Some observations on quality adjustment in the Netherlands

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Summary: This paper illustrates the way quality adjustments are made in the Dutch consumer price index.

Keywords: consumer price index, quality adjustment

1. Introduction

> *"Quality... is so very a disputable a matter, that I look upon all information of this kind as somewhat uncertain."*
> Adam Smith (1776)[1]

Quality change is commonly regarded as the biggest problem in price index compilation. It is also regarded by many as the most important potential source of bias in the consumer price index and as the most important potential source of non-comparability between CPIs of different countries.
At present, there exists no single universally accepted method which can be applied in all circumstances. Statistical offices apply a range of methods and procedures, each of which has its own advantages and disadvantages. The choice of a particular method all too often depends on the availability of data. Quality adjustment is more an art than a science and generally leaves considerable room for the artist's interpretation. Recent discussions on potential biases of the CPI show that things have not changed much since Smith's times. The Bureau of Labor Statistics (1995), which is responsible for the compilation of the USA CPI, concludes on the possibility of quality bias: "Indeed this is a question that may not have a scientific answer, in the sense that reasonable people may draw different conclusions about the effects of quality change from the same data".
This paper illustrates the way quality adjustments are made in the Dutch CPI. First, a concise description of the CPI is given in section 2. Section 3 addresses the quality change issue in the CPI. Section 4 concentrates on the actual quality adjustments made, with special attention for new cars, clothing and washing machines.
The main part of the paper is a description of the state of the art. Several price index statisticians are of the opinion, that the quality problem will not be solved repeating the same routines that have been followed until now and that new ways must be

* The views expressed in this paper are those of the author and do not necessarily reflect the policies of Statistics Netherlands.

found. Section 5 presents an overview of possible new ways to deal with quality changes.

2. The Consumer Price Index

> *"Despite the theoretical proofs to the contrary, the Consumer Price Index (CPI) 'exists' and is even of some use."*
>
> Ohta and Griliches (1975)

2.1. Purposes of a consumer price index

The aim of a consumer price index is to measure changes in consumer prices. Some of the choices that have to be made in designing a consumer price index should depend upon the relative importance of the different purposes of the index. Amongst others, a consumer price index is used as a measure of inflation, as a cost-of-living index, as an instrument for indexation of wages, pensions, alimony, rents etc. and for national accounting deflation. In the design of a consumer price index there is no unique best way of doing things. Different questions may yield different answers[2], and quality adjustment, the main theme of this report, is no exception in this respect.
The Dutch CPI can be conceived of as a (partial) cost-of-living index[3]. Most users are of the opinion that a CPI ought to tell us something about the development of the purchasing power of the household income or about the cost of living. The scope of the index is defined as the set of goods and services which are acquired by the average household for prices which are known to the households at the moment of acquisition. All acquisitions must be done by the household itself. They are made from net spendable household income[4].

2.2. Index number formula

The CPI is an estimator of a Laspeyres price index. It measures the ratio of the current cost of the base period basket to its base period cost. The Laspeyres price index of period *t* compared to base period *0* can be written as

$$P_L^{\,t} = \frac{\sum_{i=1}^{N} p_i^{\,t} q_i^{\,0}}{\sum_{i=1}^{N} p_i^{\,0} q_i^{\,0}}, \qquad (1)$$

where $p_i^{\,t}$ denotes the price of commodity *i* in period *t*, $p_i^{\,0}$ the price in period *0* and $q_i^{\,0}$ the quantity consumed of commodity *i* in the base period (*i*=1,...,N). Formula (1) can also be written as

$$P_L^{\,t} = \sum_{i=1}^{N} w_i^{\,0} \frac{p_i^{\,t}}{p_i^{\,0}}, \qquad (2)$$

where

$$w_i^{\,0} = \frac{p_i^{\,0} q_i^{\,0}}{\sum_{j=1}^{N} p_j^{\,0} q_j^{\,0}}$$

denotes the expenditure share of commodity *i* within total consumption expenditure. Formula (2) expresses that the Laspeyres price index can be seen as a weighted average of elementary indices. After aggregating all commodities into a number of commodity groups, the Laspeyres index can be written as a weighted average of the various commodity group price indices.

In reality, it is unfeasible to incorporate prices of all single items sold in the CPI. Data availability and cost constraints determine the extent to which the ideal can be achieved. The estimation of the CPI involves different kinds of samples. A sample of households taking part in a budget survey is used for estimating the commodity group weights. From each commodity group a sample of commodities (items) is drawn. Those items selected to represent the commodity group are called “representative items”. The prices of these items are collected in a sample of outlets. And then there is also a sample of price collection times within the month[5].

3. The quality problem

> *“If a commodity exists at one period and not at another, it must be omitted from any comparison of these two periods; for its prices have not varied, it has merely appeared or disappeared.”*
>
> Walsh (1921, p. 89)

A price index is intended to measure price *changes*. A problem arises with the disappearance of a particular item selected for pricing, since this prevents the desired matching of the current and previous prices. If the disappearance is expected to be short lived, for example because the item is temporarily out of stock, there is no problem. The item can be temporarily omitted from the calculation. But if this is not the case, a different approach is needed. The usual procedure in those cases is, to replace the item with a substitute. As long as the substitute is of the same quality as the one to be replaced, the price of the substitute can be used instead of the old one. However, if there is a difference in quality between the old and the new item, an adjustment is needed. An adjustment is also needed if there is a quality change in an existing item. There is always a risk that a change in quality remains undetected, especially in case of gradual improvement or decline of particular services.
To keep quality changes from influencing the price index, specifications of the articles to be priced are of crucial importance. This topic is addressed in section 3.1. Section 3.2 presents an overview of the quality adjustment methods which are presently used in the compilation of the Dutch CPI.

3.1. Specifications

In measuring "pure" price change, specifications of the articles to be priced play a central role. In principle, specifications, which are provided centrally, are as tight as possible. For most articles, the central office decides which particular variety or varieties (brand, type) should be priced. The only thing the price collector has to do for these articles is to find out whether the varieties concerned are available and if so, record their prices. If a selected shop doesn't have the exact variety, this is reported to the central office. Central office then selects a comparable shop (same shoptype, same region) from the General Business Register. If this shop doesn't sell the required variety either, a new shop is selected, and so on. Varieties being sold in the same region/shop type are considered to be of the same quality, so the price of the specified variety in a new shop can be directly compared with the price of that variety in the old shop.
For articles where tight specifications entail a considerable risk that an outlet does not sell the item exactly as specified or where price collectors cannot use them, loose specifications are used. Clothing, footwear and furniture are examples where specifications are loose. In those cases, the price collector has to select a variety that fits the specification. In principle, the most sold variety in the shop concerned has to be selected. In cases where this information is not available, it is common practice to select a variety in the middle price range.

