Quality-corrected price indexes of new passenger cars in the Netherlands, 1990-1999

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Paper presented at the Sixth Meeting of the International Working Group on Price Indices, Canberra, Australia, 2-6 April 2001.

Summary *- Market dynamics and continuous technological developments constitute a major challenge to the proper measurement of the price evolution of durable goods. In this paper, hedonic methods are used to estimate quality-corrected price indexes of new passenger cars in the Netherlands, 1990-1999. Use is made of a huge set of price, quantity and quality information about 11,000 car models, obtained from different sources. The analyses reveal that the nominal price level has increased about 20% on average, while the shares of car models with airbags, tinted glass and power steering increased from almost nothing to more than 90%. The matched model price index and the official CPI for new cars, which partially account for quality-adjustments, estimate the price increase to be equal to 10.6% respectively 11.2% for the 1990-1999 period. By contrast, the indexes based on the hedonic approach, particularly those adopting the preferred annually-estimated brand-weighted semi-log hedonic models, lead to price changes varying from +0.1% to -3.6% and thereby to a downward adjustment of the official figures by 11.1 to 14.8 percentage points, over the period 1990-1999. The pooled adjacent-years model assumes an intermediate position with a predicted quality-corrected price decrease of 1.7 % over the observation period, which is 12.9 points below the CPI.*

1. Background and problem definition

Although the political discussion following the publication of Boskin's (1996) findings has faded, the report has led to world wide renewed interest for the problems of price and volume measurement. The relevance of accurate measurement is evident. Even seemingly modest adjustments of the official consumer price index, like the -1.1 percentage point proposed by Boskin, may have excessive consequences for the income and outlays of governments, for the income developments of various social groups like social security recipients, and for everyday payments of electricity, housing and many other services. The actual performance of accurate measurement is, however, less evident. Numerous problems may occur throughout the measurement process: during conceptualization (Deaton, 1998; Diewert, 1998; and Nordhaus, 1994) as well as during operationalization (Abraham et al., 1998, Boskin et al., 1996, 1997, 1998).

A central measurement issue concerns the treatment of on-going quality developments of existing products and services, and of market introductions of new products and the disappearance from the market of obsolete products. The general idea is that quality improvements or increasing product varieties lead to more value for money. These quality improvements induce real price decreases. Important questions are, however, how to define and measure quality or quality changes, and whether all measured quality improvements should be corrected for, under all circumstances. Also, entry and exit of products in markets may distort

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measures of price and volume developments. Prices of new goods, particularly consumer durables and capital goods, often reveal high initial prices which rapidly decline and stabilize, after some period. Since official weighting schemes are revised only once in every 5 or 10 years, a substantial amount of price dynamics is missed by the consumer price index. Obviously, this leads to theoretical and practical issues, even apart from the fact that not every one subscribes to the immediate administration of all dynamics.

The purpose of this paper is to estimate quality-corrected price indexes of new passenger cars in the Netherlands, 1990-1999. The study employs the *time-age-vintage* models originally developed by Hall (1971) for the second-hand pick-up truck market, adopted by Oliner (1993) to explain price developments in the mainframe computer market, and more recently applied by Berndt, Griliches and Rappaport (1995) to explain price decreases of PC's. Use is made of information about prices and technical characteristics of more than 11,000 car models sold in the Dutch passenger car market in the 10-years period 1990-1999. The data are obtained from two different data sources: ANWB and RDC.

The results of the analyses show that during the observation period both the nominal car prices increased and the technical quality of cars improved. The average nominal price of new cars in 1999 is about 20% higher than that in 1990, while at the same time the share of car models with airbags, power steering, and tinted glass increased from almost nothing in 1990 to more than 90% in 1999. The official CPI for new passenger cars, which partly corrects for quality changes, indicates a 11.2% price increase for the same period, which is considerably lower than the increase of the average nominal price. However, the indexes developed in this study reveal quality-corrected price increases varying from +0.1% to -3.6%, which lay 11.1 to 14.8 percentage points below the official index.

The present study extends the existing literature in several ways. First, it provides further empirical support for the use of the *TAV*-model in new rather than second-hand product markets. Secondly, the huge and detailed data set employed covers the entire Dutch new car market. Thirdly, the information about prices and quality on the one hand and volume on the other hand come from different data sources, which causes merging to be of specific interest. Fourthly, following the different merging modes, the impact of different weightings in hedonic regressions is studied.

The study is structured as follows. The following section discusses the data sources, with particular reference to the merging of price, quality and volume data. Section 3 sketches the price and quality developments during the observed decade. Section 4 discusses the models used to estimate quality-corrected prices, while section 5 presents the outcomes of different quality-corrected price indexes. Section 6 concludes the paper.

2. Data

Information about prices, characteristics, and sales of passenger cars in the Netherlands come from two different sources: ANWB and RDC.[2] The ANWB file contains detailed information about the price and technical characteristics of about 11,000 passenger car models offered for sale in the Dutch new car market; about 8,000 of these models have been available in the period 1990-1999. The RDC file contains information about the actual sales and a limited set of technical characteristics of about 40,000 new car models. Since both data sources cover the entire car market, it is clear that the definition and registration of car models must differ widely. First, ANWB and RDC use different definitions of car models. Car model description is much more refined in the case of the ANWB data than it is in the case of RDC, despite the larger amount of models in the latter file. Secondly, though both sources are based on monthly information, the observation base differs: the ANWB information is based on the in-production period of car models, while the RDC data are based on monthly license registrations. The two

[2] ANWB refers to the Royal Dutch Tourist Office, which attends to the interests of tourists an road users in the Netherlands. RDC refers to the RAI Datacentre, which is responsible for car registrations in the Netherlands.

observation periods do not necessarily coincide. In fact, the ANWB in-production period of car models may be assumed to be systematically ahead of the actual sales or registration period used by the RDC. The consequences of differing observation periods are likely to be felt less when data are aggregated into quarterly or annual figures. In short, the data-matching problem may be described as an *m* to *n* situation.

The merging problem has been solved by the definition of three identifiers that fit both the ANWB and the RDC information: *EURmrk*, *EURmod* and *EURtyp*. *EURmrk* represents the most general identification by the brand of cars. It consists of a 4-character code referring to the car brand: 'MERC' for Mercedes, 'VOLK' for Volkswagen and 'MAZD' for Mazda. Problems occur in the case of mergers or take-overs. For this reason, the Mini car models are joined with Rover, Daimler models with Jaguar, and Zastava's with Yugo. This results in 69 different brands in the ANWB file and 108 brands in the RDC file; 66 brands have a match. The non-matching models consist of small brands (judged by sales volume), like Pilgrim, Boom and Bugatti. *EURmod* is 25-character code consisting of *EURmrk* and a model description. For instance, an Audi A6 is denoted as 'AUDI A6', a Citroen AX as 'CITR AX' and a Renault Megane as 'RENA MEGA'. Numerous small coding differences between the ANWB and RDC sources exist at this level. This second identifier results in 556 car models in the ANWB file and 723 models in the RDC source; 531 car models can be matched. The third identifier *EURtyp* is a 38-character code consisting of *EURmod* plus four characteristics. These characteristics have been chosen on the basis of relevance and reliability (from the merging point of view): (1) cylinder content (in 1000 cc, in 1 decimal point); (2) fuel type ('D' for diesel; and 'B' for gasoline); (3) transmission type ('A' for automatic; and 'H' for manual transmission); (4) coach type ('COMB' for station car, 'CABR' for cabriolet, 'COUP' for coupe, 'COMP' for compact (only BMW), 'SCEN' for scenic (only Renault) and 'SHUT' for shuttle (only Honda). The number of different car models according to *EURtyp* is 2688 in the ANWB file and 3092 in the RDC file; 2543 models have a match.[3]

The actual merging of the data sources has been performed by each of the three *EURkeys* (*EURmrk*, *EURmod* and *EURtyp*) and year. First, we determined the number of car models in the ANWB file by each *EURkey* and year. Secondly, we calculated the number of new cars sold to private consumers in the RDC file by *EURkey* and year. Thirdly, we merged the RDC sales figures with the ANWB information by *EURkey* and year. Fourthly, the average number of sales per car model has been calculated for each matched car model in the ANWB file, the result of which was ascribed to each car model within the respective *EURkey* and year. The average sales per car model, evaluated at the level of brand, model and type, are used as weighting variables in subsequent analyses.

3. Price and quality developments of new passenger cars in the Netherlands

The obtained price, quality and quantity information is used in various ways to measure the price dynamics of new passenger cars. Table 1 summarizes estimates of average price levels and price developments (1990 = 100) adopting different weightings. The number of observed car models in the ANWB source is seen to rapidly increase from about 2,400 in 1990 to about 4,000 in 1998. During the same decade, the average annual price of these car models, which is denoted as the nominal price level (*PriceNom*), increased from 53,012 DFL in 1990 to 63,373

[3] In addition to these three identifiers the use of a fourth key *EURuitv* has been considered consisting of *EURtyp* plus 10 other make descriptors. (1) Primary type descriptors, like 'L', 'XL' or 'GLS'. (2) Secondary type descriptors, like 'FIRST' or 'VOLCANO'. (3) Horse power (in Kwh). (4) Number of valves, '12V', '16V', '18V', '20V', or '24V'. (5) Number of cylinders, 'V4', 'V5', 'V6' et cetera. (6) Number of doors, '2D', '3D', '4D' or '5D'. (7) Four-wheel drive, '4WD'. (8) Four-wheel steering, '4WS'. (9) Roof type, 'HARD' or 'SOFT'. (10) Long wheel base, 'LWB'. Eventually, we did not use this key because it strongly increased the number of non-matching car models, and consequently the amount of unused volume information. To our defense, many of these characteristics correlate with the type characteristics defined in *EURtyp*, like horse power with cylinder content, and number of doors with type of coach.

DFL in 1999, which corresponds with an average annual rate of price change of 2.0%. Obviously, the nominal price level is not a good estimate of the average price of sold cars, since some car models are more current than others. Instead, a unit price level is desired in which the price of each car model is weighted by the associated sales. Unfortunately, our data lack this one-to-one correspondence. The desired sales weights are therefore estimated by the three RDC sales-weights that have been previously determined as the average annual sales by car model measured at the level of brands (*EURmrk*), models (*EURmod*) and makes (*EURtyp*). Weighting is seen to have a considerable influence on the measurement of the average price level (*PriceNom*, *PriceMrk*, *PriceMod*, *PriceTyp*). The average car price drops about 25% when adopting brand-based sales weights and almost 45% when weighting by sales at the car type level; the price differences between weighting by model sales and make sales are relatively small. Despite the substantial price differences observed when weighting, the differences between the associated nominal price indexes (*IndNom*, *IndMrk*, *IndMod*, *IndTyp*) are small. The indexes reveal average price increases over the entire observation period equal to about 20%, which corresponds with an average annual price increase equal to 2.0%. Furthermore, the median price level (*PriceQ*) and median price index (*IndQ*), presented to cope with the right-skewed distribution of car prices, shows a 1999 typical price comparable to the brand-weighted average price level. The corresponding price increase of 27.5% is considerably larger than the 20.3% for *IndMrk*. An obvious disadvantage of the nominal price indexes is their neglect of quality developments and market dynamics.

The matched model index (*IndMat*), calculated as a chain index based on the average of the price relative of car models that are available for two adjacent years, adjusts for quality developments (see Berndt, Griliches and Rappaport, 1995). This index estimates the price increase for the entire period to be equal to 10.6% (1.1% per year). However, the matched model index ignores a large amount of valuable information. Particularly, in times of strongly dynamic markets, like the 1992-1997 period, in which the number of different car models almost doubled, the neglect of new car model prices may lead the matched model index to mask substantial welfare improvements. It is therefore interesting to find that the results for the matched index are close to those obtained for the official CPI for new passenger cars in the Netherlands (*IndSN*). The latter index does correct for quality developments; albeit on the basis of partially explicit procedures. The official CPI estimates the price increase to be equal to 11.2% (1.2% average price increase per year). The difference between the CPI and the matched index is at a maximum in 1993 (3.6 points), but seems relatively stable since 1996. The average annual price increase differs by 0.1 percentage points.

