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Chained indices for quarterly national accounts

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

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CHAINED INDICES FOR QUARTERLY NATIONAL ACCOUNTS

Summary: Several methods are available for linking quarterly indices to a chained index that is consistent with the independently estimated annually chained index. Statistics Netherlands presently uses the so called over-the-year method. In a meeting of the Eurostat Working Group on National Accounts in February 2004 this technique was sharply criticized: of all available techniques the over-the-year method is the least suitable for calculating quarter-on-quarter growth rates. The quarter-on-quarter growth rates are considered most important figures for business cycle analysis.

In this discussion paper three linking methods are compared on the basis of their mathematical properties and the differences that arise when applying the methods to the Dutch quarterly national accounts in the period 1996-I to 2004-II. The conclusion is that indeed, the over-the-year method is not suitable for constructing a chained index and should not be used for chain linking quarterly national accounts. We recommend that the one-quarter overlap method, together with the Denton benchmarking method, is used instead of the over-the-year technique.

Keywords: quarterly national accounts, linking methods, economic growth, business cycle

1. Introduction

There are several methods for linking quarterly indices to a chained index that is consistent with the independently estimated annual index. At Statistics Netherlands presently the so called over-the-year method is used. In a meeting of the Eurostat Working Group on National Accounts in February 2004 this technique was sharply criticized: of all available techniques the over-the-year method is the least suitable for calculating quarter-on-quarter growth rates. The quarter-on-quarter growth rates are considered the most important figures for business cycle analysis.

In this discussion paper we list advantages and disadvantages of three methods. These are the over-the-year method, the annual overlap method and the one-quarter overlap method. As consistency with the annually chained index is a major point, benchmarking is also discussed. Both mathematical and practical aspects will be considered.

This paper roughly consists of three parts. We first try to answer the question what the chained indices are supposed to measure. Therefore we briefly examine the quarterly national accounts in Section 2, as these lie at the base of the expenditures of which we want to measure the growth rates. In section 3 we discuss the purpose of a quarterly chained quantity index.

The next part will dilate upon the mathematics behind the linking methods. In section 4 we will go through the formulas and show the properties of the linking methods. These properties are illustrated with examples in section 5.

The third part consists of section 6 and the appendices. In this section we will show that the different techniques lead to different growth rates when applied to real data. The data to which we apply the linking methods are the final expenditure categories taken from the Dutch quarterly national accounts from 1996-I to 2004-II.

Finally, in section 7 we present our conclusions.

2. Quarterly national accounts

The main use of quarterly national accounts is keeping track of recent economic developments. The purpose of the quarterly national accounts is presenting short run business cycle information in a mutually coherent way. In the Netherlands a system of supply and use tables is used, similar to the annual national accounts. In comparison with the latter, the quarterly national accounts are estimated at a less detailed aggregation level.

For each quarter an estimate of the most important macro-economic variables is published twice. Among these variables are the gross domestic product (GDP), final consumption, fixed capital formation and foreign trade. The first publication is called the flash estimate. It is published six weeks after the end of the quarter. The statistical information available at this time often covers only the first two months of the quarter. The second estimate is called the regular estimate. This estimate is published three months after the closing of the quarter. The results are published on a detailed level in Statistics Netherlands publication 'De Nederlandse conjunctuur'. The raw material usually covers all three months, yet the response per industry usually is not complete.

Since the ultimate goal is to estimate the volume growth of macro-economic variables, we use information about the volume growth of the main output per industry. This estimation method avoids many potential problems with changing definitions, incomplete registrations, etcetera. The volume growth is taken with respect to a known base quarter. This base quarter is the corresponding quarter in the preceding year. As soon as the supply and use tables of the annually national accounts of the preceding year are compiled, the quarterly tables of that year are benchmarked to the annual tables.

Several parts of the supply and use tables have to be estimated without any information available. Therefore assumptions have to be made on their relationship to other parts of the supply and use tables, for which we do have sources of information. A central assumption underlying the compilation of the quarterly supply and use tables, is that initially the volume growth of the intermediate consumption per industry group is equal to that of production. A second important assumption is that the volume growth of all unknown commodities produced in an industry group is equal to the volume growth of the commodities that we do have information of. Next, the imports and exports of services are assumed to be proportional to the production of these services. Finally, for taxes and subsidies on products and trade margins, the percentages are taken from the preceding annual national accounts.

3. Measuring economic developments

The nominal growth of economic quantities can be decomposed in price changes and volume growth. Generally a quantity index is used for this. Directly comparing quantities in two periods can be done by valuing both at the same prices and comparing the results by calculating the ratio of the "constant price" values. For comparing more than two periods the statistical agencies within the EU agreed to make use of chained indices. Here the period of which the prices are taken is periodically updated to the most recent period of which price information is available. For the annual accounts Statistics Netherlands uses a chained index, where the prices are taken from the preceding year[1].

A quarterly chained index must give information on short term economic developments, preferably consistent with the more accurate long term trend and level that the annual chained index provides. Here a problem arises: how do we compare the developments in certain quarters to the annual development? Quarters are more difficult to compare than years. Firstly, quarters within a year are different. They do not have an equal number of working days[2] and seasonal effects influence the production and consumption of commodities. Secondly, corresponding quarters of different years will in general be different, e.g., they can have a different number of working days.

The most important macro-economic indicator is the volume growth of the GDP with respect to a certain reference period. At Statistics Netherlands the corresponding quarter of the preceding year is chosen as the reference period. The motivation of this choice is that the volume growth "over the year" is a good indicator of the annual growth rate resulting at the end of the year, without the necessity of a correction of seasonal effects. Correction for seasonality can be done in several ways and the results depend on the method chosen. Not correcting for seasonality allows for a better international comparability.

Another valid choice is to express volume growth of the GDP as the volume change between successive quarters. The most important advantage of this is that this growth rate refers to a more recent period[3]. However, without correction for

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[1] The annual chained index is briefly described in section 4.2.

[2] The same is true for years of course, yet the relative influence of an extra working day is much smaller for yearly values.

[3] In the Dutch case, at publication time the quarter-on-quarter growth rate is centered around a point in time four and a half months ago, whereas the growth with respect to the corresponding quarter of the preceding year refers to a point in time nine months ago.

seasonal effects the quarter-on-quarter growth rate cannot be related to the annual growth rate.

So the choice between the corresponding quarter or the preceding quarter is a choice between international comparability and recentness[4]. In matters of international comparability, both Eurostat and the IMF encourage their member states to create uniformity in the use of statistical methods. The choice of the reference period has recently been a subject of debate in the National Accounts Working Group (NAWG) of Eurostat. Their conclusion is that the quarter-on-quarter growth rate is strongly preferred. For the NAWG recentness outweighs international comparability in this matter. In their own words (Eurostat 2004a): *Priority should be given to the measurement of quarter-on-quarter growth rates. This is at the core of business cycle analysis.*

[4] For a more elaborate discussion, see Buiten and Janssen (2000).

4. Comparing mathematical properties

In this section we will formally introduce three methods for constructing a quarterly chain index. At the same time we will compare the methods on the basis of the mathematical properties of their respective index formulas. The focus will mainly be on the volume growths that result from the three methods. The quarter-on-quarter growth and the growth with respect to the corresponding quarter of the preceding year will be considered separately.

4.1 A word on notation

The prices p_i^y denote the unit value price of a commodity i in year y. We will consider Y years, so $y = 0,..,Y-1$. $x_i^{y,q}$ represents the quantity of consumed or produced commodities i, in quarter $q = 1,..,4$ of year y. The production value of all commodities in quarter q in year y_2, valued at the prices of year y_1 is denoted as

$$v_{y_1}^{y_2,q} = \sum_i p_i^{y_1} x_i^{y_2,q} = p^{y_1} x^{y_2,q},$$

where with omitting the label i we implicitly mean summation. Analogously x^y means $\Sigma_q x^{y,q}$. Whenever this cannot lead to confusion, we will omit labels over which summation takes place. For all chained indices we will discuss below, the weights year, that is the year from which the prices are taken, is $y-1$. The index year, the year for which the index is defined as equal to 100, is denoted with $y = 0$.

4.2 Chain index for the annual national accounts

Compared to the quarterly chained indices, of which the techniques for constructing them are still being discussed, the techniques for constructing annually chained indices are more or less cast in stone. The annually chained index must be a Laspeyres type index, with the weights taken from the most recent year available. Statistics Netherlands uses unit value prices of the preceding year, so the annually chained quantity index can be written as

$$Q_y = \frac{p^{y-1} x^y}{p^{y-1} x^{y-1}} Q_{y-1}. \tag{4.1}$$

In the next sections we will discuss methods for constructing quarterly chained indices, which all are required to relate to equation (4.1).

4.3 The over-the-year method

The over-the-year method constructs a chained index $Q_{y,q}^{\mathrm{OTY}}$ from the following ingredients:

i) the value of the present quarter in unit value prices of the preceding year,

ii) the value of the corresponding quarter in the preceding year in prices of the preceding year and

iii) the quarterly chained index value of the corresponding quarter in the preceding year.

We find the index value by computing the ratio of the values of the present quarter and the corresponding quarter one year earlier and multiplying this ratio with the index value of the corresponding quarter of the preceding year,

$$Q_{y,q}^{\mathrm{OTY}} = \frac{p^{y-1}x^{y,q}}{p^{y-1}x^{y-1,q}} Q_{y-1,q}^{\mathrm{OTY}}. \tag{4.2}$$

The index value of the corresponding quarter one year earlier is calculated in the same way, although then of course the prices and quantities of the year $y - 2$ are used. In this way the linking takes place. The level of the chained indices is related to the average level of the quarterly production values in the year $y = 0$ by demanding that

$$Q_{1,q}^{\mathrm{OTY}} = \frac{p^{0}x^{1,q}}{\frac{1}{4}p^{0}x^{0}}, \tag{4.3}$$

for each quarter q in the first year after the index year 0.

From equation (4.2) it is immediately clear[5] that the arithmetic mean of the index value of the four quarters in a year is not automatically equal to the annually chained index (4.1). Although the differences can be small in practice, the four quarterly index values must be benchmarked to the annually chained index.

Note that equation (4.2) represents not one, but four independent chained indices. There is one chained index for each quarter of the year. According to equation (4.2) each quarter is only ever related to corresponding quarters in earlier years, but never to other quarters. This is a very important point. It means that there is no overlapping period which can serve to relate the four chained indices. The consequence of this is that non-corresponding quarters cannot be compared in any meaningful way. This makes equation (4.2) ill-defined as a *single* quarterly chained index.

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[5] It is not difficult to verify that

$$\sum_{q} \frac{p^{y-1}x^{y-1,q}}{\frac{1}{4}p^{y-1}x^{y-1}} \frac{Q_{y-1}}{Q_{y-1,q}^{\mathrm{OTY}}} Q_{y,q}^{\mathrm{OTY}} = Q_{y}.$$

We can make this explicit by considering the growth rates which can be calculated from the over-the-year index. We can find the change in volume between the present quarter and the corresponding quarter one year earlier, by dividing the index value of quarter q by the index value of quarter $y-1,q$, or

$$\frac{Q^{\mathrm{OTY}}_{y,q}}{Q^{\mathrm{OTY}}_{y-1,q}} = \frac{p^{y-1}x^{y,q}}{p^{y-1}x^{y-1,q}}\,. \tag{4.4}$$

We see that the volume change between corresponding quarters is based on a direct comparison of the two periods and that both periods are valued using the same prices. Equation (4.4) is a perfectly valid Lowe type direct quantity index. This, however, is not the case with the quarter-on-quarter growth rate,

$$\begin{aligned}\frac{Q^{\mathrm{OTY}}_{y,q}}{Q^{\mathrm{OTY}}_{y,q-1}} &= \frac{\dfrac{p^{y-1}x^{y,q}}{p^{y-1}x^{y-1,q}}\,Q^{\mathrm{OTY}}_{y-1,q}}{\dfrac{p^{y-1}x^{y,q-1}}{p^{y-1}x^{y-1,q-1}}\,Q^{\mathrm{OTY}}_{y-1,q-1}} \\ &= \frac{p^{y-1}x^{y,q}}{p^{y-1}x^{y-1,q}}\,\frac{p^{y-1}x^{y-1,q-1}}{p^{y-1}x^{y,q-1}}\,\frac{Q^{\mathrm{OTY}}_{y-1,q}}{Q^{\mathrm{OTY}}_{y-1,q-1}}, \qquad q = 2, 3, 4,\end{aligned} \tag{4.5}$$

while for the first quarter

$$\frac{Q^{\mathrm{OTY}}_{y,1}}{Q^{\mathrm{OTY}}_{y-1,4}} = \frac{p^{y-1}x^{y,1}}{p^{y-1}x^{y-1,1}}\,\frac{p^{y-2}x^{y-2,4}}{p^{y-2}x^{y-1,4}}\,\frac{Q^{\mathrm{OTY}}_{y-1,1}}{Q^{\mathrm{OTY}}_{y-2,4}}\,. \tag{4.6}$$

The quarter-on-quarter growth rates in equations (4.5) and (4.6) are clearly not based on a direct comparison of two periods. Earlier quarters, all the way back to the index year, are involved in the computation of this growth rate. Furthermore, the periods are compared using Lowe type quantity indices with different value weights $p_i^{y-1}x_i^{y,q}/\sum_i p_i^{y-1}x_i^{y,q}$. This is because the commodities i will not be produced and consumed equally over the quarters. The quarter-on-quarter growth rates in eqns. (4.5) and (4.6) explicitly show why we cannot interpret equation (4.2) as a single quarterly chained index. Instead eqn. (4.2) represents four independent chained indices, each based on sets of weights which will in general be representative only for the quarter concerned.

We have shown that the over-the-year method does not construct a well-defined quarterly chained index. We will now show that the over-the-year method also does not lead to something that can be considered as an approximate quarterly chained index, where ‘approximate’ means ‘good enough for practical purposes’.

Equation (4.2) is a recursive equation. Substituting this equation in itself and using equation (4.3) leads to the expression

$$Q_{y,q}^{\mathrm{OTY}} = \frac{p^{y-1}x^{y,q}}{p^{y-1}x^{y-1,q}} \frac{p^{y-2}x^{y-1,q}}{p^{y-2}x^{y-2,q}} \times \cdots \times \frac{p^{0}x^{1,q}}{\frac{1}{4}p^{0}x^{0}} . \tag{4.7}$$

Equation (4.7) shows the over-the-year chained index explicitly as a chain of volume changes between corresponding quarters. When the seasonal pattern in the quantities is sufficiently constant the volume change between corresponding quarters is a reasonable estimator for the ultimate year-on-year volume change, without the need to make corrections for seasonality. Assuming[6] the validity of this statement, we now can replace the volume changes between corresponding quarters by volume changes between successive years and we get an approximation for equation (4.7),

$$Q_{y,q}^{\mathrm{OTY}} \approx \frac{p^{y-1}x^{y}}{p^{y-1}x^{y-1}} \frac{p^{y-2}x^{y-1}}{p^{y-2}x^{y-2}} \times \cdots \times \frac{p^{0}x^{1,q}}{\frac{1}{4}p^{0}x^{0}} . \tag{4.8}$$

Of the chain of indices in right hand side of (4.8) only the last one depends on the label q. So, approximately, the over-the-year chained index is proportional to the level of the quarters in the *first* year after the index year. This means that the pattern of the quarters[7] in the first year will be reflected in the pattern of the index levels for all later years, even when the pattern of the quarters change due to changes in the relative prices. This effect will be illustrated in example 5.1. Equation (4.8) points out a very strange property of something that is supposed to be a chained quantity index: the over-the-year method leads to an index that is determined in part by last years weights and in part by the weights of the first year after the index year. This is not proper behaviour of a chained quantity index, which purpose it is to measure volume changes using only a set of weights that is as recent as possible.

4.4 The annual overlap method

The annual overlap method compares the value of the present quarter to the average level of the quarters of the preceding year. Linking is done by multiplying with the annually chained index value of the preceding year, so

$$Q_{y,q}^{\mathrm{AO}} = \frac{p^{y-1}x^{y,q}}{\frac{1}{4}p^{y-1}x^{y-1}} Q_{y-1} . \tag{4.9}$$

It is immediately apparent that, unlike the over-the-year method, the annual overlap method leads to an index that is proportional to the value of the present quarter in

[6] The approximation is not valid when large relative changes occur in the quantities. The approximation holds when changes only occur in the relative prices.

[7] The quarterly pattern consists of both the trend-cycle and the seasonal pattern. Note that this implies that a seasonality correction, either before or after chain-linking, will not remedy the problems of the over-the-year method.

prices of the preceding year. Also, the arithmetic mean of the four quarters in a year is equal to the annually chained index.

As we have done in the preceding section, we will explicitly look at the growth rates. The volume change between corresponding quarters is

$$\begin{aligned}\frac{Q^{\mathrm{AO}}_{y,q}}{Q^{\mathrm{AO}}_{y-1,q}} &= \frac{p^{y-1}x^{y,q}}{p^{y-2}x^{y-1,q}}\,\frac{\frac{1}{4}p^{y-2}x^{y-2}}{\frac{1}{4}p^{y-1}x^{y-1}}\,\frac{Q_{y-1}}{Q_{y-2}} \\ &= \frac{p^{y-1}x^{y,q}}{\frac{1}{4}p^{y-1}x^{y-1}}\,\frac{\frac{1}{4}p^{y-2}x^{y-1}}{p^{y-2}x^{y-1,q}}.\end{aligned} \tag{4.10}$$

In equation (4.10) the two periods that are compared are valued using different prices. Therefore the volume change between corresponding quarters is not a direct quantity index. We can however interpret (4.10) as a chained index provided that we are willing to view upon the quarterly average as an overlapping period. The quotients in the last line of (4.10) can be interpreted as $Q^{y-2}_{y-1,q\to y-1}\cdot Q^{y-1}_{y-1\to y,q}$, where the period $y-1$ denotes the average of the four quarters of that year.

The quarter-on-quarter growth rate even looks better,

$$\frac{Q^{\mathrm{AO}}_{y,q}}{Q^{\mathrm{AO}}_{y,q-1}} = \frac{p^{y-1}x^{y,q}}{p^{y-1}x^{y,q-1}}, \qquad q = 2, 3, 4\,, \tag{4.11}$$

which is a direct index, yet in the first quarter we get

$$\frac{Q^{\mathrm{AO}}_{y,1}}{Q^{\mathrm{AO}}_{y-1,4}} = \frac{p^{y-1}x^{y,1}}{\frac{1}{4}p^{y-1}x^{y-1}}\,\frac{\frac{1}{4}p^{y-2}x^{y-1}}{p^{y-2}x^{y-1,4}}\,. \tag{4.12}$$

We see that equation (4.12) looks much like equation (4.10). For the same reasons as given there we cannot look upon (4.12) as direct index, yet we can interpret this equation as a chained index if we are willing to view upon a quarterly average as an overlapping period.

