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the Dutch Experience

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Verklaring der tekens

.	= gegevens ontbreken
*	= voorlopig cijfer
x	= geheim
-	= nihil
-	= (indien voorkomend tussen twee getallen) tot en met
0 (00)	= het getal is minder dan de helft van de gekozen eenheid
niets (blank)	= een cijfer kan op logische gronden niet voorkomen
1996-1997	= 1996 tot en met 1997
1996/1997	= het gemiddelde over de jaren 1996 tot en met 1997
1996/'97	= oogstjaar boekjaar schooljaar enz. beginnend in 1996 en eindigend in 1997
1986/'87-1996/'97	= boekjaar enz. 1986/'87 tot en met 1996/'97

In geval van afronding kan het voorkomen dat de totalen niet geheel overeenstemmen met de som der opgetelde getallen.
Verbeterde cijfers in staten en tabellen zijn niet als zodanig gekenmerkt.

Explanation of symbols

	= data not available
*	= provisional figure
x	= publication prohibited (confidential figure)
-	= nil
-	= (between two figures) inclusive
0 (00)	= less than half of unit employed
a blank	= category not applicable
1996-1997	= 1996 to 1997 inclusive
1996/1997	= average for the years 1996 up to and including 1997
1996/'97	= crop year financial year school year etc. beginning in 1996 and terminating in 1997
1986/'87-1996/'97	= book year etc. 1986/'87 up to and including 1996/'97

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Abstract

Substantial part of the work on national accounts is the decomposition of value changes of economic variables into volume changes and price changes. Nearly all variables in the national accounts are aggregates or aggregates of aggregates. Various methods are available to solve the problem how to weight together the volume and price changes of individual goods and services into price and volume changes of aggregates. A very important issue is the choice between fixed weights and annually changing weights.

From 1980 onwards Statistics Netherlands uses annually changing weights and chain indices derived by the multiplication of the year-to-year changes. In this paper the history and use of chain indices in the Netherlands is briefly discussed. In the discussions preceding the introduction of chain indices, Netherlands Bureau for Economic Policy Analysis (CPB), the most important user of national accounts data, played an important part making a plea for annually changing weights and chain indices.

Four users of national accounts data, among them CPB, have been asked about their opinion on the choice between fixed weight indices and chain indices. All of them express that chain indices are a good base for the construction of economic models, since changing weights guarantee a near approximation of actual developments and the actual economic structure. However, special attention should be paid to the tuning of the model to the characteristics of the data and to the presentation of model results to the public.

Also a sensitivity analysis is carried out on the choice of index number formulae and weights. Alternative volume estimates are presented for the periods 1986-1993 and 1921-1939 applying Laspeyres and Paasche fixed weight formulae and Laspeyres, Paasche and Fisher chain formulae.

Taking the Fisher chain indices as standard, the most important conclusions are:

- both chain Laspeyres and chain Paasche volume growth rates and indices are good approximations of chain Fisher indices in nearly all cases;
- most substantial deviations from the chain Fisher indices are found when using fixed weight Laspeyres formulae.

Table of Contents

1. Introduction

An important purpose of the compilation of national accounts is measuring changes in economic variables. Changes in the production and use of goods and services are caused by a combination of two factors: a change in price and a change in quantity and quality (in national accounts often denoted as: volume change).
Part of the work on national accounts is the decomposition of value changes into volume changes and price changes. The most important purpose is the estimate of real growth rates (volume indices). The second goal is the estimate of price changes (deflators).
An important characteristic of this work when imbedded in a national accounts framework is that volume indices and deflators of various variables and at different levels of aggregation are interrelated in a systematic way. This is to be achieved by using supply and use tables or input-output tables as an integrating and balancing framework.
Price and volume indices of aggregates are always compiled from price and volume indices of individual goods and services. Direct observation of price and volume changes of aggregates is - by definition - impossible. Nearly all items in the national accounts are aggregates or aggregates of aggregates. Examples of the latter are total household consumption expenditure, total imports and total exports, but also total output and total intermediate consumption of industries. So the question rises how price and volume changes of individual goods can be added to price and volume changes of aggregates. Various methods are available to solve this problem. Different index formulae are available with different weighting schemes. So one has to make a choice. It is beyond the scope of this paper to discuss in depth the theoretical and practical considerations with respect to this choice. For a broader discussion of the theoretical and practical considerations with respect to the choice of index number formulae and weighting schemes the reader is referred to e.g. Allen (1975) and to Al et al. (1986).
Besides aggregates, special attention must be paid to a number of balancing items. Most important of course is GDP. GDP is the difference between two aggregates: total output value and total intermediate consumption of goods and services by all industries. Hence price and volume changes of GDP are the result of the price and volume changes of total output and of total intermediate consumption of all industries together. Since total output and total intermediate consumption are aggregates whose volume and price changes are a result of changes at a detailed level, price and volume changes of GDP are also a result of changes at a detailed level.

2. The choice of index number formulae

Most countries - including the Netherlands - use a combination of a Laspeyres volume index and a Paasche price index. For the formulae we refer to the annex. Characteristic for the Laspeyres volume index is that the volume changes of individual goods are weighted together with the value in a former year (the “base year”). Characteristic for the Paasche price index is that the price changes of individual goods are weighted together with their value in the current year. The deflated values derived with this index formula combination can easily be explained as “values in prices of the base year”.

Alternative solutions for the weighting problem are e.g. the combination of a Paasche volume index and a Laspeyres price index and the combination of a Fisher volume index and a Fisher price index. All those combinations have in common that there is a decomposition in price and volume changes without residuals. The Fisher volume index is the geometric mean of the Laspeyres and Paasche volume indices; the Fisher price index is the geometric mean of the Laspeyres and Paasche price indices.

