Issues encountered with quarterly volume balances measured in chain-linked euros: levels and contributions to growth - a new approach for the quarterly national accounts

Introduction

The non-additivity of chain-linked volume series raises a problem for calculating contributions to growth (as the conventional formula used for this relies on the additivity of the series processed).

Yet this calculation is essential for presenting national accounts for all the balance variables: in the quarterly accounts, net exports of goods and services and change in stocks. Since these aggregates can vary from positive to negative, there is actually little point in calculating either the growth rate or the deflators from them; and for this reason, the calculation of chain-linked volume levels itself is also unsuitable for these variables.

While it is relatively easy to deal with this problem for the annual series, the whole process is more complex for the quarterly series; until now, the traditional formula for calculating contributions to growth applicable to additive series was improperly used.

However, in July 2010, the change in reference year (from 2007 to 2008) for chain-linking volume series in the annual accounts meant that the simplistic calculation method used up to now would have produced unusable results for the quarterly net export and change in stocks figures; it thus became necessary to change the methodology as quickly as possible, so as to avoid publishing meaningless contributions to growth. Advance notice was then given in the press release and the hard-copy publication, which announced that a detailed methodological note would be published in this edition.

1. Issue of calculating contributions to growth for chain-linked volume data

Chain-linked volumes focus on changes in quantities on the basis of the previous year's price structure (previous year prices or "PYP"), with a view to rapidly reflecting changes in the structure of relative prices.

However, the volume levels at the previous year's prices cannot be used on a time series basis, because their changes from one year to the next cover both the volumes and the prices (rebasing). It is thus necessary to chain these developments using the value for a given reference year.

The main disadvantage of chain-linked volumes is the loss of additivity, or in other words, the aggregates cannot be obtained directly as the sum of components[1] ; this makes compiling the accounts and presenting them to users more complex.

Calculation of the contributions, which is based on the aggregates' additivity properties, is affected by this lack of additivity.

In the GDP calculations, at least two variables - **net exports** and **change in stocks** - have their evolution presented in terms of contribution to GDP growth.

1.1 Current method

In the NAI's quarterly publications, contributions to GDP growth have hitherto been calculated using a so-called "simplistic" method, namely the method applied previously to constant prices.
The advantage of this approach lies in its simple calculation method, and the fact that all users are familiar with it.

The formula for the contribution of component C to GDP growth at time t is as follows:

$$(C, \text{volume}_{t} - C, \text{volume}_{t-1}) / GDP, \text{volume}_{t-1}$$

This method is only mathematically correct if the data it relates to are additive[2] . And since chain-linked volumes are not, its big disadvantage is that the contributions calculated in this way are not additives either, or in other words, the sum total of the contributions of the components is not equal to GDP growth, which makes the whole exercise a lot less useful.

1.2 New method

The method being used from now on solves the problem of non-additivity by working on the series expressed in the previous year's prices.

Component C, at time t, at the previous year's price (PYP), is defined as:

$$\mathbf{C, PYP_{t}} = (C, \text{volume}_{t} * C, \text{deflator}_{t-1}) / 100$$

The PYP series are actually additive, and, by definition, exhibit the same growth rates as the chained data ("chain-linked volumes" or "CLV").

Contributions to growth will be able to be calculated from these series and from the previous year's series valued at current prices.

2. Method of annual calculation

2.1 Annual calculation formula

On an annual basis, calculation of the contribution of component C to GDP growth for year T ("Contrib, C_{GDP}") can be summarised as:

$$\mathbf{Contrib\ C_{GDP}} = (C, PYP_{T} - C, CUP_{T-1}) / GDP, CUP_{T-1}$$

where
CUP = data at current prices
PYP = data at last year's prices

1. Except for the reference year and the one after that.
2. So it always applies to data at current prices.

2.2 Contribution to growth of balances

As regards the aggregates calculated as balances, the method, notably followed by INSEE and Eurostat, is to define their contribution by measuring the difference between the constituent aggregates; this applies both to annual and quarterly data.