As a consequence the index which is constructed by the annual overlap method is not a chain of direct quarter-on-quarter indices, and therefore cannot be regarded as a proper quarterly chained index. In section 4.6, however, we show that the quarterly chained index calculated using the annual overlap method has a practical meaning as the pro rata benchmark of the chained index resulting from one-quarter overlap method.

4.5 The one-quarter overlap method

The one-quarter overlap method compares the quarterly value in prices of the preceding year to one of the quarters from the preceding year. The logical choice is to compare with the last quarter of the preceding year. As we will see this choice

leads to a chained index that is well-defined and well-behaved. The linking step takes place by multiplying with the chained index value of the reference quarter. So

$$Q_{y,q}^{\mathrm{QO}} = \frac{p^{y-1}x^{y,q}}{p^{y-1}x^{y-1,4}} Q_{y-1,4}^{QO} \,. \tag{4.13}$$

As was the case with the annual overlap method, the right hand side of eqn. (4.13) shows proportionality with the value of the present quarter in prices of the preceding year.

The volume change with respect to the corresponding quarter one year earlier,

$$\begin{aligned} \frac{Q_{y,q}^{\mathrm{QO}}}{Q_{y-1,q}^{\mathrm{QO}}} &= \frac{p^{y-1}x^{y,q}}{p^{y-2}x^{y-1,q}} \frac{p^{y-2}x^{y-2,4}}{p^{y-1}x^{y-1,4}} \frac{Q_{y-1,4}^{\mathrm{QO}}}{Q_{y-2,4}^{\mathrm{QO}}} \\ &= \frac{p^{y-1}x^{y,q}}{p^{y-1}x^{y-1,4}} \frac{p^{y-2}x^{y,4}}{p^{y-2}x^{y-1,q}}, \qquad q = 1, 2, 3 \end{aligned} \tag{4.14}$$

is not a direct quantity index in the first three quarters of the year, as the periods that are compared are not valued with same the prices. In the fourth quarter the volume change according to the one-quarter overlap method is, by definition, the same as the volume change according to the over-the-year method and therefore a direct index. For the other quarters, the volume changes in eqn. (4.14) can be interpreted as chained index $Q_{y-1,q\to y-1,4}^{y-2} \cdot Q_{y-1,4\to y,q}^{y-1}$, that is, a direct Lowe type quantity index from quarter $y-1,q$ on $y-1,4$ in prices of the year $y-2$, multiplied by the same type quantity index from quarter $y-1,4$ on y,q in prices of the year $y-1$.

The quarter-on-quarter growth rates also look good,

$$\frac{Q_{y,q}^{\mathrm{QO}}}{Q_{y,q-1}^{\mathrm{QO}}} = \frac{p^{y-1}x^{y,q}}{p^{y-1}x^{y,q-1}}, \qquad q = 2, 3, 4\,, \tag{4.15}$$

while for the first quarter

$$\frac{Q_{y,1}^{\mathrm{QO}}}{Q_{y-1,4}^{\mathrm{QO}}} = \frac{p^{y-1}x^{y,1}}{p^{y-1}x^{y-1,4}} \,. \tag{4.16}$$

This means that, when using the one-quarter overlap technique, the quarter-on-quarter growth rates are direct quantity indices. This is important, since it means that any two quarters can be compared in a useful manner. In other words, the one-quarter overlap method is the only technique discussed here that leads to a proper quarterly chained quantity index.

The major drawback of the one-quarter overlap method is that the arithmetic mean of the quarters can be very different from the annually chained index. From equation (4.13) we can show that the arithmetic mean of the quarters within a year equals

$$\begin{aligned}\frac{1}{4}\sum_q Q^{QO}_{y-1,q} &= \frac{1}{4}\sum_q \frac{p^{y-1}x^{y,q}}{p^{y-1}x^{y-1,4}}\,Q^{QO}_{y-1,4} \\ &= \frac{\frac{1}{4}p^{y-1}x^{y-1}}{p^{y-1}x^{y-1,4}}\,Q^{QO}_{y-1,4}\sum_q \frac{p^{y-1}x^{y,q}}{p^{y-1}x^{y-1}} \\ &= \frac{\frac{1}{4}p^{y-1}x^{y-1}}{p^{y-1}x^{y-1,4}}\,\frac{Q^{QO}_{y-1,4}}{Q_{y-1}}\,Q_y.\end{aligned} \tag{4.17}$$

So the arithmetic mean and the annually chained index are different by a factor that does not depend on the quarters q. In practice these differences are quite noticeable. Since the connection to the annually chained index is a requirement, the quarterly chained index values must be benchmarked to the annually chained index. We will discuss benchmarking in the next section.

4.6 Benchmarking

The goal of benchmarking is to make the quarterly indices consistent with an independently estimated annual index. Consistent here means that the arithmetic mean of the quarterly indices must equal the annually chained index. This is equivalent to demanding that the quarterly constant price values add up to the annual constant price value.

4.6.1 Pro rata

The pro rata benchmarking method tries to achieve that the quarterly values correctly average to the annual value, and nothing more. The method comprises that we multiply every quarter of the year by the same constant factor in order to make the quarterly average equal to the annual value. It is a very simple method, both in application as in explanation to the users of statistical data. This simplicity comes at a price however. Since each year gets its own correction factor, a discontinuity is introduced between the last quarter of one year and the first quarter of the following year. This is usually called the *step problem*. It implies that all of the correction that is necessary to connect the quarters with the annual index is attributed to the quarter-on-quarter growth rate in the first quarter of the year. Because of the step problem, Bloem *et al.* (2001) rate the pro rata distribution ‘unacceptable’.

Application of the pro rata benchmark to the chained index constructed with the one-quarter overlap method results in the annual overlap chained index. This is easy to see. In eqn. (4.17) we found that the quarterly average of the one-quarter chained index differs from the annually chained index by a factor that does not depend on the quarters q. Using the inverse of this factor to benchmark the one-quarter overlap chained index gives

$$\begin{aligned}\widetilde{Q}^{\mathrm{QO}}_{y,q} &= \frac{p^{y-1}x^{y-1,4}}{\frac{1}{4}p^{y-1}x^{y-1}}\frac{Q_{y-1}}{Q^{QO}_{y-1,4}}\frac{p^{y-1}x^{y,q}}{p^{y-1}x^{y-1,4}}Q^{QO}_{y-1,4} \\ &= \frac{p^{y-1}x^{y,q}}{\frac{1}{4}p^{y-1}x^{y-1}}Q_{y-1} \\ &= Q^{\mathrm{AO}}_{y,q}.\end{aligned} \tag{4.18}$$

Now, the fact that in the first quarter of the year we cannot interpret the quarter-on-quarter growth rate (4.12) as a direct index completely coincides with the discontinuity between the years introduced by the pro rata benchmarking method. In this light it is remarkable that Bloem *et al.* (2001) rate the pro rata benchmarking method unacceptable, yet endorse the annual overlap linking method as a valid alternative to the one-quarter overlap method.

4.6.2 The Denton method

A better alternative to the pro rata benchmarking technique is the so called proportional Denton method. The Denton method also adapts the level of the quarterly indices to the annual index, yet accomplishes this with the smallest possible change in

i) the original relative values of the quarterly index;

ii) the original quarter-on-quarter growth rates.

These basic principles assure that the benchmarked results retain as much as possible of the original information on the short term movements. Therefore the Denton method corresponds well to the basic principle that the annual data are the most reliable information source for both the level and the long term movement of economic variables, while the quarterly data are the only available source for the short term movements. This property is the main reason for Bloem *et al.* (2001) to recommend the use of the proportional Denton benchmarking method.

Below we apply the Denton method to a quarterly chained index $Q_{y,q} = Q_t$, where the label $t = 4y + q$ denotes the quarter, numbered sequentially from the year $y = 0$, so $t = 1,..,T = 4(y-1)$. The main role in the Denton method is played by the so called Benchmark-Indicator (BI) ratio $\widetilde{Q}_t / Q_t$ of benchmarked index values and the original index values. The solution we look for is a set of benchmarked quarterly index values $\widetilde{Q}_1,..,\widetilde{Q}_T$, that minimize the sum of squared differences of sequential BI-ratio values,

$$\sum_{t=2}^{T}\left(\frac{\widetilde{Q}_t}{Q_t} - \frac{\widetilde{Q}_{t-1}}{Q_{t-1}}\right)^2, \tag{4.19}$$

under the benchmark restriction

$$\frac{1}{4}\sum_{t=4y+1}^{4y+4}\tilde{Q}_t = Q_y \,. \tag{4.20}$$

The first order conditions for this minimalization problem can be found with the help of a Lagrange function. These first order conditions form a set of T equations. Together with the benchmark restrictions (4.20) we get a set of $T + Y$ equations. The solution to this set of equations can be written as a matrix equation and easily calculated with the help of a computer.

5. Comparing the methods when applied to some examples

In this section we examine three different examples. In each example two commodities, A and B, will be followed for a period of five years. Example 5.1 illustrates the main shortcomings of the over-the-year technique. Example 5.2 elaborates on (strong) seasonality and finally, example 5.3 shows the results in the case where each year replicates the exact same quantities of the preceding year.

Below we present the index values resulting from the three linking methods in tables and figures. In the preceding section we concluded that in the case of the over-the-year technique and the annual overlap technique this is actually not allowed, as these techniques do not lead to proper quarterly chained indices. The examples illustrate what could go wrong when applying these methods. To remind ourselves that we are actually doing something illegal, these chained indices are represented by dotted lines where no meaning can be attributed to the quarter-on-quarter growth rates. Likewise, in the tables these quarter-on-quarter growth rates are italicalized.

The index values are, when necessary, benchmarked to the annually chained index using the proportional Denton method (See section 4.6.2).

5.1 Changes in relative prices

The first example that we will discuss here is based on example 9.4 in the IMF manual of Bloem *et al.* (2001). We slightly adapted the example given there to emphasize the difference between the methods.

The yearly base change will in general change both the average price level and the relative level of the prices within an aggregate. Translating this to the influence of the base change on the quarterly values, we see that the base change can change both the average and the relative levels of the quarters within a year. This example shows this effect in a somewhat extreme way.

At the beginning of the period both commodities, A and B, are comparable in quantity and price, while at the end they are no longer comparable. Over the course of five years the unit value price of commodity B becomes 6 times that of A, while the quantity of A becomes twice that of B. These developments make that commodity B more and more dominates the aggregate towards the end of the period.

The example is constructed in such a way that the quantities of A and B have an opposite trend and opposite seasonal variation. Shifting the weight towards commodity B causes the quarterly pattern to more and more reflect the trend and seasonality of commodity B.

Table 5.1 and figure 5.1 show the results of applying the three linking methods to this situation. As was predicted in section 4.3, it turns out that changes in the

quarterly pattern due to relative price changes are completely ignored by the over-the-year method. The result of that is that the over-the-year index sharply jumps down every first quarter. This resembles the step-problem, yet the jump down is *not* the essence of the problem. In another example the jump could be upward as well. As was pointed out in section 4.3, the essence of the problem is that with the over-the-year technique there is no meaningful relation at all between the index value of adjacent quarters.

In section 4.3 we concluded that the over-the-year technique will honour the change in the average quarterly level[8], but not the changes in the relative levels of quarters within a year. Indeed this example shows that the quarterly pattern of the first year after the index year is replicated in later years. The other two methods lead to indices that are proportional to the value of the current quarter. The quarterly pattern therefore always reflects the quarterly pattern of the current year, in prices of the preceding year.

Some might argue that a seasonal correction of the data *prior* to chain linking will remedy the behaviour of the over-the-year method. This is not true. The quarterly pattern consists of both the trend-cycle and the seasonal pattern. Removing the latter will only reduce the effects of changing seasonal patterns (if these are due to relative price changes). They will not reduce the effects due to a changing trend-cycle. In fact, example 9.4 in the IMF manual of Bloem *et al.* (2001), on which this example is based, shows comparable results without any discernable seasonality in the quantities.

Further note that, despite the extreme developments in this example, the differences between the annual overlap and the (benchmarked) one-quarter overlap method are limited. As expected, we find the largest differences between these methods in the first and last quarters of the year.

[8] This is true as long as the quarterly values have approximately the same levels. When the levels differ by a factor of three, as in the next example, the annual average of the over-the-year index values will differ strongly from the annual chained index value.

Table 5.1 Example of a strongly changing aggregate[a].

		Quantity		Prices		At prices of			Chained Indices					
						Previous year		Current	Over the Year[b]		Annual overlap		One-Quarter overlap[c]	
		A	B	A	B	Level	Q/Q-4	Level	Index	qoq	Index	qoq	Index	qoq
0		**251.0**	**236.0**	**7.0**	**6.0**			**3173.0**	**100**		**100**		**100**	
1	I	66.1	58.5			813.4	1.025	889.8	102.53	*2.5*	102.53	*2.5*	102.63	*2.6*
	II	70.4	56.0			828.5	1.044	890.9	104.44	*1.9*	104.44	1.9	104.50	1.8
	III	72.7	55.5			841.6	1.061	899.1	106.09	*1.6*	106.09	1.6	106.07	1.5
	IV	73.0	57.0			852.7	1.075	914.2	107.49	*1.3*	107.49	1.3	107.35	1.2
		282.0	**227.0**	**5.5**	**9.0**	**3336.0**	**1.051**	**3594.0**	**105.14**		**105.14**		**105.14**	
2	I	74.5	56.3			916.4	1.030	945.5	105.61	*-1.8*	107.24	-0.2	107.44	0.1
	II	79.3	53.9			921.4	1.034	937.2	108.02	*2.3*	107.82	0.5	107.88	0.4
	III	81.9	53.4			931.4	1.036	942.0	109.90	*1.7*	108.98	1.1	108.91	1.0
	IV	82.3	54.9			946.2	1.035	960.0	111.25	*1.2*	110.72	1.6	110.53	1.5
		318.0	**218.5**	**4.0**	**11.5**	**3715.5**	**1.034**	**3784.8**	**108.69**		**108.69**		**108.69**	
3	I	84.5	54.2			961.1	1.016	984.9	107.34	*-3.5*	110.40	-0.3	110.55	0.0
	II	89.3	51.8			952.8	1.017	967.0	109.81	*2.3*	109.45	-0.9	109.50	-0.9
	III	91.9	51.3			957.6	1.017	968.3	111.72	*1.7*	110.00	0.5	109.96	0.4
	IV	92.3	52.7			975.5	1.016	988.8	113.05	*1.2*	112.06	1.9	111.92	1.8
		358.0	**210.0**	**3.0**	**13.5**	**3847.0**	**1.016**	**3909.0**	**110.48**		**110.48**		**110.48**	
4	I	95.5	52.2			991.0	1.006	1063.25	108.01	*-4.5*	112.03	0.0	112.07	0.1
	II	100.3	49.8			973.0	1.006	1037.33	110.49	*2.3*	110.00	-1.8	109.99	-1.9
	III	102.9	49.3			974.3	1.006	1036.19	112.41	*1.7*	110.14	0.1	110.11	0.1
	IV	103.3	50.7			994.7	1.006	1059.83	113.74	*1.2*	112.46	2.1	112.45	2.1
		402.0	**202.0**	**2.5**	**15.8**	**3933.0**	**1.006**	**4196.6**	**111.16**		**111.16**		**111.16**	

[a]) *Meaningless quarter-on-quarter growth rates are italicalized.*

[b]) *Benchmarking was not necessary.*

[c]) *Benchmarked using the proportional Denton method.*

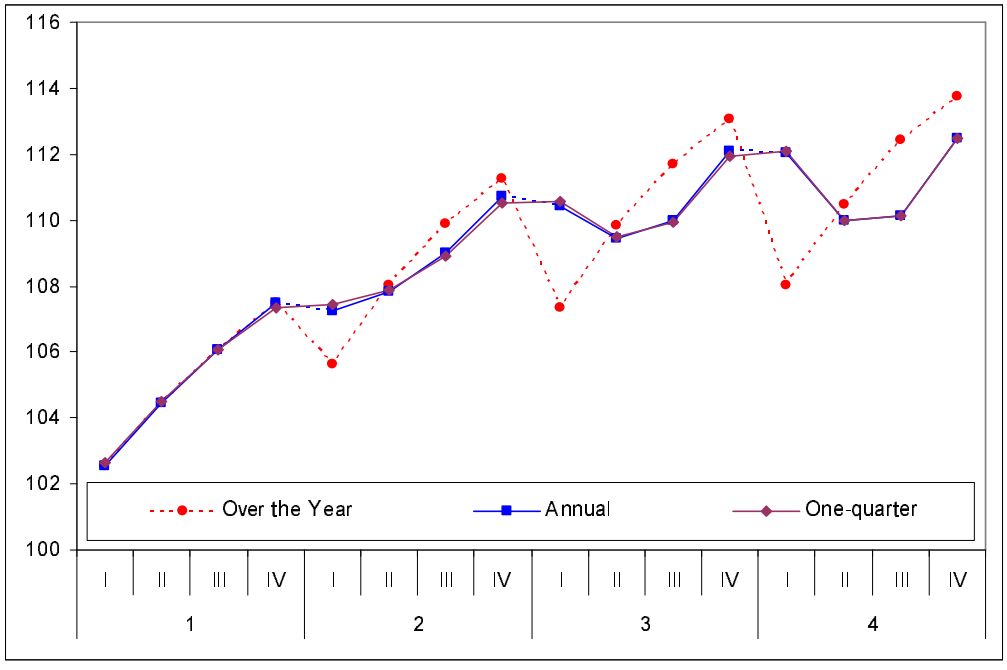

Figure 5.1 Differences between the three methods due to changing relative prices.

5.2 Strong seasonality

Seasonality is common among economic quarterly data. Of many commodities both production and consumption are subject to influences of the season. We speak of strong seasonality when nothing is produced or consumed of a commodity in one or more quarters. The quantity is zero in such quarters and a price actually does not exist (although there will be a yearly unit value price). Strong seasonality is a problem, as most index formulas cannot handle zero quantities very well.

The index formulas of our three chained indices are no exception to this. Note however that the three chained indices are based on annually averaged prices. Therefore we have no problem with the non-existence of certain prices in one or more quarters. The chained indices therefore can deal with strong seasonality, as long as it is part of an aggregate where other components never disappear.

In this example we again look at two commodities, A and B. Commodity A is only produced in the third quarter of the year. In the last two years production moves to the fourth quarter. Commodity B is produced in all quarters and its development is much smoother.