3. Fixed or changing weighting schemes

Applying the Laspeyres volume index number formula, volume changes are weighted with the values in a "base year". Next question is which year should be chosen as the base year. Generally spoken there is a choice between a fixed base year and a changing base year. The latter method is often called the "method of chain indices".

With the method of fixed weights for a series of years, the weights are derived from a single year in the past. An advantage of this method is that in longer series of values in constant prices deflated parts of aggregates exactly add up to the deflated aggregate. However, a very serious disadvantage is that volume changes of aggregates are calculated with outdated weights. This disadvantage is especially severe when relative prices change rapidly. As a result economic growth is often significantly overestimated.

Applying the chained Laspeyres volume index means that weights change every year and are derived from the previous year. Since those weights are more up-to-date, a better approximation of the "real world" volume changes is obtained than with the method of fixed weights. Time series results can be obtained by multiplying separately estimated year-to-year volume indices: hence the name chain indices. An important advantage of the chain index method is that the above mentioned overestimations of growth rates are avoided. There is also a disadvantage: in time series in constant prices the deflated parts of an aggregate no longer exactly add up to the deflated aggregate. As a result "mathematical discrepancies" will appear that cannot be removed without disturbing the underlying "actual" volume and price movements.

The contrast between fixed weight methods and changing weight methods is to a certain extent not absolute but only exists in relative terms. Even countries that apply fixed weights, periodically change the weights and choose another base year. In chaining the sub-series they also have a non-additivity problem.

Confronted with the choice between fixed weight and changing weight methods, a preference for yearly changing weights is expressed in recent international guidelines. The following quotations are from SNA and ESA.

SNA-1993 says:

(section 16.41) " If the objective is to measure the actual movements of prices and volumes from period to period indices should be compiled only between consecutive time periods. Changes in prices and volumes between periods that are separated in time are then obtained by cumulating the short-term movements: i.e., by linking the indices between consecutive periods together to form "chain indices". Such chain indices have a number of practical as well as theoretical advantages. For example, it is possible to obtain a much better match between products in consecutive time periods than between periods that are far apart, given that products are continually disappearing from markets to be replaced by new products, or new qualities. Chain indices are also being increasingly demanded by economists and others for analytical purposes and are being increasingly used for special purpose indices, such as consumer price indices, in order to have indices whose weighting structures are as up-to-date and relevant as possible".

ESA-1995 says:

(section 10.62) "The preferred measure of year to year changes in volume is a Fisher volume index which is defined as the geometric mean of the Laspeyres and the Paasche indices. Changes in volume over longer periods being obtained by chaining, i.e. by cumulating the year to year volume movements."

(section 10.64) "Chain indices that use Laspeyres volume indices to measure changes in volume and Paasche price indices to measure year to year price movements provide acceptable alternatives to Fisher indices."

But ESA-1995 also says:

(section 10.65) "Although the preferred measure of volume and price is a chain index, it must be recognised that the lack of additive consistency can be a serious disadvantage for many types of analysis." (section 10.66) "It is therefore recommended that disaggregated constant price data, i.e. direct valuation of

current quantities at base-year prices, are compiled in addition to the chain indices for the main aggregates."

4. A short history of deflation practice in the Netherlands

For the afterwar period, Statistics Netherlands has published annual estimates of values in constant prices and volume indices of national accounts variables from 1948 onwards. In addition, for the period 1900 to 1920 annual volume growth rates of national product are available. In 1987, new macro economic data for the period 1921 to 1939 have been published. Recently, new volume changes and deflators for that period have been published as well.
In the afterwar period, two periods can be distinguished with respect to the estimation methods: 1948 to 1980 and 1981 up to present.

1948 to 1980

For this period data have been published for GDP, imports, exports, domestic final demand categories and value added of industry groups. The level of aggregation was high; e.g. the number of industry groups at the beginning was 5 and later on 14. The estimates were carried out in constant prices of fixed base years (successively 1953, 1958, 1963, 1970 and 1975). The deflation was carried out after the estimates in current prices were finished. Generally speaking current values were deflated at a rather more detailed level (and with various index number formulae). However, the balancing of the estimates took place at a very high level of aggregation.

1981 to present

During the 70s a need arose for more coherence between statistics of values, volumes and prices. The co-ordination instrument should be the input-output tables. At the outset the ideas went to a system of fixed weight price indices.
In the discussions the most important user of national accounts data, Netherlands Bureau for Economic Policy Analysis (CPB), has played a very important role. CPB has nearly always constructed models based on values in prices of the previous year. During the time that Statistics Netherlands did not yet provide that kind of data, CPB itself compiled the data. Because of the data requirements for their more complicated and more disaggregated models the CPB was and is strongly in favour of a system of chained (Laspeyres) volume indices and chained (Paasche) price indices. This could be realised in a series of input-output tables in prices of the previous year.
An important motivation of the CPB's opinion can be found in their bad experiences during the oil-crises in the 70s with the use of fixed weight indices and values in constant prices of a fixed base year in their model at that time.
The result of the discussions has been recorded in a common paper of Balk (Statistics Netherlands) and Eijgenraam (CPB) in 1979. They concluded that there was a need for a dynamically defined price index number; in such a theory more-period-indices are defined as a chain of single-period-indices; for single-period-indices from a theoretical point of view so-called superlative indices are preferable (Diewert, 1978); good approximations are the Tornqvist and Fisher indices; for single-period-indices also Laspeyres and Paasche indices are considered to be good approximations.
The result of the discussions during the late 70's has been that from the reporting year 1981 onwards two important methodological (and also organisational) changes have been introduced in the Dutch national accounts. The first is that for various variables in the national accounts time series of volume indices and deflators have been calculated by chaining the year-to-year indices. The basis for this was the compilation of input-output tables (from 1986 onwards replaced by supply and use tables) in constant prices of the previous year. An important organisational change was that from 1981 onwards, the annual input-output tables in current prices and in prices of the previous year, value changes, volume changes and price changes have all been compiled simultaneously (see De Boer and Broesterhuizen, 1986). As a result, yearly Laspeyres volume changes are available, weighted with the values of the previous year, in combination with Paasche deflators.