- the contribution of net exports of goods and services (netX) to changes in GDP is defined as the difference between the contribution of exports to this variable and of imports to this same variable:

  Contrib netX $_{\mathbf{GDP}}$ = contrib X $_{GDP}$ - contrib M $_{GDP}$

  where
  X = exports
  M = imports

- The contribution of change in stocks (dstocks), which constitute the balancing item in the expenditure approach, is calculated by measuring the difference between GDP growth and the contributions of all the other components of this approach of GDP:

  Contrib d Stocks $_{\mathbf{GDP}}$ = growth GDP - Contrib Cpriv $_{GDP}$ - Contrib Cpub $_{GDP}$ - Contrib I $_{GDP}$ - (Contrib X $_{GDP}$ - Contrib M $_{GDP}$)

  where
  Cpriv = private consumption
  Cpub = public consumption
  I = total investment

3. INSEE's calculation method for chained quarterly data using the annual overlap method

The issue becomes a lot more complex when calculating the contributions to growth on a quarterly basis.

Before going on to describe how the contributions are calculated, the chaining technique used in the quarterly accounts is reviewed briefly below, as a recap.

3.1 Recapitulation: calculation of chain-linked volumes at quarterly frequency

In order to mirror the principle followed for the annual accounts, the quarterly volume series at chained prices could be calculated at the previous quarter's prices (which is referred to as quarterly chain-linking).

However, there are two problems with this method: on the one hand, the four quarters in volume terms, each using a different price system, could not be added up directly to obtain the annual aggregate; and on the other hand, intra-annual movements of some prices could generate erratic trends from one quarter to the next.

So, in order to ensure greater consistency with the annual accounts, an approach working with the previous year's prices as well has been chosen (this is known as annual chain-linking).

Like many European countries and in line with Eurostat's recommendations, the NAI has adopted the annual overlap technique[1], whereby the volume for each quarter is calculated at the average price of the previous year and chained on the basis of the annual accounts.

This technique has two advantages:
– it enables the levels for the four quarters of the year to be added up so that the annual figure (additivity of all the quarters in the year) can be obtained directly;

1. Selected because it is relatively easy to use in the context of the temporal disaggregation method applied for compiling the Belgian quarterly accounts. In principle, two other methods are available: on the one hand the one-quarter overlap system and on the other hand, the over-the-year overlap technique, which has nevertheless been rejected by both the IMF (SNA) and Eurostat as it is liable to lead to very uneven trends, while also showing additivity and consistency problems.

– it makes it possible to obtain directly annual growth figures that are consistent between quarterly and annual accounts.

It nevertheless has a disadvantage in that the volume growth in the first quarter of a given year from the fourth quarter of the previous year spans the change in pricing system (the volume for the first quarter of year T is calculated at year T-1 prices, while the volume for the fourth quarter of year T-1 is calculated at year T-2 prices).

3.2 Calculation of contributions to growth for volumes calculated using the «annual overlap» technique

The following principle applies: in order to get round the problem of non-additivity, just as for the annual calculation given above, contributions are addressed by converting into the previous year's prices (PYP), which are of course additive and present the same growth rates as the data in CLV (by definition of the CLVs and the annual overlap technique).

Interested readers may want to refer to the very detailed methodological note published by INSEE[1] , which is summarised below.

3.2.1 Quarter-on-quarter calculation (quarter q compared with quarter q-1)

At quarterly intervals, data given in PYP present the same trends as the data in CLV **for quarters 2 to 4.**

The contribution of component C to GDP volume growth is:

$$\textbf{Contrib C}_{\textbf{GDP}}\ \textbf{q, q-1} = \left[\frac{C\,CLV,\ q-C\,CLV,\ q-1}{GDP\,CLV,\ q-1}\right] * \left\langle \frac{C\,P,\ T-1}{GDP\,P,\ T-1} \right\rangle$$

where:

CLV = chained linked volume data
P = annual deflator derived from the CLV = annual CUP / annual CLV
q = quarter q
T = year T

where the term given between [ ] is the instinctive calculation of the contribution for additive data, which is then adjusted for the price differential between component C and the GDP for the previous year T-1 (term given between $\langle\ \rangle$).

However, a problem crops up for the first quarter of a year T, which in PYP terms is estimated at prices in T-1, while the quarter before it, the fourth quarter of year T-1, is calculated at prices in year T-2 instead.

Therefore, in the case of quarter-on-quarter contributions to growth for the first three months of a year, it is necessary to adapt the calculation to adjust for this difference in pricing system.

This is precisely what the term between { } below does; the difference in annual relative prices between T-1 and T-2 (first term between brackets) is weighted by the difference between the quarterly and annual volume shares of the component in the gross domestic product recorded in the fourth quarter of the previous year (second term between brackets).