The index constructed with the over-the-year technique is the only one that shows that the peak in the third quarter of year 2 is larger than the year before. In a direct comparison of both quarters this would be the correct conclusion. However, a proper chained quantity index should show the peak to be lower than the year before. This is due to the fact that in the base change the relative price of commodity A was considerably lowered. The over-the-year index does not reflect this price change and thus does not behave like a chained index.

In this example the annual average of the quarterly index values differs considerably from the annually chained index, in the case of both the over-the-year and the one-quarter overlap methods. Therefore both indices are benchmarked using the proportional Denton technique (see section 4.6.2). In application to more realistic values the over-the-year index value usually differs only slightly from the annual index, yet in this example there is a large relative difference in the quarterly levels within the year.

After moving the seasonal peak to the fourth quarter the over-the-year method leads us to believe that a residue of it has remained in the third quarter. This is a manifestation of the same behaviour shown in example 5.1: the over-the-year technique ignores changes in the relative levels of the quarters when these changes are due to price effects.

Again, in the light of the extreme character of this example, the differences between annual overlap and one-quarter overlap methods are limited. We find the largest differences in the first and last quarters of the year.

Table 5.2 The effect of strong seasonality in the aggregate[a].

						At prices of			Chained Indices					
		Quantity		Prices		Previous		Current	Over the Year[b]		Annual overlap		One-Quarter overlap[b]	
		A	B	A	B	Level	Q/Q-4	Level	Index	qoq	Index	qoq	Index	qoq
0		**251.0**	**236.0**	**7.0**	**6.0**	**3173**			**100.00**		**100.00**		**100.00**	
1	I	0.0	57.8			346.9	0.437	520.3	43.87	*-56.1*	43.73	*-56.3*	42.82	*-57.2*
	II	0.0	57.1			342.7	0.432	514.0	43.33	*-1.2*	43.20	-1.2	42.33	-1.1
	III	282.0	56.4			2312.4	2.915	2058.6	291.83	*573.4*	291.51	574.8	289.47	583.9
	IV	0.0	55.7			334.3	0.421	501.4	41.54	*-85.8*	42.14	-85.5	45.96	-84.1
		282.0	**227.0**	**5.5**	**9.0**	**3336**	**1.051**	**3594**	**105.14**		**105.14**		**105.14**	
2	I	0.0	55.6			500.7	0.962	639.8	40.77	*-61.2*	58.60	39.1	50.52	9.9
	II	0.0	55.0			494.7	0.962	632.1	40.15	*-1.5*	57.89	-1.2	54.51	7.9
	III	318.0	54.3			2237.6	1.087	1896.3	309.49	*670.8*	261.85	352.4	267.46	390.7
	IV	0.0	53.6			482.5	0.962	616.6	44.38	*-85.7*	56.47	-78.4	62.30	-76.7
		318.0	**218.5**	**4.0**	**11.5**	**3715**	**1.034**	**3784**	**108.70**		**108.70**		**108.70**	
3	I	0.0	53.5			615.4	0.962	722.4	49.60	*-54.4*	70.69	25.2	66.82	7.3
	II	0.0	52.8			607.6	0.961	713.3	53.42	*7.7*	69.80	-1.3	69.08	3.4
	III	0.0	52.2			599.9	0.316	704.2	143.14	*168.0*	68.91	-1.3	69.82	1.1
	IV	358.0	51.5			2024.1	3.283	1769.1	195.79	*36.8*	232.53	237.4	236.23	238.4
		358.0	**210.0**	**3.0**	**13.5**	**3847**	**1.016**	**3909**	**110.49**		**110.49**		**110.49**	
4	I	0.0	51.5			695.4	0.963	813.9	56.40	*-49.0*	78.62	-66.2	86.73	-63.3
	II	0.0	50.8			686.3	0.962	803.2	54.89	*-2.7*	77.59	-1.3	80.63	-7.0
	III	0.0	50.2			677.2	0.962	792.6	135.92	*147.6*	76.56	-1.3	75.69	-6.1
	IV	402.0	49.5			1874.1	1.059	1786.9	197.44	*45.3*	211.88	176.7	201.61	166.4
		402.0	**202.0**	**2.5**	**15.8**	**3933**	**1.006**	**4197**	**111.16**		**111.16**		**111.16**	

[a]) *Meaningless quarter-on-quarter growth rates are italicalized.*

[b]) *Benchmarked using the proportional Denton method.*

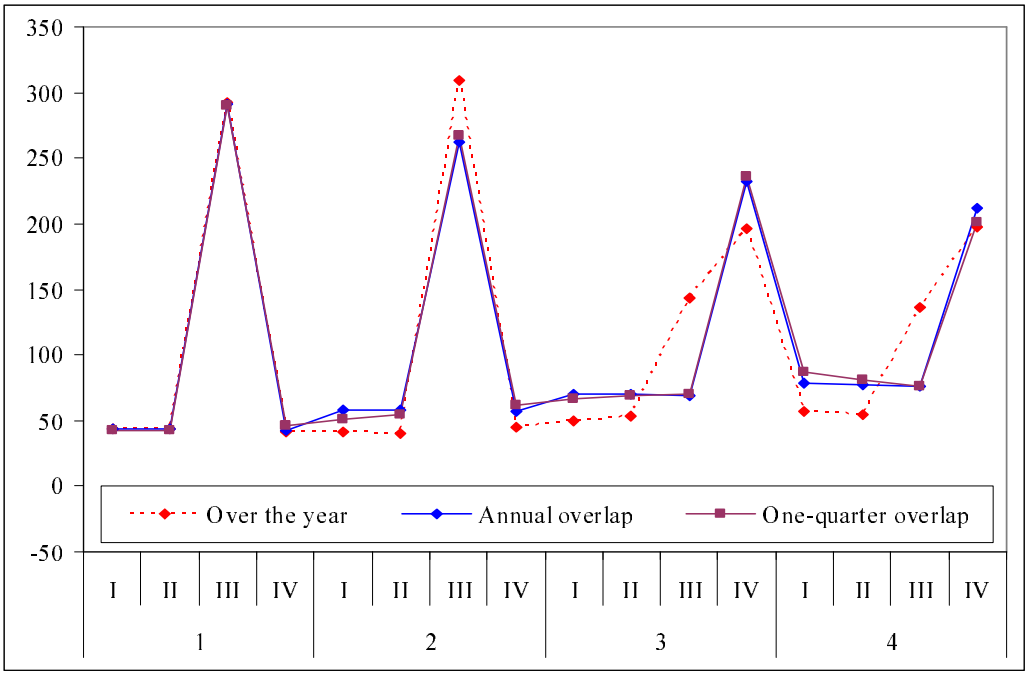

Figure 5.2 Strong seasonality leads to differences.

5.3 Identity

The last example is quite simple: the quantities of commodities A and B are kept equal to the corresponding quarter one year earlier, while the relative prices do change. Table 5.3 and figure 5.3 show the behaviour of the three methods in this situation.

The over-the-year method is the only method that results in a zero volume growth between corresponding quarters in subsequent years. The annual overlap and one-quarter overlap methods result in non-zero volume growths. The cause of this is the annual change of base prices.

Although apparently resulting in the only correct answer, we must stress that the over-the-year index does not behave like a chained index. In fact, in this case the over-the-year method leads to index values identical to a fixed base Lowe quantity index with base prices taken from the year 0. The changing of the base prices in this example is completely ignored by the over-the-year method.

The differences in the results of the annual-overlap and Denton benchmarked one-quarter overlap are small. We find the largest differences in the first and last quarters of the year.

Table 5.3 Example where the quantities do not change over the year[a].

		Quantity		Prices		At constant prices of			Chained Indices					
						Previous year		Current	Over the Year		Annual overlap		One-Quarter overlap[b]	
		A	B	A	B	Level	Q-4=1	Level	Index	qoq	Index	qoq	Index	qoq
0		**282.0**	**50.0**	**7.0**	**6.0**	**2274.0**			**100.00**		**100.00**		**100.00**	
1	I	71.5	13.5			581.5	1.023	514.8	102.29	2.3	102.29	*2.3*	102.37	*2.4*
	II	73.5	15.5			607.5	1.069	543.8	106.86	4.5	106.86	4.5	106.93	4.5
	III	67.5	9.5			529.5	0.931	456.8	93.14	-12.8	93.14	-12.8	93.13	-12.9
	IV	69.5	11.5			555.5	0.977	485.8	97.71	4.9	97.71	4.9	97.57	4.8
		282.0	**50**	**5.5**	**9.0**	**2274.0**	**1.000**	**2001.0**	**100.00**		**100.00**		**100.00**	
2	I	71.5	13.5			514.8	1.000	441.3	102.29	*2.3*	102.90	2.9	103.19	3.2
	II	73.5	15.5			543.8	1.000	472.3	106.86	*4.5*	108.70	5.6	108.79	5.4
	III	67.5	9.5			456.8	1.000	379.3	93.14	*-12.8*	91.30	-16.0	91.21	-16.2
	IV	69.5	11.5			485.8	1.000	410.3	97.71	*4.9*	97.10	6.3	96.82	6.1
		282.0	**50.0**	**4.0**	**11.5**	**2001.0**	**1.000**	**1703.0**	**100.00**		**100.00**		**100.00**	
3	I	71.5	13.5			441.3	1.000	396.8	102.29	*2.3*	103.64	3.6	103.94	3.9
	II	73.5	15.5			472.3	1.000	429.8	106.86	*4.5*	110.92	7.0	111.03	6.8
	III	67.5	9.5			379.3	1.000	330.8	93.14	*-12.8*	89.08	-19.7	88.98	-19.9
	IV	69.5	11.5			410.3	1.000	363.8	97.71	*4.9*	96.36	8.2	96.05	7.9
		282.0	**50.0**	**3.0**	**13.5**	**1703.0**	**1.000**	**1521.0**	**100.00**		**100.00**		**100.00**	
4	I	71.5	13.5			396.8	1.000	392.1	102.29	*2.3*	104.34	4.3	104.53	4.5
	II	73.5	15.5			429.8	1.000	428.7	106.86	*4.5*	113.02	8.3	113.04	8.1
	III	67.5	9.5			330.8	1.000	318.9	93.14	*-12.8*	86.98	-23.0	86.91	-23.1
	IV	69.5	11.5			363.8	1.000	355.5	97.71	*4.9*	95.66	10.0	95.53	9.9
		282.0	**50.0**	**2.5**	**15.8**	**1521.0**	**1.000**	**1495.0**	**100.00**		**100.00**		**100.00**	

[a]) *Meaningless quarter-on-quarter growth rates are italicalized.*

[b]) *Benchmarked using the proportional Denton method.*

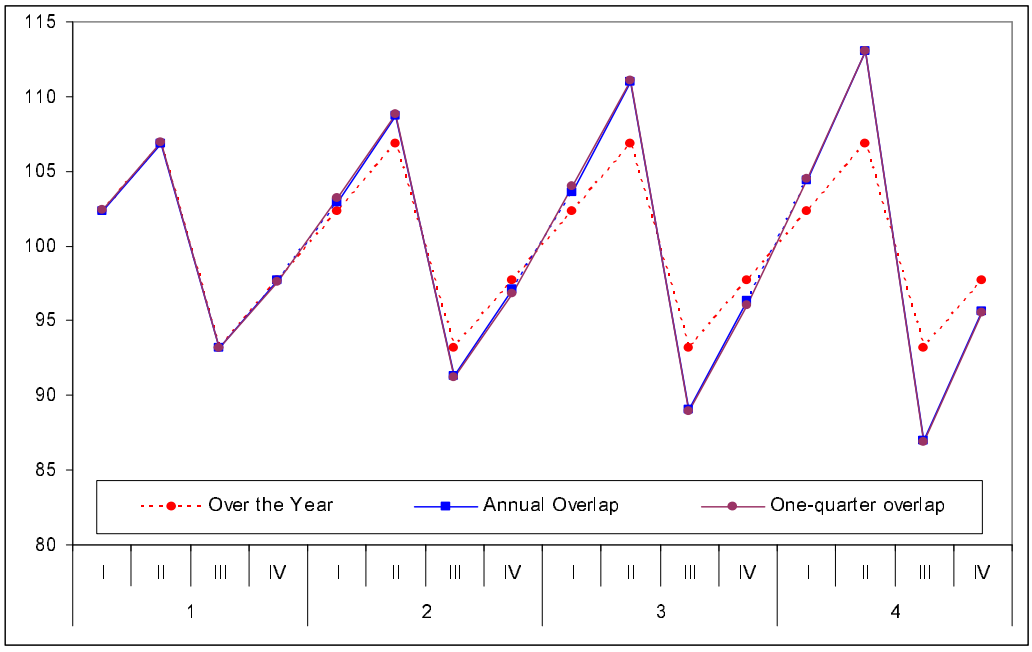

Figure 5.3 Differences also arise when the quantities do not change over the year.

6. Comparing the methods when applied to real expenditures

As was stipulated in section 4.3 the chained index calculated using the over-the-year method cannot be interpreted as a quantity index. In this section we will ignore that conclusion and pretend as if indeed there is anything to compare. Of course, a valid question is how large the differences will be when the over-the-year method would be replaced by one of the other methods.

The results of applying the three methods to real expenditures can be found in the appendices A through I. Table 6.1 below provides an index to the appendices.

Table 6.1 Index to the appendices.

Appendix	Page	Expenditure
A	36	Gross Domestic Product
B	38	Final consumption expenditure by households inc. NPI households
C	40	Final consumption expenditure of the general government
D	42	Gross fixed capital formation by industry
E	44	Gross fixed capital formation by general government
F	46	National expenditures
G	48	Imports of goods and services
H	50	Exports of goods and services
I	52	Total final expenditure

Below we first compare the over-the-year method and the one-quarter overlap method in section 6.1. Next, in section 6.2, we compare the annual overlap method and the one-quarter overlap method. The focus will be one the quarter-on-quarter volume growth and the volume growth with respect to the corresponding quarter of the preceding year (over the year).

6.1 Comparing the over-the-year and one-quarter overlap methods

6.1.1 Quarter-on-quarter growth rates

In table 6.2 we compare the mean of the absolute value of the differences in the quarter-on-quarter volume change. The differences (in percent points) are averaged over all the expenditures mentioned in table 6.1. The differences are further averaged by quarter on the bottom row and averaged by year in the rightmost column.

The averaged differences of all the expenditures mentioned in table 6.1 of course do not mean anything in themselves, yet this crude experiment clearly shows us two things. The first thing to note is that the absolute differences are largest in the first and second quarters of the year. This is because the level of the over-the-year index is most different from the one-quarter overlap index in the first quarter. This in turn is caused by the facts that the over-the-year index and the one-quarter overlap index are equal in the fourth quarter (before benchmarking), that both indices must average to the same annually chained index (after benchmarking) and that all expenditures show an upward trend.

The second thing to note is that the differences tend to become larger the further away from the index year. There is a cumulative effect, as can be expected from the properties of the over-the-year method as shown in section 4.3. The over-the-year method ignores part of the effects of the annual base change and therefore shows more and more differences the further away from the index year.

Table 6.2 Mean absolute difference between the quarter-on-quarter volume changes according to the one-quarter overlap method and the over-the-year method.

Year	Quarter				Annual average
	I	II	III	IV	
	%-point				
1996		0.0	0.0	0.0	0.0
1997	0.1	0.1	0.0	0.1	0.1
1998	0.1	0.3	0.1	0.1	0.2
1999	0.5	0.5	0.2	0.2	0.4
2000	0.6	0.4	0.3	0.2	0.4
2001	0.9	0.9	0.3	0.4	0.6
2002	1.0	0.9	0.3	0.3	0.6
2003	0.8	0.9	0.4	0.4	0.6
2004	0.9				0.9
Mean	0.6	0.5	0.2	0.2	0.4

It is also useful to compare the quarterly average of the differences (not the absolute value of the differences) of the quarter-on-quarter growth according to the one-quarter overlap method and the over-the-year method. A non-vanishing quarterly average may indicate a bias. If differences are due to chance only they ought to average out to zero in the long term.

Indeed, as table 6.3 shows, the average differences are not negligible. The average differences in a specific quarter can be upward or downward, depending on the type of expenditures at hand. The differences are larger for less aggregated expenditures, such as capital formation, imports, exports and consumption.

A simple *t*-test reveals that many of these average differences are significantly different from zero. In table 6.3 the significant differences are shown in boldface.

The over-the-year method leads to a bias in the quarter-on-quarter growth rates when applied to expenditures in the Dutch quarterly national accounts. That means that, given the history of a certain expenditure series, the over-the-year method consistently over- or underestimates the quarter-on-quarter growth rate in certain quarters of the year. This is especially the case in the first quarter of the year.

Table 6.3 Mean difference (bias) of the quarter-on-quarter volume changes according to the one-quarter overlap method and the over-the-year method.

Expenditures	Quarter[a]			
	I	II	III	IV
	%-point			
Gross Domestic Product	**-0.3**	0.2	**0.3**	**-0.2**
Final consumption by households	**-0.5**	**0.4**	0.0	0.1
Final consumption by government	**0.0**	0.0	**-0.1**	**0.1**
Fixed capital formation by industry	0.5	**-0.5**	0.0	-0.2
Fixed capital formation by government	**2.8**	**-2.6**	-0.3	0.0
National expenditures	**0.1**	-0.1	**0.3**	**-0.5**
Imports	**-0.1**	0.0	0.0	0.1
Exports	**-0.7**	**0.3**	-0.1	**0.5**
Total final expenditure	**-0.2**	0.0	**0.2**	**-0.1**

[a]) *Differences in boldface are statistically significant at the 95% confidence level.*

6.1.2 Sign changes

Special attention should be given to the cases where the quarter-on-quarter growth rate according to the one-quarter overlap method and the over-the-year method have the opposite sign: the sign of this growth rate determines whether or not we are in an economic crisis.

In the appendices we counted the number of quarters where applying the other method would lead to the opposite sign. It turns out that this is rare: only in two of the total 330 cases the quarter-on-quarter growth rates have the opposite sign. Note however that these data are not corrected for seasonality. We expect sign changes to occur more often when a seasonal correction is applied after chain-linking and benchmarking. We have not investigated into this aspect any further.

6.1.3 The over-the-year growth rate

The differences in the over-the-year growth rates according to the one-quarter overlap method and the over-the-year method are much smaller. The over-the-year growth rate calculated with the one-quarter overlap method is a chained index, as was pointed out in section 4.5. The over-the-year method of course leads to a direct index between corresponding quarters.