The advantage of using chain indices and the relatively minor disadvantage of the resulting non-additivity of constant price series has also been elaborated by Al et al. (1986).
At present, the annual National accounts publications of Statistics Netherlands contain the following time series: values in current prices, annual volume growth rates, volume indices, annual price changes, indices of deflators and values in prices of a base year (recently: 1990). The series of volume indices and deflators are chain indices derived from multiplying the annual changes. The values in prices of a constant base year are calculated with the help of chained volume indices. Hence in this case, sub-series are non-additive to aggregates in our publication.

5. Opinion of users of Netherlands' national accounts

The authors have asked a number of institutions in the Netherlands that use national accounts data for model construction about their opinion on the choice between fixed weight indices and chain indices. In addition their experience with the use of chain indices provided by Statistics Netherlands has been enquired.

The CPB is the most important user of national accounts data in the Netherlands. It played an important role in the discussions preceding the introduction of chain indices in the Netherlands (see section 4). The CPB had and still has a strong preference for chaining single-period- indices based on annually changing weights. In their opinion, values in constant prices for a longer period, based on fixed weights, yield meaningless data. They say that their experience with the use of chain indices is outstanding. For them, the non-additivity of values in constant prices is no problem. Discrepancies due to aggregations are not eliminated.

Other users who have been approached are NEI (Netherlands Economic Institute), Groningen University and The Netherlands' Central Bank.

It is the opinion of the model builders at NEI that chain indices are a good base for the construction of economic models. However, it is necessary that model constructors carefully "tune" the specification of their models to the characteristics of the data. They think that the often mentioned problem of the aggregation discrepancies is not a real problem, but a matter that calls for special attention when presenting the data to the public.

Researchers at the economic faculty of Groningen University do not use constant price series at all. Their macro-economic models require figures on volume changes. So the issue of non-additivity is not relevant for them. If only constant price figures were available, these could only be used if they yielded the correct volume indices.

The department for monetary and economic policy of The Netherlands' Central Bank (DNB) says that indices with annually changing weights have the advantage of a strong connection with actual developments. Hence this department has no problems with Statistic Netherlands' practice. The department of economic research of DNB uses annual changes as well as values in current and constant prices in their macro-economic models. If there are problems with mathematical discrepancies in model results, the solution is mostly found by an adjustment of the changes in inventories.

6. Results from changing vs. fixed weighting schemes and different index number formulae

SNA-1993 states:
(section 16.43) “In general, Laspeyres indices, whether volume or price, tend to increase more (or decrease less) than Paasche indices, but if fixed base indices are replaced by chain indices, the index number spread between Laspeyres and Paasche is likely to be greatly reduced. The relationship between a fixed base index and the corresponding chain index is not always the same, however, as it must depend upon the paths followed by individual prices and quantities over time”.
(section 16.44) “If individual prices and quantities tend to increase or decrease monotonically over time it can be shown that the chain Laspeyres will tend to increase less than the fixed weight Laspeyres while the chain Paasche will tend to increase more than the fixed Paasche. In these circumstances, therefore, chaining will reduce the index number spread, possibly almost eliminating it.”
We will illustrate the differences between the results of different methods for the estimation of real annual growth rates on the basis of Dutch data. We present results for two periods. Firstly, we have made alternative estimates for the period 1986-1993, based on detailed data in the supply and use tables in current prices and in constant prices of the previous year for that period. Secondly, we give some results from the sensitivity analysis that den Bakker made for the interwar period (1921-1939) of the influence of the choice of the index number formulae and the choice of the weighting scheme (see den Bakker, 1991).

Period 1986-1993

In the Dutch supply and use tables, 250 industries, 850 commodities and 10 final demand categories are defined. Supply and use tables are available for the period 1986-1993. For the years 1987-1993, the value in current prices, the value in prices of the previous year, the volume index and the deflator are available for every cell of the supply and the use table. For our calculations, the price and volume indices of the cells are considered as individual indices (of course this is an assumption: almost every cell of the supply and use tables is already an aggregate). At higher levels of aggregation indices are calculated with different index number formulae and with fixed and changing weighting schemes.
Table 1 gives the results of the alternative estimates of the growth rates of GDP, final demand categories and imports.

Table 1. Growth rates (t/t-1) according to different index number formulae (1986-1993): macro totals (%)