If a chosen variety is no longer available, the price collector has to select a successor of more or less the same quality. No specific action takes place to adjust for quality changes that may occur. All varieties fitting the specification and being sold in the same shop type are considered to be of the same quality.
For several articles, mailed questionnaires are used (for example, for rents, electricity, gas and water, medical care, tobacco, postal tariffs, consumption related taxes, government services, etc.). Generally, where prices are uniform or where price collection using mailed questionnaires is more convenient, no field collection takes place.
In case of centrally collected prices tight specifications are used. In case of the rent survey, for example, each house in the survey is considered as a separate variety. Quality adjustment is carried out at the level of separate varieties.

3.2. Quality adjustment methods in the Dutch CPI

Presently quality adjustments are solely carried out at the Central Office, where commodity specialists tackle problems like selecting new varieties (in the case of tight specifications), adapting loose specifications and deciding which part of a price difference between old and new variety, or between an old and a new (loose) specification can be attributed to the difference in quality.
Price collectors do not estimate the effects of quality changes. Price collectors do make quality judgements, however. In case of loose descriptions, they have to select items fitting the specifications. If a specific variety that has been selected for pricing is no longer available, they have to choose another variety of comparable quality.
The first thing a commodity specialist has to do when a substitution has taken place is to decide whether the substitute product and the original product differ in quality. This is done on the basis of a feature-by-feature comparison. If one or more specifications differ, this does not automatically lead to the conclusion that the products are of different quality. It is up to the commodity specialist to decide whether the differences are important enough. If they are, a quality adjustment has to be made.
Below a description of the quality adjustment methods used in the Dutch CPI is given. In these descriptions it is always assumed that in the current period *t* product *A* is replaced by product *B*. A synthetic price of product *B* in the previous period *t-1* is calculated as:

$$p_B^{t-1} = g p_A^{t-1}$$

where p_A^{t-1} is the observed price of product *A* in the previous period *t-1*. Factor *g* is called the *quality adjustment factor*.

3.2.1. Quantity adjustment

Probably the simplest case of quality adjustment occurs when the difference between old and new variety can be regarded as one of them containing a larger quantity than the other. For example, when a box of chocolates containing 250 grammes is replaced by a box containing 300 grammes, the adjustment factor can be simply obtained as

$$g = \frac{q_B}{q_A}$$

where q_A and q_B denote the quantity of the old variety A and the new variety B, respectively.
In the example, g = 300/250 = 1.2. So, assuming that the price of variety A in the previous period t-1 was equal to 8 and that the price of variety B in period t equals

10, the pure price change between t-1 and t is 10 / (8 * 1.2) = 1.0417. Proportional conversion makes sence as long as the change in quantity is relatively minor.
Quantity adjustment can also be applied in other cases where a quality change can be translated into a quantity change. Examples are car tires or razor blades that last longer.
It should be clear that quantity adjustment can only be applied in a limited number of cases.

3.2.2. Option cost adjustment
Where a new variety has an extra feature that was previously available as an option, (a part of) the price of purchasing the feature as an optional extra in the earlier time period can be taken as the value of the quality change.
The adjustment factor can be obtained as

$$g = \frac{\hat{p}_B^{\,t-1}}{p_A^{\,t-1}}$$

where $\hat{p}_B^{\,t-1}$ is estimated as the price of the previous version plus the price of the optional feature.
Option cost adjustment can be applied in a limited number of cases. In section 4 some examples are given, which will illustrate the limitations of this approach.

3.2.3. Overlap method
When there is an overlap in the availability of the old and the new variety, prices for both can be obtained at the same time. The difference in price levels can be used as an estimate of the difference in quality.
The adjustment factor becomes

$$g = \frac{p_B^{\,t}}{p_A^{\,t}}$$

The rationale behind overlap pricing is that, when several varieties are for sale simultaneously, relative prices more or less reflect the average consumer's valuation. While some choose variety A and others variety B, it makes sense to take the price difference as a measure of the average difference in quality.
When different varieties are simultaneously available during an extended period, this approach seems to be justified. However, this is not usually the case with disappearing and new items. Overlap pricing may result in downward bias when, during a period of rising prices, sellers try to let price changes coincide with changes in varieties. Especially when a model change involves a modest increase in quality (or maybe no increase at all) and the change is mainly a change in fashion or style, this method tends to bias the index downward. Upward bias is also possible, for products with rapidly changing technologies.

3.2.4. Subjective quality adjustment
In this method the commodity specialist decides on the proportion ϑ of the difference between the current price of product B and the previous price of product A that can be considered as a "pure" price change.[6] The adjustment factor can be obtained as

$$g = \frac{p_B^{\,t}}{p_B^{\,t} - (1-\vartheta)(p_B^{\,t} - p_A^{\,t-1})} = \frac{p_B^{\,t}}{p_A^{\,t-1} + \vartheta(p_B^{\,t} - p_A^{\,t-1})}$$

Note that if old and new variety are considered to be of the same quality (ϑ=1), prices can be directly compared: g = 1.

The link-to-show-no-change method is a special case of subjective quality adjustment (ϑ=0). The adjustment factor becomes

$$g = \frac{p_B^{\,t}}{p_A^{\,t-1}}$$

It should come as no surprise, that index number compilers wish to avoid subjective quality adjustment as much as possible and that users of the index demand that it be objective. In reality, however, this approach is not an exception to the rule.

3.*2.5. Imputation*

The "true" price change is imputed from a set of similar items. The adjustment factor can be written as:

$$g = \frac{p_B^{\,t}}{p_A^{\,t-1} I^{t,t-1}}$$

where $I^{t,t-1}$ denotes the month-to-month price index for the group of similar items.

Imputation suffers from similar drawbacks as, for example, overlap pricing. Especially when price increases coincide with model changes, this method tends to bias the index downward.

3.2.6. Hedonic adjustment

Hedonic adjustment involves the use of multiple regression to relate the prices of a group of similar items to a number of quantifyable characteristics. The estimated coefficients can be regarded as implicit prices for the characteristics.

There are several ways to use the information from a hedonic function to construct a price index (see also Triplett (1986)).

In the first variant an explicit quality adjustment is made. If the old model is replaced by a new one and if the two models differ in the characteristics quantities embodied in them, this difference can be valued by the implicit characteristics prices.