A point in case is whether the car market signals the sort of quality developments which makes worth the effort of evaluating the current practice of price index measurement. Appendix A illustrates the development of quality characteristics that are also part of the hedonic analyses below. The results indicate that during the observation period new cars have substantially improved in terms of engine performance, safety, comfort and ease of use. Specifically, the horsepower of new car models has increased from 79 *HP* in 1990 to 92 *HP* in 1999 (*AAG* 1.7%), while the efficiency of fuel consumption has improved from 9.3 *l*/100*km* in 1990 to 8.4 *l*/100*km* in 1999 (*AAG* -1.1%). The share of cars with fuel injection has almost doubled from 51% in 1990 to 91% in 1999 (*AAG* 6.7%) and that of diesel-driven car models increased from 18% to 26% (*AAG* 3.9%). The percentage of cars with 8 or more cylinders remained relatively stable. Moreover, the share of cars with airbags has risen from 6% to 91% in 1999, corresponding with an average annual growth of 34.5%. Also, the shares of cars with central locking, tinted glass, and ABS brake system have increased from about 10% to more than 90% (ABS 68%). The share of models with power steering has increased from 27% to 94%, and that of cars with air-conditioner from 1% to 41% in 1999. Furthermore, the market share of mid-class cars (Class 3 and 4) has strongly increased from 55% to 66%. This change in market presence has occurred at the expense of the upper market segments (Class 5 and 6), which decreased with an average annual rate of 4.1%, and of the lowest market segment (Class 1) that decreased from a 2.0% share in 1990 to 1.0% in 1999. Obviously, the observed quality developments are substantial. The following section will discuss methods that relate the observed price variation to the differences in various quality characteristics of new car models in the Netherlands, 1990-1999.

Table 1 about here

4. Estimation method

Direct price measurements have various drawbacks. They either entirely ignore quality developments (*IndNom*, *IndQ*), or adjust for quality changes in such a brutal way that much valuable information is lost (*IndMat*), or base quality adjustments partly on subjective estimates (*IndSN*). In this section the use of hedonic methods for price measurement is discussed. This approach has been introduced in economics by Court (1939) with an analysis of automobile prices, and enhanced by Griliches (1961, 1971), and Adelman and Griliches (1961).[4] Recent applications mainly concern personal computers, mainframes and computer parts. In this section the background, estimation method, specification tests and estimation results are briefly discussed.

The specification of hedonic models

Hedonic models, as elaborated in the household production theory by e.g. Lancaster (1966*a*, *b*), are based on the idea that cars and other durables can be viewed as bundles of technical characteristics. The price of this bundle is assumed to equal the sum of the (implicit) prices of the characteristics that constitute the bundle. In regression terms:

$$p_{it} = \beta_{0t} + \mathbf{x}'_{it}\,\beta_t + \varepsilon_{it} \tag{1}$$

Here, p_{it} is the (log) price of passenger car model *i* in period *t*; $\mathbf{x}'_{it}$ is a vector of technical characteristics; the parameter vector β_t represents the implicit prices of the corresponding characteristics; and ε_{it} is an independently distributed error term with expected value 0 and variance σ^2. The estimated parameters form the basis of the quality-corrected price indexes derived in the next section.

A related approach, based on the repackaging theory of Fisher and Shell (1971), consists of directly estimating the quality-corrected price differential on the basis of time dummy variables in pooled regressions. The enhanced *time-age* and *time-age-vintage* specifications have been developed by Hall (1971) to measure the price development of second-hand pick-up trucks. This *TAV*-specification has recently been applied by Berndt and Griliches (1993), Oliner (1993) and Berndt, Griliches and Rappaport (1995) to mainframes and personal computers (also see Jorgenson, 1996). The *TAV*-model considers the price of a car in a specific time period (*t*) with a specific age (*a*) and from a specific vintage (*v*). Obviously, time, age and vintage information are collinear: $t = v + a$, or $v = t - a$. Under the assumption that the price of a durable good with age *a* in period *t* is equal to the net present value of future capital services, Hall (1971) shows that price variation among cars can be attributed to: a loss of capital efficiency (obsolescence, depending on age *a*); product-specific quality changes (embodied technical change, depending on vintage *v*); and variation in the (rental) price of capital services and more efficient use of

[4] Hedonic methods have been frequently applied to the measurement of car prices. See Fisher, Griliches and Kaysen, 1962; Griliches, 1964; Cagan, 1965; Cramer, 1966; Dhrymes, 1971; Hall, 1971; Cowling and Cubbin, 1971; Boyle and Hogarty, 1974; Friedlander, Winston and Wang, 1983; Mertens and Ginsburgh, 1985; Ginsburgh and Vanhamme, 1989; Mertens, 1990; and Verboven, 1996). In addition they have been applied to a wide variety of durable goods like refrigerators (Dhrymes, 1967), washing machines (Gavett, 1967) and houses (Bailey, Muth and Nourse, 1963; and Musgrave, 1969). Formalizations of the hedonic models are found in Rosen (1974), Triplett (1986), Feenstra (1995), Fixler and Zieschang (1993), Berry, Levinsohn and Pakes (1995) and Goldberg (1995).

capital of the market as a whole (disembodied capital change, depending on time t). Hall's (1971) specification is based on a rather technical interpretation of volume variation of the supplied capital services. Also, it is designed to study the price dynamics of specific new and used cars rather than of new cars of specific car models. Various economic factors can be assumed to play a role in the price dynamics of car models, such as the brand image of cars, marketing strategies of manufacturers, and heterogeneity and development of consumer preferences. These economic factors are taken into accounted in the empirical approach by Oliner (1993) who does attribute price variation to time, age and vintage next to technical qualities, but who does not adopt the strictly technical interpretation. Age effects, in this view, represent the impact of all factors associated with the duration of car models in the market, such as variations in the technical specifications (not yet specified in the technical specifications) or pricing strategies of manufacturers over the life cycle of car models. Vintage effects represent systematic influences associated with the introduction year of car types (as far as not yet covered by the technical characteristics). The most elaborate specification of the pooled model including age and vintage effects may accordingly be written as:

$$p_{itav} = \beta_{0t} + \pi_1 dt_{T0+1} + \ldots + \pi_T dt_T + \alpha_1 da_1 + \ldots + \alpha_A da_A + \\ + \upsilon_1 dv_{V0+1} + \ldots + \upsilon_{V-1} dv_{V-1} + \mathbf{x}'_{iv}\,\beta + \varepsilon_{itav} \qquad (2)$$

In this model, p_{itav} represents the (log) price in period t of car type i with age a and vintage v; $\mathbf{x}$ and β have the same interpretation as before; and ε is an independently distributed error term with mean 0 and variance σ^2. The impacts of time, age and vintage are represented by dummy variables to increase flexibility. Because of collinearity constraints, the dummy variables for the base year dt_{T0}, for new car types da_0, and for the oldest and most recent vintages dv_{v0} and dv_{vV} are omitted. The parameters $\pi_1, \ldots, \pi_T$ of the corresponding time dummies are interpreted as quality-corrected price differentials with respect to the base period. The parameters $\alpha_1, \ldots, \alpha_A$ represent the price effects of a longer duration of the car model in the market. Following Hall (1971), negative age effects may be expected as the expected return of capital services declines with the position of the car type in the product life cycle. Negative age effects may also be expected for manufacturers following skimming strategies in which they introduce car models at high initial prices and successively lower the price as age proceeds, maintaining quality constant. Positive age effects may be expected when manufacturers pursue penetration strategies introducing base car models at relatively low initial prices, which are enhanced and sold at higher prices when age progresses. The parameters $\nu_1, \ldots, \nu_{V-1}$ represent systematic deviations from the trended quality development over the entire observation period as far as not embodied in the technical characteristics. They may be expected close to zero, when the technical characteristics in the model are aptly specified.

Estimation method and specification tests

Linear, semi-log and double-log specifications of the hedonic models have been estimated. The log specifications are based on logarithmically transformed car prices, while in addition the double-log specification incorporates log transformations of the quantitatively measured technical characteristics, like horse power and fuel consumption. The use of log-transformed car prices is slightly preferred in advance because of the highly right-skewed distribution of car prices. Box-Cox regressions are performed to gain further insight into the proper model. Adopting Cramer's (1986: 133) procedure, the dependent car price is divided by its associated geometric average, the result is transformed in the familiar Box-Cox way and related to the car characteristics. The Box-Cox parameters are subsequently estimated by non-linear least squares. All estimated Box-Cox parameters are found to be close to zero, which pleads in favor of the log-specifications and against the linear specification. In addition, J-tests by Davidson and McKinnon (1983) are performed to distinguish between the semi-log and double-log specifications.[5] Taking the semi-log specification as null hypothesis and the double-log specification as the alternative gives rise to values of the test parameter close to zero, both for the annual and the pooled regressions. Though close to zero, the estimated test parameter is significant in many instances. By contrast, the parallel *J*-test, which takes the double-log specification as the null hypothesis and the semi-log specification as the alternative, yields highly significant values of the test parameter varying from 0.90 to 1.95. Both versions of the *J*-test, though not strictly conclusive, indicate a preference for the semi-log model. The latter specification is therefore used to calculate the price indexes in the next section.

The hedonic models are estimated both annually and pooled. Tests of parameter constancy show that the pooled *TA*-specifications are uniformly rejected in favor of the annual regression models: the implicit prices can therefore not be assumed constant over the observation period. Applying the *RMSE* criterion suggested by Berndt, Griliches and Rappaport (1995) gives a mildly different picture: the relative change in *RMSE* for the adjacent year regressions is nowhere larger than 3.1%, whereas the maximum *RMSE*-change for the pooled model is 11.6%. It follows that the bi-annually pooled approach can be maintained, whereas the pooled model is still rejected. The explanatory power of the estimated models is invariably high: the R^2 values are well over 0.90 in most situations.

A final specification issue concerns the weighting of observations in the hedonic regressions. The issue is controversial since the origin of the hedonic method. Weighting has been proposed by Griliches (1971) to cope with year to year differences in sample selection. The impact of such differences is particularly felt in the case of pooled regressions, in which the quality-adjusted price differential is estimated by the coefficient of the time dummy variable. Also, weighting is preferable in view of our attempt to measure the price dynamics of a typical car model. By contrast, weighting may be considered superfluous when the variation in car prices is entirely due to the specified technical characteristics. In our study, a pragmatic rather than fundamental trail is followed by examining whether or not weighting matters in a statistical sense. Recall that our merging procedure led to four different weights: one based on the in-production period (not on sales) and three others based on average sales measured at the level of brands, models and types. The relative appropriateness of each weight is determined on the basis of Breusch and Pagan (1979) tests. Weighted regressions are performed using each of the four weights. The residuals from these regressions are squared, divided by the *MSE*, and subsequently regressed on the other three weights separately. The latter yields a chi-square test to evaluate the assumed homoskedasticity: if it is maintained, the other weights have no additional heteroskedastic effect; if it is rejected, the other variables do have an additional heteroskedastic effect. The idea is that the desired weight leaves no residual heteroskedastic effects for the other three weights. The following results are obtained. Based on pooled semi-log *TA*-regressions weighted by in-production period, homoskedasticity is rejected for all three sales-based weights (*p*-values below 0.000). Performing the same regressions using sales-based weights instead, leads to insignificant effects of the in-production period (p = 0.515, 0.685 and 0.635, for the brand, model and type-based weights respectively). This clearly indicates that weighting by sales is preferable from a statistical point of view. The subsequent distinction between the three sales weights is less easily made. The type-weighted regressions lead to a significant heteroskedastic effect of brand weights (p = 0.039) and an insignificant effect of the model weights (p = 0.313); the model-weighted regressions show a significant brand effect (p = 0.064) and no type effect (p = 0.392); and the brand-weighted analysis reveals a significant model effect (p = 0.027) but again no type effect (p = 0.164). The latter findings suggest that

[5] The *J*-tests are performed by adding the predicted values of the alternative (H_1)-specification, say z, to the model specification under H_0. The H_0-specification is maintained if the estimated parameter α of z in this regression does not differ significantly from zero; under H_0 plim $\hat{\alpha}$ =0. In addition, *F*-tests have been performed to evaluate the contribution of both the continuous variables and the log-transformed continuous variables in a super model containing both types of variables next to the dummy characteristics. These *F*-tests do not give a definite result. However, the *F*-values evaluating the contribution of the continuous variables, are substantially larger than those evaluating the impact of the log-transformed variables.

brand and model-based weighting are both preferred to type-based weighting; however, they are not conclusive with respect to a choice between brand and model weights. A mild preference for brand-based weighting may be based on the significant influence of this variable in the type-weighted analyses. The outcomes for the preferred brand-weighted semi-log hedonic models are presented in appendix B.