1. INSEE methodology (available in French only): http://www.insee.fr/fr/indicateurs/cnat_trim/Pub_Meth/Calcul%20des%20contributions%20en%20volumes%20cha%EEn%E9s.pdf

For the first quarter, the formula becomes:

$$\text{Contrib C}_{GDP}\ q,\ q\text{-}1 = \left[\frac{C\,CLV,\ q-1 - C\,CLV,\ q-1}{GDP\,CLV,\ q-1}\right] * \frac{C\,P,\ T-1}{GDP\,P,\ T-1} + \left\{\left(\frac{C\,P,\ T-1}{GDP\,P,\ T-1} - \frac{C\,P,\ T-2}{GDP\,P,\ T-2}\right) * \left(\frac{C\,CLV,\ q-1}{GDP\,CLV,\ q-1} - \frac{C\,CLV,\ T-1}{GDP\,CLV,\ T-1}\right)\right\}$$

where q = q1 of year T
q-1 = q4 of year T-1

3.2.2 Year-on-year calculation (quarter q compared with quarter q-4)

In the case of contributions to year-on-year growth, the comparison of each of the quarters involves two pricing systems (T-1 prices for the quarters in T, and T-2 prices for the quarters in T-1).

The adjustment factor must be applied **for all quarters**:

$$\text{Contrib C}_{GDP}\ q,\ q\text{-}4 = \left[\frac{C\,CLV,\ q-1 - C\,CLV,\ q-4}{GDP\,CLV,\ q-4}\right] * \frac{C\,P,\ T-1}{GDP\,P,\ T-1} - \left\{\left(\frac{C\,P,\ T-1}{GDP\,P,\ T-1} - \frac{C\,P,\ T-2}{GDP\,P,\ T-2}\right) * \left(\frac{C\,CLV,\ q-4}{GDP\,CLV,\ q-4} - \frac{C\,CLV,\ T-1}{GDP\,CLV,\ T-1}\right)\right\}$$

3.2.3 In practice:

INSEE's website provides an Excel macro to calculate contributions to growth from quarterly data in value terms and in chain-linked euros computed using the annual overlap technique. Go to the following webpage:

http://www.insee.fr/fr/themes/theme.asp?theme=16&sous_theme=8&type=2&nivgeo=0&page=methodologie.htm

then click on the Excel tab marked "exemple de calcul de contributions".

4. Illustration

4.1 On an annual basis

The examples given in table 1 show that the differences between the results obtained from the two methods are often quite small, owing to relatively minor changes in relative prices between the components of the most detailed level of calculation. Since international trade flows often exhibit more marked changes in relation to GDP than private consumption does, the differences there between the two calculation methods are slightly greater.

TABLE 1 CONTRIBUTION OF SOME MAJOR AGGREGATES OF THE EXPENDITURE APPROACH TO ANNUAL VOLUME GROWTH OF GDP (JULY 2010 VERSION)

	Private consumption			Exports of goods and services			Imports of goods and services		
	"Simplistic" method	Calculation via PYP	Difference	"Simplistic" method	Calculation via PYP	Difference	"Simplistic" method	Calculation via PYP	Difference
1996	1.0%	1.1%	-0.1%	2.3%	2.4%	-0.1%	2.7%	2.6%	0.1%
1997	1.2%	1.1%	0.1%	6.4%	6.6%	-0.2%	5.8%	5.6%	0.2%
1998	1.4%	1.4%	0.0%	3.2%	3.3%	-0.1%	3.8%	3.7%	0.1%
1999	1.1%	1.1%	0.0%	3.1%	3.1%	0.0%	1.9%	1.8%	0.1%
2000	1.5%	1.4%	0.1%	8.3%	8.3%	0.0%	8.5%	8.0%	0.5%
2001	0.7%	0.8%	-0.1%	0.8%	0.8%	0.0%	0.1%	0.1%	0.0%
2002	0.3%	0.3%	0.0%	2.1%	2.1%	0.0%	0.7%	0.7%	0.0%
2003	0.4%	0.3%	0.1%	0.6%	0.6%	0.0%	0.6%	0.6%	0.0%
2004	0.8%	0.8%	0.0%	5.1%	4.9%	0.2%	4.9%	4.6%	0.3%
2005	0.7%	0.5%	0.2%	3.7%	3.5%	0.2%	4.5%	4.2%	0.3%
2006	1.0%	0.9%	0.1%	4.1%	4.1%	0.0%	3.7%	3.5%	0.2%
2007	0.9%	0.9%	0.0%	3.7%	3.6%	0.1%	3.8%	3.7%	0.1%
2008	0.7%	0.8%	-0.1%	1.4%	1.4%	0.0%	2.5%	2.4%	0.1%
2009	-0.1%	-0.1%	0.0%	-9.9%	-9.9%	0.0%	-9.4%	-9.4%	0.0%