First we repeat the crude experiment of table 6.2. We average the differences in all expenditures mentioned in table 6.1, and present the results broken down by quarter and by year. There is no sign of a cumulative effect on the differences in the over-the-year volume growths. Rather the largest differences seem to be related to incidental effects in the years 1999 and 2001. Again we see that the differences are largest in the first quarter of the year.

Table 6.4 Mean absolute difference of the over-the-year volume changes according to the one-quarter overlap method and the over-the-year method.

Year	Quarter				Annual average
	I	II	III	IV	
	%-point				
1996	-	-	-	-	-
1997	0.1	0.1	0.1	0.1	0.1
1998	0.2	0.0	0.0	0.1	0.1
1999	0.4	0.1	0.2	0.2	0.2
2000	0.2	0.1	0.1	0.2	0.1
2001	0.5	0.2	0.2	0.2	0.3
2002	0.1	0.1	0.1	0.1	0.1
2003	0.1	0.1	0.1	0.1	0.1
2004	0.1	0.1			0.1
Mean	0.2	0.1	0.1	0.1	0.1

In order to get an impression of the size of the differences in the over-the-year growth rates, we first look at the averaged absolute differences. Table 6.5 shows that the differences are negligible for all expenditures but the gross fixed capital formation, both by the industry and by the government.

Table 6.5 Mean absolute differences in the over-the-year volume growth of the one-quarter overlap method and over-the year method broken down by expenditure.

Expenditures	Quarter			
	I	II	III	IV
	%-point			
GDP	0.1	0.1	0.1	0.0
Consumption households	0.1	0.0	0.1	0.1
Consumption government	0.0	0.0	0.0	0.0
Capital formation industry	0.4	0.1	0.2	0.3
Capital formation government	0.8	0.2	0.4	0.3
National expenditures	0.1	0.1	0.1	0.1
Imports	0.1	0.1	0.1	0.1
Exports	0.1	0.1	0.1	0.2
Total final expenditure	0.1	0.1	0.0	0.1

Next we average the differences per quarter over all years in order to find a bias. The results of both linking methods only really differ in the case of the gross fixed capital formation by general government. Although larger than is the case with other expenditures, these average differences are not significant at the 95% confidence level. Only in four cases the (small) differences are significant. They are shown in boldface in table 6.6. Of course, simultaneous *t*-testing of 36 numbers at 95% confidence level could point out between 1 and 6 cases as being significant even when in reality none of these cases is. The conclusion therefore is that there are no large structural differences in the over-the-year growth rates when applying the over-the-year and one-quarter overlap methods to the Dutch quarterly national accounts.

Table 6.6 Mean differences of the over-the-year volume changes according to the one-quarter overlap method and the over-the-year method.

Expenditures	Quarter[a]			
	I	II	III	IV
	%-point			
GDP	-0.1	0.0	0.1	0.0
Final consumption by households	**-0.1**	0.0	0.0	0.0
Final consumption by government	**0.0**	0.0	**0.0**	0.0
Fixed capital formation by industry	0.0	0.0	0.0	0.0
Fixed capital formation by government	0.5	-0.2	-0.2	-0.2
National expenditures	0.0	0.0	0.1	0.0
Imports	0.0	0.0	0.0	0.1
Exports	-0.1	0.0	0.0	0.1
Total final expenditure	0.0	0.0	**0.0**	0.0

[a]) *Differences in boldface are statistically significant at the 95% confidence level.*

6.2 Comparing the annual overlap and one-quarter overlap methods

As was noted in section 4.6, the annual overlap method on the one hand and the one-quarter overlap method extended with the Denton benchmark on the other hand, can be seen as two different benchmarks of the same (one-quarter overlap) method. So we should expect the results of the annual overlap method to show the main disadvantage of the pro rata benchmarking method: the introduction of a step between successive years.

6.2.1 Quarter-on-quarter growth rates

We repeat again the crude experiment of table 6.2. We average the differences in all expenditures mentioned in table 6.1, and present the results broken down by quarter and by year in table 6.7. The first thing to notice is that the averaged differences appear to be very small. There is no sign of a cumulative effect on the differences in

the quarter-on-quarter volume growths. Rather the largest differences seem to be related to incidental effects in the years 1999 and 2001. The differences are largest in the first quarter of the year. This could indicate a (small) step problem.

Table 6.7 Mean absolute difference of the quarter-on-quarter volume changes according to the one-quarter overlap method and the annual overlap method.

Year	Quarter				Year
	I	II	III	IV	
1996		0.0	0.0	0.0	0.0
1997	0.0	0.0	0.0	0.0	0.0
1998	0.0	0.0	0.0	0.1	0.0
1999	0.1	0.1	0.0	0.0	0.1
2000	0.1	0.0	0.0	0.1	0.0
2001	0.1	0.1	0.0	0.0	0.1
2002	0.1	0.0	0.0	0.0	0.0
2003	0.0	0.0	0.0	0.0	0.0
2004	0.0				0.0
Mean	0.1	0.0	0.0	0.0	0.0

Next we compare the quarterly average of the differences of the quarter-on-quarter growth according to the one-quarter overlap method and the annual overlap method. A non-vanishing quarterly average may indicate a bias. If differences are due to chance only they ought to average out to zero in the long term.

Table 6.8 shows that the average differences are negligible. The differences are only visible in the gross capital formation by government and in the exports. These are both less aggregated expenditures. Moreover, none of these averaged differences are significant, as a simple *t*-test points out. With respect to the one-quarter overlap method, the annual overlap method does not lead to a bias in the quarter-on-quarter volume growth.

Table 6.8 Mean difference (bias) of the quarter-on-quarter volume changes according to the one-quarter overlap method and the annual overlap method.

Quarter:	Quarter			
	I	II	III	IV
	%-point			
GDP	0.0	0.0	0.0	0.0
Consumption households	0.0	0.0	0.0	0.0
Consumption government	0.0	0.0	0.0	0.0
Capital formation industry	0.0	0.0	0.0	0.0
Capital formation government	-0.1	0.0	0.0	0.0
National expenditures	0.0	0.0	0.0	0.0
Imports	0.0	0.0	0.0	0.0
Exports	0.1	0.0	0.0	0.0
Total final expenditure	0.0	0.0	0.0	0.0

6.2.2 Sign changes

The quarter-on-quarter growth rates according to the one-quarter overlap method and the annual overlap method never show a different sign when applied to the Dutch quarterly national accounts.

6.2.3 The over-the-year growth rate

The differences in the over-the-year growth rates according to the one-quarter overlap method and the annual overlap method are small as well. With either method the over-the-year growth rate is a chained index, as was pointed out in sections 4.4 and 4.5.

First we repeat the crude experiment of table 6.2. We average the differences in all expenditures mentioned in table 6.1, and present the results broken down by quarter and by year. There is no sign of a cumulative effect on the differences in the over-the-year volume growths. Rather the largest differences seem to be related to incidental effects. The differences are largest in the first and last quarters of the year.

Table 6.9 Mean absolute difference of the over-the-year volume changes according to the one-quarter overlap method and the annual overlap method.

Year	Quarter				Year
	I	II	III	IV	
1996	-	-	-	-	-
1997	0.0	0.0	0.0	0.0	0.0
1998	0.1	0.0	0.0	0.1	0.1
1999	0.0	0.0	0.0	0.1	0.0
2000	0.1	0.0	0.0	0.1	0.1
2001	0.1	0.0	0.0	0.0	0.0
2002	0.1	0.0	0.0	0.1	0.1
2003	0.0	0.0	0.0	0.0	0.0
2004	0.1	0.0			0.0
Mean	0.1	0.0	0.0	0.1	0.0

In order to get an impression of the size of the differences in the over-the-year growth rates, we first look at the averaged absolute differences. Table 6.10 shows that the differences are invisible for all expenditures but the gross fixed capital formation, both by the industry and by the government.

Table 6.10 Mean absolute differences in the over-the-year volume growth of the one-quarter overlap method and annual overlap method broken down by expenditure.

Expenditure	Quarter			
	I	II	III	IV
	%-point			
GDP	0.0	0.0	0.0	0.0
Consumption households	0.0	0.0	0.0	0.0
Consumption government	0.0	0.0	0.0	0.0
Capital formation industry	0.1	0.1	0.1	0.1
Capital formation government	0.1	0.1	0.1	0.1
National expenditures	0.0	0.0	0.0	0.0
Imports	0.0	0.0	0.0	0.0
Exports	0.1	0.0	0.0	0.1
Total final expenditure	0.0	0.0	0.0	0.0

Finally we average the differences per quarter over all years in order to find a bias. The results are in table 6.11. The conclusion therefore is that there are no structural differences at all in the over-the-year growth rates when applying the annual overlap and one-quarter overlap methods to the Dutch quarterly national accounts.

Table 6.11 Mean differences of the over-the-year volume changes according to the one-quarter overlap method and the annual overlap method.

Expenditure	Quarter			
	I	II	III	IV
	%-point			
GDP	0.0	0.0	0.0	0.0
Consumption households	0.0	0.0	0.0	0.0
Consumption government	0.0	0.0	0.0	0.0
Capital formation industry	0.0	0.0	0.0	0.0
Capital formation government	0.0	0.0	0.0	0.0
National expenditures	0.0	0.0	0.0	0.0
Imports	0.0	0.0	0.0	0.0
Exports	0.0	0.0	0.0	0.0
Total final expenditure	0.0	0.0	0.0	0.0

7. Conclusions

In this discussion paper we have compared three linking methods. We have looked at their mathematical properties and at the differences that arise when applying the methods to the Dutch quarterly national accounts in the period 1996-I to 2004-II.

7.1 Over-the-year

The over-the year method leads to a chained index which is ill-defined. With this technique, each quarter is only ever related to corresponding quarters in earlier years. There is no overlapping period which can serve to relate non-corresponding quarters. That means that no useful interpretation can be attributed to the ratio of the index values of two non-corresponding quarters.

When we ignore mathematical sanity, we find that the over-the-year technique also leads to aberrant results. The over-the-year chained index ignores changes in relative prices when moving from base period to the next. When constructing a chained quarterly index it is obviously not a good idea to choose a method that partly ignores the effect of base changing.

Applying the methods to the time series of the Dutch quarterly national accounts also shows that the over-the-year method leads to results that are very much different from the other two methods. These differences are most clearly seen in the quarter-on-quarter growth rates. When applied to the Dutch quarterly national accounts, these differences show a cumulative effect: the further away from the index year, the larger these differences tend to be. The differences are largest in the first and second quarter of the year and tend to be smaller at a higher aggregation level. The growth rates rarely have the opposite sign when applied to data that has not been corrected for seasonality. However, we expect this to occur more often when applied to data that has been corrected for seasonality. The differences per quarter do not vanish when averaged over an eight year period. That means that the over-the-year method leads to a bias. This bias can be upward or downward in any quarter depending on the type of expenditures.

When comparing the over-the-year growth rates according to the one-quarter overlap method and the over-the-year method we are comparing a chained quantity index to direct quantity index. When applied to the Dutch quarterly national accounts the differences in the over-the-year growth rates are negligible in all but two cases: the gross fixed capital formation by industry and by general government. These differences appear to rise from large incidental investments. The differences per quarter vanish when averaged over a long period. That indicates that the chained index of the one-quarter overlap method is not biased with respect to the direct index of the over-the-year method. This is good news for statistical agencies that wish to

replace the direct growth rate with a chained growth rate that can be meaningfully linked into a chained quarterly index.

The conclusion is clear: the over-the-year method is not suitable for constructing a chained index and should not be used for chain linking quarterly national accounts.

7.2 Annual overlap

The annual overlap method leads to a chained index that does not directly relate quarters belonging to different years. Instead quarters in different years are related by a chained index, where the overlapping 'period' is the quarterly average of the preceding year. The annual overlap method can be seen as a pro rata benchmark of the one-quarter overlap method. The pro rata benchmarking method leads to a step between the last quarter of the year and the first quarter of the next year.

When applied to the time series of the Dutch quarterly national accounts, the results differ only slightly from the one-quarter overlap method.

Although the annual overlap method introduces a step between different years, the size of this step is negligible for most expenditures. Therefore the annual overlap method is a valid alternative to the one-quarter overlap method. However, there is no good reason not to use a better method when it is available.

7.3 One-quarter overlap

The only method that leads to a chained index that is truly a chain of direct quarter-on-quarter indices is the one-quarter overlap method. Using this method, a meaningful comparison of the volumes of any two quarters can be made. Therefore this is the preferred method for chain linking quarterly national accounts.

The one-quarter overlap method must be benchmarked in order ensure the correspondence between the annually chained index and the quarterly chained index. Of course, after benchmarking the index is no longer the same true chain of direct quarter-on-quarter indices. However, the basic principles of the proportional Denton method assures that the benchmarked results retain as much as possible of the original information on the short term movements. Therefore the Denton method is better than the pro rata method.

We advice to use the one-quarter overlap method for chain linking quarterly national accounts, and using the Denton method for benchmarking the quarterly index values to the annual chained index.

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Appendices

The results of applying the three methods to real expenditures can be found in the appendices A through I. The table below provides an index to the appendices.

Appendix	Page	Expenditure
A	36	Gross Domestic Product
B	38	Final consumption expenditure by households inc. NPI households
C	40	Final consumption expenditure of the general government
D	42	Gross fixed capital formation by industry
E	44	Gross fixed capital formation by general government
F	46	National expenditures
G	48	Imports of goods and services
H	50	Exports of goods and services
I	52	Total final expenditure

A. Gross Domestic Product

Largest differences in the quarter-on-quarter growth rate: –0.5 percent (2002-IV) and +0.6 percent (2003-III). In 16 out of 33 quarters (48%) the difference is 0.2 or larger.

Table A.1 Three linking methods applied to the Gross Domestic Product.

Period	Yearly	Annual Overlap			Quarterly overlap				Over-the-year		
			q-1	q-4	orig.	benchm.	q-1	q-4		q-1	q-4
		1995=100	*%*		*1995=100*		*%*		*1995=100*	*%*	
1996-I		99.4			99.4	99.4			99.4		
II		104.7	5.3		104.7	104.7	5.3		104.7	5.3	
III		101.7	-2.8		101.7	101.7	-2.8		101.7	-2.8	
IV	103.0	106.3	4.5		106.3	106.3	4.5		106.3	4.5	
1997-I		102.9	-3.1	3.5	102.9	102.9	-3.1	3.5	102.9	-3.2	3.5
II		108.7	5.6	3.8	108.7	108.7	5.6	3.8	108.7	5.6	3.8
III		105.4	-3.1	3.6	105.4	105.4	-3.1	3.6	105.5	-3.0	3.6
IV	107.0	110.9	5.3	4.4	110.9	110.9	5.3	4.4	110.9	5.2	4.4
1998-I		108.8	-2.0	5.6	108.8	108.8	-2.0	5.7	108.6	-2.1	5.5
II		113.3	4.2	4.2	113.3	113.3	4.2	4.2	113.3	4.4	4.3
III		109.3	-3.5	3.7	109.3	109.3	-3.5	3.7	109.4	-3.4	3.8
IV	111.6	115.2	5.4	3.9	115.2	115.2	5.4	3.9	115.2	5.3	3.9
1999-I		112.3	-2.5	3.3	112.4	112.4	-2.5	3.3	112.2	-2.6	3.3
II		117.4	4.5	3.6	117.5	117.4	4.5	3.6	117.3	4.6	3.5
III		113.7	-3.2	4.0	113.8	113.7	-3.2	4.0	113.8	-3.0	4.0
IV	116.1	121.0	6.4	5.0	121.1	121.0	6.4	5.0	121.1	6.4	5.1
2000-I		117.5	-2.9	4.6	117.6	117.5	-2.9	4.6	117.4	-3.0	4.7
II		122.4	4.2	4.2	122.5	122.4	4.2	4.2	122.1	4.0	4.1
III		117.1	-4.3	3.0	117.2	117.1	-4.3	3.0	117.3	-4.0	3.1
IV	120.1	123.6	5.5	2.1	123.7	123.6	5.5	2.1	123.7	5.5	2.1
2001-I		120.1	-2.8	2.2	120.1	120.0	-2.9	2.2	119.6	-3.3	1.8
II		124.5	3.7	1.7	124.6	124.5	3.7	1.7	124.4	4.1	1.9
III		118.2	-5.0	1.0	118.3	118.3	-5.0	1.0	118.7	-4.6	1.3
IV	121.8	124.6	5.3	0.8	124.6	124.6	5.4	0.8	124.6	4.9	0.7
2002-I		120.6	-3.2	0.4	120.6	120.6	-3.2	0.5	120.1	-3.6	0.4
II		125.0	3.6	0.4	124.9	125.0	3.6	0.4	124.9	4.1	0.4
III		119.4	-4.5	1.0	119.4	119.4	-4.5	1.0	120.0	-4.0	1.0
IV	122.5	125.2	4.9	0.5	125.2	125.2	4.8	0.5	125.2	4.3	0.5
2003-I		120.3	-3.9	-0.3	120.4	120.3	-3.9	-0.3	119.8	-4.3	-0.2
II		123.4	2.6	-1.3	123.5	123.4	2.6	-1.3	123.2	2.8	-1.4
III		117.8	-4.6	-1.4	117.9	117.8	-4.6	-1.4	118.3	-4.0	-1.4
IV	121.5	124.4	5.7	-0.6	124.5	124.4	5.6	-0.6	124.5	5.3	-0.5
2004-I		121.7	-2.2	1.2	121.9	121.7	-2.2	1.2	121.2	-2.7	1.2
II		125.1	2.7	1.3	125.2	125.0	2.7	1.3	124.8	3.0	1.3

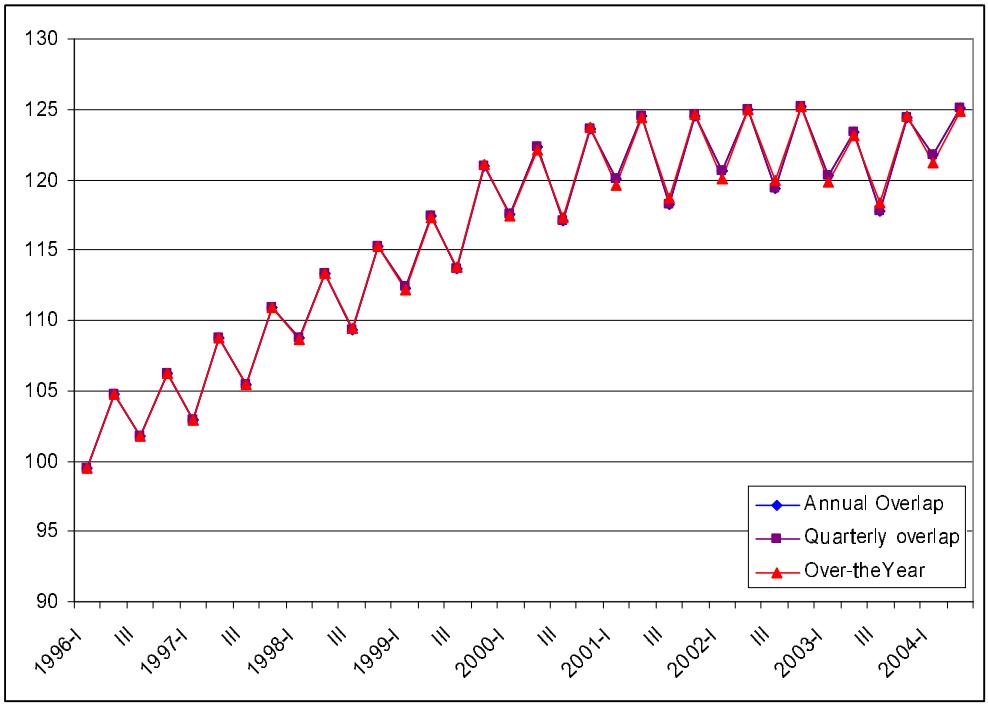


Figure A.1 Three linking methods applied to the Gross Domestic Product.