The results for the annual hedonic regressions are in line with those for the pooled regressions. In this case, performing the unweighted regressions a further interesting phenomenon is observed: the model-based weights tend to be less significant than the brand-based weights (though being significant as such for nine out of ten years), but the type-based weights are no longer significant for seven out of ten years. This suggests that weighting becomes less relevant when the sales weights refer to narrower defined car models. This would lead to two interesting speculations. First, weighting annual hedonic models by unit sales may be unnecessary when the selected sample closely reflects the population of car models offered for sale in the market. If the number of car model varieties is limited by the extent of the market, one may expect that unweighted regression based on detailed product descriptions (as is the case here) takes differences in market share implicitly into account. This idea is further supported by the high correlation between the number of varieties per brand and market share, which is 0.76 for the entire observation period. Second, the fact that brand and model-based weights still have significant effects may signify misspecification of the systematic part of the model rather than random heteroskedastic variation. An explanation may be that the performance of hedonic models is affected by general pricing strategies of manufacturers. These pricing strategies may be less felt at the level of models and types, because the room for manufacturers to substantially differentiate their strategies for cars within the detailed level of car types is relatively limited. Elaboration of this issue is left for future research.

The specification tests give rise to a preference for the annually-estimated, brand-weighted, semi-log models. The discussion of the estimation results for these models is confined to the age effects. In the annual and pooled *TA*-model these age effects are largely positive. This supports the idea that the age effects have an economic rather than technical interpretation. A likely explanation is that manufacturers gradually improve the quality of their car models after introduction without immediately adjusting the basic technical characteristics of the model. Particularly strong positive effects are observed for car models with a life cycle of 10 years or more. These cars consist for a large part, 54%, of very luxurious car models. A strikingly negative age effect is observed for the cohort of car models introduced in 1987 (and to a lesser extent for the 1988 cohort as well). The associated age effects for this vintage can be identified in table B.1 on the diagonal that runs from 1990/age=3 to 1999/age=12. These negative effects are accompanied by a strongly negative vintage effect in the fully pooled *TAV*-model (*V87* = -0.090). This suggests that quality adjustments in car models from 1987 lag behind the trended quality development over the 1983-1999 period, even after purging for the influence of the observed technical characteristics.

Table 2 about here

5. Quality-corrected price indexes of new passenger cars

The results of the hedonic regressions can be used in various ways to construct quality-corrected price indexes. This section estimates and compares price indexes based on the estimation results of the preferred semi-log models. The emphasis is on the indexes based on the results of the preferred annual brand-weighted semi-log model, though price indexes for all estimated semi-log models are presented in Table 2.

Price indexes on the basis of annual hedonic regression models

Laspeyres and Paasche-like price indexes are constructed on the basis of the annual hedonic regressions together with annual averages of the quality indicators. The quality-corrected Laspeyres-like index is defined as the average of the implicit price ratios in current and base periods, weighted by the value shares of the technical characteristics in the predicted car price in the base period. Formally, the quality-corrected fixed base-period Laspeyres price index (ILF_t) is defined as the predicted price of a car model with average base period characteristics $\bar{\mathbf{x}}_0$ at current implicit prices $\boldsymbol{\beta}_t$ divided by the predicted car price in the base period:

$$ILF_t = \frac{\exp\left(\boldsymbol{\beta}_t{}' \bar{\mathbf{x}}_0\right)}{\exp\left(\boldsymbol{\beta}_0{}' \bar{\mathbf{x}}_0\right)} \qquad t = T_0+1, ..., T \qquad (3)$$

which may be conveniently reformulated as:

$$\ln ILF_t = \left(\boldsymbol{\beta}_t - \boldsymbol{\beta}_0\right)' \bar{\mathbf{x}}_0 \qquad t = T_0+1, ..., T \qquad (4)$$

This illustrates that the Laspeyres-like quality-adjusted relative price change with respect to the base-period price level is interpreted as the change in implicit price weighted by the base-period technical characteristics of car models.

The chain-weighted Laspeyres index (ILC_t) is obtained by multiplying the index value from the foregoing period by the price differential weighted by the technical characteristics from the previous period ($\bar{\mathbf{x}}_{t-1}$):

$$ILC_t = ILC_{t-1} \times \frac{\exp\left(\boldsymbol{\beta}_t{}' \bar{\mathbf{x}}_{t-1}\right)}{\exp\left(\boldsymbol{\beta}_{t-1}{}' \bar{\mathbf{x}}_{t-1}\right)} \qquad t = T_0+1, ..., T \qquad (5)$$

Analogously to (4), this may be reformulated to read:

$$\ln(ILC_t/ILC_{t-1}) = \left(\boldsymbol{\beta}_t - \boldsymbol{\beta}_{t-1}\right)' \bar{\mathbf{x}}_{t-1} \qquad t = T_0+1, ..., T \qquad (6)$$

which shows that the quality-corrected relative price change between two successive periods is equal to the change in implicit prices weighted by the average characteristics of the first period.

The **x**-vector in equations (3) to (6) contains all explanatory variables from the hedonic model (1) including the age effects. Following Berndt, Griliches and Rappaport (1995), the index is determined by substituting the estimated implicit prices and the appropriate averages of the technical indicators into (1) and subsequently calculating the exponent (because of the employed semi-log specification). The fixed base period Laspeyres index ILF_t relates the quality-corrected price change to the average quality level of cars in base period 1990, whereas the Laspeyres chain index ILC_t is based on a dynamic adjustment of the reference period to the immediately preceding year.

Furthermore, quality-corrected Paasche-like indexes are determined as the average of the implicit price relatives weighted by the value shares of current quality indicators at base period prices. More precisely, the fixed current-quality Paasche-like index IPF_t is defined as the predicted car price in current implicit prices and average current quality divided by the predicted price on the basis of average current qualities at base period implicit prices:

$$IPF_t = \frac{\exp\left(\boldsymbol{\beta}_t{}' \bar{\mathbf{x}}_t\right)}{\exp\left(\boldsymbol{\beta}_0{}' \bar{\mathbf{x}}_t\right)} \qquad t = T_0+1, ..., T \qquad (7)$$

According the *IPF* in (7), the quality-corrected relative price change is interpreted as the difference between from current and base-period implicit prices weighted by current car model quality, which is more easily seen from:

$$\ln IPF_t = (\boldsymbol{\beta}_t - \boldsymbol{\beta}_0)' \bar{\mathbf{x}}_t \qquad t = T_0+1, ..., T \qquad (8)$$

The corresponding chained quality-corrected Paasche index (IPC_t) follows as:

$$IPC_t = IPC_{t\text{-}1} \times \frac{\exp(\boldsymbol{\beta}_t' \bar{\mathbf{x}}_t)}{\exp(\boldsymbol{\beta}_{t-1}' \bar{\mathbf{x}}_t)} \qquad t = T_0+1, ..., T \qquad (9)$$

As before (9) can be reformulated to read:

$$\ln(IPC_t/IPC_{t\text{-}1}) = (\boldsymbol{\beta}_t - \boldsymbol{\beta}_{t-1})' \bar{\mathbf{x}}_t \qquad t = T_0+1, ..., T \qquad (10)$$

which shows that according the *IPC* the quality-adjusted relative price change between adjacent periods is equal to the change in implicit prices weighted by the average current period quality.
The quality-corrected Laspeyres and Paasche-like price indexes thus obtained, are presented in Table 2. The indexes yield very similar results: the quality-corrected price of new passenger cars increases unto 1993 (or 1994), and subsequently decreases monotonically unto 1998. In 1999 the corrected price level is about the 1990 average new car price. The extent of the estimated price developments differ between the four methods. Both Paasche-like indexes lead to relative price differentials with respect to the base period, that are systematically above the level indicated by the Laspeyres indexes. The results suggest that the utility of the bundles of quality characteristics systematically differs between the current and reference periods (*cf.* Deaton and Muellbauer, 1980: 172), which seems plausible in light of the fast diffusion of technical novelties throughout the observation period, as discussed in Section 3. In the case of the semi-log brand-weighted specification, the corrected fixed base period Paasche index (*IPF*) in 1993, with a value of 1.082 is 4.3 percentage points above the corresponding Laspeyres index (*ILF*); the chained Paasche index (*IPC*) in 1993, with value 1.069, is 2.1 points higher than the chained Laspeyres index (*ILC*). In 1999, the quality-corrected price indexes are largely below the 1990 level, except for the fixed base Laspeyres index (*ILF*) that yields a 1999 value equal to 100.1. The chained Laspeyres index (*ILC*) and fixed current-quality Paasche indexes (*IPF*) both indicate quality-corrected price index values of 96.4 in 1999, 3.6 points below the 1990 level; the chained Paasche index (*IPC*) ends at an index value of 99.0. Comparing these results with the official CPI for new cars, the hedonic indexes indicate that quality-corrected prices of new cars have stabilized over the decade, whereas the CPI reports a price increase of 11.2%. This would imply an upward CPI bias over the observation period of 11.1 to 14.8 percentage points. This may seem less sensational than the biases found for personal computers (*cf.* Berndt, Griliches and Rappaport, 1995: 226, who report an average annual price decrease of 30% for computers), but the differences are still substantial. This is emphasized by the sevenfold larger weight of new cars in the official CPI (3.325 for new passenger cars versus 0.483 for data processing apparatus; 1995=100).
The results are relatively robust against the choice of weightings. The general pattern of the alternatively weighted indexes still reveals quality-corrected prices that increase unto 1993, and subsequently decrease unto 1998, after which the price level seems to stabilize. The other indexes also point at a mild price decrease in 1999 with respect to 1990.
The calculated Laspeyres and Paasche indexes are interpreted as the estimated price development of a typical car model, which is a hypothetical car with technical characteristics matching the average quality indicators in the market. Alternatively, the quality-corrected Laspeyres and Paasche indexes may be determined as the (weighted) average of the quality-corrected price differentials of all car models. In the case of the semi-log and double-log specifications this implies that the sequence of averaging and calculating exponents is reversed;

in the case of the linear hedonic specification this alternative method obviously makes no difference. Adopting this alternative approach again leads to estimated price developments that are similar to previous estimates: quality-corrected prices increase from 1990 to 1993 (or 1994) and subsequently decrease to 1999 price levels, which are below the 1990 price levels. The Paasche indexes still yield estimates larger than the Laspeyres index values. Interestingly, the 1999 estimates for this alternative calculation method are about 1.5 to 3.0 percentage points below the corresponding index estimates originally calculated.

Price indexes on the basis of pooled hedonic regression models

Additionally, price indexes are estimated on the basis of the pooled *TAV*-models (2). The results are discussed here, despite the fact that these models did not pass our specification tests, with the exception of the adjacent-years regressions. An advantage of pooled estimation for index calculations is that the quality-corrected price differentials between two periods can immediately be derived from the estimated parameters of the time dummies. Another advantage over annual regressions is that the estimation of the quality-corrected price differential is less sensitive to the presence of multicollinearity among the specified technical characteristics.