	Laspeyres (weights 1986)	Laspeyres (chain)	Fisher (chain)	Paasche (chain)	Paasche (weights t,1986)
Gross Domestic Product (market prices)					
1987	1.4	1.4	1.4	1.4	1.4
1988	3.4	2.6	2.6	2.6	2.7
1989	4.8	4.7	4.6	4.4	4.6
1990	4.2	4.1	4.0	3.9	3.5
1991	2.3	2.3	2.2	2.2	2.0
1992	2.0	2.0	2.0	2.0	2.0
1993	1.3	0.8	0.8	0.8	0.7
Consumption expenditure of households					
1987	2.7	2.7	2.7	2.7	2.7
1988	0.7	0.8	0.8	0.8	0.8
1989	3.5	3.5	3.5	3.5	3.5
1990	4.2	4.2	4.2	4.2	4.1
1991	3.3	3.1	3.1	3.1	2.9
1992	2.5	2.5	2.5	2.5	2.4
1993	1.1	1.0	1.0	0.9	0.9
Gross fixed capital formation					
1987	0.9	0.9	0.9	0.9	0.9
1988	4.6	4.5	4.5	4.5	4.5
1989	5.0	4.9	4.9	4.9	4.8
1990	1.7	1.6	1.6	1.5	1.4
1991	0.2	0.2	0.2	0.2	-0.1
1992	0.8	0.6	0.6	0.6	0.4
1993	-2.5	-2.8	-2.8	-2.9	-3.0
Exports					
1987	4.0	4.0	3.9	3.7	3.7
1988	10.3	9.0	9.0	9.0	9.1
1989	6.8	6.6	6.5	6.3	6.2
1990	5.4	5.3	5.3	5.2	5.0
1991	4.9	4.7	4.7	4.6	4.7
1992	3.1	2.9	2.8	2.8	2.9
1993	2.1	1.5	1.4	1.4	1.4
Imports					
1987	4.2	4.2	4.0	3.9	3.9
1988	7.7	7.6	7.5	7.4	7.4
1989	6.6	6.7	6.7	6.6	6.4
1990	4.4	4.2	4.2	4.1	4.0
1991	4.3	4.1	4.1	4.1	3.9
1992	2.2	2.1	2.0	2.0	2.1
1993	-1.5	-2.1	-2.2	-2.3	-2.4

The results in the column “Paasche (weights t, 1986)” are obtained by deflation with fixed base (1986) Laspeyres deflators and henceforth will be called “fixed weight” Paasche volume indices.

At first sight the differences between the results for different formulae seem to be rather small. However, one must take into consideration that they concern large macro totals. In the Netherlands every 0.1 % of GDP equals about 600 million guilders (280 million ECU). Secondly, if the differences every year show the same sign (- or +) in a time series, yearly differences, however small, can cause serious long term deviations. Thirdly, only one year with a larger deviation can cause large deviations in all succeeding years of a time series.

When discussing the results we will consider the chain Fisher volume indices as the “standard” with which we compare other results. The reason is that Fisher indices can be seen as good approximations of superlative indices that can be seen as ideal indices from a theoretical point of view (see also section 4).

The sequence of the columns of the tables in this paper has been chosen such that a certain following order of results could be expected: highest growth rates are expected with the fixed weight Laspeyres formula and lowest with the fixed weight Paasche formula and the results of the chain formulae are expected to be in between.

The results in table 1 show that most substantial divergences are with Laspeyres fixed weight indices. The Laspeyres, Fisher and Paasche chain type indices in most cases yield comparable results and the differences between the Paasche fixed weight and chain indices are generally speaking much smaller than between the Laspeyres fixed weight and chain indices. A remarkable and for the statistical practice very important conclusion which can be drawn is that, as ESA states, the Laspeyres chain indices provide good approximations of the “ideal” Fisher chain indices and that the Laspeyres fixed weight indices do less or not at all. This is especially important for the cases where the differences between Laspeyres and Paasche fixed weight indices and between the Laspeyres fixed weight index and the Laspeyres chain index are substantial. See: GDP (1988 and 1993), Consumption of households (1991), Capital formation (1992 and 1993), Exports (1988, 1989, 1990 and 1993), Imports (1990, 1991 and 1993).

Generally speaking the results in table 1 also bear out the statement of SNA that Laspeyres volume indices yield higher growth rates than Paasche volume indices and that the differences between the Laspeyres and Paasche chain indices are smaller than between the corresponding fixed weight indices.

Table 2 presents the time series of volume indices corresponding with the annual growth rates in table 1. It will not be surprising that the conclusions that can be drawn from the results in table 1 and 2 are quite similar.

Table 2. Time series of volume indices according to different index number formulae (1986=100)

	Laspeyres (weights 1986	Laspeyres (chain)	Fisher (chain)	Paasche (chain)	Paasche (weights t,1986)
Gross Domestic Product (market prices)					
1987	101.4	101.4	101.4	101.4	101.4
1988	104.9	104.1	104.0	104.0	104.1
1989	109.9	108.9	108.8	108.6	108.9
1990	114.5	113.4	113.1	112.8	112.7
1991	117.1	116.0	115.6	115.3	115.0
1992	119.5	118.3	117.9	117.5	117.3
1993	121.0	119.2	118.9	118.5	118.2
Consumption expenditure of households					
1987	102.7	102.7	102.7	102.7	102.7
1988	103.5	103.6	103.6	103.6	103.5
1989	107.1	107.2	107.2	107.1	107.1
1990	111.6	111.7	111.7	111.6	111.5
1991	115.3	115.2	115.1	115.0	114.7
1992	118.2	118.1	118.0	117.9	117.4
1993	119.5	119.3	119.2	119.1	118.5
Gross fixed capital formation					
1987	100.9	100.9	100.9	100.9	100.9
1988	105.5	105.5	105.5	105.5	105.5
1989	110.8	110.7	110.7	110.7	110.6
1990	112.6	112.4	112.4	112.4	112.1
1991	112.8	112.7	112.6	112.6	112.0
1992	113.8	113.4	113.3	113.2	112.4
1993	111.0	110.2	110.1	109.9	109.0
Exports					
1987	104.0	104.0	103.9	103.7	103.7
1988	114.8	113.4	113.2	113.0	113.1
1989	122.6	120.9	120.5	120.1	120.1
1990	129.1	127.4	126.9	126.4	126.1
1991	135.4	133.4	132.8	132.2	132.0
1992	139.5	137.2	136.6	135.9	135.9
1993	142.5	139.3	138.5	137.8	137.7
Imports					
1987	104.2	104.2	104.0	103.9	103.9
1988	112.2	112.1	111.8	111.6	111.6
1989	119.7	119.6	119.3	118.9	118.8
1990	124.9	124.7	124.2	123.8	123.5
1991	130.3	129.8	129.3	128.9	128.3
1992	133.2	132.5	132.0	131.4	131.0
1993	131.2	129.7	129.1	128.5	127.9

Tables 3.a, 3.b and 3.c give the results of alternative calculations of the annual volume growth rates of total output, total intermediate consumption and value added for three industries which play quite a different role in the Dutch economy.