Source: NAI

4.2 On a quarterly basis

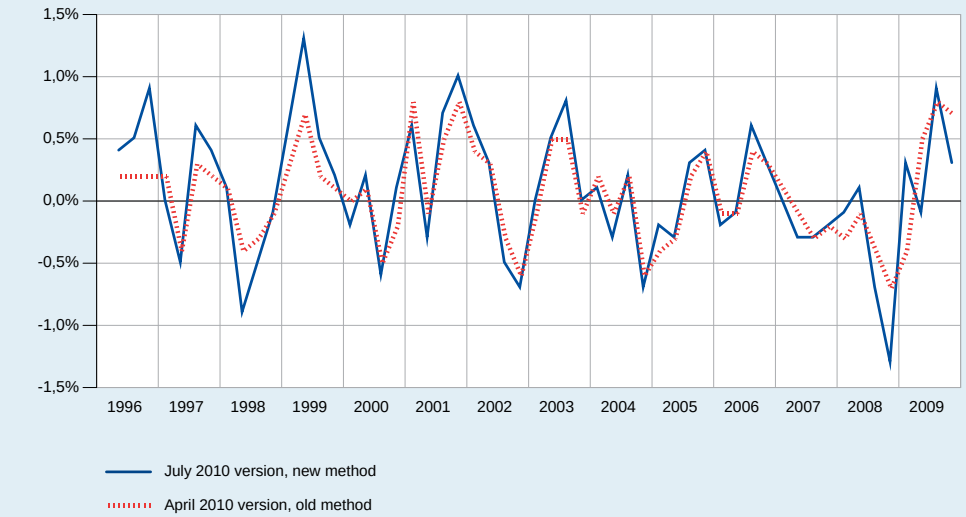
Similar observations can be made mutatis mutandis for the components of the quarterly accounts. For the sake of conciseness, this analysis will be limited to comparing the results for the two balances that enter into the calculation of quarterly GDP, i.e. net exports and change in stocks.

4.2.1 Net exports of goods and services

- Compared with the previous quarter

The change of method does not fundamentally alter the profile of contributions of the net external balance to GDP growth. The new method nevertheless gives slightly more volatile results (chart 1).

CHART 1 **CALCULATION REVISION OF CONTRIBUTION OF NET EXPORTS[1] TO QUARTER-ON-QUARTER VOLUME GDP GROWTH**



Source: NAI
1 Seasonally and calendar adjusted data

Changes in the previous year's export and import prices compared with changes in the GDP deflator have an amplifying effect, as set out in table 2. The differences also stem from the revision of the quarterly accounts after calibration with the new annual national accounts published in mid July 2010[1] (chart 2).