In a fully pooled semi-log model the parameter $\pi_{t|T_0}$ for an arbitrary time dummy dt_t is interpreted as the difference between the logarithmically transformed price levels of current and base period, maintaining quality fixed: $\pi_{t|T_0} = \log \bar{p}_t - \log \bar{p}_{T_0} = \log \bar{p}_t / \bar{p}_{T_0}$. The price index for the pooled *T*-model thus follows as:

$$IT_t = \frac{\bar{p}_t}{\bar{p}_{T_0}} = e^{\log \bar{p}_t / \bar{p}_{T_0}} = e^{\pi_{t|T_0}} \qquad t = T_0+1, ..., T \qquad (7)$$

The same holds for the *TA*- and *TAV*-versions of the hedonic model. In the models based on adjacent-years regressions, the parameters $\pi_{t|t-1}$ of the time dummies dt_t are interpreted as the quality-corrected price differentials between cars in the current period and the preceding period: $\pi_{t|t-1} = \log \bar{p}_t - \log \bar{p}_{t-1} = \log \bar{p}_t / \bar{p}_{t-1}$. The associated price index $IADJ_t$ is calculated as a chained price index, multiplying the index value of the preceding period by the time effect of the current period:

$$IADJ_t = IADJ_{t-1} \times e^{\pi_{t|t-1}} \qquad t = T_0+1, ..., T \qquad (6)$$

The required calculations are relatively simple for the two log-specifications.[6] The general impression from Table 2 is that the results are conform the previous findings for the Laspeyres and Paasche-like indexes based on annual regressions: the quality-corrected price level increases from 1990 to 1993 and decreases thereafter, leading to a corrected 1999 price level that is near the 1990 price level. More specifically, the results of the semi-log *T*-, *TA*- and *TAV*-specifications indicate quality-corrected 1999 price levels that are 1.025, 1.000, respectively 0.987 times the price level of new passenger cars in 1990, which corresponds with average annual growth rates of 0.3%, 0.0% and -0.1%. The price index for the adjacent-years regressions shows a slight price decrease over the full decade, yielding a 1999 quality-corrected

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[6] The corresponding calculations for the linear specification are less trivial. In the linear model, the estimated effects are interpreted as the quality-corrected (absolute) price differences between current and reference period (either T_0 or the preceding year *t*-1): $\pi_{t|T_0} = \bar{p}_t - \bar{p}_{T_0}$; $\pi_{t|t-1} = \bar{p}_t - \bar{p}_{t-1}$. These differences need to be divided by an estimate of the average price level in the reference period $\bar{p}_{T_0}$ (or $\bar{p}_{t-1}$). The required estimates are obtained by substituting the (weighted) averages of the quality indicators (including age and vintage) and the estimated implicit prices into the hedonic models. This yields three indexes for each pooled model, depending on the estimation period used to calculate the averages: the current period (*IADJcur*, *ITcur*, *ITAcur* and *ITAVcur*), the base period (*IADJbas*, *ITbas*, *ITAbas*, *ITAVbas*) or the entire observation period (*IADJbi*, *ITall*, *ITAall*, *ITAVall*).

price index value equal to 98.3. The differences between the pooled hedonic price indexes and the CPI amount to 8.7 to 12.9 percentage points. Furthermore, the quality-corrected price indexes obtained for the alternative weighting schemes again point at increasing prices unto 1993 and a 1999 price level that is comparable to or just below the price level of new cars in 1990. The numerical differences between the pooled indexes are small.

Summary

The use of hedonic models to estimate quality-adjusted price indexes leads to considerable differences with respect to the official CPI. The quality-adjusted price indexes invariably lead to increasing prices during the first part of the nineties, which are at a maximum in 1993, one year before the CPI reaches its maximum. During the second part of the nineties the new car prices decline. This continues until 1998, after which prices tend to stabilize. The final outcome of the quality-corrected index depends on the specific model and weightings applied. In the case of the preferred annual brand-weighted semi-log specification, it is found that the quality-corrected price level in 1999 is 0.1 percentage point above to 3.6 percentage points below the 1990 price level. This implies that the estimated quality-corrected price increase over 1990-1999 is 11.1 to 14.8 percentage points below the predicted 11.2% by the CPI. The adjacent-years model assumes an intermediate position with a predicted quality-corrected price decrease of 1.7 % over the observation period, 12.9 points below the CPI.

6. Summary of findings and discussion

This study has estimated quality-corrected price developments of new passenger cars sold in the Netherlands, 1990-1999. The estimates are based on a large amount of ANWB data about the price and technical characteristics of new cars, together with actual RDC sales information. Estimates of the implicit prices of technical characteristics have been obtained following a familiar hedonic approach, adopting the *TAV*-specification recently applied by Berndt, Griliches and Rappaport (1995). Use is made of four different weightings: weighting by the in-production period (no weighting by sales), and weighting by sales per car model measured at the level of brand, model and make. Based on specification tests, the annually-estimated brand-weighted semi-log specification is the preferred price-quality model; the corresponding adjacent-years model is second-best. The quality-corrected price indexes include both base-year quality (Laspeyres-like) indexes and current quality (Paasche-like) indexes; both fixed base-period indexes and chain indexes. The various hedonic based indexes are compared with a matched model index on the basis of nominal car prices in subsequent years and with the official CPI.

The official CPI and matched model indexes show comparable adjusted price developments in the observation period: quality-corrected car prices have increased 11.2% (average annual growth 1.2%) according to the CPI and 10.6% (average annual growth 1.1%) according to the matched model index estimated on the basis of ANWB information. Both quality-corrected indexes reveal substantially lower price increases than the uncorrected indexes based on nominal car prices. Depending on the weightings, the average nominal price increase for the entire period varies from 19% to 23.5% (corresponding with average annual growth rates varying from 2.0% to 2.4%). The various hedonic indexes differ in detail, but conform in their general pattern: the quality-corrected prices of new passenger cars rise during the first part of the nineties, they decline after 1993 (or 1994) and seem to stabilize in 1998. The preferred annually-estimated brand-weighted semi-log hedonic models yield index values in 1999 that differ +0.1% to -3.6% from 1990 prices, which is 11.1 to 14.8 percentage points below the official CPI. At first sight, this bias seems less spectacular than in the case of personal computers. At the same time, however, the bias for new car prices is associated with weight 3.325 in the official CPI (1995=100) which is about 7 times as large as the CPI weight of data processing equipment (0.483).

Some model assumptions require further elaboration. For instance, the relevant technical characteristics of cars as described in the data sources, are assumed to apply to the entire in-production period. In part, this is justified because of the detailed level at which car models are described: changes in product specification are likely to be registered as new makes. In part, this assumption is not justified, because manufacturers may differ in their market strategies. One manufacturer frequently introduces new makes for which the product specifications are fixed, while another frequently alters product specifications though keeping the model description the same. Both the extent of these marketing differences and their consequences for the results are unknown. Furthermore, some of the selected technical characteristics, like airbags, tinted glass, power steering and injection fuelling, have penetrated the car market very quickly. On the one hand this reduces the complexity of the quality measurement problem, leading to a better performance of the traditional matched- model approach to measurement. On the other hand, these indicators rapidly become less useful for hedonic analyses, urging for better indicators to describe quality differences between cars and between periods. A similar remark applies to quality variations within a particular technical feature. For instance, air-conditioning may be a discriminating technical feature as such, but the probable quality variation among air-conditioning systems is not covered by the present hedonic approach.

A further methodological issue concerns the use of *time-age* and *time-age-vintage* models to analyze prices of new cars. These models have been developed for second-hand markets characterized by homogeneous products (pick-up trucks, see Hall, 1971) and perfect competition. This interpretation may partly be transferred to differentiated products in imperfectly competitive markets (Triplett, 1986). However, this adoption induces various relevant questions, like what exactly is the service produced by a new car? How should obsolescence be interpreted in the case of new car models rather than specific used cars? What is the impact of differences in the life cycle of car models on price fluctuations? What is the role of buyers' motivation, like status or image, on the estimation of price developments? Do all aspects of car transactions have to be accounted for in the price measurement (or which do and which do not)? Do quality-corrected price developments have to be interpreted simply as all price variations that correlate with 'time', or do more meaningful interpretations exist? Many of the implied effects are covered by the age and vintage effects in the *TA*- and *TAV*-models, but theory is required to thoroughly underpin these effects.

A concluding issue is that the present analysis is focussed on the quality effects at the moment of first sale. As a consequence, quality features of a temporal nature, like the sustainability of engine, coach or paint are not immediately covered in the models. Potentially important quality improvements may therefore not be measured. Extending the present analysis with data about second-hand car markets may solve this problem. In this way the age effects more closely resemble their original interpretation as the costs of loss of capital efficiency. Another solution would be the specification of life-cycle costs, like the cost of fuel, taxes and maintenance. This approach has been applied to the price developments of light (Nordhaus, 1994), cataract treatments (Shapiro and Wilcox, 1996) and appendectomy treatments (Van Tuinen, De Boo, and Van Rijn, 1998). In view of the continuous improvements of the durability of passenger cars it is expected that such model extensions lead to further downward adjustments of the quality-corrected new passenger car price index.

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Table 1 - Price indexes of new passenger cars using different methods (1990 = 100)

	Number of car models			*Average price of new cars*				*Median*	*Price indexes*						
Year	*nMod*	*nMat*	*pMat*	*PriceNom*	*PriceMrk*	*PriceMod*	*PriceTyp*	*PriceQ*	*IndNom*	*IndMrk*	*IndMod*	*IndTyp*	*IndQ*	*IndMat*	*IndSN*
1990	2382			53012	40261	31803	29052	39418	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1991	2403	1807	0.75	54685	42977	33379	30159	41550	1.032	1.067	1.050	1.038	1.054	1.019	1.030
1992	2527	1772	0.70	59073	45400	36664	33472	43370	1.114	1.128	1.153	1.152	1.100	1.060	1.090
1993	2857	1898	0.66	62385	48096	37358	34152	47337	1.177	1.195	1.175	1.176	1.201	1.084	1.120
1994	3214	2082	0.65	62575	49750	38435	35148	49035	1.180	1.236	1.209	1.210	1.244	1.095	1.130
1995	3427	2301	0.67	62811	48511	38557	35671	47450	1.185	1.205	1.212	1.228	1.204	1.097	1.130
1996	3864	2493	0.65	63122	47811	37923	35317	47824	1.191	1.188	1.192	1.216	1.213	1.093	1.107
1997	4209	2615	0.62	62205	47983	37907	35878	48658	1.173	1.192	1.192	1.235	1.234	1.091	1.107
1998	4181	2951	0.71	62594	48522	38307	36116	50000	1.181	1.205	1.204	1.243	1.268	1.094	1.107
1999	3588	3170	0.88	63373	48415	37858	35865	50272	1.195	1.203	1.190	1.235	1.275	1.106	1.112
Ntot	32652	21089	0.70					*TAAG*	2.0%	2.1%	2.0%	2.4%	2.7%	1.1%	1.2%

Table 2 - Price indexes determined on the basis of the various semi-log models, 1990-1999 (1990 = 100)

		Year										
Index	*Description*	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	*AAG*
IndNom	Unweighted average, whole sample	1.000	1.032	1.114	1.177	1.180	1.185	1.191	1.173	1.181	1.195	0.020
IndMrk	Brand-weighted, whole sample	1.000	1.067	1.128	1.195	1.236	1.205	1.188	1.192	1.205	1.203	0.021
IndMod	Model-weighted, whole sample	1.000	1.050	1.153	1.175	1.209	1.212	1.192	1.192	1.204	1.190	0.020
IndTyp	Type-weighted, whole sample	1.000	1.038	1.152	1.176	1.210	1.228	1.216	1.235	1.243	1.235	0.024
IndMat	Matched model	1.000	1.019	1.060	1.084	1.095	1.097	1.093	1.091	1.094	1.106	0.011
IndSN	CPI new passenger cars	1.000	1.030	1.090	1.120	1.130	1.130	1.107	1.107	1.107	1.112	0.012
					Weighted by in-production period (not by sales)							
Annual regressions I (price development average car)												
ILF	Laspeyres, fixed base period	1.000	1.004	1.020	1.023	1.012	1.001	0.992	0.951	0.938	0.985	-0.002
IPF	Paasche, fixed base period	1.000	1.013	1.060	1.078	1.065	1.056	1.031	1.000	0.983	0.993	-0.001
ILC	Laspeyres, chain index	1.000	1.004	1.026	1.032	1.023	1.008	0.987	0.964	0.951	0.954	-0.005
IPC	Paasche, chain index	1.000	1.013	1.045	1.058	1.048	1.037	1.020	1.001	0.991	0.997	0.000
Annual regressions II (average price development all cars)												
ILF	Laspeyres, fixed base period	1.000	0.993	0.995	0.991	0.977	0.961	0.951	0.913	0.900	0.966	-0.004
IPF	Paasche, fixed base period	1.000	1.006	1.042	1.052	1.032	1.019	0.997	0.962	0.943	0.956	-0.005
ILC	Laspeyres, chain index	1.000	0.993	1.000	0.998	0.982	0.964	0.945	0.925	0.917	0.928	-0.008
IPC	Paasche, chain index	1.000	1.006	1.029	1.036	1.021	1.008	0.996	0.979	0.972	0.981	-0.002
Adjacent-years regressions												
IADJ	*Adjacent-years regressions*	1.000	1.009	1.039	1.049	1.040	1.027	1.008	0.989	0.979	0.985	-0.002
Pooled regressions												
IT	Pooled regression, *T*-model	1.000	1.007	1.039	1.051	1.041	1.029	1.014	1.001	0.996	1.007	0.001
ITA	Pooled regression, *TA*-model	1.000	1.003	1.032	1.042	1.031	1.017	1.000	0.985	0.979	0.986	-0.002
ITAV	Pooled regression, *TAV*-model	1.000	0.994	1.017	1.026	1.015	0.996	0.974	0.958	0.943	0.941	-0.007