Agriculture and horticulture

This is an industry which includes very different activities. As a result of different volume and price changes of output and input in the underlying sub-industries (livestock raising, arable farming and horticulture) the average production structure of total agriculture can change rapidly. Hence, one can expect rather substantial deviations of volume indices calculated with different index number formulae. Especially for value added, which is, as the balancing item of output and intermediate consumption, influenced by changes in both output and input. Table 3.a shows that, with some exceptions for 1991 and 1993, deviations in output and intermediate consumption are rather modest. Differences in the results are more substantial with value added. For 1987-1991 chain indices give

the best approximations of the “ideal” Fisher indices. However, it is remarkable that for 1992 and 1993 the chain Laspeyres and the chain Paasche indices act relatively badly.

Table 3.a Growth rates (t/t-1) of gross output, intermediate consumption and value added of “Agriculture and horticulture” according to different index number formulae (1986-1993) (%)

	Laspeyres (weights 1986)	Laspeyres (chain)	Fisher (chain)	Paasche (chain)	Paasche (weights t,1986)
Gross output					
1987	-1.4	-1.4	-1.6	-1.8	-1.8
1988	1.9	2.0	1.9	1.8	1.7
1989	3.3	3.4	3.2	3.0	2.9
1990	3.8	3.5	3.4	3.2	3.5
1991	2.2	2.0	1.6	1.3	1.1
1992	2.0	2.4	2.1	1.8	1.8
1993	0.5	0.8	0.4	-0.1	0.6
Intermediate consumption					
1987	0.7	0.7	0.6	0.5	0.5
1988	-0.5	-0.4	-0.5	-0.5	-0.4
1989	-0.0	0.2	0.1	0.1	0.2
1990	-1.3	-1.6	-1.5	-1.5	-1.4
1991	1.2	1.2	1.3	1.3	1.4
1992	0.0	0.1	0.0	-0.1	0.1
1993	-0.5	-0.6	-0.6	-0.7	-0.3
Value added (basic prices)					
1987	-4.2	-4.2	-4.5	-4.7	-4.7
1988	5.3	5.2	5.1	5.0	4.4
1989	7.8	7.5	7.1	6.6	6.4
1990	10.0	9.5	9.2	8.9	9.5
1991	3.2	2.8	2.0	1.2	0.8
1992	4.2	4.9	4.4	4.0	4.6
1993	1.6	2.5	1.5	0.6	3.2

Petro-chemical industry

This industry is rather sensitive to fluctuations on the international markets. Because it absorbs for the greater part semi-manufactured products from oil refineries, it is also relatively sensitive to substantial price fluctuations.

Table 3.b Growth rates (t/t-1) of gross output, intermediate consumption and value added of "Petro-chemical industry" according to different index number formulae (1986-1993) (%)

	Laspeyres (weights 1986)	Laspeyres (chain)	Fisher (chain)	Paasche (chain)	Paasche (weights t,1986)
Gross output					
1987	4.8	4.8	3.9	3.1	3.1
1988	8.9	9.7	9.7	9.7	9.7
1989	1.7	0.6	0.8	0.9	0.2
1990	3.1	3.3	2.9	2.6	3.2
1991	-4.1	-5.3	-5.4	-5.4	-5.3
1992	-2.2	-2.6	-2.6	-2.6	-3.3
1993	-0.8	-1.8	-1.8	-1.9	-2.2
Intermediate consumption					
1987	6.2	6.2	5.9	5.7	5.7
1988	12.5	11.5	11.3	11.2	11.5
1989	-0.9	-1.3	-2.3	-3.4	-4.1
1990	0.9	1.5	1.7	1.8	1.6
1991	-4.6	-4.3	-4.4	-4.5	-4.6
1992	-2.0	-2.9	-3.0	-3.2	-3.5
1993	-3.1	-2.9	-3.0	-3.1	-3.4
Value added (basic prices)					
1987	1.2	1.2	-0.8	-2.7	-2.7
1988	-0.6	5.6	6.3	7.0	8.1
1989	9.6	4.0	7.3	10.8	8.1
1990	9.0	6.7	5.8	4.9	8.0
1991	-2.8	-8.2	-8.3	-8.4	-6.7
1992	-2.8	-1.2	-0.9	-0.1	-2.1
1993	5.1	2.7	2.8	2.9	2.8

The consequence is that the resulting volume growth rates from different index number formulae show larger deviations (see: table 3.b). It should be noted that the fixed weight Paasche indices as well as the chain Laspeyres and the chain Paasche indices sometimes also show larger deviations. However, table 3.b shows that larger deviations again most frequently occur with the fixed weight Laspeyres indices. As could be expected the most substantial deviations are found with value added (a balancing item).

Construction of buildings and dwellings

This industry shows strong fluctuations in volume growth rates. However price movements and changes in production structure are rather gradual. This means that the estimates of volume growth rates are less dependent on the type of index number formula.