The adjustment factor becomes

$$g = \frac{\hat{p}_B^{\,t-1}}{p_A^{\,t-1}} \text{ or } g = \frac{p_B^{\,t}}{\hat{p}_A^{\,t}}$$

where $\hat{p}_B^{\,t-1}$ and $\hat{p}_A^{\,t}$ denote the estimated previous price of product B and the estimated current price of product A, respectively, based on hedonic coefficients.

In the second variant a price index is directly defined on the characteristics and calculated from the characteristics prices and quantities.

The third variant takes models from different years into one equation. Time dummies are supposed to pick up the effect of time on prices. The coefficients of the time dummies can then be used as a measure of "pure" price change.

Despite its attractiveness from a theoretical point of view, the hedonic method is still rarely used in practice, sixty years after Court (1939) suggested it for the first time. Since then, a lot of research has been carried out on hedonics, especially for cars, but also for other consumer goods like refrigerators, computers, hifi-equipment, wall-to-wall carpetting, housing and clothing[7]. Only some statistical offices use hedonics in practice on a very limited scale (housing, clothing, second hand cars, computers).

For clothing, the hedonic approach is used by some offices as a way of dealing with seasonal unavailability. It seems to offer acceptable results, but it remains to be seen whether it is superior to alternative (and cheaper) ways of dealing with this problem.

Statistics Netherlands uses hedonics for second hand cars to treat differences in age and milleage per brand/model. This seems to be an attractive solution to deal with

the “unique goods” character of second hand cars, but it doesn’t answer the question how much the quality of (second hand) cars has improved over the years.
For new cars, hedonics haven’t been very successful. Much of the early exploratory work on hedonics was focussed on cars. Triplett (1990) argues that automobiles may have been the wrong place to start. The way automobile characteristics enter the utility function is very complicated, very hard to model, and for this reason the appropriate set of variables is hard to determine.
Hedonics are no miracle cure. But this does not mean that we should abandon the idea altogether. What is needed, is: more, and better data and more (and better) research.

4. Quality adjustment in practice

> *“Quality change is the house-to-house combat of price measurement”*
>
> Shapiro and Wilcox (1996)

In this section, actual quality adjustments for some selected areas are presented. Section 4.1 concentrates on cars, a notoriously difficult area for index compilers. Section 4.2 deals with clothing, where seasonality and fashion are especially complicating factors. Washing machines are considered in section 4.3. Section 4.4 goes briefly into other goods and services. Section 4.5. evaluates present practices.

4.1.Cars[8]

4.1.1.Price observation and quality adjustment

The CPI for new cars in the Netherlands is based on list prices. In reality, car prices are negotiable (directly, or by way of trade-in value). A discount of 5% is believed to be fairly common. In basing the index on list prices we implicitly assume that, in the long run, the development of list prices doesn't differ from the development of transaction prices.
The national CPI for new cars is based on the list-prices of 36 specified models. For eight of them, a change in quality was reported in 1994. For two others, there was even twice a change in 1994.
Car prices are centrally collected. Usually, quality changes are reported by the respondent (most of the times the importer). In other cases, large price differences will induce the commodity specialist to explore the possibility of a quality change. There is no guarantee that all changes are detected by the specialist. The use of more durable materials or parts may often be overseen.
When the returned questionnaire indicates a quality change the importer is contacted. Based on his information and the information the specialist gets from car magazines it is tried to quantify the change in quality. Sometimes, usually when minor changes occur, list prices of the options are used, for example when tinted windows are now standard and were optional before. In the latter case the new (list) price is compared with the sum of the old price and the price of the tinted windows.
Changes imposed by government are not considered as quality changes. Price changes resulting from the introduction of obligatory safety belts some years ago were treated as real price movements[9].
When a completely new model replaces an old one, the method of overlap pricing is used. The price difference at one moment is taken as a measure of the quality difference between the two cars. The limitations of this procedure are obvious.

4.1.2.Quality adjustments in 1994

This section presents an overview of the quality adjustments for cars in 1994. There were twelve model changes in the cars selected for pricing. One change was judged to be of minor importance and disregarded. In four cases a completely new model was introduced, which resulted in applying the overlap method. The new models were respectively 4.2, 8.6, 10.2 and 13.3% more expensive than their predecessors. Using overlap pricing, these price changes were entirely eliminated from the index.
In the remaining cases option cost adjustment was used. Table 1 shows the results for these cars.

Table 1. Quality adjustments using option cost method in 1994

Nr.	old list price	new list price	estimated value quality change	"pure "price change in %	total price change in %	quality change in %
1	54950	45996	-500	-15.53	-16.29	-0.76
2	49950	49950	1975	- 3.80	-	3.80
3	49950	49950	1074	- 2.10	-	2.10
4	30990	30490	1340	- 5.61	- 1.61	4.00
5	22950	23590	1900	- 5.07	2.79	7.86
6	21820	22120	530	- 1.03	1.37	2.40
7	30545	30870	850	- 1.67	1.06	2.73

An example of option cost adjustment is given below.
One of the models selected for pricing was model X 1.4i, 5 gears, 5 doors. The new model had some extra features compared to the old one: tinted windows, velours upholstery, a new front and crossbars in the doors. The price of the old model was Dfl. 30545, the price of the new model was Dfl. 30870. The new front and upholstery were disregarded. The options list of the old model indicated a price of Dfl. 600 for tinted windows, and the price of the crossbars was estimated to be Dfl. 250. The change in price of model X was calculated to be 30870/(30545+250+600), or a decrease of 1.67%. Direct comparison gives a rise of 1.06%, a difference of 2.73%.
There are moments when we feel somewhat uncomfortable with option cost adjustment. Suppose, for example, that the price of a new model is Dfl. 500 higher than the price of the old model and that the new model has standard ABS, while for the old model ABS was optional for Dfl. 3000 extra. Should we record a price fall of Dfl. 2500? Looking at it from the point of view of someone who bought the old model including ABS, it seems defendable. But how about someone who isn't interested in ABS, at least not as long as it is as expensive as in this example?
A real life example is the case of a particular make and model Y. In 1985, the price of this car was Dfl. 29295. In a period of ten years twelve quality adjustments were made. Added were: 5^{th} gear, fuel injection, two extra doors, ABS, power steering, central locking system, airbag, revolution counter, adjustable headlights, extra indicators, electrical windows, extra head rests and an adjustable chair. Also a more powerful engine was installed.
Early 1995 the price of this car was Dfl. 53500. Direct comparison with the 1985 model showed a rise of over 80%. The recorded price rise in the CPI was only 10%. Option cost adjustment eliminated most of the price difference.