(continued)

table 2 continued

Index	*Description*	*Year* 1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	*AAG*
					Weight by sales per car model measured at the level of brands							
Annual regressions I (price development average car)												
ILF	Laspeyres, fixed base period	1.000	1.020	1.035	1.039	1.041	1.029	0.996	0.985	0.955	1.001	0.000
IPF	Paasche, fixed base period	1.000	1.027	1.066	1.082	1.070	1.043	0.998	0.966	0.954	0.964	-0.004
ILC	Laspeyres, chain index	1.000	1.020	1.042	1.048	1.045	1.024	0.994	0.985	0.973	0.964	-0.004
IPC	Paasche, chain index	1.000	1.027	1.060	1.069	1.062	1.045	1.018	1.006	0.996	0.990	-0.001
Annual regressions II (average price development all cars)												
ILF	Laspeyres, fixed base period	1.000	1.013	1.017	1.017	1.014	1.001	0.971	0.960	0.930	0.986	-0.002
IPF	Paasche, fixed base period	1.000	1.019	1.049	1.058	1.038	1.013	0.969	0.933	0.920	0.934	-0.008
ILC	Laspeyres, chain index	1.000	1.013	1.024	1.025	1.017	0.996	0.967	0.959	0.949	0.948	-0.006
IPC	Paasche, chain index	1.000	1.019	1.043	1.048	1.036	1.019	0.993	0.981	0.973	0.971	-0.003
Adjacent-years regressions												
IADJ	*Adjacent-years regressions*	1.000	1.023	1.052	1.061	1.057	1.037	1.009	0.999	0.989	0.983	-0.002
Pooled regressions												
IT	Pooled regression, *T*-model	1.000	1.020	1.056	1.070	1.068	1.053	1.028	1.026	1.022	1.025	0.003
ITA	Pooled regression, *TA*-model	1.000	1.016	1.047	1.059	1.057	1.039	1.012	1.008	1.003	1.000	0.000
ITAV	Pooled regression, *TAV*-model	1.000	1.011	1.039	1.050	1.050	1.033	1.009	1.006	0.994	0.987	-0.001
					Weight by sales per car model measured at the level of models							
Annual regressions I (price development average car)												
ILF	Laspeyres, fixed base period	1.000	1.016	1.041	1.044	1.039	1.033	1.008	0.967	0.935	0.946	-0.006
IPF	Paasche, fixed base period	1.000	1.028	1.065	1.084	1.072	1.050	1.012	0.995	0.991	0.997	0.000
ILC	Laspeyres, chain index	1.000	1.016	1.045	1.049	1.048	1.033	1.009	0.995	0.986	0.980	-0.002
IPC	Paasche, chain index	1.000	1.028	1.063	1.075	1.072	1.057	1.029	1.018	1.011	1.001	0.000
Annual regressions II (average price development all cars)												
ILF	Laspeyres, fixed base period	1.000	1.016	1.031	1.026	1.016	1.011	0.990	0.949	0.918	0.932	-0.008
IPF	Paasche, fixed base period	1.000	1.026	1.055	1.064	1.048	1.028	0.989	0.972	0.965	0.974	-0.003
ILC	Laspeyres, chain index	1.000	1.016	1.037	1.035	1.027	1.013	0.990	0.979	0.971	0.970	-0.003
IPC	Paasche, chain index	1.000	1.026	1.051	1.055	1.045	1.033	1.005	0.996	0.989	0.983	-0.002
Adjacent-years regressions												
IADJ	*Adjacent-years regressions*	1.000	1.021	1.053	1.062	1.059	1.044	1.018	1.006	0.998	0.989	-0.001
Pooled regressions												
IT	Pooled regression, *T*-model	1.000	1.017	1.053	1.067	1.065	1.051	1.026	1.017	1.015	1.017	0.002
ITA	Pooled regression, *TA*-model	1.000	1.014	1.047	1.059	1.057	1.043	1.016	1.006	1.002	1.002	0.000
ITAV	Pooled regression, *TAV*-model	1.000	1.007	1.037	1.052	1.053	1.045	1.019	1.007	0.999	0.993	-0.001
					Weight by sales per car model measured at the level of types							
Annual regressions I (price development average car)												
ILF	Laspeyres, fixed base period	1.000	1.014	1.047	1.060	1.060	1.045	1.021	1.003	0.980	1.010	0.001
IPF	Paasche, fixed base period	1.000	1.025	1.065	1.088	1.085	1.060	1.030	1.020	1.016	1.013	0.001
ILC	Laspeyres, chain index	1.000	1.014	1.052	1.061	1.063	1.044	1.021	1.009	1.002	0.993	-0.001
IPC	Paasche, chain index	1.000	1.025	1.066	1.085	1.088	1.071	1.043	1.032	1.026	1.014	0.002
Annual regressions II (average price development all cars)												
ILF	Laspeyres, fixed base period	1.000	1.014	1.039	1.045	1.039	1.027	1.009	0.989	0.967	0.999	0.000
IPF	Paasche, fixed base period	1.000	1.022	1.056	1.073	1.065	1.042	1.011	1.000	0.992	0.992	-0.001
ILC	Laspeyres, chain index	1.000	1.014	1.046	1.049	1.046	1.027	1.007	0.997	0.993	0.988	-0.001
IPC	Paasche, chain index	1.000	1.022	1.056	1.067	1.065	1.050	1.022	1.015	1.008	1.000	0.000
Adjacent-years regressions												
IADJ	*Adjacent-years regressions*	1.000	1.018	1.056	1.072	1.074	1.055	1.030	1.019	1.010	0.999	0.000
Pooled regressions												
IT	Pooled regression, *T*-model	1.000	1.017	1.062	1.079	1.081	1.064	1.037	1.027	1.024	1.024	0.003
ITA	Pooled regression, *TA*-model	1.000	1.014	1.056	1.072	1.074	1.056	1.029	1.017	1.014	1.012	0.001
ITAV	Pooled regression, *TAV*-model	1.000	1.007	1.044	1.058	1.060	1.048	1.019	1.002	0.991	0.982	-0.002

Appendix A
The development of quality characteristics of new passenger cars in the Netherlands, 1990-1999.

Table A Annual average values of technical characteristics of new passenger cars, 1990-1999 (weighted by in-production period)

Var	*Description*	*Year* 1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	*AAG*
XPK	Horse power (HP)	78.93	80.39	83.89	86.31	87.79	89.30	90.70	90.84	91.38	91.66	0.017
XWLB	Wheelbase (mm)	2561.01	2557.19	2562.57	2575.11	2581.06	2587.80	2597.37	2601.83	2610.53	2606.95	0.002
XTOP	Top speed (km/h)	178.77	178.57	181.37	183.41	185.17	186.13	187.69	188.21	188.87	189.53	0.007
XVOL	Volume (m3)	10.56	10.50	10.57	10.65	10.71	10.81	10.91	10.99	11.12	11.10	0.006
XMAS	Weight (kg)	1142.92	1156.93	1185.05	1210.01	1224.88	1239.40	1251.61	1256.66	1269.62	1268.59	0.012
XVB1	Avg. mileage (l/100km)	9.29	9.39	9.48	9.45	9.33	9.28	9.11	8.78	8.58	8.44	-0.011
XVB2	Avg. mileage EC93 (l/100km)	0.01	0.07	0.20	0.48	0.98	1.88	4.04	7.18	8.21	8.32	1.221
XBND	Tier radius (mm)	274.25	274.93	276.11	276.76	277.17	278.10	278.90	279.72	281.38	281.83	0.003
DFORD	dummy Ford	0.07	0.07	0.07	0.07	0.08	0.07	0.07	0.06	0.05	0.05	-0.040
DMERC	dummy Mercedes	0.06	0.05	0.05	0.06	0.06	0.06	0.07	0.08	0.09	0.08	0.047
DOPEL	dummy Opel	0.11	0.11	0.12	0.12	0.10	0.11	0.14	0.14	0.10	0.11	-0.002
DPEUG	dummy Peugeot	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.04	0.000
DRENA	dummy Renault	0.06	0.07	0.06	0.06	0.06	0.05	0.04	0.05	0.05	0.06	-0.009
DVOLK	dummy Volkswagen	0.08	0.09	0.07	0.06	0.07	0.06	0.07	0.08	0.10	0.11	0.037
DVOLV	dummy Volvo	0.05	0.04	0.03	0.03	0.05	0.07	0.08	0.05	0.06	0.05	0.013
DREST	dummy Overige	0.53	0.54	0.55	0.55	0.54	0.53	0.49	0.49	0.50	0.49	-0.008
D2D	dummy 2-doors	0.09	0.09	0.08	0.08	0.07	0.07	0.07	0.07	0.06	0.06	-0.039
D3D	dummy 3-doors	0.20	0.22	0.21	0.20	0.19	0.18	0.17	0.16	0.16	0.16	-0.028
D4D	dummy 4-doors	0.34	0.33	0.31	0.32	0.33	0.33	0.32	0.31	0.28	0.27	-0.024
D5D	dummy 5-doors	0.36	0.37	0.39	0.40	0.41	0.41	0.44	0.46	0.50	0.50	0.037
DAUT	dummy Automatic transm.	0.30	0.30	0.31	0.32	0.32	0.34	0.36	0.36	0.36	0.36	0.019
DAUTX	dummy Automatic extra	0.23	0.23	0.24	0.24	0.25	0.27	0.28	0.28	0.27	0.27	0.017
DHNDX	dummy Manual extra	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00			-1.000
DKLS1	dummy Class 1	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	-0.023
DKLS2	dummy Class 2	0.11	0.13	0.12	0.13	0.12	0.11	0.11	0.11	0.11	0.11	-0.009
DKLS3	dummy Class 3	0.27	0.27	0.27	0.26	0.27	0.27	0.28	0.28	0.28	0.30	0.010
DKLS4	dummy Class 4	0.28	0.28	0.28	0.28	0.30	0.29	0.30	0.33	0.37	0.36	0.029
DKLS5	dummy Class 5	0.24	0.22	0.23	0.24	0.23	0.23	0.22	0.20	0.19	0.17	-0.033
DKLS6	dummy Class 6	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.06	0.05	0.05	-0.060
DTRN	dummy Terrain car	0.02	0.04	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.057
DV8	dummy V8 (or more)	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.03	-0.005
DINJ	dummy Fuel Injection	0.51	0.67	0.79	0.87	0.90	0.93	0.93	0.94	0.93	0.91	0.067
DDIES	dummy Diesel	0.18	0.18	0.19	0.19	0.20	0.19	0.20	0.22	0.25	0.26	0.039
DABG	dummy Airbag	0.06	0.11	0.22	0.34	0.47	0.60	0.72	0.83	0.89	0.91	0.345
DMET	dummy Metallic paint	0.02	0.03	0.05	0.08	0.09	0.11	0.14	0.14	0.11	0.09	0.212
DSBK	dummy Power steering	0.27	0.42	0.63	0.75	0.82	0.86	0.90	0.93	0.94	0.94	0.147
DCDV	dummy Central locking	0.08	0.15	0.30	0.45	0.57	0.68	0.78	0.84	0.87	0.86	0.305
DGET	dummy Tinted glass	0.08	0.16	0.34	0.52	0.64	0.75	0.87	0.93	0.93	0.91	0.308
DAIR	dummy Airconditioning	0.01	0.02	0.04	0.09	0.13	0.20	0.30	0.37	0.40	0.41	0.517
DABS	dummy ABS-brake system	0.07	0.12	0.23	0.31	0.36	0.40	0.47	0.56	0.65	0.68	0.290
DAGE0	dummy Age = 0	0.27	0.16	0.22	0.25	0.26	0.23	0.27	0.31	0.22	0.09	-0.110
DAGE1	dummy Age = 1	0.36	0.37	0.27	0.29	0.34	0.36	0.30	0.33	0.41	0.33	-0.009
DAGE2	dummy Age = 2	0.17	0.23	0.23	0.19	0.17	0.22	0.23	0.18	0.18	0.34	0.077
DAGE3	dummy Age = 3	0.09	0.11	0.13	0.12	0.11	0.08	0.11	0.10	0.10	0.13	0.045
DAGE4	dummy Age = 4	0.07	0.05	0.07	0.07	0.05	0.06	0.05	0.05	0.04	0.06	-0.011
DAGE5	dummy Age = 5	0.02	0.05	0.02	0.04	0.04	0.03	0.02	0.02	0.03	0.03	0.055
DAGE6	dummy Age = 6	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.00	0.02	0.016
DAGE7	dummy Age = 7	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	-0.167
DAGE8	dummy Age = 8	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.039
V83	dummy Vintage 1983	0.01	0.00	0.00	0.00							
V84	dummy Vintage 1984	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00			
V85	dummy Vintage 1985	0.02	0.01	0.01	0.00	0.00						
V86	dummy Vintage 1986	0.07	0.05	0.03	0.01	0.00	0.00					
V87	dummy Vintage 1987	0.09	0.05	0.02	0.01	0.01	0.00	0.00	0.00	0.00		
V88	dummy Vintage 1988	0.17	0.11	0.07	0.04	0.01	0.01	0.00	0.00	0.00	0.00	
V89	dummy Vintage 1989	0.36	0.23	0.13	0.07	0.04	0.01	0.00	0.00	0.00		
V90	dummy Vintage 1990	0.27	0.37	0.23	0.12	0.05	0.03	0.01	0.00	0.00		
V91	dummy Vintage 1991		0.16	0.27	0.19	0.11	0.06	0.02	0.01	0.00	0.00	
V92	dummy Vintage 1992			0.22	0.29	0.17	0.08	0.05	0.02	0.00	0.00	
V93	dummy Vintage 1993				0.25	0.34	0.22	0.11	0.05	0.03	0.02	
V94	dummy Vintage 1994					0.26	0.36	0.23	0.10	0.04	0.03	
V95	dummy Vintage 1995						0.23	0.30	0.18	0.10	0.06	
V96	dummy Vintage 1996							0.27	0.33	0.18	0.13	
V97	dummy Vintage 1997								0.31	0.41	0.34	
V98	dummy Vintage 1998									0.22	0.33	
V99	dummy Vintage 1999										0.09	