Table 3.c Growth rates (t/t-1) of gross output, intermediate consumption and value added of "Construction of buildings and dwellings" according to different index number formulae (1986-1993) (%)

	Laspeyres (weights 1986)	Laspeyres (chain)	Fisher (chain)	Paasche (chain)	Paasche (weights t,1986)
Gross output					
1987	5.1	5.1	5.1	5.1	5.1
1988	12.2	12.2	12.3	12.3	12.3
1989	4.6	4.6	4.6	4.6	4.6
1990	0.5	0.5	0.5	0.5	0.5
1991	0.5	0.5	0.5	0.5	0.6
1992	-2.2	-2.2	-2.2	-2.2	-2.2
1993	-4.4	-4.4	-4.4	-4.4	-4.4
Intermediate consumption					
1987	6.7	6.7	6.7	6.7	6.7
1988	13.4	13.4	13.4	13.4	13.4
1989	5.6	5.6	5.6	5.5	5.5
1990	0.6	0.6	0.6	0.6	0.5
1991	1.7	1.7	1.7	1.7	1.8
1992	-1.6	-1.6	-1.6	-1.7	-1.8
1993	-3.0	-3.1	-3.2	-3.2	-3.3
Value added (basic prices)					
1987	1.4	1.4	1.4	1.4	1.4
1988	9.5	9.6	9.6	9.7	9.7
1989	2.1	2.2	2.2	2.3	2.3
1990	0.2	0.1	0.1	0.2	0.2
1991	-2.5	-2.4	-2.3	-2.3	-2.3
1992	-3.7	-3.8	-3.7	-3.6	-2.8
1993	-8.1	-7.4	-7.2	-7.0	-6.6

Table 3.c shows that gross output and intermediate consumption yield only very small (or no) differences between the results of different formulae. The same holds in most cases for value added. However for 1993 both fixed weight indices show substantial deviations from the three chain indices.

Period 1921-1939

The interwar figures provide a very interesting data set for testing the differences between growth rates arising from the use of different index number formulae and weighting schemes. The reason is that the interwar period is characterised by large fluctuations in economic growth rates and price movements. During the years 1921-1939 periods of economic growth and decline alternated.
Table 4.a gives the annual growth rates of GDP during the interwar period estimated with different index number formulae. The results are derived from an earlier study of den Bakker (1991).

Table 4.a Growth rates (t/t-1) of GDP at market prices according to different index number formulae (Interwar period) (%)

	Laspeyres (weights 1921)	Laspeyres (chain)	Fisher (chain)	Paasche (chain)	Paasche (weights t,1921)
1922	.5	6.5	6.1	5.6	5.6
1923	2.7	2.1	2.0	1.9	1.7
1924	8.1	7.2	7.3	7.5	7.8
1925	3.9	3.6	3.3	3.1	3.1
1926	7.5	6.8	6.7	6.6	6.0
1927	5.1	4.6	4.6	4.5	4.2
1928	5.3	4.9	4.8	4.8	4.7
1929	2.3	2.4	2.3	2.3	2.9
1922-29	5.2	4.7	4.6	4.5	4.5
1930	-1.6	-1.2	-1.1	-1.1	-1.7
1931	-5.4	-4.6	-4.5	-4.4	-5.4
1932	-1.2	-0.9	-1.1	-1.3	-2.3
1933	-0.2	0.4	0.4	0.3	0.6
1934	-0.2	-1.1	-1.3	-1.4	-1.5
1930-34	-1.7	-1.5	-1.5	-1.6	-2.1
1935	4.4	2.7	3.0	3.2	2.9
1936	6.4	5.5	5.3	5.2	5.6
1937	7.2	5.7	5.8	5.9	7.0
1938	-4.4	-3.2	-2.9	-2.7	-2.9
1939	9.1	8.1	8.3	8.6	9.8
1935-39	4.5	3.8	3.9	4.0	4.5

The years 1921/29 and 1934/39 are periods of growth. Table 4.a shows that for those years (except 1929) the fixed weight Laspeyres indices give higher volume growth rates than the Paasche indices and also higher growth rates than the chain Laspeyres indices. Furthermore it is quite clear that, just as for 1987-1993, the chain Laspeyres indices give a much better approximation of the “ideal” chain Fisher indices than the fixed weight Laspeyres indices. Besides it is remarkable that for 1924, 1936 and 1937 the fixed weight Paasche index as well as the fixed weight Laspeyres index is higher than all three chain indices.
The years 1929/34 (except 1933) are a period of economic decline. For those years the difference between the fixed weight Laspeyres and Paasche indices is not systematic. However, in most cases fixed weight Laspeyres indices show sharper declines than the chain Laspeyres indices. Again a very important conclusion is that the chain Laspeyres gives a much better approximation of the chain Fisher than the fixed weight Laspeyres indices. Also for this period the differences between the chain Laspeyres, Fisher and Paasche indices are - relatively - small.

Table 4.b Volume indices of GDP at market prices according to different index number formulae (Interwar period), 1921=100

	Laspeyres (weights 1921)	Laspeyres (chain)	Fisher (chain)	Paasche (chain)	Paasche (weights t,1921)
1922	106.5	106.5	106.1	105.6	105.6
1923	109.4	108.7	108.2	107.7	107.4
1924	118.3	116.5	116.2	115.8	115.8
1925	122.9	120.7	120.0	119.3	119.4
1926	132.1	128.9	128.1	127.3	126.6
1927	138.8	134.9	133.9	132.9	131.9
1928	146.1	141.4	140.4	139.3	138.1
1929	149.4	144.8	143.7	142.5	142.1
1930	147.0	143.1	142.1	141.0	139.7
1931	139.0	136.5	135.7	134.8	132.1
1932	137.3	135.3	134.2	133.1	129.1
1933	137.0	135.9	134.6	133.5	129.9
1934	136.7	134.3	133.0	131.6	128.0
1935	142.7	138.0	136.9	135.9	131.7
1936	151.9	145.6	144.2	142.9	139.1
1937	162.9	153.8	152.5	151.3	148.9
1938	155.7	148.9	148.1	147.2	144.6
1939	169.9	161.0	160.4	159.8	158.8

Table 4.b shows the time series of volume indices of GDP for the years 1921 to 1939. Despite of the strong price and volume fluctuations during that period the chain Laspeyres and Paasche indices show much similarity with the “ideal” chain Fisher indices. The highest deviation is 1.4 (see 1936). In contrast, the series of fixed weight Laspeyres indices yields very high deviations from the Fisher indices for many years. Highest deviations are for 1937 (9.1) and for 1939 (9.5). The series of fixed weight Paasche indices shows higher deviations than the chain Paasche indices (highest for 1935: 5.2), but the deviations are less than for the fixed weight Laspeyres.