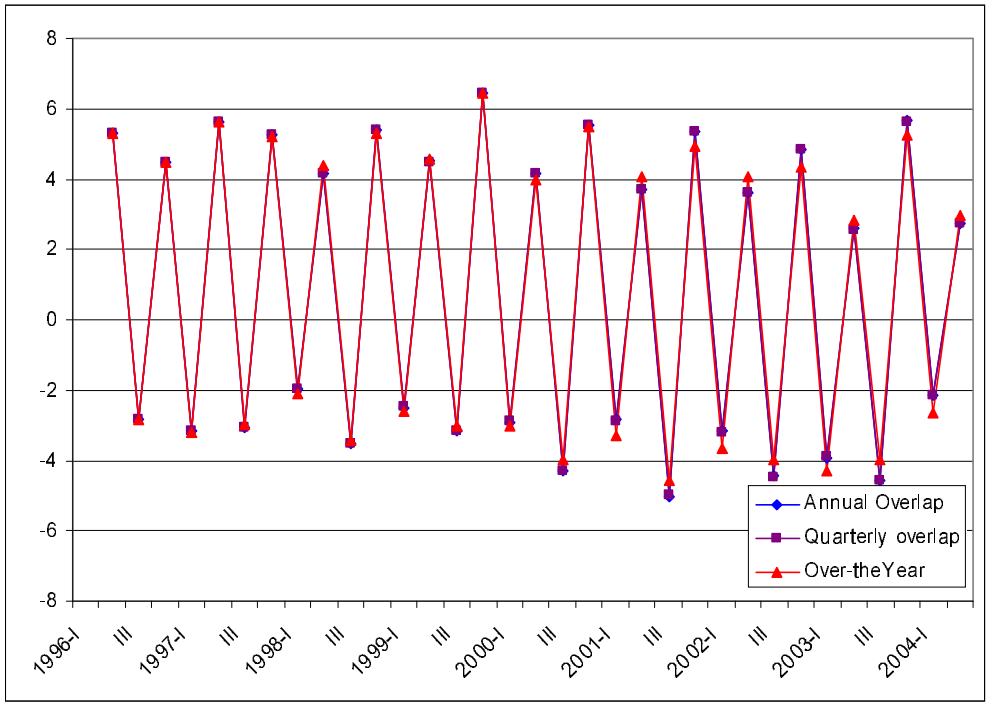


Figure A.2 Quarter-on-quarter growth rates according to three linking methods.

B. Final consumption expenditure by households inc. NPI households

Largest differences in the quarter-on-quarter growth rate: –0.9 percent (2004-I) and +0.8 percent (2004-II). In 16 out of 33 quarters (48%) the difference is 0.2 or larger.

Table B.1 Three linking methods applied to the consumption of households.

Period	Yearly	Annual Overlap			Quarterly overlap				Over-the-year		
			q-1	q-4	orig.	benchm.	q-1	q-4		q-1	q-4
		1995=100	*%*		*1995=100*		*%*		*1995=100*	*%*	
1996-I		101.0			101.0	101.0			101.0		
II		105.1	4.1		105.1	105.1	4.1		105.1	4.1	
III		102.5	-2.4		102.5	102.5	-2.4		102.5	-2.4	
IV	104.0	107.4	4.7		107.4	107.4	4.7		107.4	4.7	
1997-I		103.7	-3.5	2.7	103.7	103.7	-3.5	2.7	103.6	-3.6	2.6
II		108.5	4.6	3.3	108.5	108.5	4.6	3.3	108.6	4.8	3.3
III		105.5	-2.7	2.9	105.5	105.6	-2.7	2.9	105.6	-2.7	3.0
IV	107.1	110.7	4.9	3.1	110.7	110.7	4.9	3.1	110.7	4.8	3.1
1998-I		107.7	-2.8	3.8	107.6	107.7	-2.8	3.8	107.4	-3.0	3.7
II		113.6	5.5	4.7	113.6	113.6	5.5	4.7	113.7	5.9	4.7
III		111.1	-2.2	5.2	111.1	111.1	-2.2	5.2	111.2	-2.2	5.3
IV	112.3	116.9	5.2	5.5	116.9	116.8	5.2	5.5	116.9	5.1	5.5
1999-I		113.5	-2.9	5.4	113.6	113.5	-2.8	5.4	113.2	-3.1	5.4
II		119.4	5.2	5.1	119.5	119.4	5.2	5.1	119.5	5.6	5.1
III		116.0	-2.8	4.4	116.1	116.0	-2.9	4.4	116.1	-2.9	4.4
IV	117.6	121.6	4.8	4.0	121.7	121.5	4.8	4.0	121.7	4.8	4.1
2000-I		119.1	-2.0	4.9	119.4	119.1	-1.9	4.9	118.8	-2.4	5.0
II		123.2	3.5	3.2	123.5	123.2	3.4	3.2	123.2	3.7	3.1
III		119.5	-3.0	3.0	119.7	119.5	-3.1	3.0	119.5	-3.1	2.9
IV	121.8	125.3	4.9	3.1	125.6	125.3	4.9	3.1	125.6	5.1	3.2
2001-I		120.6	-3.8	1.2	120.8	120.6	-3.8	1.2	120.1	-4.3	1.1
II		125.2	3.9	1.6	125.5	125.2	3.9	1.6	125.3	4.3	1.6
III		120.8	-3.5	1.1	121.1	120.8	-3.5	1.2	120.9	-3.5	1.2
IV	123.4	127.1	5.1	1.4	127.4	127.1	5.1	1.4	127.4	5.3	1.4
2002-I		122.9	-3.3	1.9	123.1	122.9	-3.3	1.9	122.2	-4.1	1.7
II		126.6	3.0	1.1	126.9	126.6	3.0	1.1	126.7	3.7	1.1
III		122.0	-3.6	0.9	122.3	122.0	-3.6	0.9	122.2	-3.6	1.0
IV	125.0	128.5	5.4	1.1	128.8	128.5	5.3	1.1	128.8	5.4	1.1
2003-I		123.1	-4.2	0.2	123.5	123.1	-4.2	0.2	122.4	-5.0	0.2
II		125.5	2.0	-0.8	125.9	125.5	2.0	-0.8	125.7	2.7	-0.8
III		120.1	-4.3	-1.5	120.5	120.1	-4.3	-1.5	120.4	-4.2	-1.5
IV	123.8	126.4	5.2	-1.7	126.7	126.4	5.2	-1.7	126.7	5.3	-1.6
2004-I		123.7	-2.1	0.5	124.0	123.7	-2.1	0.4	122.9	-3.1	0.4
II		126.1	1.9	0.4	126.4	126.1	1.9	0.4	126.2	2.7	0.4

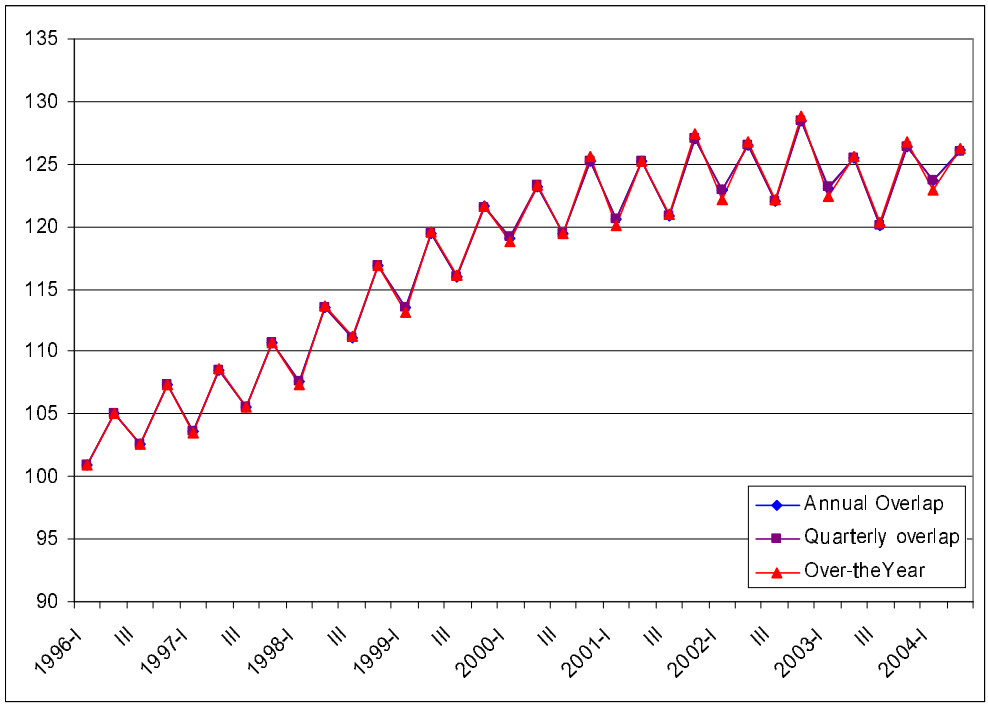


Figure B.1 Three linking methods applied to the consumption of households.

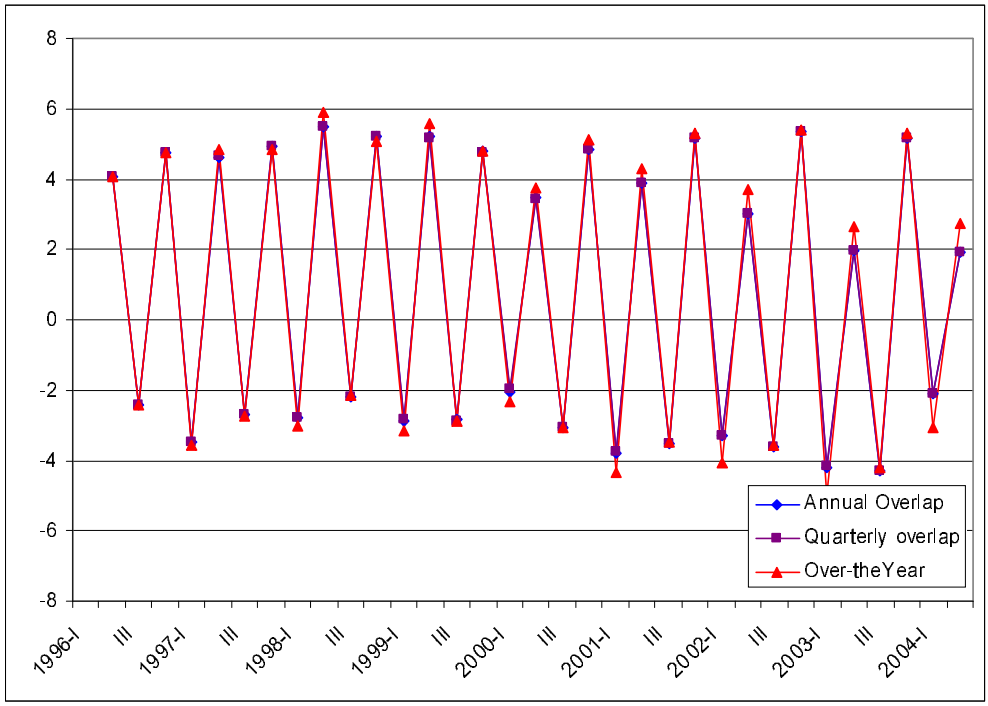


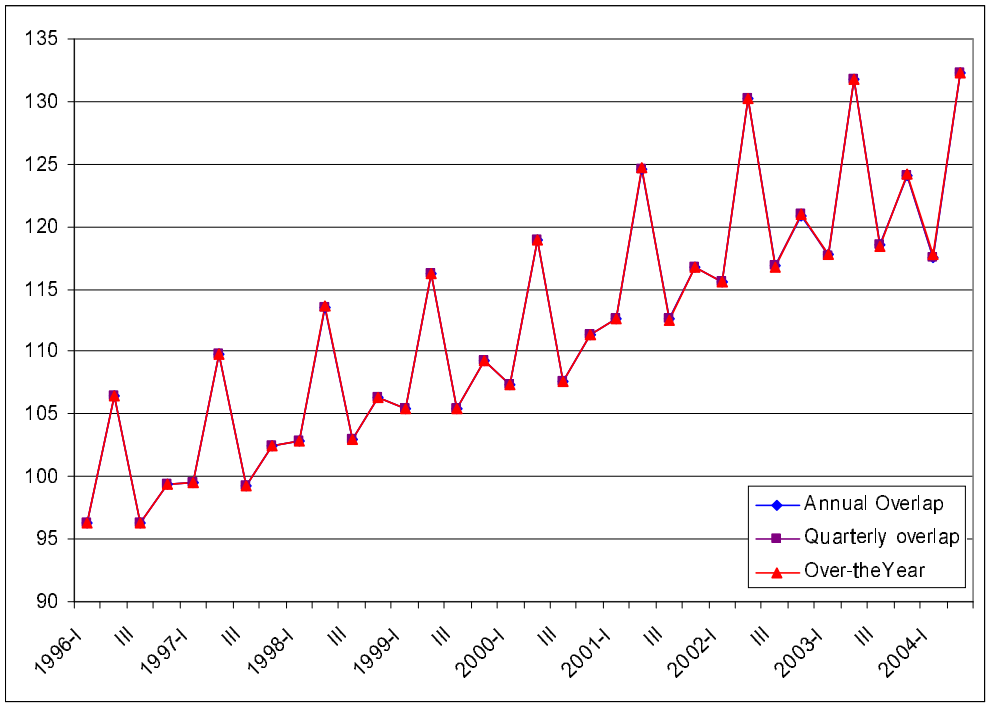
Figure B.2 Quarter-on-quarter growth rates according to three linking methods.

C. Final consumption expenditure of the general government

Largest differences in the quarter-on-quarter growth rate: –0.2 percent (2004-II) and +0.2 percent (2003-IV). The differences are never larger than 0.2 percentage point.

Table C.1 Three linking methods applied to the consumption of the government.

Period	Yearly	Annual Overlap			Quarterly overlap				Over-the-year		
			q-1	q-4	orig.	benchm.	q-1	q-4		q-1	q-4
		1995=100	*%*		*1995=100*		*%*		*1995=100*	*%*	
1996-I		96.3			96.3	96.3			96.3		
II		106.5	10.6		106.5	106.5	10.6		106.5	10.6	
III		96.2	-9.6		96.2	96.2	-9.6		96.2	-9.6	
IV	99.6	99.4	3.3		99.4	99.4	3.2		99.4	3.3	
1997-I		99.5	0.1	3.3	99.5	99.5	0.1	3.3	99.5	0.1	3.3
II		109.8	10.4	3.1	109.8	109.8	10.4	3.1	109.8	10.4	3.1
III		99.3	-9.5	3.2	99.3	99.3	-9.5	3.2	99.3	-9.6	3.1
IV	102.8	102.5	3.2	3.1	102.5	102.5	3.2	3.2	102.5	3.3	3.2
1998-I		102.9	0.4	3.5	102.9	102.9	0.4	3.5	102.9	0.4	3.4
II		113.5	10.3	3.4	113.6	113.5	10.4	3.4	113.6	10.4	3.5
III		103.0	-9.3	3.8	103.1	103.0	-9.3	3.8	103.0	-9.4	3.7
IV	106.4	106.3	3.1	3.7	106.3	106.3	3.2	3.7	106.3	3.2	3.7
1999-I		105.5	-0.8	2.5	105.5	105.5	-0.8	2.5	105.5	-0.8	2.5
II		116.2	10.2	2.3	116.2	116.2	10.2	2.3	116.3	10.2	2.3
III		105.5	-9.2	2.4	105.5	105.5	-9.2	2.4	105.4	-9.4	2.3
IV	109.1	109.3	3.6	2.8	109.3	109.3	3.6	2.8	109.3	3.7	2.8
2000-I		107.3	-1.8	1.8	107.3	107.3	-1.8	1.8	107.4	-1.7	1.8
II		118.9	10.8	2.3	118.9	118.9	10.8	2.3	118.9	10.7	2.3
III		107.7	-9.4	2.1	107.7	107.7	-9.4	2.1	107.6	-9.5	2.1
IV	111.3	111.3	3.4	1.9	111.3	111.3	3.4	1.9	111.3	3.5	1.9
2001-I		112.6	1.1	4.9	112.6	112.6	1.2	5.0	112.7	1.2	5.0
II		124.6	10.7	4.9	124.7	124.6	10.7	4.9	124.7	10.6	4.8
III		112.6	-9.7	4.6	112.6	112.6	-9.7	4.6	112.5	-9.8	4.6
IV	116.7	116.7	3.7	4.9	116.8	116.7	3.7	4.9	116.8	3.8	4.9
2002-I		115.5	-1.0	2.6	115.6	115.5	-1.0	2.6	115.6	-1.0	2.6
II		130.2	12.7	4.5	130.3	130.2	12.7	4.5	130.2	12.6	4.4
III		116.9	-10.2	3.8	116.9	116.9	-10.2	3.8	116.8	-10.3	3.8
IV	120.9	120.9	3.4	3.6	121.0	120.9	3.5	3.6	121.0	3.6	3.6
2003-I		117.7	-2.7	1.9	117.7	117.7	-2.7	1.9	117.8	-2.6	1.9
II		131.8	12.0	1.2	131.8	131.8	12.0	1.2	131.8	11.8	1.2
III		118.6	-10.0	1.4	118.6	118.6	-10.0	1.4	118.4	-10.1	1.4
IV	123.0	124.1	4.7	2.6	124.1	124.1	4.7	2.6	124.1	4.8	2.6
2004-I		117.6	-5.3	-0.1	117.6	117.5	-5.3	-0.1	117.7	-5.2	-0.1
II		132.4	12.6	0.4	132.4	132.3	12.6	0.4	132.3	12.4	0.4



F *i* *g*
g *o* *v*

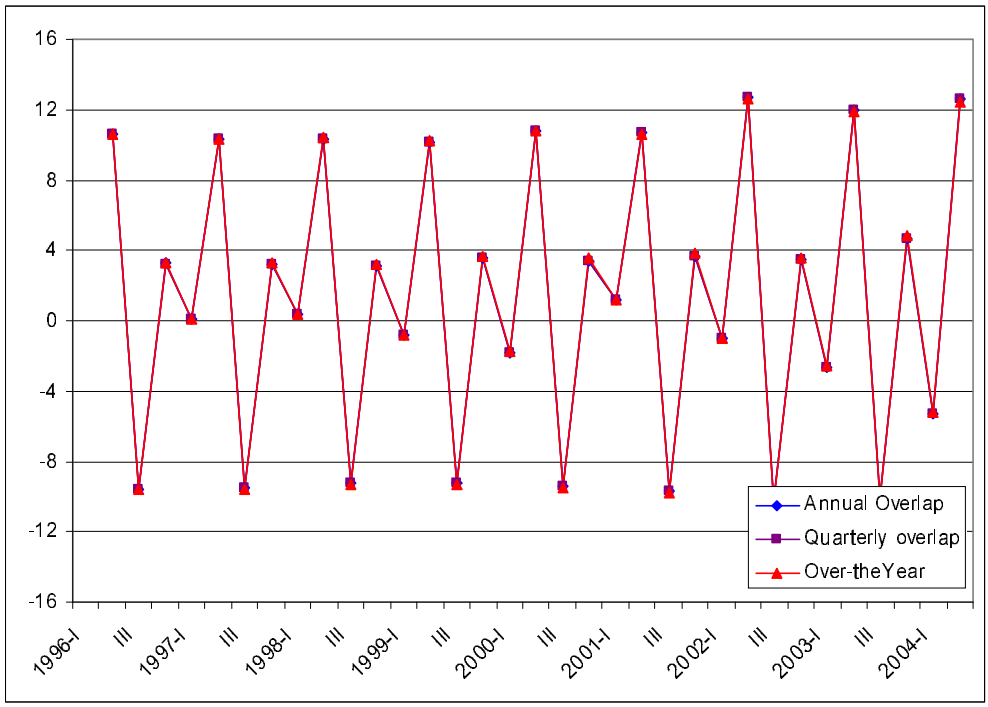


Figure C.2 Quarter-on-quarter growth rates according to three linking methods.