4.1.3. Quality adjustments in 1997

This paragraph presents an overview of the quality adjustments for cars in 1997. There were fourteen model changes in the cars selected for pricing. Six changes were judged to be of minor importance and disregarded (direct price comparison). In two cases a completely new model was introduced, which resulted in the application of the link-to-show-no-change procedure. The new models were 2.4 % and 29.7 %,

respectively, more expensive than their predecessors. By linking, these price changes were eliminated from the index. In the remaining cases the option cost method was used. Table 2 shows the results for these cars.

Table 2. Quality adjustments using option price method in 1997

Nr.	old list price	new list price	estimated value quality change	"pure" price change in %	total price change in %	quality change in %
1	29845	29845	648	-2.13	.00	2.13
2	32090	31440	680	-4.06	-2.03	2.03
3	44245	45245	1050	- .11	2.26	2.37
4	46850	46850	293	- .62	.00	.62
5	41150	41150	293	- .71	.00	.71
6	55265	59565	2120	3.80	7.78	3.98

4.1.4. Effects over a longer period

Where do all our efforts lead to? Table 3 and figure 1 show a comparison between the official car price index and a unit value index over the period 1972 - 1995. As might be expected, the unit value index shows a higher rise than the official index, indicating that, on average, higher quality cars are bought nowadays.

Table 3. Development of list prices of new cars, 1972=100

Year	unit value	CPI new car index
1972	100	100
1973	112	108
1974	117	113
1975	134	123
1976	151	137
1977	166	144
1978	182	149
1979	197	156
1980	208	161
1981	221	173
1982	228	184
1983	236	193
1984	248	201
1985	262	209
1986	275	219
1987	296	229
1988	324	242
1989	335	242
1990	353	244
1991	372	252
1992	402	266
1993	472	273
1994	459	276
1995	444	276
1996	446	270

Figure 1. A comparison between the unit value index for cars and the CPI car index

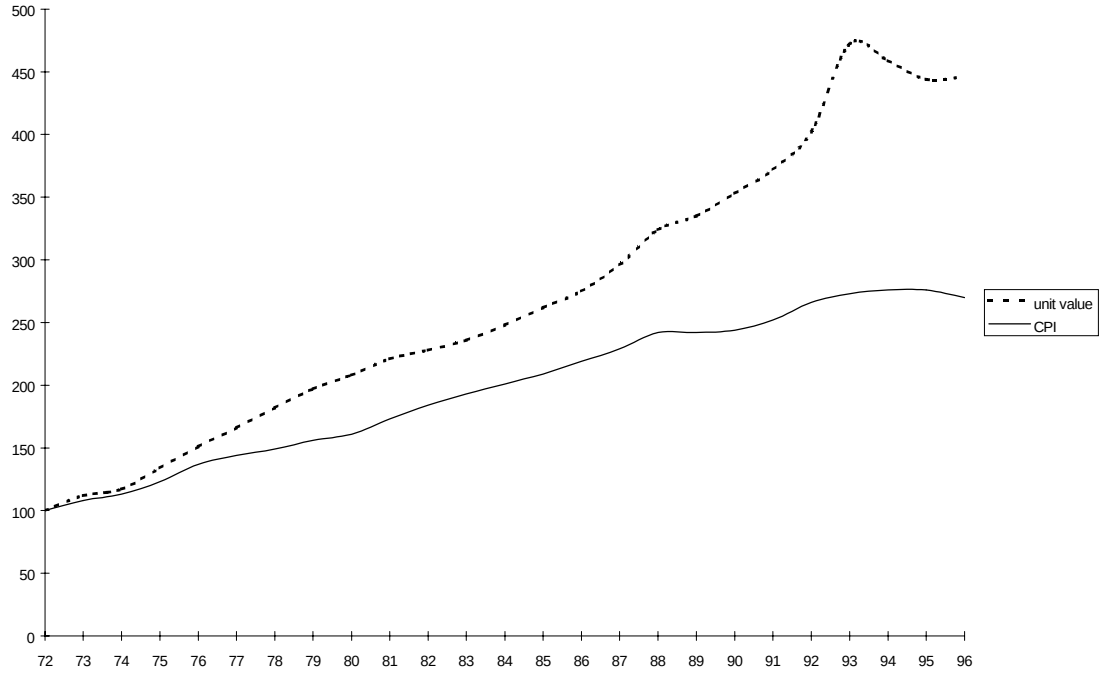


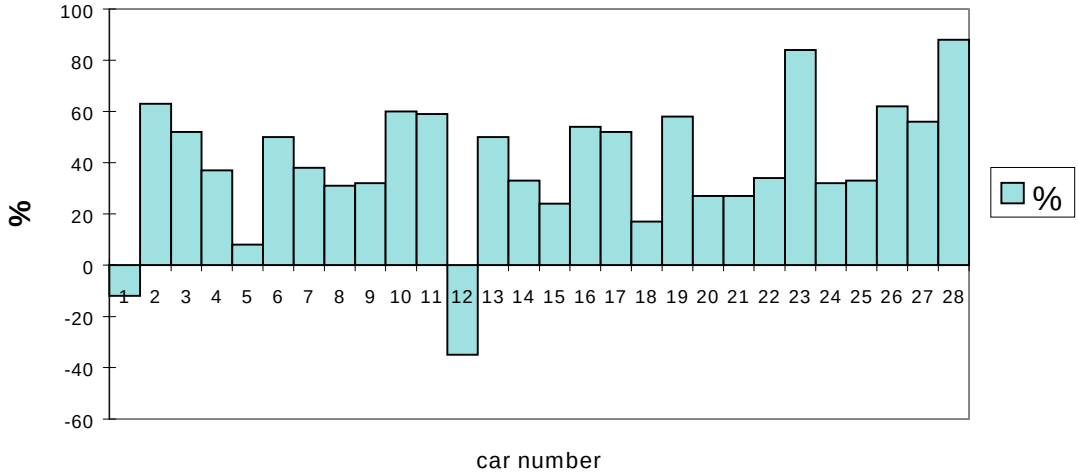
Table 4 shows the prices of some popular cars in the year 1972, the prices of these cars updated to 1994 with the help of the official car price index, and the prices of their "successors" in 1994[10]. According to the official index, cars have become 2.75 times as expensive over the period considered. Generally, the successors are more expensive than their price-updated predecessors, the difference giving some indication about the difference in quality. This is also illustrated in figure 2.

A comparison between the offical car index and an index computed as an unweighted average of ratio's of prices unadjusted for quality changes (for 1994 this index is 384 (1972=100), based on the cars in table 4) shows that roughly 40 percent of the price rise of automobiles can be attributed to quality improvements.