7. Non-additivity

When using chain indices to construct time series of values in constant prices of a certain base year, the problem arises that the deflated parts of an aggregate do not add up to the deflated aggregate itself. The magnitude of this "mathematical discrepancy" varies with the way the aggregate is split up in different sub groups. In the Dutch National Accounts the mathematical discrepancies in constant price tables are not eliminated, but these tables are left non-additive. In footnotes the non-additivity is explained to the users.
In the publication National Accounts of the Netherlands (see: CBS, 1995) constant price tables are not presented separately, but always in conjunction with other tables and in a fixed sequence: current prices, volume changes, chain volume indices and values at constant prices (by applying these volume indices). Price changes and chain indices of deflators are given as well.
To give an impression of the order of magnitude, table 5 presents mathematical discrepancies for the supply and disposition of goods and services of the years 1986 to 1993 in prices of 1986. It appears that, especially within final expenditure, differences are quite substantial. Further, mathematical discrepancies happen to be positive as well as negative.

Table 5. Supply and disposition of goods and services at prices of 1986

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	1986	1987	1988	1989	1990	1991	1992	1993
1 Domestic product (gross, market prices)	437860	444051	455664	476987	496589	507866	518153	522104
2 Imports (cif)	205440	213989	230257	245783	256104	266656	272161	266465
Mathematical discrepancy	*0*	*-2*	*-169*	*-305*	*-313*	*-448*	*-460*	*38*
3 Disposable for final expenditure (gross)	643300	658038	685752	722466	752380	774074	789854	788607
4 Final consumption expenditure								
general government	67940	69729	70720	71809	72985	74103	75347	76475
households	260230	267349	269603	279005	290786	299795	307364	310453
5 Fixed capital formation (gross)								
enterprises	78160	78718	82202	86784	87573	87471	87109	84451
general government	11190	11435	12018	12075	12893	13204	14183	14023
6 Changes in inventories								
enterprises	3830	-118	-57	-1019	-1252	-939	-577	767
8 Exports (fob)	221950	230924	251652	268387	282708	295997	304507	309155
Mathematical discrepancy	*0*	*3*	*-387*	*5425*	*6687*	*4443*	*1922*	*-6717*
9 Total final expenditure (gross)	643300	658038	685752	722466	752380	774074	789854	788607

Table 6 shows the consequences of an elimination of the mathematical discrepancies for the years 1992 and 1993. The first two columns of table 6 are derived from table 5. The third column gives the corresponding volume growth rates for 1992/93. The next two columns give values in prices of 1986 after the elimination of discrepancies by a proportional distribution over GDP and imports and over final demand categories. The last column gives the new volume growth rates. A comparison of the results before and after elimination shows that elimination turns out to be fatal for the estimation of the volume growth rates of final demand categories. Most striking is final consumption of households: a growth of 1.0% has reversed to a decline of 0.1% after elimination. The conclusion is that elimination of mathematical discrepancies can affect the estimation of growth rates in a very severe way and must be avoided.

Table 6. Consequences of the elimination of mathematical discrepancies

	Mathematical discrepancy not eliminated			**Mathematical discrepancy eliminated**		
	1992	1993	growth rate	1992	1993	growth rate
1. Gross domestic product	518.2	522.1	+0.8	517.9	522.1	0.8
2. Imports	272.2	266.5	-2.1	272.0	266.5	-2.0
Mathematical discrepancy	-0.5	+0.0		-	-	
3. ∑ 1 + 2	789.9	788.6	-0.2	789.9	788.6	-0.2
4a. Final consumption of government	75.3	76.5	+1.5	75.5	75.8	+0.4
4b. Final consumption of households	307.4	310.5	+1.0	308.1	307.8	-0.1
5a. Fixed capital formation of enterprises	87.1	84.5	-3.1	87.3	83.7	-4.1
5b. Fixed capital formation of government	14.2	14.0	-1.1	14.2	13.9	-2.2
6. Changes in stocks	-0.6	+0.8		-0.6	+0.8	
7. Exports	304.5	309.2	+1.5	305.2	306.6	+0.4
Mathematical discrepancy	+1.9	-6.7		-	-	
8.∑ 4a. - 7	789.9	788.6	-0.2	789.9	788.6	-0.2

8. Concluding remarks

In this paper we discussed the use of chain indices in the Netherlands. In Dutch practice chain indices are applied from 1980 onwards. In the discussions preceding to the introduction of chain indices, CPB, the most important user of national accounts data, plays an important role in making a plea for annually changing weights and chain indices. CPB still has a strong preference for chaining one-period growth rates based on annually changing weights. They call their experience with the use of chain indices excellent.
Three other users of national accounts data have been asked about their opinion on the choice between fixed weight indices and chain indices. They all agree that chain indices are a good base for the construction of economic models.
Further:

- it is necessary that model builders carefully tune the specification of their model to the characteristics of the data;
- non-additivity need not be a real problem, if researchers give special attention to the presentation of the data to the public;
- for policy makers it is important that chain indices have a strong correspondence to actual developments.