D. Gross fixed capital formation by industry

Largest differences in the quarter-on-quarter growth rate: –1.4 percent (1999-II) and +1.5 percent (2000-I). The differences are larger than 0.2 percentage point in 21 of 33 quarters.

Table D.1 Three linking methods applied to the fixed capital formation by industry.

Period	Yearly	Annual Overlap			Quarterly overlap				Over-the-year		
			q-1	q-4	orig.	benchm.	q-1	q-4		q-1	q-4
		1995=100	*%*		*1995=100*		*%*		*1995=100*	*%*	
1996-I		94.3			94.3	94.3			94.3		
II		114.4	21.3		114.4	114.4	21.3		114.4	21.3	
III		96.1	-16.0		96.1	96.1	-16.0		96.1	-16.0	
IV	106.0	119.1	24.0		119.1	119.1	24.0		119.1	24.0	
1997-I		111.0	-6.8	17.6	111.1	111.0	-6.8	17.7	111.1	-6.7	17.8
II		125.1	12.7	9.3	125.2	125.2	12.7	9.4	125.0	12.5	9.2
III		101.7	-18.7	5.9	101.8	101.7	-18.7	5.9	101.6	-18.7	5.8
IV	114.8	121.3	19.2	1.8	121.4	121.2	19.1	1.7	121.4	19.5	1.9
1998-I		118.5	-2.3	6.8	118.7	118.4	-2.3	6.6	118.8	-2.2	6.9
II		124.7	5.2	-0.4	124.9	124.5	5.2	-0.5	124.4	4.7	-0.5
III		108.7	-12.8	6.8	108.9	108.7	-12.7	6.8	108.5	-12.8	6.8
IV	119.4	125.9	15.8	3.8	126.1	126.2	16.1	4.1	126.1	16.2	3.9
1999-I		126.8	0.7	7.0	125.9	126.5	0.2	6.8	128.1	1.6	7.9
II		133.7	5.4	7.2	132.8	133.7	5.7	7.4	133.6	4.3	7.4
III		116.2	-13.1	6.9	115.4	116.3	-13.0	7.0	115.9	-13.3	6.8
IV	129.2	140.1	20.6	11.3	139.1	140.3	20.6	11.2	139.1	20.1	10.3
2000-I		128.7	-8.1	1.5	127.9	128.8	-8.1	1.9	129.8	-6.7	1.3
II		139.0	8.0	4.0	138.2	139.1	7.9	4.0	139.1	7.2	4.1
III		115.2	-17.1	-0.8	114.5	115.2	-17.2	-1.0	114.9	-17.5	-0.9
IV	130.0	137.0	18.9	-2.2	136.1	136.8	18.8	-2.4	136.1	18.5	-2.1
2001-I		129.2	-5.7	0.4	128.8	129.4	-5.5	0.4	129.6	-4.8	-0.1
II		137.3	6.2	-1.2	136.8	137.4	6.2	-1.2	137.5	6.1	-1.2
III		112.0	-18.5	-2.8	111.6	111.9	-18.5	-2.8	111.9	-18.6	-2.6
IV	128.3	134.6	20.2	-1.7	134.1	134.4	20.1	-1.8	134.1	19.9	-1.5
2002-I		124.7	-7.4	-3.5	124.6	124.8	-7.2	-3.6	124.8	-6.9	-3.7
II		130.8	5.0	-4.7	130.8	130.8	4.9	-4.7	130.6	4.6	-5.0
III		105.7	-19.2	-5.6	105.7	105.7	-19.2	-5.6	105.9	-18.9	-5.3
IV	120.8	122.1	15.5	-9.3	122.1	122.1	15.5	-9.2	122.1	15.3	-9.0
2003-I		117.8	-3.5	-5.5	117.8	117.8	-3.5	-5.6	117.9	-3.4	-5.5
II		123.9	5.1	-5.3	123.9	123.9	5.1	-5.3	123.4	4.7	-5.5
III		100.4	-18.9	-5.0	100.4	100.4	-18.9	-5.0	100.8	-18.4	-4.9
IV	116.4	123.6	23.1	1.2	123.6	123.6	23.1	1.3	123.6	22.7	1.3
2004-I		123.3	-0.3	4.6	123.5	123.5	-0.1	4.8	123.3	-0.3	4.5
II		126.1	2.3	1.8	126.3	126.3	2.3	2.0	125.7	2.0	1.8

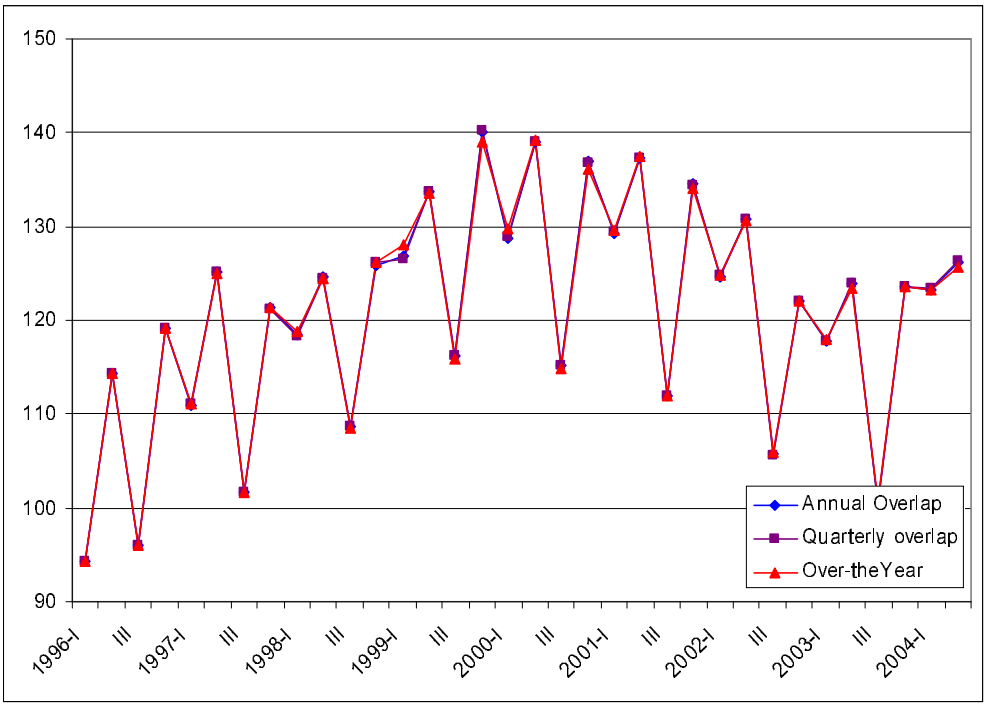


Figure D.1 Three linking methods applied to the fixed capital formation by industry.

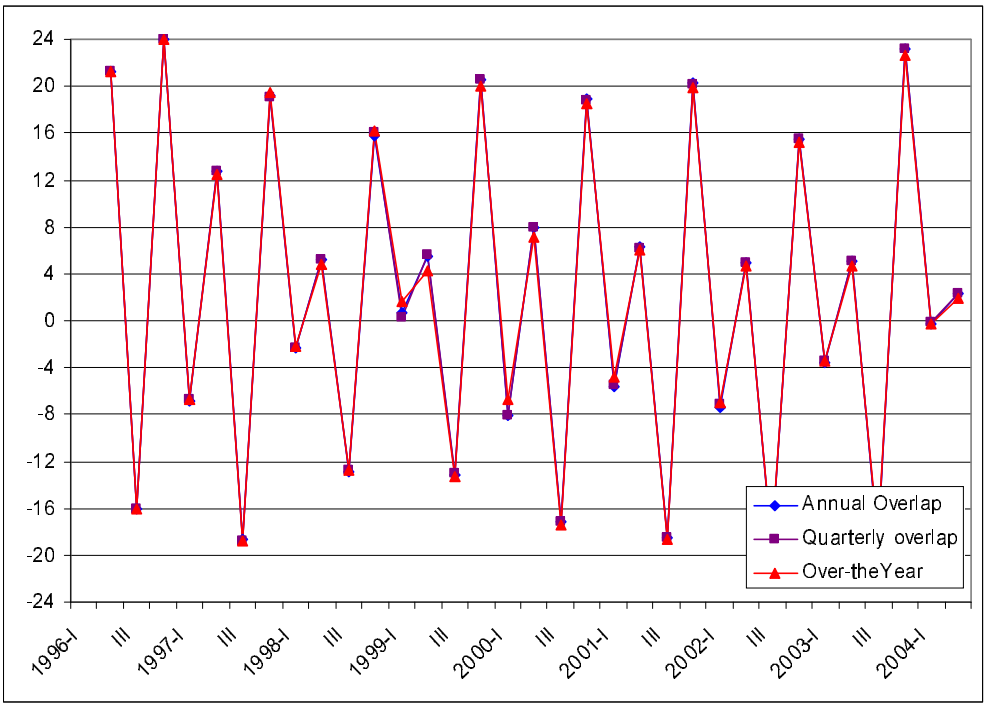


Figure D.2 Quarter-on-quarter growth rates according to three linking methods.

E. Gross fixed capital formation by general government

Largest differences in the quarter-on-quarter growth rate: –6.1 percent (2001-II) and +5.2 percent (2002-I). The differences are larger than 0.2 percentage point in 22 of 33 quarters. The growth rates have a different sign in quarter 2004-II.

Table E.1 Three linking methods applied to capital formation by the government.

Period	Yearly	Annual Overlap			Quarterly overlap				Over-the-year		
			q-1	q-4	orig.	benchm.	q-1	q-4		q-1	q-4
		1995=100	*%*		*1995=100*		*%*		*1995=100*	*%*	
1996-I		86.9			86.9	86.9			86.9		
II		109.1	25.5		109.1	109.1	25.5		109.1	25.5	
III		107.6	-1.4		107.6	107.6	-1.4		107.6	-1.4	
IV	108.3	129.6	20.5		129.6	129.6	20.5		129.6	20.5	
1997-I		89.0	-31.3	2.4	89.0	89.0	-31.3	2.5	89.2	-31.1	2.7
II		104.3	17.2	-4.4	104.3	104.3	17.2	-4.3	104.1	16.7	-4.5
III		104.6	0.3	-2.7	104.6	104.6	0.3	-2.7	104.6	0.5	-2.7
IV	105.0	122.2	16.7	-5.7	122.2	122.1	16.7	-5.8	122.2	16.8	-5.7
1998-I		98.9	-19.0	11.2	98.9	98.9	-19.1	11.1	99.3	-18.7	11.3
II		107.5	8.6	3.0	107.4	107.4	8.6	2.9	107.2	7.9	2.9
III		107.9	0.4	3.1	107.9	107.9	0.5	3.1	107.9	0.7	3.2
IV	110.6	128.0	18.6	4.8	127.9	128.2	18.8	4.9	127.9	18.5	4.7
1999-I		101.4	-20.8	2.5	100.9	101.3	-21.0	2.4	102.8	-19.6	3.5
II		113.7	12.1	5.8	113.1	113.7	12.3	5.9	113.8	10.7	6.2
III		116.2	2.2	7.7	115.6	116.3	2.3	7.7	115.3	1.3	6.8
IV	116.6	135.3	16.5	5.7	134.7	135.3	16.4	5.6	134.7	16.8	5.3
2000-I		114.1	-15.7	12.6	113.6	114.0	-15.8	12.6	115.4	-14.3	12.3
II		124.9	9.5	9.9	124.4	124.8	9.4	9.7	124.9	8.2	9.8
III		118.0	-5.5	1.6	117.5	118.0	-5.4	1.5	117.4	-6.0	1.8
IV	124.0	138.8	17.7	2.6	138.3	139.1	18.0	2.8	138.3	17.8	2.7
2001-I		120.0	-13.6	5.2	118.4	119.6	-14.0	4.9	125.2	-9.4	8.5
II		136.8	14.0	9.5	135.0	136.7	14.3	9.6	135.5	8.2	8.5
III		134.3	-1.8	13.8	132.5	134.5	-1.6	14.0	132.5	-2.2	12.9
IV	136.0	153.0	13.9	10.2	151.0	153.3	14.0	10.2	151.0	14.0	9.2
2002-I		137.6	-10.1	14.7	135.8	137.8	-10.1	15.2	143.6	-4.9	14.7
II		148.3	7.8	8.5	146.4	148.4	7.7	8.5	146.9	2.3	8.4
III		146.0	-1.6	8.7	144.1	145.9	-1.6	8.5	144.0	-2.0	8.7
IV	147.4	157.5	7.9	3.0	155.5	157.4	7.9	2.7	155.5	8.0	3.0
2003-I		135.1	-14.3	-1.8	133.5	135.1	-14.2	-1.9	140.7	-9.5	-2.0
II		146.5	8.5	-1.2	144.8	146.6	8.5	-1.2	145.0	3.1	-1.3
III		146.1	-0.3	0.1	144.3	146.1	-0.3	0.1	144.3	-0.5	0.2
IV	146.8	159.7	9.3	1.3	157.8	159.6	9.3	1.4	157.8	9.4	1.5
2004-I		141.3	-11.5	4.6	139.6	141.3	-11.5	4.6	147.2	-6.7	4.6
II		145.2	2.8	-0.9	143.5	145.2	2.8	-0.9	143.7	-2.4	-0.9

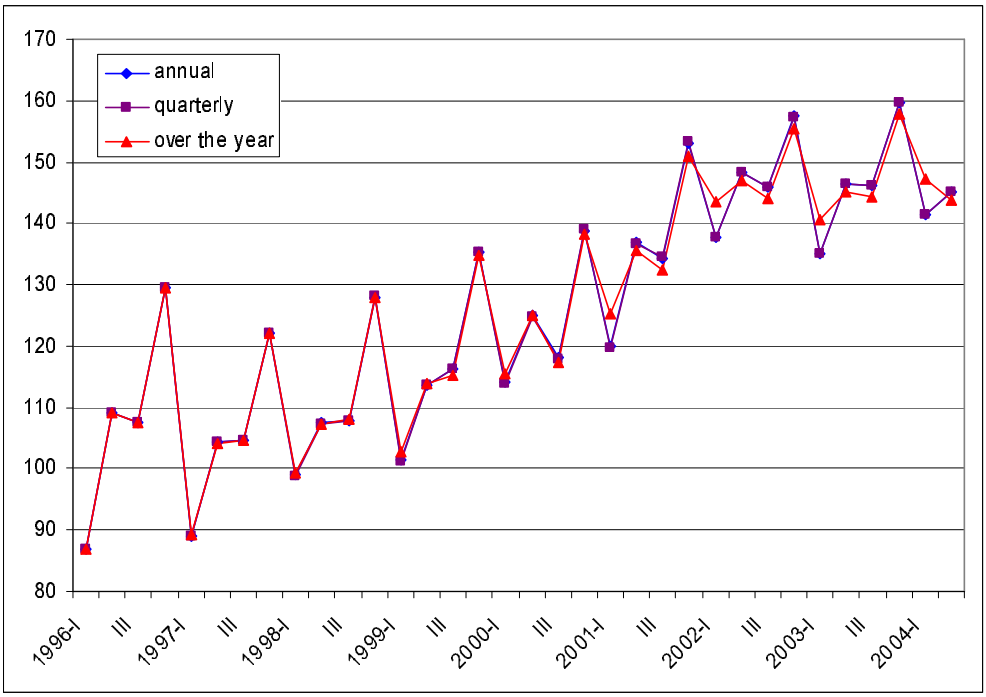


Figure E.1 Three linking methods applied to capital formation by the government.