Note Age-effects beyond dAge8 and vintage effects before V83 are not presented because of low information content.

Appendix B
Estimation results of the semi-log hedonic models, weighted by sales per car brand

Table B1 - Estimation results for the annually-estimated brand-weighted semi-log hedonic models, 1990-1999

		Year									
Var	*Description*	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
INTERCEP		8.572	8.437	8.356	8.840	8.990	8.807	8.776	8.628	8.312	7.602
		(0.212)	(0.171)	(0.158)	(0.134)	(0.122)	(0.118)	(0.110)	(0.101)	(0.103)	(0.113)
DAGE1	dummy Age = 1	-0.002	-0.005	0.010	0.005	0.024	0.017	0.013	0.010	-0.008	0.035
		(0.008)	(0.007)	(0.007)	(0.006)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.008)
DAGE2	dummy Age = 2	-0.035	0.003	0.037	0.036	0.031	0.033	0.042	0.017	0.010	0.022
		(0.010)	(0.008)	(0.007)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.008)
DAGE3	dummy Age = 3	-0.043	-0.006	0.013	0.037	0.061	0.020	0.031	0.043	0.007	0.057
		(0.014)	(0.011)	(0.009)	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.009)
DAGE4	dummy Age = 4	0.007	-0.042	0.040	0.035	0.075	0.057	0.055	0.071	0.027	0.053
		(0.017)	(0.014)	(0.011)	(0.009)	(0.009)	(0.008)	(0.008)	(0.009)	(0.008)	(0.010)
DAGE5	dummy Age = 5	0.057	0.046	-0.022	0.032	0.053	0.063	0.061	0.067	0.076	0.060
		(0.039)	(0.017)	(0.017)	(0.012)	(0.010)	(0.012)	(0.010)	(0.011)	(0.013)	(0.012)
DAGE6	dummy Age = 6	0.020	0.079	0.089	-0.095	-0.048	0.051	0.125	0.080	0.071	0.137
		(0.036)	(0.041)	(0.018)	(0.023)	(0.022)	(0.014)	(0.016)	(0.015)	(0.023)	(0.019)
DAGE7	dummy Age = 7	-0.002	0.009	0.110	0.100	-0.169	-0.072	0.002	0.040	0.129	0.111
		(0.042)	(0.035)	(0.040)	(0.022)	(0.029)	(0.033)	(0.027)	(0.042)	(0.035)	(0.046)
DAGE8	dummy Age = 8		0.010	0.007	0.131	0.145	-0.237	-0.031	-0.165	0.038	0.152
			(0.041)	(0.038)	(0.043)	(0.056)	(0.074)	(0.045)	(0.064)	(0.077)	(0.045)
DAGE9	dummy Age = 9			0.020	0.037	0.061	0.173	-0.248	0.332	-0.162	
				(0.039)	(0.045)	(0.048)	(0.073)	(0.091)	(0.233)	(0.083)	
DAGE10	dummy Age = 10	0.899			0.020	0.032			-0.016	0.570	
		(2.016)			(0.079)	(0.067)			(0.249)	(0.330)	
DAGE11	dummy Age = 11	0.673					0.011			0.029	0.799
		(2.016)					(0.083)			(0.311)	(0.614)
DAGE12	dummy Age = 12			1.062				0.575			
				(0.869)				(0.679)			
DAGE13	dummy Age = 13				0.975				0.595		
					(0.962)				(0.512)		
XPK	Horse power (HP)	0.005	0.005	0.005	0.005	0.005	0.004	0.004	0.004	0.004	0.004
		(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
XWLB	Wheelbase (mm)	-0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
XTOP	Top speed (km/h)	0.005	0.004	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.002
		(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
XVOL	Volume (m3)	0.021	0.011	0.008	0.003	-0.008	0.007	-0.012	-0.021	-0.010	-0.005
		(0.007)	(0.006)	(0.006)	(0.005)	(0.005)	(0.004)	(0.004)	(0.003)	(0.004)	(0.004)
XMAS	Weight (kg)	0.000	0.000	0.000	0.001	0.000	0.000	0.001	0.001	0.001	0.001
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
XVB1	Avg. mileage (l/100km)	0.017	0.013	0.009	0.003	0.012	0.015	0.009	-0.001	-0.006	0.002
		(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
XVB2	Avg. mileage EC93 (l/100km)	0.008	0.001	-0.007	-0.003	-0.004	-0.004	-0.001	-0.003	-0.001	-0.015
		(0.010)	(0.003)	(0.002)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.002)
XBND	Tier radius (mm)	0.000	0.000	0.001	0.001	0.001	0.002	0.001	0.002	0.002	0.003
		(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
DFORD	dummy Ford	0.004	0.026	0.012	-0.006	-0.036	-0.036	-0.066	-0.067	-0.072	-0.067
		(0.013)	(0.010)	(0.010)	(0.008)	(0.008)	(0.008)	(0.007)	(0.006)	(0.006)	(0.007)
DMERC	dummy Mercedes	0.301	0.322	0.278	0.243	0.228	0.273	0.319	0.268	0.267	0.261
		(0.035)	(0.029)	(0.023)	(0.019)	(0.016)	(0.016)	(0.016)	(0.015)	(0.015)	(0.016)
DOPEL	dummy Opel	0.045	0.050	0.029	0.033	-0.028	-0.026	-0.015	-0.034	-0.031	-0.033
		(0.011)	(0.009)	(0.008)	(0.007)	(0.006)	(0.007)	(0.006)	(0.005)	(0.006)	(0.007)
DPEUG	dummy Peugeot	0.040	0.047	0.074	0.072	0.047	0.054	0.042	0.007	-0.013	-0.009
		(0.012)	(0.011)	(0.011)	(0.009)	(0.008)	(0.008)	(0.007)	(0.006)	(0.006)	(0.006)
DRENA	dummy Renault	0.035	0.070	0.065	0.069	0.061	0.050	0.044	0.022	-0.008	-0.030
		(0.015)	(0.012)	(0.011)	(0.009)	(0.008)	(0.008)	(0.007)	(0.006)	(0.006)	(0.007)
DVOLK	dummy Volkswagen	0.179	0.165	0.159	0.179	0.092	0.086	0.039	0.024	0.035	0.051
		(0.014)	(0.012)	(0.010)	(0.009)	(0.008)	(0.007)	(0.007)	(0.006)	(0.007)	(0.007)
DVOLV	dummy Volvo	0.135	0.149	0.113	0.078	0.036	0.065	0.116	0.088	0.097	0.116
		(0.017)	(0.014)	(0.013)	(0.012)	(0.011)	(0.010)	(0.011)	(0.011)	(0.012)	(0.014)
D2D	dummy 2-doors	0.134	0.173	0.194	0.226	0.255	0.246	0.242	0.246	0.284	0.306
		(0.017)	(0.015)	(0.013)	(0.011)	(0.010)	(0.010)	(0.010)	(0.009)	(0.009)	(0.010)
D3D	dummy 3-doors	-0.019	-0.011	-0.012	-0.010	-0.005	-0.015	-0.010	-0.013	-0.012	-0.011
		(0.009)	(0.008)	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)
D4D	dummy 4-doors	-0.029	-0.029	-0.024	-0.017	-0.010	-0.019	-0.017	-0.004	-0.004	-0.008
		(0.008)	(0.006)	(0.006)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)
DAUT	dummy Automatic transm.	0.135	0.125	0.065	0.071	0.051	0.053	0.058	0.069	0.079	0.096
		(0.017)	(0.014)	(0.012)	(0.011)	(0.011)	(0.011)	(0.009)	(0.008)	(0.008)	(0.009)