Table 4. Comparison of 1972 models with 1994 successors

nr.	make and model 1972	list price	updated price	make and model 1994	List Price	diff. in %
1	Alfa Romeo Giulia 1300 Super	11490	31600	Alfa 33 1.4 inj kat 5d	27650	-12
12	Audi 60 4d	10480	28820	Audi 80 4d 1.6 inj kat	46989	63
3	BMW 1602	11799	32450	BMW 316 4d	49250	52
4	Citroen2CV 6	5495	15110	Citroen AX 1.1 3d	20720	37
5	Citroen GS Club	9565	26300	Citroen BX 1.4 5d Deauville	28420	8
6	Datsun Cherry 1000 2d	6590	18120	Nissan 1.4 3d L	27095	50
7	Fiat 850 E	5529	15200	Fiat Uno 1.1	20900	38
8	Fiat 127	6333	17420	Fiat Punto 1.1 3d S	22750	31
9	Fiat 124 Sedan	8208	22570	Fiat Tempra 1.4 4d L	29750	32
10	Fort Escort 1100 2d	6680	18370	Fort Escort 1.4 kat 3d CL	29390	60
11	Fort Taunus 1300L 2d	8710	23950	Fort Mondeo 1.6 4d CLX	37990	59
12	Lada 1200	7800	21450	Lada 2105 1500	13975	-35
13	Mazda 1300 standard	6999	19250	Mazda 323 1.6	28895	50
14	Mercedes Benz 200	17898	49220	Mercedes Benz 190 2.0 kat	65450	33
15	Mercedes Benz 200d	18753	51570	Mercedes Benz 190 2.0 diesel	63800	24
16	Opel Kadett 1100 2d	7193	19780	Opel Astra 1.4 inj kat 3d GL	30450	54
17	Opel Ascona 1600N 2d	8573	23580	Opel Vectra 1.6 inj 52 kat	35950	52
18	Peugeot 204	8695	23910	Peugeot 306 1.1 inj kat 5d	28060	17
19	Peugeot 504	12495	34360	Peugeot 605 2.0 4d sl	54185	58
20	Renault 4 Export	6090	16750	Renault Twingo	21340	27
21	Renault 12	8320	22880	Renault 19 5d RL	28985	27
22	Renault 16L	10025	27570	Renault Laguna 5d RN	36995	34
23	Saab 96 V4	10490	28850	Saab 900 2.0 inj 16	52950	84
24	Toyota Corolla 1200 special	7999	22000	Toyota Corolla 1.3 3d friend	28995	32
25	Toyota Carina 1600	9999	27450	Toyota Carina 1.6 inj 85 4d	36430	33
26	VW 1300	6749	18560	VW Golf 1.4 3d CL	29995	62
27	Volvo 142	13990	38470	Volvo 850 2.0	59950	56
28	Volvo 144 de luxe automatic	16885	46430	Volvo 960 3.0 4d automatic	87500	88

Fig. 2. Differences between observed and updated list prices



4.2. Clothing

Seasonal unavailability complicates the compilation of an index for clothing. In principle, one has the choice between one single set of weights for all months (in which case fictitious prices must be imputed for those months where there is no price to observe) and different sets of weights for different months, reflecting the varying availabilities of items. In the latter case, the meaning of month-to-month changes in the index becomes unclear.

Statistics Netherlands applies the Rothwell-formula for seasonal items, like fresh fruit, vegetables etc. The essence of the Rothwell approach is, that different sets of weights for different months are used. For clothing (and footwear) an approach is used which can be characterized as a simplified version of the Rothwell approach. Two baskets are distinguished: a basket of winter clothes and a basket of summer clothes. From April up and until August the whole weight of seasonal clothing is atributed to summer clothes. From October up and until February the whole weight is attributed to winter clothes. In March and September both baskets are used in the index, each having half of the weight.

Another complicating factor is fashion. Quality adjustment procedures like overlap pricing, link-to-show-no-change and imputation may likely result in overadjustment of the quality change, and therefore in downward bias of the index. It can be argued that, where fashion is important, a specific variety is gradually loosing quality, even though it is physically unchanged.

For clothing, loose specifications are used. Tight centrally provided specifications are not feasible, because there is less standardisation than with many other kinds of commodities. Fashion and style can considered as important determinants of how much people are willing to pay for clothes. However, they are difficult to describe objectively. An example of a loose specification is given in Box 1.

A price collector is supposed to select in each outlet a variety fitting the specification. This variety should be representative for the particular shop. When the selected variety is no longer available, the collector has to select a successor which has more

or less the same quality as its predecessor. If there exist certain widely recognized price bands for an item, this can be most easily done by selecting a successor from the same price band as to which the disappeared variety belonged. This procedure is all the more acceptable when the substitute item comes from the same manufacturer.

Box 1. Example of a loose specification for clothing

Men's summer coat

- two pockets;
- model 'blouson';
- cotton, 100% or with max. 35% polyester;
- smooth lining;
- common size.

In order to keep the specifications up-to-date, business-specialists are consulted twice a year (before summer season, resp. winter season starts). However, this doesn't rule out the possibility that specifications will have to be adapted during summer and/or winter season, for instance when it regularly happens that price collectors are unable to find varieties fitting the specification.
As has been said before, quality differences between varieties fitting the specification are ignored (in as far as they are sold in the same shop type). When a new specification is made, it has to be decided whether varieties fitting the old specification and varieties fitting the new specification can be judged comparable or not. In the first case, prices can be directly compared. In the second case, quality adjustment is carried out with the help of the usual procedures, which maybe result in some downward bias. Maybe it should be recommended to omit quality adjustment for clothing altogether: it is obvious that the quality of cars, audiovisual equipment, computers etc. has improved substantially during the last decennia, but what about clothes? If short skirts were last year's fashion, and long skirts this year's, or vice versa, why not treat the price difference as a real price difference?

4.3. Washing machines

Table 5 shows the official CPI index for washing machines, compared with indexes which are unadjusted for quality change. The CPI washing machine index is presently based on five different makes. Comparison of column (2) and (3) shows the effect of quality adjustment for the models observed in the CPI. It would be wrong to

Table 5. Effects of quality adjustment for washing machines

Make	CPI washing machine indexes	CPI washing machines indexes, unadjusted for quality change *	Same as (3), but with selection of models based on representativity rather than comparability*
(1)	(2)	(3)	(4)
			1995=100
	Jan.'99		
ABC	91,88	88,22	113,95
DEF	80,58	94,28	98,65
GHI	93,36	103,45	104,54
JKL	92,85	92,3	93,65
MNO	95,45	112,37	103,2
Total	90,51	94,17	101,76

* Based on recommended selling prices

conclude from it that the quality of washing machines has not much improved during the last five years. In keeping the effects of quality change from the index, not only quality adjustments as such, but also the selection of substitute items plays a crucial role. The selection of a substitute in the CPI is in the first place aimed towards comparability, and not towards representativity. Column (4) compares the prices of a representative sample of washing machines drawn in 1999 with the prices of the representative sample drawn in 1995. The difference between column (2) and column (4) shows the combined effect of quality adjustment and (comparable) item selection.