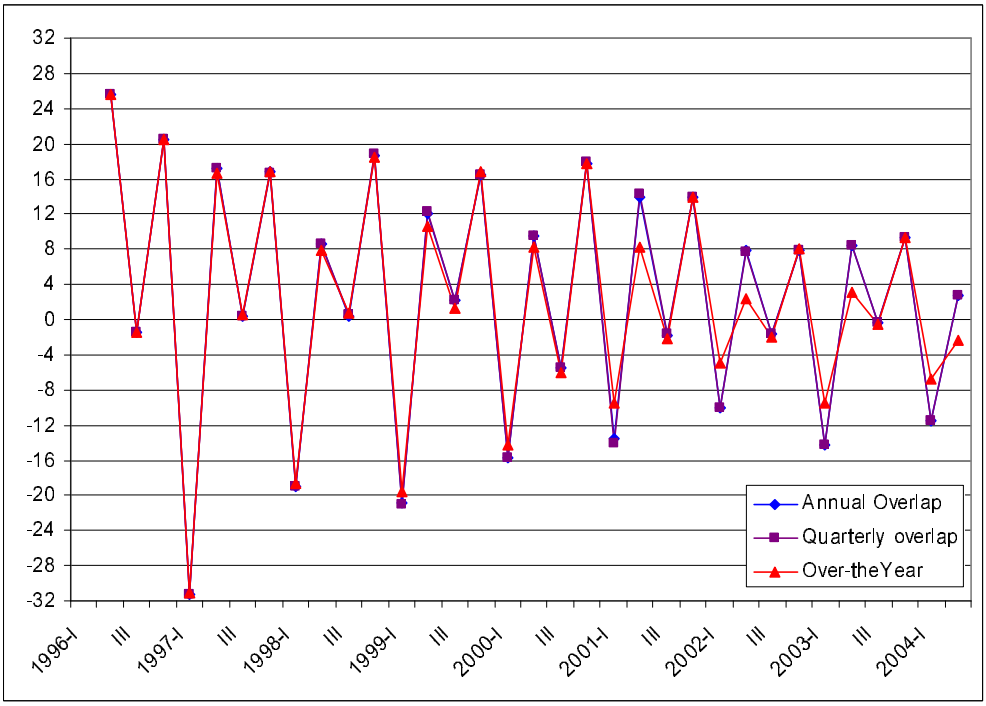


Figure E.2 Quarter-on-quarter growth rates according to three linking methods.

F. National expenditures

Largest differences in the quarter-on-quarter growth rate: –1.0 percent (2001-IV) and +0.8 percent (2003-III). The differences are larger than 0.2 percentage point in 11 of 33 quarters.

Table F.1 Three linking methods applied to the national expenditures.

Period	Yearly	Annual Overlap			Quarterly overlap				Over-the-year		
			q-1	q-4	orig.	benchm.	q-1	q-4		q-1	q-4
		1995=100	*%*		*1995=100*		*%*		*1995=100*	*%*	
1996-I		98.8			98.8	98.8			98.8		
II		105.1	6.4		105.1	105.1	6.4		105.1	6.4	
III		100.2	-4.7		100.2	100.2	-4.7		100.2	-4.7	
IV	102.8	107.2	7.0		107.2	107.2	7.0		107.2	7.0	
1997-I		103.0	-3.9	4.2	103.0	103.0	-3.9	4.2	103.0	-3.9	4.2
II		109.4	6.2	4.1	109.3	109.4	6.2	4.1	109.4	6.2	4.1
III		103.9	-5.1	3.7	103.8	103.9	-5.0	3.7	104.0	-5.0	3.8
IV	106.9	111.2	7.0	3.7	111.1	111.2	7.0	3.7	111.1	6.9	3.6
1998-I		110.4	-0.7	7.1	110.3	110.4	-0.7	7.2	110.3	-0.7	7.0
II		113.7	3.0	4.0	113.7	113.7	3.0	3.9	113.8	3.2	4.0
III		108.8	-4.4	4.7	108.7	108.8	-4.4	4.7	108.9	-4.3	4.7
IV	112.0	115.3	6.0	3.7	115.2	115.3	6.0	3.7	115.2	5.8	3.7
1999-I		113.2	-1.8	2.5	113.1	113.2	-1.8	2.5	113.2	-1.8	2.6
II		118.2	4.5	3.9	118.1	118.2	4.5	4.0	118.2	4.5	3.9
III		114.4	-3.2	5.2	114.3	114.4	-3.2	5.2	114.5	-3.1	5.2
IV	116.9	121.7	6.4	5.6	121.6	121.7	6.3	5.6	121.6	6.2	5.6
2000-I		117.8	-3.2	4.1	117.7	117.8	-3.2	4.1	117.8	-3.1	4.1
II		123.7	5.0	4.6	123.6	123.6	5.0	4.6	123.4	4.8	4.4
III		115.6	-6.5	1.0	115.5	115.6	-6.5	1.0	115.9	-6.1	1.2
IV	120.0	122.8	6.2	0.9	122.7	122.9	6.3	1.0	122.7	5.9	0.9
2001-I		120.7	-1.7	2.5	120.3	120.6	-1.9	2.4	120.6	-1.8	2.4
II		125.9	4.3	1.8	125.5	125.9	4.4	1.8	125.7	4.3	1.9
III		117.8	-6.4	1.9	117.4	117.9	-6.4	2.0	118.5	-5.7	2.2
IV	122.2	124.2	5.4	1.1	123.8	124.3	5.4	1.1	123.8	4.5	0.9
2002-I		121.0	-2.6	0.2	120.6	121.1	-2.6	0.4	121.0	-2.3	0.4
II		126.6	4.6	0.6	126.2	126.6	4.6	0.6	126.4	4.5	0.5
III		118.4	-6.5	0.5	118.0	118.4	-6.5	0.4	119.0	-5.9	0.4
IV	122.8	125.3	5.8	0.8	124.9	125.2	5.8	0.7	124.9	4.9	0.8
2003-I		120.8	-3.5	-0.2	120.6	120.9	-3.5	-0.2	120.7	-3.3	-0.2
II		125.6	4.0	-0.8	125.4	125.6	3.9	-0.8	125.3	3.8	-0.9
III		116.9	-6.9	-1.2	116.7	116.9	-7.0	-1.3	117.6	-6.2	-1.2
IV	122.2	125.4	7.2	0.1	125.1	125.3	7.2	0.1	125.1	6.4	0.2
2004-I		122.1	-2.6	1.0	121.8	122.0	-2.6	1.0	122.0	-2.5	1.1
II		126.2	3.4	0.4	126.0	126.2	3.4	0.4	125.8	3.1	0.4

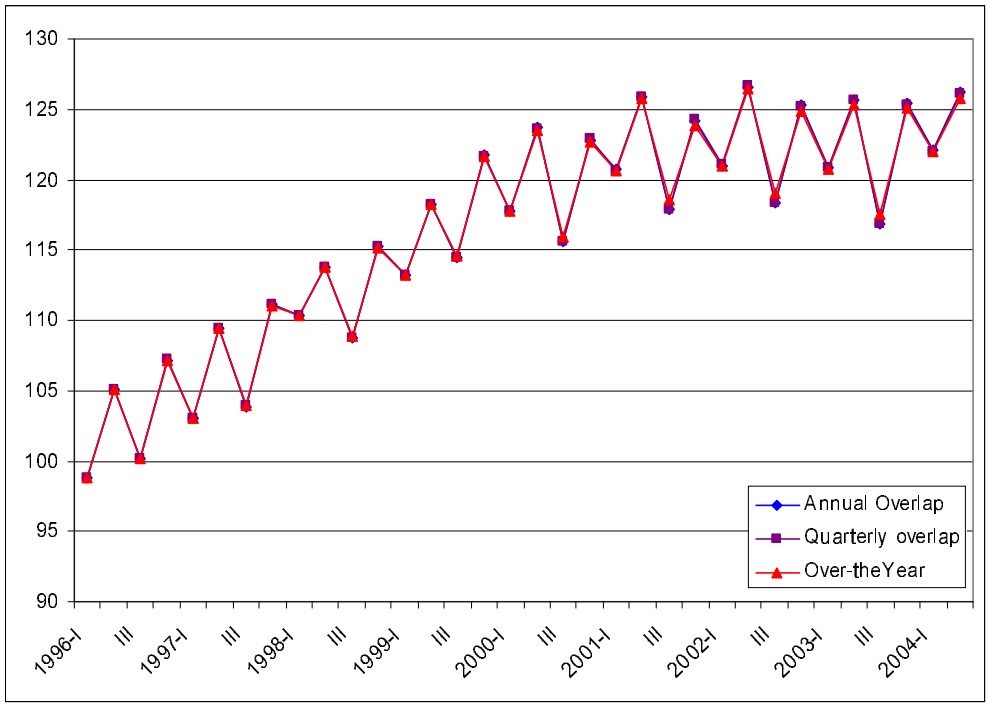


Figure F.1 Three linking methods applied to the national expenditures.

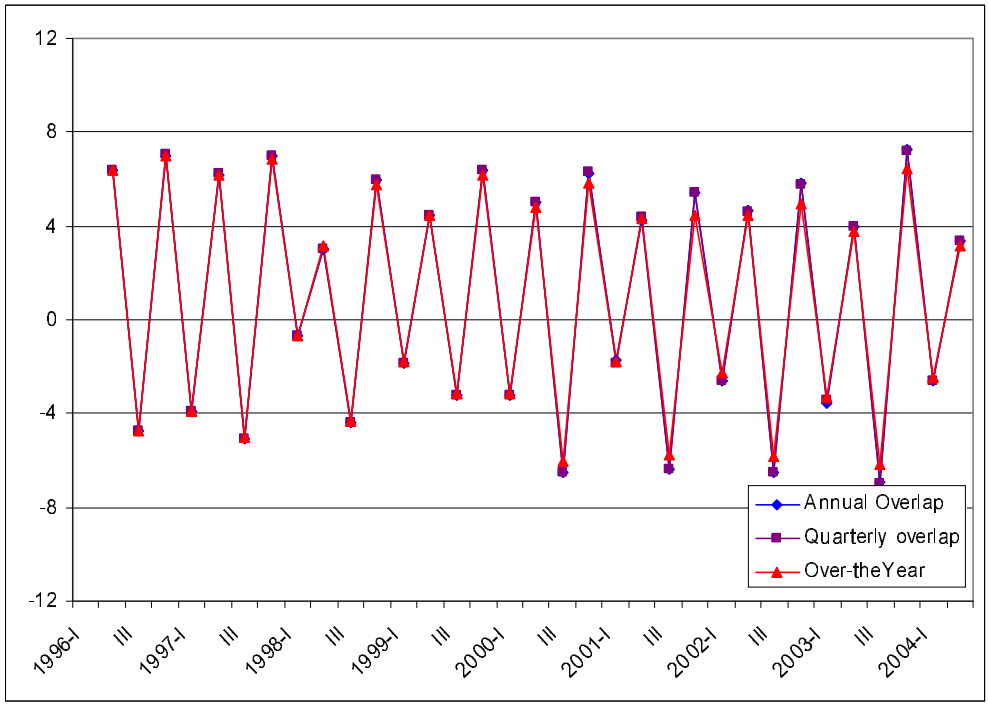


Figure F.2 Quarter-on-quarter growth rates according to three linking methods.

G. Imports of goods and services

Largest differences in the quarter-on-quarter growth rate: –0.5 percent (2002-II) and +0.5 percent (2003-IV). The differences are larger than 0.2 percentage point in 10 of 33 quarters.

Table G.1 Three linking methods applied to the imports.

Period	Yearly	Annual Overlap			Quarterly overlap				Over-the-year		
			q-1	q-4	orig.	benchm.	q-1	q-4		q-1	q-4
		1995=100	*%*		*1995=100*		*%*		*1995=100*	*%*	
1996-I		104.2			104.2	104.1			104.2		
II		102.8	-1.3		102.8	102.7	-1.3		102.8	-1.3	
III		100.0	-2.7		100.0	100.0	-2.7		100.0	-2.7	
IV	104.4	110.6	10.6		110.6	110.6	10.6		110.6	10.6	
1997-I		110.4	-0.2	6.0	110.3	110.4	-0.2	6.0	110.4	-0.2	6.0
II		114.8	4.0	11.7	114.7	114.8	4.0	11.8	114.8	4.0	11.8
III		111.3	-3.1	11.3	111.2	111.3	-3.1	11.3	111.3	-3.1	11.3
IV	114.3	120.8	8.6	9.3	120.7	120.8	8.6	9.2	120.7	8.5	9.2
1998-I		123.4	2.1	11.8	123.4	123.4	2.2	11.8	123.3	2.2	11.7
II		122.7	-0.6	6.9	122.7	122.7	-0.6	6.9	122.8	-0.5	6.9
III		120.3	-1.9	8.2	120.3	120.3	-1.9	8.1	120.3	-2.0	8.1
IV	124.1	129.9	7.9	7.5	129.9	129.9	8.0	7.5	129.9	7.9	7.6
1999-I		127.0	-2.2	2.9	126.9	127.0	-2.2	2.9	127.0	-2.2	3.0
II		129.4	1.9	5.5	129.3	129.4	1.9	5.5	129.4	1.9	5.4
III		128.0	-1.1	6.4	127.9	128.0	-1.1	6.4	128.0	-1.1	6.4
IV	131.3	140.7	9.9	8.3	140.6	140.6	9.9	8.3	140.6	9.8	8.2
2000-I		141.1	0.3	11.1	141.2	141.2	0.4	11.2	140.9	0.2	10.9
II		145.1	2.8	12.1	145.2	145.1	2.8	12.1	145.0	2.9	12.0
III		139.9	-3.6	9.3	140.0	139.8	-3.6	9.3	140.0	-3.5	9.3
IV	145.1	154.3	10.3	9.7	154.5	154.2	10.3	9.6	154.5	10.4	9.9
2001-I		151.2	-2.0	7.2	151.6	151.3	-1.9	7.1	151.1	-2.1	7.3
II		149.8	-1.0	3.3	150.2	149.8	-1.0	3.2	149.6	-1.0	3.2
III		143.8	-4.0	2.8	144.2	143.8	-4.0	2.8	143.7	-4.0	2.6
IV	148.3	148.5	3.2	-3.8	148.9	148.5	3.2	-3.7	148.9	3.6	-3.6
2002-I		147.1	-1.0	-2.8	147.4	147.1	-0.9	-2.8	147.1	-1.2	-2.6
II		150.8	2.5	0.7	151.2	150.8	2.6	0.7	150.5	2.3	0.6
III		146.0	-3.2	1.5	146.4	146.0	-3.2	1.5	145.8	-3.1	1.5
IV	149.6	154.4	5.8	4.0	154.8	154.4	5.7	4.0	154.8	6.1	4.0
2003-I		148.6	-3.7	1.1	149.1	148.7	-3.7	1.1	148.6	-4.0	1.0
II		150.5	1.3	-0.2	151.0	150.5	1.2	-0.2	150.1	1.0	-0.2
III		145.1	-3.6	-0.6	145.5	145.1	-3.6	-0.6	144.9	-3.5	-0.6
IV	150.5	157.8	8.8	2.2	158.3	157.8	8.8	2.2	158.3	9.2	2.3
2004-I		153.8	-2.5	3.5	154.4	153.9	-2.5	3.5	153.9	-2.8	3.5
II		160.3	4.2	6.5	160.9	160.4	4.2	6.6	159.6	3.7	6.3

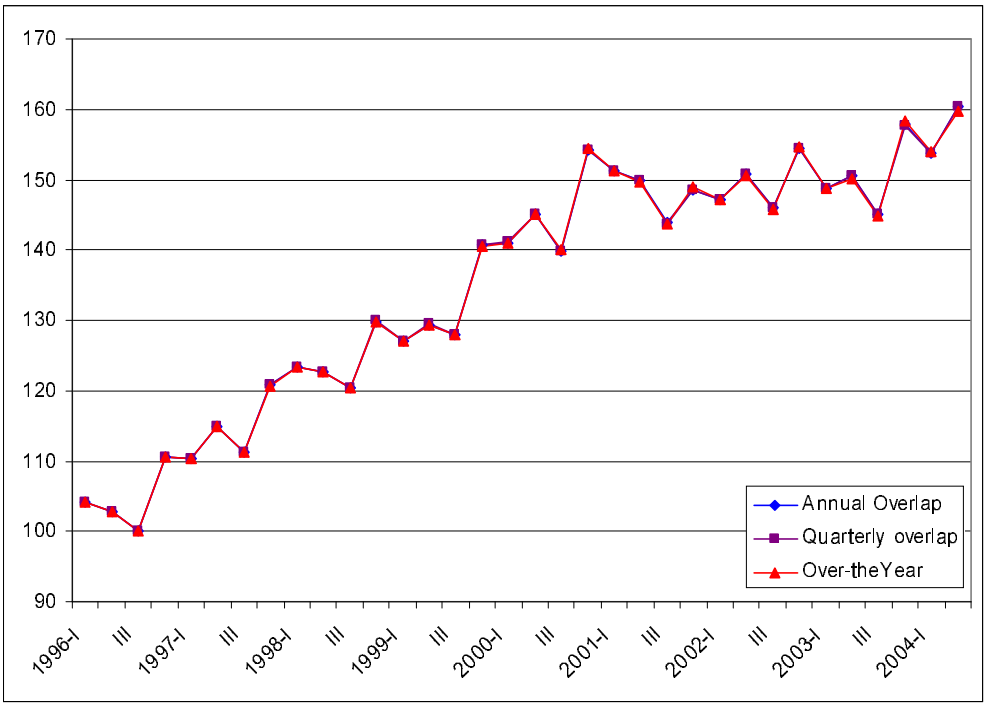


Figure G.1 Three linking methods applied to the imports.