continued

table B1 continued

Var	*Description*	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
DAUTX	dummy Automatic extra	-0.051	-0.049	0.008	-0.003	0.005	0.005	-0.003	-0.006	-0.009	-0.017
		(0.017)	(0.014)	(0.013)	(0.011)	(0.011)	(0.011)	(0.009)	(0.008)	(0.008)	(0.009)
DHNDX	dummy Manual extra	0.001	0.001	0.002	0.004	-0.017	0.007	0.034	0.165		
		(0.025)	(0.025)	(0.022)	(0.026)	(0.024)	(0.048)	(0.054)	(0.102)		
DKLS1	dummy Class 1	-0.265	-0.244	-0.235	-0.357	-0.466	-0.413	-0.386	-0.380	-0.297	-0.178
		(0.049)	(0.042)	(0.038)	(0.034)	(0.030)	(0.028)	(0.027)	(0.025)	(0.027)	(0.030)
DKLS2	dummy Class 2	-0.194	-0.145	-0.107	-0.233	-0.304	-0.291	-0.263	-0.261	-0.205	-0.107
		(0.037)	(0.031)	(0.028)	(0.024)	(0.022)	(0.021)	(0.020)	(0.021)	(0.023)	(0.026)
DKLS3	dummy Class 3	-0.185	-0.120	-0.113	-0.221	-0.273	-0.276	-0.248	-0.252	-0.208	-0.136
		(0.031)	(0.026)	(0.024)	(0.021)	(0.019)	(0.019)	(0.018)	(0.018)	(0.021)	(0.023)
DKLS4	dummy Class 4	-0.073	-0.034	-0.045	-0.147	-0.196	-0.216	-0.201	-0.206	-0.181	-0.132
		(0.027)	(0.022)	(0.021)	(0.019)	(0.017)	(0.017)	(0.016)	(0.017)	(0.019)	(0.021)
DKLS5	dummy Class 5	-0.016	-0.001	-0.039	-0.119	-0.135	-0.168	-0.148	-0.153	-0.125	-0.076
		(0.023)	(0.020)	(0.019)	(0.018)	(0.016)	(0.016)	(0.015)	(0.016)	(0.019)	(0.021)
DTRN	dummy Terrain car	0.086	0.108	0.068	0.092	0.092	0.031	0.026	0.076	0.089	0.093
		(0.032)	(0.026)	(0.024)	(0.019)	(0.018)	(0.018)	(0.018)	(0.015)	(0.017)	(0.019)
DV8	dummy V8 (or more)	0.078	-0.022	-0.025	0.037	0.086	0.035	0.057	0.054	0.066	0.115
		(0.060)	(0.046)	(0.037)	(0.030)	(0.027)	(0.029)	(0.026)	(0.026)	(0.028)	(0.028)
DINJ	dummy Fuel Injection	0.002	0.009	0.035	0.040	0.029	0.019	-0.009	-0.014	-0.006	-0.002
		(0.008)	(0.007)	(0.008)	(0.008)	(0.007)	(0.008)	(0.008)	(0.007)	(0.007)	(0.008)
DDIES	dummy Diesel	0.289	0.271	0.232	0.176	0.165	0.175	0.138	0.105	0.099	0.095
		(0.015)	(0.012)	(0.011)	(0.010)	(0.009)	(0.009)	(0.008)	(0.007)	(0.008)	(0.008)
DABG	dummy Airbag	0.048	0.004	0.004	-0.005	0.003	0.005	0.006	0.017	0.021	0.059
		(0.021)	(0.011)	(0.008)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.007)
DMET	dummy Metallic paint	0.063	0.039	0.026	0.028	0.008	0.021	0.044	0.059	0.054	0.066
		(0.022)	(0.015)	(0.011)	(0.009)	(0.007)	(0.006)	(0.006)	(0.005)	(0.006)	(0.007)
DSBK	dummy Power steering	-0.025	-0.010	0.036	0.041	0.060	0.035	0.048	0.037	0.027	0.038
		(0.009)	(0.007)	(0.007)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	(0.009)
DCDV	dummy Central locking	-0.034	-0.024	-0.000	0.009	0.024	0.030	0.035	0.037	0.042	0.043
		(0.016)	(0.011)	(0.008)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)
DGET	dummy Tinted glass	0.018	0.033	0.012	0.008	0.003	0.012	0.003	0.008	-0.008	-0.012
		(0.014)	(0.010)	(0.007)	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)
DAIR	dummy Air conditioning	-0.060	-0.036	-0.002	-0.006	0.016	0.002	0.019	0.023	0.032	0.037
		(0.032)	(0.019)	(0.015)	(0.009)	(0.007)	(0.006)	(0.005)	(0.004)	(0.004)	(0.004)
DABS	dummy ABS-brake system	0.050	0.065	0.099	0.115	0.103	0.096	0.049	0.038	0.039	0.049
		(0.018)	(0.012)	(0.009)	(0.007)	(0.007)	(0.006)	(0.005)	(0.004)	(0.005)	(0.005)
Df	*Degrees of Freedom*	1769	2224	2352	2702	3047	3234	3648	3836	3649	2891
RMSE	*Root MSE*	1.425	1.358	1.227	0.962	0.920	0.882	0.830	0.723	0.772	0.867
R2	*R-square*	0.931	0.935	0.939	0.946	0.947	0.946	0.945	0.951	0.952	0.955
λ	*Box Cox parameter*	-0.068	-0.143	-0.086	-0.121	-0.114	-0.132	-0.209	-0.218	-0.228	-0.264
		(0.034)	(0.030)	(0.029)	(0.027)	(0.025)	(0.025)	(0.025)	(0.023)	(0.024)	(0.025)
α	*D&McK: semi (H0)*	-0.053	0.016	-0.117	-0.066	0.142	-0.018	0.045	0.007	0.017	-0.134
	vs double (H1)	(0.115)	(0.093)	(0.092)	(0.085)	(0.075)	(0.077)	(0.073)	(0.066)	(0.070)	(0.084)
α'	*D&McK: double (H0)*	1.076	1.036	1.120	1.094	0.956	1.075	1.061	1.054	1.052	1.185
	vs semi (H1)	(0.087)	(0.071)	(0.066)	(0.061)	(0.058)	(0.061)	(0.060)	(0.055)	(0.058)	(0.067)

Note Estimated standard standard errors between parentheses

Table B2 - Estimation results for the bi-annually estimated brand-weighted semi-log hedonic models, 1990-1999

		Adjacent years								
Var	*Description*	9190	9291	9392	9493	9594	9695	9796	9897	9998
INTERCEP		8.433	8.306	8.510	8.862	8.889	8.887	8.711	8.445	7.941
		(0.132)	(0.117)	(0.103)	(0.092)	(0.084)	(0.080)	(0.073)	(0.071)	(0.076)
D00	time dummy	0.023	0.028	0.008	-0.004	-0.018	-0.028	-0.011	-0.009	-0.007
		(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
DAGE1	dummy Age = 1	-0.006	0.005	0.008	0.011	0.020	0.016	0.011	0.003	0.005
		(0.005)	(0.005)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
DAGE2	dummy Age = 2	-0.009	0.018	0.035	0.031	0.033	0.039	0.030	0.014	0.009
		(0.006)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)
DAGE3	dummy Age = 3	-0.022	0.009	0.024	0.046	0.042	0.026	0.037	0.024	0.024
		(0.008)	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.005)
DAGE4	dummy Age = 4	-0.020	-0.001	0.038	0.051	0.064	0.057	0.059	0.046	0.035
		(0.011)	(0.009)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
DAGE5	dummy Age = 5	0.038	0.025	0.007	0.055	0.055	0.058	0.062	0.067	0.053
		(0.015)	(0.012)	(0.010)	(0.008)	(0.008)	(0.008)	(0.007)	(0.008)	(0.008)
DAGE6	dummy Age = 6	0.040	0.063	0.048	-0.088	0.022	0.084	0.105	0.075	0.103
		(0.026)	(0.016)	(0.013)	(0.016)	(0.011)	(0.010)	(0.011)	(0.013)	(0.014)
DAGE7	dummy Age = 7	0.004	0.043	0.099	0.022	-0.127	-0.034	0.005	0.095	0.119
		(0.027)	(0.026)	(0.020)	(0.018)	(0.022)	(0.021)	(0.022)	(0.027)	(0.028)
DAGE8	dummy Age = 8	0.005	0.014	0.055	0.126	0.010	-0.101	-0.063	-0.090	0.086
		(0.042)	(0.028)	(0.028)	(0.034)	(0.044)	(0.038)	(0.035)	(0.049)	(0.038)
DAGE9	dummy Age = 9		0.009	0.030	0.056	0.085	0.028	-0.208	-0.130	-0.193
			(0.040)	(0.029)	(0.033)	(0.039)	(0.056)	(0.081)	(0.075)	(0.087)
DAGE10	dummy Age = 10	0.965		0.006	0.047	0.026		-0.012	0.212	0.563
		(1.970)		(0.090)	(0.052)	(0.066)		(0.269)	(0.201)	(0.353)
DAGE11	dummy Age = 11	0.714				0.017	0.002		0.003	0.217
		(1.970)				(0.084)	(0.080)		(0.302)	(0.289)
DAGE12	dummy Age = 12		1.002	1.033			0.582	0.577		
			(0.926)	(0.782)			(0.705)	(0.638)		
DAGE13	dummy Age = 13			1.026	0.955			0.588	0.575	
				(1.105)	(0.962)			(0.553)	(0.532)	
XPK	Horse power (HP)	0.005	0.005	0.005	0.005	0.005	0.004	0.004	0.004	0.004
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
XWLB	Wheelbase (mm)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
XTOP	Top speed (km/h)	0.005	0.003	0.002	0.001	0.001	0.001	0.001	0.001	0.002
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
XVOL	Volume (m3)	0.017	0.012	0.007	-0.002	-0.000	-0.004	-0.017	-0.016	-0.006
		(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)
XMAS	Weight (kg)	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
XVB1	Avg. mileage (l/100km)	0.017	0.011	0.007	0.009	0.014	0.013	0.005	-0.003	-0.005
		(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
XVB2	Avg. mileage EC93 (l/100km	0.002	-0.004	-0.004	-0.004	-0.004	-0.002	-0.002	-0.003	-0.004
		(0.003)	(0.002)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
XBND	Tier radius (mm)	0.000	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.003
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
DFORD	dummy Ford	0.016	0.022	0.007	-0.021	-0.034	-0.053	-0.068	-0.068	-0.062
		(0.008)	(0.007)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)	(0.004)	(0.005)
DMERC	dummy Mercedes	0.327	0.308	0.269	0.242	0.251	0.298	0.294	0.269	0.266
		(0.022)	(0.018)	(0.015)	(0.012)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
DOPEL	dummy Opel	0.048	0.044	0.035	0.002	-0.026	-0.017	-0.025	-0.031	-0.032
		(0.007)	(0.006)	(0.005)	(0.005)	(0.004)	(0.005)	(0.004)	(0.004)	(0.004)
DPEUG	dummy Peugeot	0.043	0.057	0.073	0.056	0.051	0.050	0.024	-0.003	-0.011
		(0.008)	(0.008)	(0.007)	(0.006)	(0.006)	(0.005)	(0.005)	(0.004)	(0.004)
DRENA	dummy Renault	0.056	0.066	0.067	0.064	0.058	0.049	0.031	0.007	-0.013
		(0.010)	(0.008)	(0.007)	(0.006)	(0.006)	(0.006)	(0.005)	(0.004)	(0.005)
DVOLK	dummy Volkswagen	0.172	0.168	0.176	0.134	0.089	0.060	0.033	0.031	0.047
		(0.009)	(0.008)	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
DVOLV	dummy Volvo	0.141	0.132	0.100	0.054	0.050	0.091	0.103	0.090	0.104
		(0.011)	(0.009)	(0.009)	(0.008)	(0.008)	(0.007)	(0.007)	(0.008)	(0.009)
D2D	dummy 2-doors	0.155	0.183	0.211	0.243	0.250	0.243	0.244	0.265	0.296
		(0.011)	(0.010)	(0.009)	(0.008)	(0.007)	(0.007)	(0.006)	(0.006)	(0.007)
D3D	dummy 3-doors	-0.014	-0.011	-0.011	-0.007	-0.010	-0.013	-0.011	-0.013	-0.011
		(0.006)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
D4D	dummy 4-doors	-0.030	-0.026	-0.021	-0.013	-0.014	-0.018	-0.012	-0.004	-0.006
		(0.005)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)