4.4. Other goods and services

What can be said about other goods and services?

Generally, the categories “Food and non-alcoholic beverages” and “Alcoholic beverages and tobacco” do not pose any particular problems in the context of quality adjustment, although there are some exceptions. Take, for example, the case of a price increase for some TV dinners of about 30 %. The producer explained that the price increase was accompanied by a quality increase (tastier, more meat). At the same time it was hinted that part of the price change was real. In cases like this, one all too often has to resort to an educated guess.

Footwear is treated in the same way as clothing.

Rental housing doesn’t present us with particular difficulties. In the Netherlands, landlord and tenant have to agree in advance on the rent increase associated with quality improvement or renovation. This amount can therefore be used as a measure of the tenant’s minimum appraisal of the quality change.

Major problems occur for electrical household appliances, hifi-equipment and alike and some services (communication, transport).[11] Usually direct comparison (if it is decided that old and new variety are not really different) and overlap pricing, or, if that is not possible, link-to-show-no-change and other variants of subjective quality adjustments (for example, to take 50% of the price difference of the old and new variety as a measure of the quality difference if some concealed price increase is assumed) are the only possibilities to deal with it. Subjective judgements can usually not be avoided.

Services are generally quite problematic. As mentioned earlier, there is a considerable risk that changes in quality remain undetected, especially in the case of gradual improvement or decline in quality. Take for example gradual improvement in hotel services. This will usually only catch the eye if accompanied by a notable price increase. The same applies for many recreational and cultural services. But our problems are not over as soon as a quality change is detected, as the example in Box 2 quite convincingly demonstrates. A case like this must be the price statistician’s nightmare. It was discussed in a Eurostat Working Party meeting on Harmonization of consumer price indices. The result was a complete tie between the four options presented. Can one therefore conclude, that there is no right or wrong in quality adjustment?

Box 2. The case of cable television network, or:
De Gustibus est disputandum.

Old situation:

The operator of a cable TV system in a middle large town offered a package of 17 channels for Dfl. 13.- per month. The package consisted of 6 Dutch channels, two German channels (ARD and ZDF), BBC 1 and BBC2, CNN and some others.

New situation:

People can choose a standard package of 14 channels (price Dfl. 14.-) and the combination of the standard package plus an extra package (11 channels) for the total price of Dfl. 20.-. BBC2, ZDF, CNN and TRT are not included in the standard package. Instead, a new Dutch channel is added.

Question: what is the true price change assuming that the cable television network operator has a monopoly?

Several options are possible, including:

1. Compare the prices of the old package and the new standard package directly.

Reason: Both packages are more or less of the same quality. The additional Dutch channel is enough compensation for the loss of some foreign channels which the average household doesn't watch anyway.
Conclusion: the true price change is (14/13 - 1) * 100 =7.7%.

2. Compare the prices of the old package and the new standard package and quality adjust using the number of channels as a quality indicator.

Reason: It is no use discussing the quality of different channels. Simply use the number of channels as a proxy of quality. The new standard package comes closest to the old package. Therefore, they should be compared.
Conclusion: the true price change is (17/14 * 14/13 - 1) * 100 = 30.8%.

3. Compare the prices of the old package and the new standard package plus the extra package directly.

Reason: People who want to keep the same channels as in the old situation, are forced to buy the extra package. The additional channels do not offer any additional utility, since they are all broadcasting the same rubbish (old American soaps, talk shows, second rate TV movies and so on). Removing BBC2, ZDF and CNN from the standard package is just a trick to sell more extra packages (which otherwise no one would have bought).
Conclusion: the true price change is (20/13 - 1) * 100 = 53.8%.

4. Compare the prices of the old package and the new standard package plus the extra package and quality adjust using the number of channels as a quality indicator.

Reason: The fact that many additional channels become available means that the consumer has much more choice. This should be reflected in the CPI. Use the number of channels as a quality indicator.
Conclusion: the true price change is (17/25 * 20/13 -1) = 4.6 %.

4.5. Evaluation

What can be concluded about present practices of quality adjustment in the Netherlands? Firstly, the adjustments made do have a significant impact on the CPI. Secondly, judgment is of primary importance. Notwithstanding the fact that the decision whether old and new variety are comparable has to be based on a detailed comparison of the characteristics of both products, we found evidence that the size of the price difference between both products all too often plays a crucial role in the decision making process. Maybe this should not come as a big surprise. Price statisticians start feeling uncomfortable as soon as a quality judgment implies a big price change (there may be exceptions for one or two product categories, e.g. computers). Unless a strong case can be made (and this usually isn't the case), it is

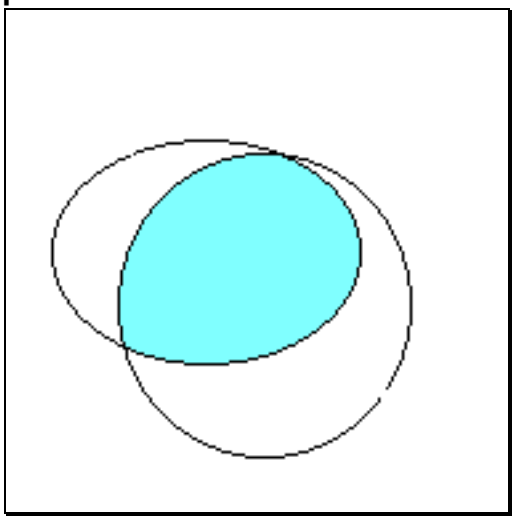
tempting to choose the line of least resistance. But if this is so, what does it mean for price index construction? And how can we improve things?
.

