5 years).

Disadvantages of FACTS

- Policy advisers now ask for even more output dimensions, especially for car types (see chapter 6 of this report).
- The basic assumptions of a constant money budget for car ownership and use and that households will seek to maintain their mobility level are at odds with economic theory. The assumptions imply cost maximisation within some range: the households try to ‘fill’ the budget by choosing the most expensive affordable car. The empirical evidence on these assumptions is mixed. Some international evidence is discussed in sections 4.17 and 4.22; some Dutch work is report in the subsections below.
- Generally speaking a model is better if it uses fewer assumptions to get the same outputs. FACTS is a powerful instrument, but rests on far-reaching assumptions, which might be tested empirically using models that require less observations.
- FACTS is not really suitable for giving impacts of large changes in cost (because of these basis assumptions): in case of large cost changes (could be larger than observed before), it becomes more likely that households will change the car budget share and the number of kilometers. This cannot be tested with FACTS.
- FACTS is not really a causal model, but a system that consists of a number of pre-defined decision rules and some random procedures.
• The psychological car cost variable is an artificial device to correct for wrong car type share predictions; the decision to let all influences on car type choice have impacts through cost variables only poses severe restrictions and can lead to implausible car type choice results. Changes in variable and/or fixed cost (including variabilisation) will in FACTS be translated into cost changes including the psychological cost, which can lead to implausible choices in terms of light versus heavy cars and in terms of old versus new cars.

• Car use is not explained in FACTS, but comes from drawing from a distribution, and is not directly affected by variable or fixed car cost. In an indirect way there is some effect: the kilometrage can be reduced to some degree if the car cost exceed the budget.

• Whether there will be second cars in the household in FACTS, mainly depends on the sum of the mobility needs (in terms of kilometers) of the household. One might argue that most households with two or more cars will rather own more than one car because they need two cars simultaneously than because they have to make many kilometres in total, since the fixed cost of a second car are substantial (synchronicity instead of additivity). Other households might have more than one car, because some car types are more suited for certain travel purposes (e.g. shopping, recreation) than others (specialisation of car types within a household).

Review of the discussion on monetary travel budgets in ‘Time to Travel, A model for the allocation of time and money’ by Kraan (1996)

The purpose of this Ph.D. thesis is to study how limited time and money budgets will lead to limited growth of mobility. A –selective- review is included in this memorandum because of its relevance for the basic assumptions of the FACTS model (constant money budget per household segment; maintaining mobility level). An overview of recent Dutch evidence on constant time budgets can be found in Van Wee, et al. (2001). This paper however does not deal with money budgets, as are used in FACTS.

The model used in the thesis, which will not be discussed here, is based on the flexible budget approach by Golob et al (1981) and Downes & Emerson (1985). It is not the intention to provide a summary, however we focus on the discussion throughout the thesis about the impact of the money budget restriction on a household’s possibilities to travel.

In addition to following on the BREVER-law (well-known, but also often criticised) which states that the time spent on travel is constant, models such as FACTS and UMOT make the assumption that the percentage of the income spent on travel is fixed as well. A counterintuitive critique, for example, is that when car speed increases, a longer car distance can be covered within the same time, but this will cost more money (assuming the variable cost does not change). Keeping the budget of money constant, some expensive car kilometers should be compensated by cheaper kilometers, for instance public transport kilometers.
The problem lies in the fact that there is no interaction between the money spent on travel and other activities. Even when a more flexible approach is taken and money can be spent otherwise, travel is still considered as an end itself, and not as derived demand. Other activities are grouped as one variable, where a distinction between various activities (or travel purposes) as reason for the trip should be taken in to account. Due to the lack of interrelationship a thorough activity-based study would be needed to really solve the problem.

Activity-based approaches consider the total activity pattern. In contrast to the conventional four stage models, both frequencies, and time expenditures are endogenous, depending on total activity pattern. Money expenditure is also included in the total activity pattern. Every activity will cost an amount of money, which can be divided between fixed and variable costs. For travel, the fixed costs are purchase or maintenance of the car, the purchase of public transport season ticket, or the purchase of a bicycle. The trip length normally determines the variable costs. Individuals make various kinds of decisions subject to time and money constraints. Activities can be distinguished by their type (obligatory, maintenance and leisure) and the characteristics duration, location, frequency and costs. Out-of-home activities will generate travel, where obligatory trips are fixed in the short run.

Although the theory outlined above is well-defined, there is no data available in the Netherlands to test the model that allocates both time and money expenditures. The problem is that time and money expenditure data is given by different survey units, individuals versus households. In terms of time expenditures the model in the thesis considers individuals, but the money spent on activity patterns is mostly household based. In most of the cases one or two members of the household earn an income that is used for expenditures of the entire household. The model should be adjusted to a household model with individuals being modelled in a submodel.

Review of ‘Large changes in prices. An empirical controlled budget approach’

The outcomes of this project, that was carried out by MuConsult for AVV, were reported at the CVS by Rosenberg, Meurs and Meijer (1997). The purpose of the study was to examine if large price changes have proportionally different (i.e. greater) effects on mobility and car ownership than small price changes. The review of this paper is included in this memorandum because we think this is relevant for evaluating the basic assumptions of FACTS.

When a price increase in a transport good occurs a household can compensate this by adjusting the budget reserved for transport (income effect) or decreasing their budgets for other goods, which can also be a reduction in the household savings (substitution effect). The assumption made throughout the article is that households will first adjust their transport budget, before changing other budgets like housing, food, clothing or recreation. This approach is consistent with the two-stage budgeting approach in Deaton and Muellbauer (1980).

The project included a budget game with 830 workers who all possessed a car. The reaction of the respondents to a large increase in price was monitored. Price increases were made on the fuel price, which were compensated or not-compensated by fixed car costs and public transport fares in combination with the first two options.
In total, eleven combinations were evaluated and the overall conclusion is that consumers will compensate the price increases mainly by cutting down on their savings. But also other non-transport related budgets were affected, such as food and clothing, and recreation. If savings were made on car costs, this was mostly done by reducing the number of car kilometers.

Examining the price elasticities, the conclusion can be drawn that large price increases have relatively more effect than small ones. Four other remarks, focusing on car users, can be made:

- The elasticities are greater for low income households than for households with high incomes, which may indicate that economic growth reduces price elasticity.
- A reduction on car kilometers is mainly achieved by decreasing the private (not including commuting here) kilometers rather than kilometers driven for commuting. However, an abrupt large increase in the price is more likely to reduce the commuting kilometers than a small increase.
- ‘Urban’ households are more price sensitive than households that live in a more rural area. This is caused by the high share of low income classes in cities and the better quality of public transport.
- When car users are compensated for increasing fuel prices by a reduction on the fixed car costs the elasticities drop significantly.

In the long run, some additional options to adjust the household budget were provided to compensate for the price increase. The options that the households could choose included moving to a location nearer to work, changing jobs, working at home or relocating to less expensive housing. None of the options were chosen often, because transaction costs are perceived as high. Nevertheless, the households who were willing to change their budget by one of the options, estimated the probability, to actually perform the change, as high.