TABLE 2 **CHANGES IN PREVIOUS YEAR PRICES IN RELATION TO THE GDP DEFLATOR**

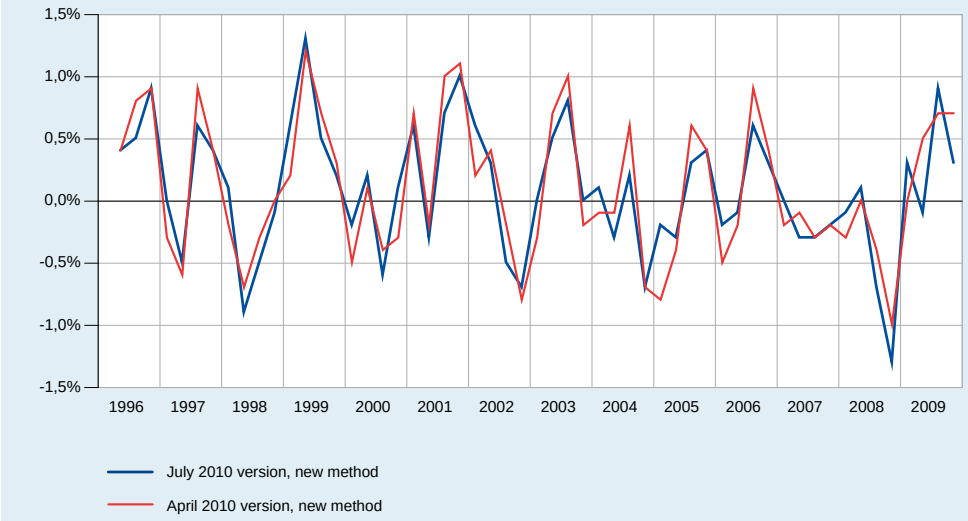
= factor $\langle \frac{CP,\ T-1}{GDP\ P,\ T-1} \rangle$ in the contribution calculation formula

	for exports	for imports	for net exports
	fX	fM	=fX-fM
1996	4.4%	-2.4%	6.7%
1997	2.4%	-3.4%	5.8%
1998	2.7%	-2.7%	5.5%
1999	-0.2%	-6.3%	6.1%
2000	-0.5%	-5.6%	5.0%
2001	2.9%	-0.2%	3.1%
2002	2.2%	-1.0%	3.2%
2003	-0.4%	-4.6%	4.2%
2004	-3.7%	-7.6%	4.0%
2005	-3.8%	-6.9%	3.1%
2006	-2.2%	-5.2%	3.0%
2007	-1.9%	-4.1%	2.2%
2008	-2.0%	-4.4%	2.3%
2009	0.0%	0.0%	0.0%

Source: NAI

1. Here, the quarterly series are fully revised even if the annual volume growth is only updated for the most recent years. The quarterly accounts are actually estimated by starting the calculation procedure with chain linked volumes, whose levels are totally modified by the change in reference year. Moreover, adding new annual and quarterly data at the end of the time series implies recalculating seasonal and calendar effects, which also has an impact on past data in value terms, derived as the ratio between volumes and deflators.

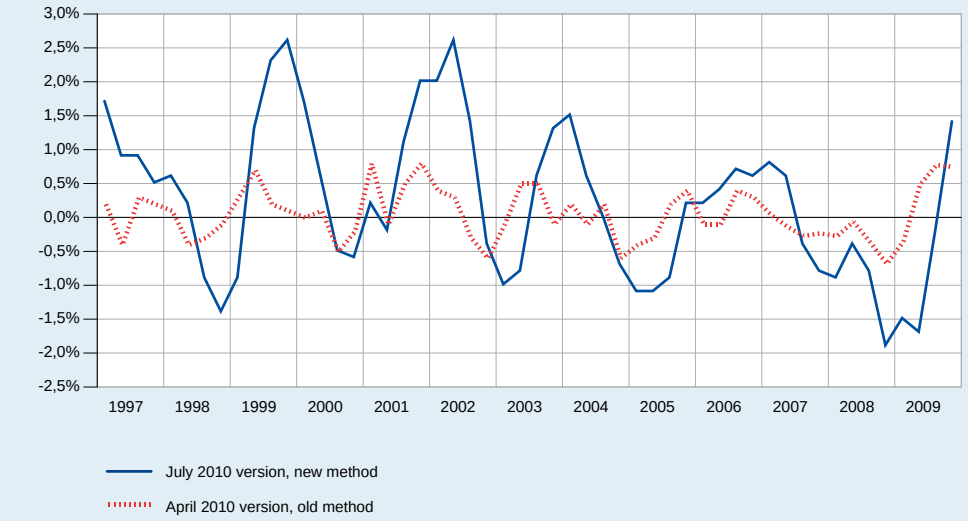
CHART 2 **CONTRIBUTION OF NET EXPORTS[1] TO QUARTER-ON-QUARTER VOLUME GDP GROWTH: IMPACT OF CHANGE IN VERSION**



Source: NAI
1 Seasonally and calendar adjusted data.

- Compared with the same quarter of the previous year

CHART 3 **CALCULATION REVISION OF CONTRIBUTION OF NET EXPORTS[1] TO YEAR-ON-YEAR VOLUME GDP GROWTH



Source: NAI
1 Seasonally and calendar adjusted data.