5. Where do we go from here?

> *"Despite more than twenty years working in or around consumer price indices I have yet to come across a 'quality adjustment' that I would regard as exemplary. After the first ten or so of those years I was frequently aproached by index compilers from around the world in the expectation that I would have a response to the request 'Tell me what to do for quality adjustment'. My answer was always a confident 'Nobody knows how to adjust for quality'. Sometimes I would add on seeing the usual expression of disbelief 'Even the Americans!'".*
>
> Sellwood (1997)

Maybe this is not the right moment to complicate things further, but let's give it a try. In the traditional approach (what every statistical office is doing) a sample of varieties is priced through time, and when a variety dissappears, another variety is selected which is supposed to be the successor of the disappeared variety. But this is not what happens in real life, of course. *Individual* consumers may behave that way, but the CPI relates to groups of consumers (or to the unexisting "representative" consumer) and then the idea of a particular variety taking the place of a disappearing variety makes no sense. Figure 3 illustrates this. In different periods of time there exist different universes of varieties which are bought by consumers. There may exist a certain overlap, but this overlap may become smaller if the periods are farther apart. Suppose now, that we could observe the whole universe of varieties sold in different periods, and that we would like to use all information in a price index, how could this be done? This issue is taken up in section 5.1.
Section 5.2 deals with the aspect of complementarity. In the traditional approach, different commodities are usually treated separately. However, if complementarity exists between different commodities, it is the combination of the complementary commodities which is relevant to the consumer. The basic assumption that a commodity with unchanged technical characteristics keeps having the same quality and therefore does not need quality adjustment does not necessarily hold if this commodity is used in combination with other goods.
An issue that has been often overlooked is whether quality adjustment has the same meaning irrespective of the purpose of the index. This will be picked up in section 5.3.

Figure 3. The universe of varieties for a particular commodity in different periods of time.[12]



5.1. The double universe approach

Let us return to figure 3. In the traditional approach we restrict ourselves to (a sample from) the varieties available in the base period. As long as these varieties belong to the shaded area, there is no problem, and for the varieties no longer available we choose successors and adjust for quality differences.

Suppose now, that we have complete information on all varieties sold in base and comparison period. It could be argued, that, ideally, all information should be used, treating base and comparison period symmetrically. Can we construct an index using all the information, regardless whether certain varieties did exist in both periods or not? In a recent Eurostat paper (see: Eurostat, 1998) this issue is taken up. In the so-called double universe approach an index is formulated as a unit-value index (the average of all varieties[13] sold in the comparison period divided by the average price of all base period varieties), divided by a quality adjustment factor *g*.

It is argued that the double universe formulation is the most attractive choice from a theoretical point of view, "since it has a clear interpretation in terms of the average price change of the whole micro-universes which are in the scope for the price index". However, the paper does not make clear how one could estimate the quality adjustment factor *g*. It is generally known, that a unit-value index as such is not a price index. A unit-value index changes as a result of changing prices, but also as a result of changing relative quantities and quality changes. The factor *g* serves as some *deus ex machina* which transforms something which isn't a price index into something which is. As long as we don't have a clue how to estimate *g*, this approach won't bring us any further. Let's illustrate this with the help of the example of bananas (see Box 3).

Suppose that in period *0* bananas are a perfectly homogeneous commodity. The universe consists of only one variety A. If we abstract from the notion of different shop types offering different services, and if in period *1* we still have only variety A, the price index can be simply calculated as the average price per kilo in the comparison period divided by the average price per kilo in the base period. This is a unit-value index, but since bananas are perfectly homogeneous, it is also a price index[14].

Suppose now, that in period *2* a new variety B of bananas emerges. These bananas are more expensive, but since they are ecological, some people prefer them to the ordinary ones. Our unit value index is calculated as the average price per kilo of bananas (ordinary and ecological) divided by the average price per kilo of bananas in

the base period (ordinary only). This index is likely to show a price increase, even if the price of ordinary bananas has fallen. Some adjustment factor is needed to correct for the fact that in period *2* some better quality bananas have been introduced, but where to get it from? In period *3* we still have the two varieties, but the relative quantities have changed, compared to period *2*. As a result of that the unit-value index for bananas again shows an increase, while at the same time the prices of the two varieties have fallen. Most of us would expext the price index to fall, so an adjustment factor is needed to accomplish this, but again the question is: where do we get it from?
A simple solution in the latter case would be to treat the two varieties as distinct commodities and construct a price index (Laspeyres, Paasche, Fisher, or unweighted). They all provide more or less acceptable answers, as the example shows. But these and other "traditional" price indices cannot deal with new and disappearing commodities: following Walsh's advice (see the motto of section 3) we must omit them from the comparison. And that brings us back to where we started.

Box 3. Bananas in a double universe world.

	quantity	total value	average price	unit-value index*)	
period 0					
variety A	1000	4000	4.-		
period 1					
variety A	1100	4840	4.40	110	
period 2					
variety A	900	3780	4.20		
variety B	200	1200	6.-		
total	1100	4980	4.53	102.9	
period 3					
variety A	800	3200	4.-		
variety B	350	2030	5.80		
total	1150	5230	4.55	100.4	
different price indices *)					
Laspeyres					95.6
Paasche					95.8
Fisher					95.7
unweighted arithmetic average of ratios					96.0
ratio of unweighted average prices				96.1	

*) indices relating to previous period prices

5.2. Complementary goods

The traditional approach focusses on individual commodities and their value for the consumer. In much of the theoretical literature on the CPI the focus is not primarily on the commodities but on the so-called service characteristics of commodities, which are assumed to be produced by combinations of commodities. These service characteristics appear in the consumer's utility function and not the commodities themselves. The consumers production function specifies the relationship between the commodities (inputs) and the service characteristics (outputs). Let's take light as an example. Lightbulbs as such do not provide utility, or electricity, but it is the combination of the two that does. So why not try and define a price index on light instead of lightbulbs and electricity?[15]
Despite its attractiveness from a theoretical point of view, this approach is not without difficulties. First of all, we do not know which are the relevant service characteristics,

how they should be measured and what is the contribution of the commodities used in producing them. Take, for example, a television set. It can be combined with electricity, a cable network subscription, a video-recorder, a camcorder, to produce something like “light entertainment”, amongst others. But how are we going to measure the amount of light entertainment entering the utility function, and estimate a price for it? And how are we going to compare it through time, realizing that years ago there were only black and white television sets, no videorecorders and camcorders, and before that, no television sets at all? However, maybe this is an extreme example, an example where the traditional approach doesn’t offer a satisfying solution either. Nevertheless, the traditional approach still has the important advantage, that the index is based on observable outcomes of consumer behaviour: the quantities of commodities they buy and the prices they pay.

5.3. Different CPIs for different uses: different quality adjustments for different uses?

Usually, a CPI is supposed to serve, amongst others, as an inflation indicator, a measure of the development of the cost-of-living, a deflator and a compensation index.The question is, whether one single CPI can perform all these tasks well. Another question is, whether quality adjustment always should give the same answers, regardless which purpose is to be served.