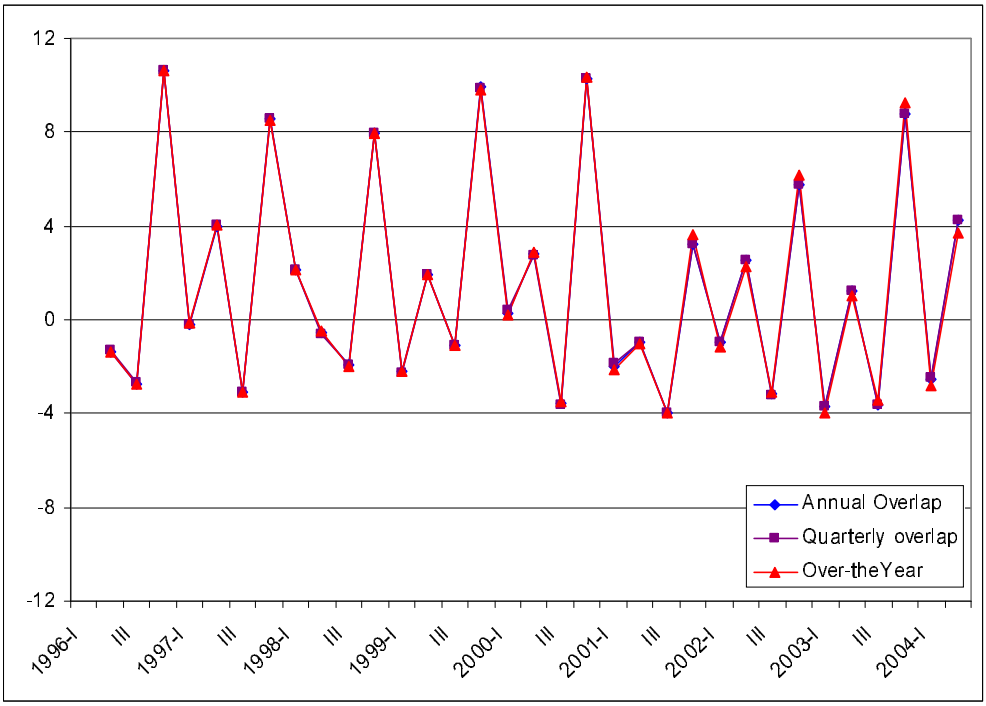


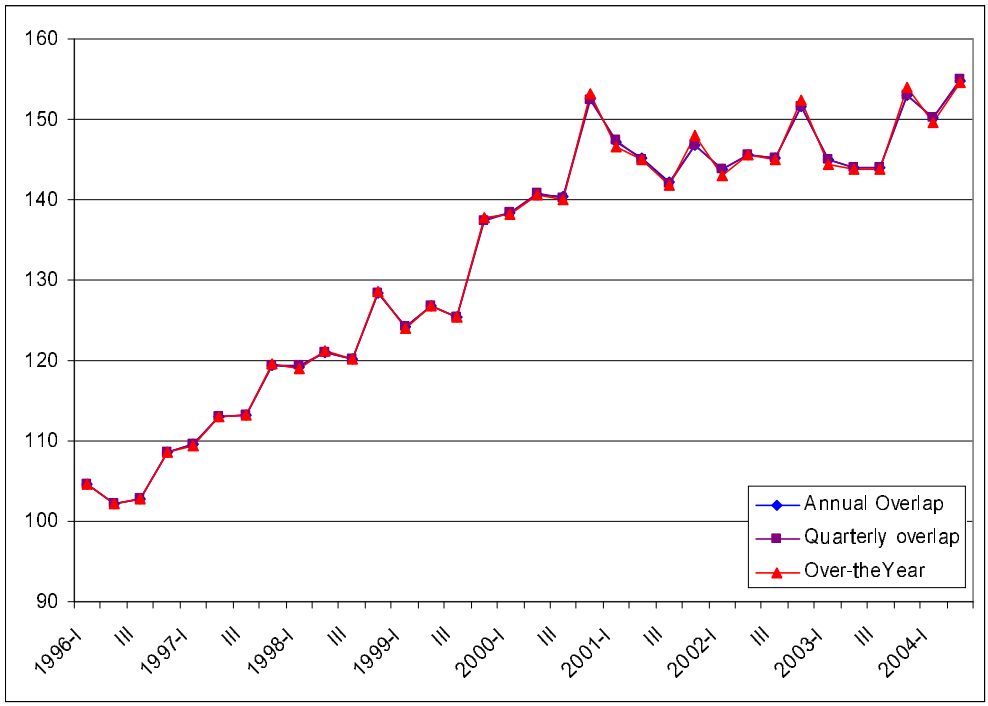
Figure G.2 Quarter-on-quarter growth rates according to three linking methods.

H. Exports of goods and services

Largest differences in the quarter-on-quarter growth rate: –1.3 percent (2002-I) and +1.1 percent (2001-IV). The differences are larger than 0.2 percentage point in 18 of 33 quarters. The growth rates have a different sign in quarter 2003-III.

Table H.1 Three linking methods applied to the exports.

Period	Yearly	Annual Overlap			Quarterly overlap				Over-the-year		
			q-1	q-4	orig.	benchm.	q-1	q-4		q-1	q-4
		1995=100	*%*		*1995=100*		*%*		*1995=100*	*%*	
1996-I		104.7			104.7	104.7			104.7		
II		102.2	-2.3		102.2	102.2	-2.3		102.2	-2.3	
III		102.7	0.5		102.7	102.7	0.5		102.7	0.5	
IV	104.6	108.6	5.8		108.6	108.6	5.8		108.6	5.8	
1997-I		109.5	0.8	4.6	109.6	109.5	0.8	4.6	109.4	0.7	4.5
II		113.1	3.2	10.6	113.1	113.1	3.2	10.6	113.1	3.4	10.6
III		113.2	0.1	10.2	113.2	113.2	0.1	10.2	113.2	0.1	10.2
IV	113.8	119.5	5.6	10.0	119.5	119.4	5.5	10.0	119.5	5.6	10.0
1998-I		119.3	-0.2	8.9	119.4	119.3	-0.1	8.9	119.0	-0.4	8.8
II		121.1	1.5	7.1	121.2	121.1	1.5	7.1	121.1	1.7	7.1
III		120.1	-0.8	6.2	120.3	120.1	-0.8	6.1	120.2	-0.8	6.2
IV	122.2	128.4	6.8	7.4	128.5	128.3	6.8	7.4	128.5	6.9	7.5
1999-I		124.1	-3.3	4.1	124.4	124.2	-3.2	4.1	124.0	-3.5	4.2
II		126.9	2.2	4.8	127.1	126.9	2.2	4.8	126.7	2.2	4.7
III		125.3	-1.2	4.3	125.6	125.3	-1.2	4.3	125.3	-1.1	4.3
IV	128.5	137.5	9.7	7.1	137.8	137.5	9.7	7.2	137.8	10.0	7.2
2000-I		138.3	0.6	11.4	138.8	138.5	0.7	11.5	138.1	0.2	11.4
II		140.7	1.7	10.9	141.2	140.8	1.7	11.0	140.6	1.8	10.9
III		140.3	-0.3	12.0	140.8	140.3	-0.3	12.0	140.0	-0.4	11.8
IV	143.0	152.7	8.8	11.0	153.2	152.5	8.7	10.9	153.2	9.4	11.2
2001-I		147.3	-3.6	6.5	148.4	147.4	-3.3	6.4	146.5	-4.4	6.1
II		145.1	-1.5	3.2	146.2	145.1	-1.6	3.1	145.0	-1.0	3.2
III		142.1	-2.0	1.3	143.2	142.1	-2.1	1.3	141.7	-2.3	1.2
IV	145.3	146.8	3.3	-3.9	147.9	146.8	3.3	-3.7	147.9	4.4	-3.5
2002-I		143.9	-2.0	-2.3	144.8	143.8	-2.0	-2.4	143.1	-3.3	-2.4
II		145.5	1.1	0.3	146.4	145.5	1.2	0.3	145.6	1.7	0.4
III		145.2	-0.2	2.2	146.1	145.3	-0.2	2.3	145.1	-0.3	2.4
IV	146.6	151.5	4.3	3.2	152.5	151.6	4.3	3.3	152.5	5.1	3.1
2003-I		145.0	-4.3	0.7	145.9	145.0	-4.3	0.8	144.4	-5.3	0.9
II		144.0	-0.7	-1.1	144.9	144.0	-0.7	-1.1	143.9	-0.4	-1.2
III		144.1	0.1	-0.8	145.0	144.1	0.1	-0.8	143.7	-0.1	-0.9
IV	146.5	152.9	6.2	0.9	153.9	152.9	6.1	0.9	153.9	7.1	1.0
2004-I		150.2	-1.8	3.6	151.3	150.3	-1.7	3.6	149.5	-2.9	3.5
II		154.9	3.1	7.6	156.0	155.0	3.1	7.7	154.7	3.5	7.5



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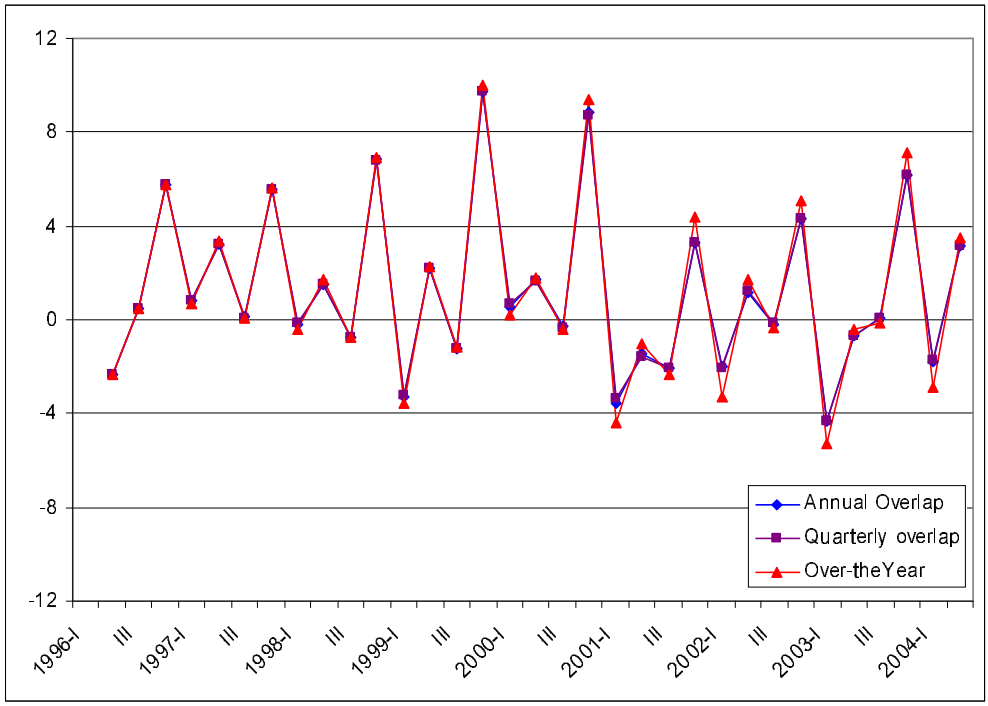

Figure H.2 Quarter-on-quarter growth rates according to three linking methods.

I. Total final expenditure

Largest differences in the quarter-on-quarter growth rate: –0.4 percent (2001-I) and +0.5 percent (2003-III). The differences are larger than 0.2 percentage point in 8 of 33 quarters.

Table I.1 Three linking methods applied to the total final expenditure.

Period	Yearly	Annual Overlap			Quarterly overlap				Over-the-year		
			q-1	q-4	orig.	benchm.	q-1	q-4		q-1	q-4
		1995=100	*%*		*1995=100*		*%*		*1995=100*	*%*	
1996-I		101.0			101.0	101.0			101.0		
II		104.0	3.0		104.0	104.0	3.0		104.0	3.0	
III		101.1	-2.8		101.1	101.1	-2.8		101.1	-2.8	
IV	103.5	107.7	6.5		107.7	107.8	6.5		107.7	6.5	
1997-I		105.5	-2.1	4.4	105.4	105.5	-2.1	4.4	105.4	-2.1	4.4
II		110.8	5.0	6.5	110.8	110.8	5.0	6.5	110.8	5.1	6.5
III		107.4	-3.1	6.2	107.4	107.4	-3.1	6.2	107.4	-3.0	6.2
IV	109.5	114.3	6.4	6.1	114.3	114.3	6.4	6.1	114.3	6.4	6.1
1998-I		113.7	-0.5	7.8	113.7	113.8	-0.5	7.9	113.6	-0.6	7.7
II		116.5	2.4	5.2	116.5	116.5	2.4	5.2	116.5	2.6	5.2
III		113.1	-3.0	5.3	113.1	113.1	-3.0	5.3	113.1	-2.9	5.3
IV	115.9	120.2	6.3	5.2	120.2	120.2	6.3	5.2	120.2	6.3	5.2
1999-I		117.3	-2.4	3.1	117.3	117.3	-2.4	3.1	117.2	-2.5	3.2
II		121.5	3.6	4.3	121.5	121.5	3.6	4.3	121.4	3.6	4.2
III		118.5	-2.4	4.8	118.6	118.5	-2.4	4.8	118.6	-2.3	4.8
IV	121.2	127.7	7.7	6.2	127.7	127.6	7.7	6.2	127.7	7.7	6.2
2000-I		125.4	-1.7	6.9	125.6	125.5	-1.7	6.9	125.4	-1.8	6.9
II		130.0	3.7	7.0	130.2	130.0	3.6	7.0	129.8	3.5	6.9
III		124.8	-4.0	5.3	124.9	124.7	-4.1	5.2	124.9	-3.8	5.3
IV	128.5	133.9	7.3	4.9	134.0	133.8	7.3	4.9	134.0	7.3	5.0
2001-I		130.6	-2.5	4.1	130.7	130.5	-2.5	4.0	130.3	-2.8	3.9
II		133.0	1.9	2.3	133.2	133.0	1.9	2.3	132.9	2.0	2.4
III		126.9	-4.6	1.7	127.0	126.9	-4.6	1.7	127.1	-4.3	1.8
IV	130.8	132.6	4.5	-1.0	132.7	132.6	4.5	-0.9	132.7	4.4	-1.0
2002-I		129.5	-2.3	-0.8	129.6	129.5	-2.4	-0.8	129.2	-2.6	-0.8
II		133.7	3.2	0.5	133.7	133.7	3.2	0.5	133.5	3.3	0.5
III		128.3	-4.0	1.2	128.4	128.3	-4.0	1.2	128.7	-3.6	1.2
IV	131.6	135.0	5.2	1.8	135.1	135.0	5.2	1.8	135.1	5.0	1.8
2003-I		129.8	-3.9	0.2	130.0	129.8	-3.8	0.2	129.6	-4.1	0.2
II		132.5	2.1	-0.9	132.7	132.5	2.1	-0.9	132.2	2.0	-1.0
III		126.9	-4.2	-1.1	127.1	126.9	-4.2	-1.1	127.3	-3.7	-1.1
IV	131.2	135.6	6.8	0.4	135.8	135.5	6.8	0.4	135.8	6.7	0.5
2004-I		132.4	-2.3	2.0	132.7	132.5	-2.3	2.0	132.2	-2.6	2.0
II		136.8	3.3	3.2	137.0	136.8	3.3	3.2	136.3	3.1	3.1

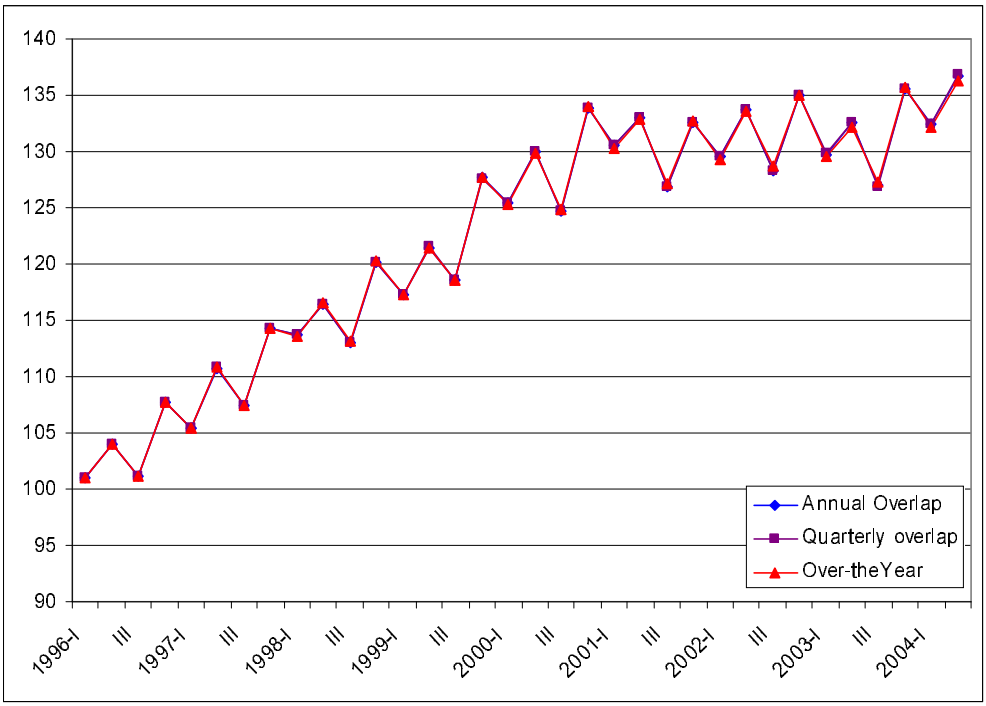

Figure I.1 Three linking methods applied to the total final expenditure.

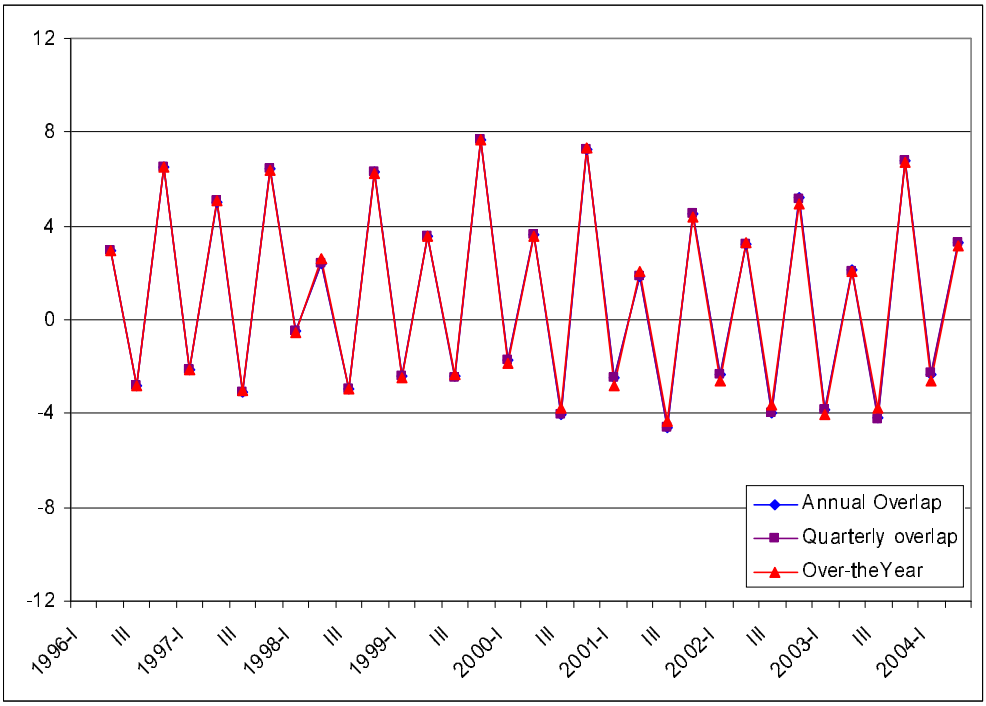

Figure I.2 Quarter-on-quarter growth rates according to three linking methods.