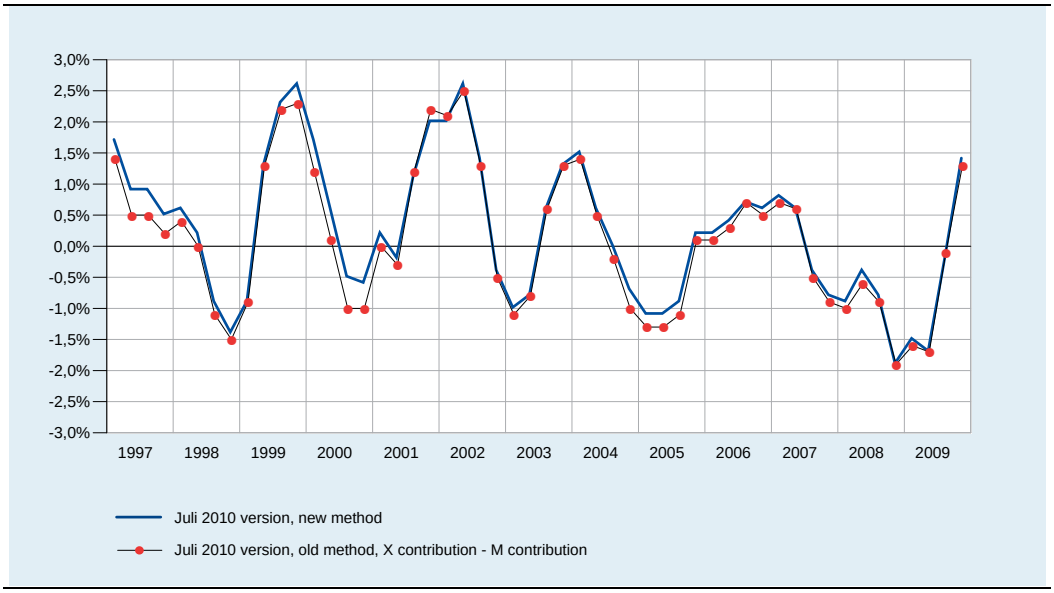
The differences between the two methods are greater when calculating growth rates on the same quarter of the previous year (chart 3).This may seem quite logical since the weakness of the simplistic method lies mainly in the first three-month period for the quarter-on-quarter calculation, while the differences between the annual relative prices are disregarded in each of the four quarters when year-on-year comparisons are made.

However, the main cause of the divergences between the old and new methods is something quite different: in the past, the contribution to growth was calculated directly from chain-linked net export volumes themselves (because of the non-additivity). **But, it should be recalled that the calculation of chain-linked volumes is not suitable for balances that can take on both positive or negative values or be close to zero**[1].

In the quarterly accounts, this process has nonetheless been carried out up until now, along the lines of annual accounting practice, as wall as the method used for quarterly chain-linking (requiring PYP), but this was far from perfect.

If, under the old method, the contribution of net exports had been calculated as the difference between the contribution of exports and that of imports, the result obtained would have been quite close to that under the new method, as shown in chart 4.

CHART 4 **CONTRIBUTION OF NET EXPORTS[1] TO YEAR-ON-YEAR VOLUME GDP GROWTH: COMPARISON BETWEEN THE NEW METHOD AND THE OLD METHOD APPLIED TO FLOWS**