Let’s illustrate this with an example. It is generally recognized, that personal computers have continuously become better during the last several years. Let us, for the sake of the argument, assume that, ten years ago, the price of an average pc was Dfl. 3000.-, and that the price of an average (much better) pc nowadays is again Dfl. 3000.-. The average 1998 pc offers more value for money than its 1988 predecessor, so our “pure” price index should show a decrease. Consequently, the increase in average quality should show up somewhere in the volume index. So far, we don’t have any problems. However, suppose now that our price index is used for wage indexation. Ceteris paribus employees receive less money. However, to be able to afford a computer, one still needs Dfl. 3000.-, assuming that it is not possible to buy a pc that is comparable with the 1988 pc for a fraction of its original price and that it also is not possible to buy a fraction of a 1998 pc which is comparable to the 1988 one. Or, to say it in other words: we cannot ignore the fact that a lot of goods and services are indivisible. In quality adjustment more quality is translated into more quantity, and in the context of a compensation index this can only be justified if goods are divisible, or if the quality change is of the quantity augmenting type (razor blades which last longer).

Let’s give another example: medical care. Yesterday’s medical care is no longer available. Nowadays medical care is probably much better, but to be able to afford it, one needs to pay nowadays prices (mostly health insurance premiums). Therefore, in a compensation index it can be justified to include the development of an average health care insurance premium, simply accepting the fact that the consumer is probably better off nowadays than ten or twenty years ago. At the same time it should be recognized that this would most likely not be the recommended approach for an inflation index or a deflator.

The conclusion must be, that different purposes may require different solutions in quality adjustment.

6. Conclusions

> *"...price statistics, abundant as they are, have to be approached with upmost caution."*
>
> Morgenstern (1963)

In this paper, we focussed on the problem of quality adjustment in the construction of the Dutch consumer price index. Quality adjustments are carried out according to the state of the art, which leaves considerable room for the artist's interpretation. Judgment all too often plays a crucial role. At the same time, the adjustments made do have a significant effect on the CPI.

Sceptics reviewing the problems with quality adjustments might observe that the entire process is virtually impossible and that we should not even try any longer, but instead concentrate on something more objective, whatever that might be. In this respect we would like to quote Griliches (1971): "The fact that 'truth' cannot be achieved doesn't mean that one shoudn't strive to do so". And we agree with Moulton (1996), when he states: "Perhaps the most encouraging outcome to date is the renaissance of research on price measurement issues. New data sources, such as supermarket scanner data and microdata from retail and trade associations, are providing detailed information that previously was not available."

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Notes

[1] I am grateful to Hulten (1997) for drawing my attention to Smith's observation.
[2] See, for example: Triplett (1983) and Turvey et al. (1989).
[3] In fact, there is not just one CPI in the Netherlands, there are several. There are three 'central' CPIs for different groups of households (all households, households of employees with low, resp. high income) and three CPIs exclusive of the effect of tax changes, for the three groups mentioned.
[4] For more details, see: Balk and de Haan (1993) and Balk (1993).
[5] A more elaborate description of the sampling methods and practices used (also for other member countries of the European Union) is given in Boon (1997).
[6] Where possible, information from the producer or importer is used. It occasionally happens that a producer is willing to admit, that new and old variety are essentially the same and that the introduction of the new variety has some element of concealed price rise.
[7] Some studies on new cars are: Griliches(1961), Ohta and Griliches (1975), Arguea and Hsiao (1993), and for the USA car market, Cowling ans Cubbin (1972) for the UK, Feenstra for US imports of Japanese cars, Cramer (1966) and Kroonenberg and Cramer (1974) for the Dutch car market and Thompson (1987) for the Irish car market. On used cars, see: Ohta (1987), Laitinen and Weckström-Eno (1995) and Viitanen (1995), on refrigerators, see: Triplett and McDonald (1977), on computers, seeCole et al.(1986), Dalén (1989) and Shiratsuka (1995) , on hifi-equipment, see: Hoven (1979), on televisions: Silver et al. (1997), on wall-to-wall carpetting, see: Hoven (1981), on clothing: Norberg (1993), on housing: Hoven (1984), Palmquist (1984) Ozanne and Malpezzi (1985) and on breakfast cereals: Morgan, Metzen and Johnson (1979) and Stanley and Tschirhart (1991).
[8] This section builds strongly on an earlier paper written by Ron van der Werf and Leendert Hoven which was presented at an Eurostat task force meeting on quality adjustment in the harmonized consumer price index. The meeting took place from 26 through 28 July 1995 at Statistics Finland in Helsinki.
[9] Whether a price rise resulting from an imposed quality change should be treated as a real price rise or not, is far from obvious. The argument that it is a price rise is that it has been forced upon consumers. Consumers have lost the option of not buying them. The counter argument is that consumers are now getting a safer (or a less polluting) car for their money. Turvey et al. (1989, p. 82) state that "the problem can be clarified, if not solved, by looking at it in terms of the uses of the index. Is it for measuring inflation? If so, is a rise in car prices bacause they now have catalytic converters inflationary? Is the index designed for wage indexation? If so, should wages rise when cars become more expensive in order to reduce pollution? Is the index used for deflating the value of car sales? If so, are more complex cars equivalent to an increase in numbers? These questions should be posed by the statistician, but answering them is not just a statistical matter. This is a good reason for having an advisory committee on the consumer price index."
[10] There is of course an element of subjectivity involved in this exercise. Table 4 can be considered as the outcome of an attempt to reconstruct official CPI practises during the last decades. Usually a successor of the same make is chosen, ignoring the fact that there may be a car of another make which technically comes closer to the car that is no longer available. However, it is not only quality in a technical sense that matters to the consumer.
[11] Medical care also poses major problems: see, for example, Hoven (1990) and Van Tuinen et al. (1997). However, insured medical care is not within the scope of the Dutch CPI.
[12] The oval in the upper left corner represents the universe of varieties sold in the base period, the other one represents the universe in some later period. The shaded area is the overlap.
[13] In the Eurostat document the concept 'observation point' is used, a (usually tightly specified) item in a specific outlet.
[14] On the use of unit-value indices, see: Balk (1995). Generally, a unit-value index suffers from two defects: it does not satisfy the proportionality test (a proportional change of all prices does in general not result in the same proportional change of the unit-value index) and it is sensitive to the units of measurement.
[15] Nordhaus (1994) calculated a price index based on the price per lumenhour and compared it to a measure based on the traditional approach. His analysis showed a big difference between the two, his index being the lowest. Van Tuinen et al. (1997) tried to apply this approach for medical care.