We have carried out a sensitivity analysis of the choice of index number formulae and weights in the deflation of national accounts data. For the period 1986-1993 alternative estimates are presented for the volume growth rates of GDP, private consumption of households, gross fixed capital formation, imports and exports, and for the output, intermediate consumption and value added of three industries. For the period 1921-1939 alternative estimates are given for the volume growth rates of GDP.
Considering the chain Fisher indices as a standard, most important conclusions that can be drawn from those results are:

- in nearly all cases both chain Laspeyres and chain Paasche volume growth rates and indices prove to be good approximations of chain Fisher indices. This affirms the statement in ESA-1995 (section 10.64) that chain Laspeyres volume indices (in combination with chain Paasche price indices) provide acceptable alternatives to chain Fisher indices;
- the results show that most substantial deviations from the chain Fisher indices are found with the fixed weight Laspeyres formula. This is very important since fixed weight Laspeyres volume indices often are used in constant price estimations of national accounts data;
- fixed weight Paasche indices generally speaking behave better than fixed weight Laspeyres indices, but in some cases they can also lead to severe deviations from the chain indices.

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Annex Index number formulae

1) Fixed weights

Laspeyres volume index

$$\frac{\sum p_0 q_t}{\sum p_0 q_0} = \frac{\sum p_0 q_0 \frac{q_t}{q_0}}{\sum p_0 q_0}$$

Paasche volume index

$$\frac{\sum p_t q_t}{\sum p_t q_0} = \frac{\sum p_t q_t}{\sum p_t q_t \frac{q_0}{q_t}}$$

Fisher volume index

$$\sqrt{Laspeyres * Paasche}$$

2) Annual changing weights

Laspeyres volume index

$$\frac{\sum p_{t-1} q_t}{\sum p_{t-1} q_{t-1}} = \frac{\sum p_{t-1} q_{t-1} \frac{q_t}{q_{t-1}}}{\sum p_{t-1} q_{t-1}}$$

Paasche volume index

$$\frac{\sum p_t q_t}{\sum p_t q_{t-1}} = \frac{\sum p_t q_t}{\sum p_t q_t \frac{q_{t-1}}{q_t}}$$

Fisher volume index

$$\sqrt{Laspeyres * Paasche}$$

Related publications **(translated)**

National accounts (incl. diskette)	P-2	ƒ 75,00
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A large number of the above mentioned publications can be consulted in the libraries of Statistics Netherlands at Voorburg (direct line +31 70 337 5151) or Heerlen (direct line +31 45 570 71 87).

List of occasional papers

The list below will give an impression of the subjects covered in previously published Occasional papers. A complete list of all available Occasional papers can be obtained from the National accounts information desk (telephone 31 70 337 58 76; fax 31 70 337 59 81; e-mail infopni@cbs.nl).

NA/80 **What's in a NAMEA? Recent results of the NAMEA-approach to environmental accounting, Keuning, Steven J. and Mark de Haan** (1996).
The National Accounting Matrix including Environmental Accounts (NAMEA) shows environmental pressures in physical units that are consistent with the monetary figures in the national accounts. This paper introduces the NAMEA-concept, provides some illustrative analyses of the recently completed NAMEA time-series, and demonstrates that social accounts and social indicators can easily be integrated. This results in a fairly broad, multi-purpose statistical information system.

NA/81 **Balance sheet valuation: produced intangible assets and non-produced assets, Pommée, Marcel and Willem Baris** (1996).
This paper deals with the estimation of opening and closing stocks of produced intangible assets such as mineral exploration, computer software and artistic originals and non-produced assets such as land, subsoil assets, patented entities and purchased goodwill. The first section elaborates on the main conceptual issues related to the compilation of stock data such as the asset boundary, the relation between flows and stocks and principles of valuation. The following sections discuss each of the asset categories in detail.

NA/82 **Micro-meso-macro linkage for labour in The Netherlands, Leunis, Wim P. and Jolanda G. Timmerman** (1996).
This paper describes recent developments in the area of labour market statistics and shows the advantages of integrating these data in the system of Labour accounts and in Social Accounting Matrices. The benefits of such integrated information surpasses the sum of the benefits of various source data. A subsequent effort to adjust the micro data and aggregate figures increases the possible uses of statistics even further.

NA/83 **The interaction between national accounts and socio-economic policy, Keuning, Steven J.** (1996).
This paper addresses the interaction between national accounts and socio-economic policy formulation. In the Netherlands, this interaction mainly occurs through the widespread application of formal economic modelling. Lately, however, the domestic use of national accounts figures swells because of their growing relevance to policy-making and because the Netherlands' national accounts incorporate all kinds of social and environmental data.

NA/84 **The future of the national accounts, Bos, Frits** (1996).
This paper investigates the consequences of globalisation, European unification, automation and more market-oriented government for the national accounts as a central international overview-statistic on national economies. The perspective on the future is a mixture of exploiting present and new potentials and coping well with dangers.

NA/85 **Accounting for the use of financial capital as an input in production; with an application to multi-factor productivity change estimation, Keuning, Steven J. and Ted Reininga** (1997).
It is increasingly acknowledged that the financial structure of a firm is an important determinant of its economic activity. Therefore, the use of financial capital should be seen as a separate input in the production process. This paper attempts to operationalize a meso-economic measurement of financial capital inputs in production and shows the consequences for the estimation of multi-factor productivity change. This approach establishes a much closer relationship of macro-economic accounting and analysis to business economics

NA/86 **Volume measurement of government output; the Dutch practice since revision 1987, Kazemier, Brugt** (1997).
In 1992, Statistics Netherlands published the first results of a major revision of national accounts statistics. Part of this revision was the introduction of an alternative method to estimate the volume change of government output. This paper briefly describes this alternative method and the results of the revision with respect to the volume change of government services.