continued

table B2 continued

Var	*Description*	9190	9291	9392	9493	9594	9695	9796	9897	9998
DAUT	dummy Automatic transm.	0.128	0.089	0.068	0.058	0.052	0.054	0.062	0.075	0.087
		(0.011)	(0.009)	(0.008)	(0.008)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)
DAUTX	dummy Automatic extra	-0.047	-0.013	0.003	0.003	0.005	0.000	-0.003	-0.008	-0.012
		(0.011)	(0.010)	(0.008)	(0.008)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)
DHNDX	dummy Manual extra	-0.004	-0.004	-0.007	-0.010	-0.017	-0.011	0.066	0.177	
		(0.018)	(0.017)	(0.016)	(0.018)	(0.021)	(0.035)	(0.046)	(0.106)	
DKLS1	dummy Class 1	-0.243	-0.228	-0.281	-0.418	-0.441	-0.415	-0.388	-0.334	-0.246
		(0.032)	(0.028)	(0.025)	(0.023)	(0.021)	(0.019)	(0.018)	(0.018)	(0.020)
DKLS2	dummy Class 2	-0.168	-0.127	-0.160	-0.271	-0.298	-0.287	-0.268	-0.228	-0.160
		(0.024)	(0.021)	(0.018)	(0.016)	(0.015)	(0.015)	(0.014)	(0.015)	(0.017)
DKLS3	dummy Class 3	-0.150	-0.121	-0.159	-0.254	-0.278	-0.271	-0.255	-0.225	-0.180
		(0.020)	(0.018)	(0.016)	(0.014)	(0.013)	(0.013)	(0.013)	(0.014)	(0.016)
DKLS4	dummy Class 4	-0.055	-0.044	-0.087	-0.177	-0.207	-0.215	-0.208	-0.191	-0.165
		(0.017)	(0.015)	(0.014)	(0.013)	(0.012)	(0.012)	(0.011)	(0.013)	(0.014)
DKLS5	dummy Class 5	-0.012	-0.024	-0.071	-0.134	-0.153	-0.161	-0.151	-0.137	-0.111
		(0.015)	(0.014)	(0.013)	(0.012)	(0.011)	(0.011)	(0.011)	(0.012)	(0.014)
DTRN	dummy Terrain car	0.104	0.082	0.077	0.100	0.066	0.030	0.055	0.083	0.091
		(0.020)	(0.018)	(0.015)	(0.013)	(0.012)	(0.013)	(0.012)	(0.011)	(0.013)
DV8	dummy V8 (or more)	0.017	-0.021	0.002	0.057	0.061	0.046	0.052	0.062	0.086
		(0.037)	(0.029)	(0.024)	(0.021)	(0.020)	(0.019)	(0.018)	(0.019)	(0.020)
DINJ	dummy Fuel Injection	0.007	0.021	0.040	0.042	0.028	0.006	-0.012	-0.011	-0.008
		(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
DDIES	dummy Diesel	0.284	0.252	0.210	0.175	0.173	0.158	0.125	0.101	0.100
		(0.009)	(0.008)	(0.008)	(0.007)	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)
DABG	dummy Airbag	0.016	0.005	-0.002	-0.002	0.004	0.005	0.009	0.014	0.032
		(0.010)	(0.007)	(0.005)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
DMET	dummy Metallic paint	0.044	0.030	0.026	0.010	0.015	0.034	0.051	0.054	0.055
		(0.012)	(0.009)	(0.007)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
DSBK	dummy Power steering	-0.018	0.011	0.039	0.055	0.045	0.044	0.044	0.031	0.026
		(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)
DCDV	dummy Central locking	-0.028	-0.011	0.004	0.017	0.026	0.033	0.036	0.041	0.046
		(0.009)	(0.007)	(0.005)	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)	(0.004)
DGET	dummy Tinted glass	0.029	0.021	0.009	0.004	0.005	0.007	0.004	0.001	-0.009
		(0.008)	(0.006)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)
DAIR	dummy Air conditioning	-0.041	-0.015	-0.006	0.008	0.009	0.013	0.021	0.027	0.035
		(0.016)	(0.012)	(0.008)	(0.005)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
DABS	dummy ABS-brake system	0.057	0.077	0.102	0.105	0.098	0.067	0.043	0.038	0.044
		(0.010)	(0.007)	(0.006)	(0.005)	(0.005)	(0.004)	(0.003)	(0.003)	(0.003)
Df	*Degrees of Freedom*	4037	4621	5100	5796	6327	6928	7530	7531	6585
RMSE	*Root MSE*	1.393	1.309	1.105	0.962	0.906	0.863	0.781	0.751	0.826
R2	*R-square*	0.932	0.935	0.940	0.943	0.945	0.944	0.947	0.951	0.952
λ	*Box Cox parameter*	-0.101	-0.092	-0.085	-0.107	-0.119	-0.163	-0.210	-0.220	-0.244
		(0.022)	(0.021)	(0.019)	(0.018)	(0.017)	(0.017)	(0.017)	(0.016)	(0.017)
α	*D&McK: semi (H0)*	-0.014	0.015	-0.078	0.070	0.060	0.037	0.041	0.031	-0.051
	vs double (H1)	(0.073)	(0.065)	(0.063)	(0.058)	(0.054)	(0.052)	(0.049)	(0.048)	(0.055)
α'	*D&McK: double (H0)*	1.052	1.040	1.100	1.016	1.017	1.049	1.042	1.038	1.115
	vs semi (H1)	(0.056)	(0.049)	(0.045)	(0.043)	(0.042)	(0.042)	(0.041)	(0.040)	(0.044)
F (with respect to annual regressions)		1.627	3.709	3.370	6.876	2.628	3.753	2.692	2.728	4.944
p -value		(0.006)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ΔRMSE (% w.r.t. annual RMSE)		0.341%	1.311%	1.063%	2.355%	0.590%	0.910%	0.515%	0.526%	1.339%

Note *D00 denotes the appropriate time dummy variable (=1 for the most recent period, = 0 for the base period); estimated standard standard errors between parentheses*

Table B3 - Estimation results for the fully pooled, brand-weighted semi-log hedonic *T* -, *TA* - and *TAV* -models, 1990-1999

		Model					*Model*		
Var	*Description*	*T*	*TA*	*TAV*	*Var*	*Description*	*T*	*TA*	*TAV*
INTERCEP		8.489	8.436	8.492	*DSBK*	dummy Power steering	0.032	0.034	0.031
		(0.041)	(0.041)	(0.043)			(0.002)	(0.002)	(0.002)
D91	dummy 91	0.020	0.016	0.011	*DCDV*	dummy Central locking	0.016	0.016	0.016
		(0.003)	(0.003)	(0.003)			(0.002)	(0.002)	(0.002)
D92	dummy 92	0.055	0.046	0.039	*DGET*	dummy Tinted glass	-0.003	0.000	0.002
		(0.003)	(0.003)	(0.004)			(0.002)	(0.002)	(0.002)
D93	dummy 93	0.067	0.058	0.049	*DAIR*	dummy Air conditioning	0.019	0.020	0.019
		(0.003)	(0.003)	(0.005)			(0.002)	(0.002)	(0.002)
D94	dummy 94	0.066	0.055	0.049	*DABS*	dummy ABS-brake system	0.042	0.044	0.046
		(0.003)	(0.003)	(0.007)			(0.002)	(0.002)	(0.002)
D95	dummy 95	0.051	0.038	0.033	*DAGE1*	dummy Age = 1		0.006	0.008
		(0.003)	(0.004)	(0.008)				(0.002)	(0.002)
D96	dummy 96	0.027	0.012	0.009	*DAGE2*	dummy Age = 2		0.016	0.023
		(0.004)	(0.004)	(0.009)				(0.002)	(0.003)
D97	dummy 97	0.026	0.008	0.006	*DAGE3*	dummy Age = 3		0.019	0.029
		(0.004)	(0.004)	(0.011)				(0.002)	(0.005)
D98	dummy 98	0.022	0.003	-0.006	*DAGE4*	dummy Age = 4		0.034	0.043
		(0.004)	(0.004)	(0.012)				(0.003)	(0.007)
D99	dummy 99	0.025	0.000	-0.013	*DAGE5*	dummy Age = 5		0.038	0.046
		(0.004)	(0.005)	(0.013)				(0.004)	(0.008)
XPK	Horse power (HP)	0.005	0.005	0.005	*DAGE6*	dummy Age = 6		0.048	0.052
		(0.000)	(0.000)	(0.000)				(0.007)	(0.011)
XWLB	Wheelbase (mm)	0.000	0.000	0.000	*DAGE7*	dummy Age = 7		0.013	0.023
		(0.000)	(0.000)	(0.000)				(0.011)	(0.013)
XTOP	Top speed (km/h)	0.002	0.002	0.002	*DAGE8*	dummy Age = 8		0.028	0.041
		(0.000)	(0.000)	(0.000)				(0.016)	(0.018)
XVOL	Volume (m3)	0.003	0.003	0.003	*DAGE9*	dummy Age = 9		0.050	0.061
		(0.001)	(0.001)	(0.001)				(0.022)	(0.023)
XMAS	Weight (kg)	0.000	0.000	0.000	*DAGE10*	dummy Age = 10		0.053	0.079
		(0.000)	(0.000)	(0.000)				(0.056)	(0.056)
XVB1	Avg. mileage (l/100km)	0.013	0.012	0.011	*DAGE11*	dummy Age = 11		0.065	0.113
		(0.001)	(0.001)	(0.001)				(0.095)	(0.096)
XVB2	Avg. mileage EC93 (l/100kn	-0.004	-0.003	-0.003	*DAGE12*	dummy Age = 12		0.753	0.778
		(0.000)	(0.000)	(0.000)				(0.565)	(0.561)
XBND	Tier radius (mm)	0.001	0.001	0.001	*DAGE13*	dummy Age = 13		0.666	0.702
		(0.000)	(0.000)	(0.000)				(0.610)	(0.606)
DFORD	dummy Ford	-0.033	-0.030	-0.033	*V84*	dummy Vintage 1984			-0.056
		(0.003)	(0.003)	(0.003)					(0.023)
DMERC	dummy Mercedes	0.292	0.286	0.282	*V85*	dummy Vintage 1985			0.002
		(0.006)	(0.006)	(0.006)					(0.023)
DOPEL	dummy Opel	0.008	0.007	0.003	*V86*	dummy Vintage 1986			0.030
		(0.002)	(0.002)	(0.002)					(0.018)
DPEUG	dummy Peugeot	0.032	0.034	0.036	*V87*	dummy Vintage 1987			-0.090
		(0.003)	(0.003)	(0.003)					(0.017)
DRENA	dummy Renault	0.041	0.041	0.039	*V88*	dummy Vintage 1988			-0.011
		(0.003)	(0.003)	(0.003)					(0.016)
DVOLK	dummy Volkswagen	0.099	0.096	0.090	*V89*	dummy Vintage 1989			-0.024
		(0.003)	(0.003)	(0.003)					(0.014)
DVOLV	dummy Volvo	0.088	0.094	0.092	*V90*	dummy Vintage 1990			0.006
		(0.004)	(0.004)	(0.004)					(0.013)
D2D	dummy 2-doors	0.231	0.232	0.230	*V91*	dummy Vintage 1991			-0.001
		(0.004)	(0.004)	(0.004)					(0.012)
D3D	dummy 3-doors	-0.007	-0.008	-0.007	*V92*	dummy Vintage 1992			-0.001
		(0.002)	(0.002)	(0.002)					(0.011)
D4D	dummy 4-doors	-0.016	-0.016	-0.016	*V93*	dummy Vintage 1993			-0.003
		(0.002)	(0.002)	(0.002)					(0.010)
DAUT	dummy Automatic transm.	0.069	0.071	0.072	*V94*	dummy Vintage 1994			-0.011
		(0.004)	(0.004)	(0.004)					(0.009)
DAUTX	dummy Automatic extra	-0.003	-0.005	-0.005	*V95*	dummy Vintage 1995			-0.011
		(0.004)	(0.004)	(0.004)					(0.009)
DHNDX	dummy Manual extra	-0.014	-0.016	-0.013	*V96*	dummy Vintage 1996			-0.016
		(0.009)	(0.009)	(0.009)					(0.008)
DKLS1	dummy Class 1	-0.364	-0.346	-0.351	*V97*	dummy Vintage 1997			-0.019
		(0.010)	(0.010)	(0.010)					(0.008)
DKLS2	dummy Class 2	-0.247	-0.232	-0.234	*V98*	dummy Vintage 1998			0.010
		(0.008)	(0.008)	(0.008)					(0.008)

continued

table B3 continued

Var	*Description*	*Model* *T*	*TA*	*TAV*	*Var*	*Description*	*Model* *T*	*TA*	*TAV*
DKLS3	dummy Class 3	-0.234	-0.222	-0.222					
		(0.007)	(0.007)	(0.007)	*Df*	*Degrees of Freedom*	29782	29769	29754
DKLS4	dummy Class 4	-0.166	-0.158	-0.158	*RMSE*	*Root MSE*	1.060	1.056	1.049
		(0.006)	(0.006)	(0.006)	*R2*	*R-square*	0.934	0.934	0.935
DKLS5	dummy Class 5	-0.107	-0.102	-0.102	λ	*Box Cox parameter*	-0.062	-0.064	-0.068
		(0.006)	(0.006)	(0.006)			(0.008)	(0.008)	(0.008)
DTRN	dummy Terrain car	0.093	0.094	0.094	α	*D&McK: semi (H0)*	0.151	0.147	0.141
		(0.007)	(0.007)	(0.007)		*vs double (H1)*	(0.026)	(0.026)	(0.026)
DV8	dummy V8 (or more)	0.040	0.043	0.042	α'	*D&McK: double (H0)*	0.947	0.957	0.957
		(0.011)	(0.011)	(0.011)		*vs semi (H1)*	(0.021)	(0.021)	(0.020)
DINJ	dummy Fuel Injection	0.024	0.029	0.026	*F(with respect to T-model)*			17.962	23.638
		(0.002)	(0.002)	(0.002)	*p* -value			(0.000)	(0.000)
DDIES	dummy Diesel	0.197	0.195	0.192	*ΔRMSE (%, w.r.t. T-model)*			0.370%	1.059%
		(0.003)	(0.003)	(0.003)	*F (w.r.t. TA-model)*				28.343
DABG	dummy Airbag	0.003	0.006	0.008	*p* -value				(0.000)
		(0.002)	(0.002)	(0.002)	*ΔRMSE (%, w.r.t. TA-model)*				0.687%
DMET	dummy Metallic paint	0.029	0.029	0.030	*F (w.r.t. annual models)*			14.033	
		(0.003)	(0.003)	(0.003)	*p* -value			(0.000)	
					ΔRMSE (%, w.r.t. annual models)			8.746%	

Note *Estimated standard standard errors between parentheses*