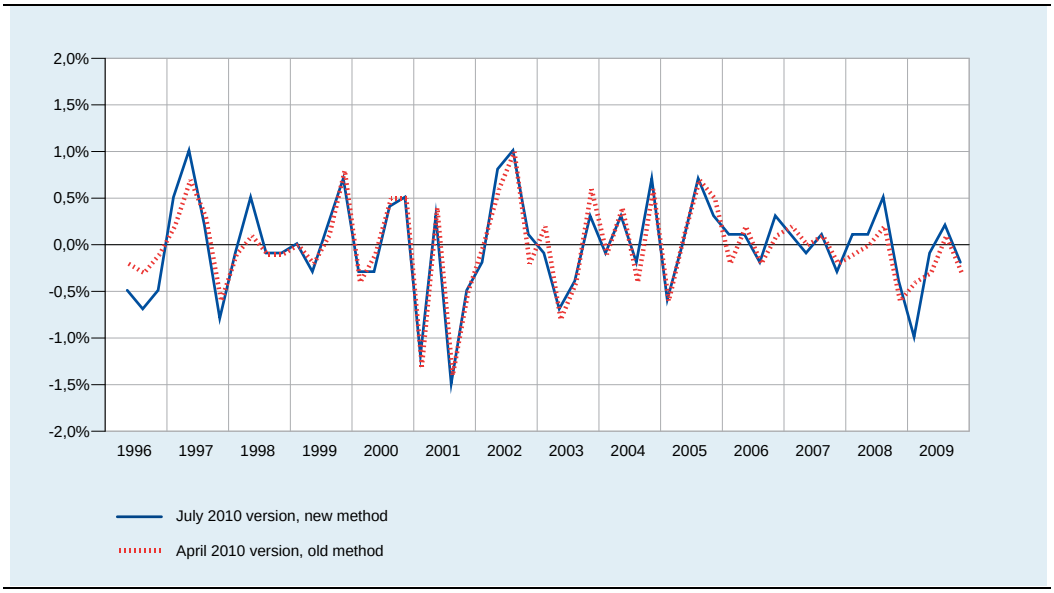
Source: NAI
1 Seasonally and calendar adjusted data.

1. «Strictly speaking, any national accounts variable that, by definition, can take on both positive or negative values is not suited for chain-linking, the sign of the resulting chain is uninterpretable, values close to zero lead to large fluctuations in the chain, and any real zero in the series would cause the chain to either break or fix the series at zero for all following observations. The main variables concerned in national accounts are the changes in inventories, the acquisition less disposal of valuables and the external balance. (...) In consequence, it is common to not provide any volume series for these variables at all, but to show them only at current prices and at previous year's prices, and to supplement this with their contributions to GDP growth from an auxiliary calculation.» (Source: Eurostat, «Frequently asked questions on national Accounts», 2010)

4.2.2 Change in stocks

- Compared with the previous quarter

CHART 5 **CALCULATION REVISION OF CONTRIBUTION OF CHANGE IN STOCKS[1] TO QUARTER-ON-QUARTER VOLUME GDP GROWTH**

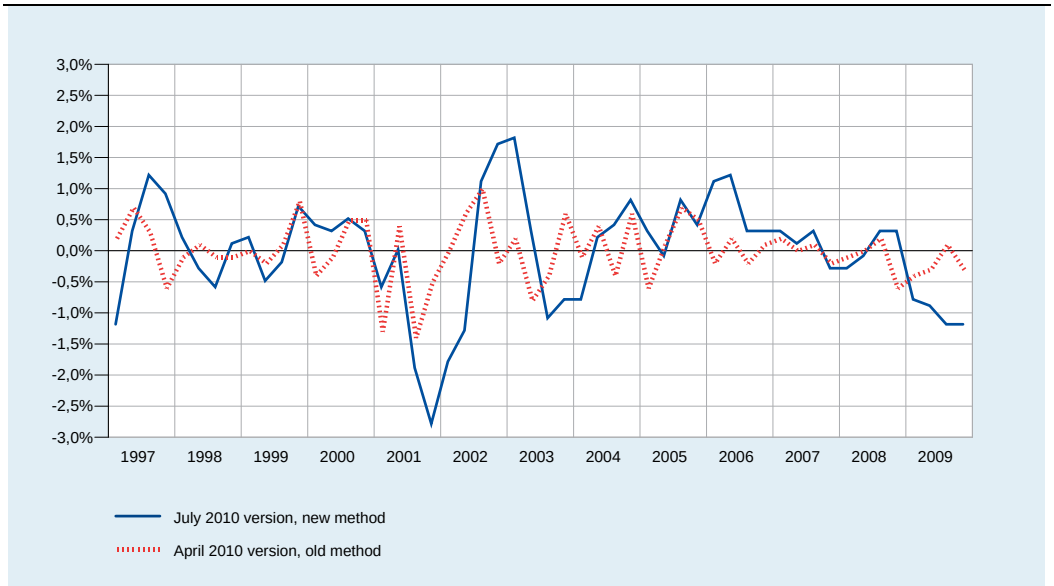


Source: NAI
1 Seasonally and calendar adjusted data.

The revision of contributions of change in stocks to quarter-on-quarter GDP growth generally tends to be very minor (chart 5).

- Compared with the same quarter of the previous year

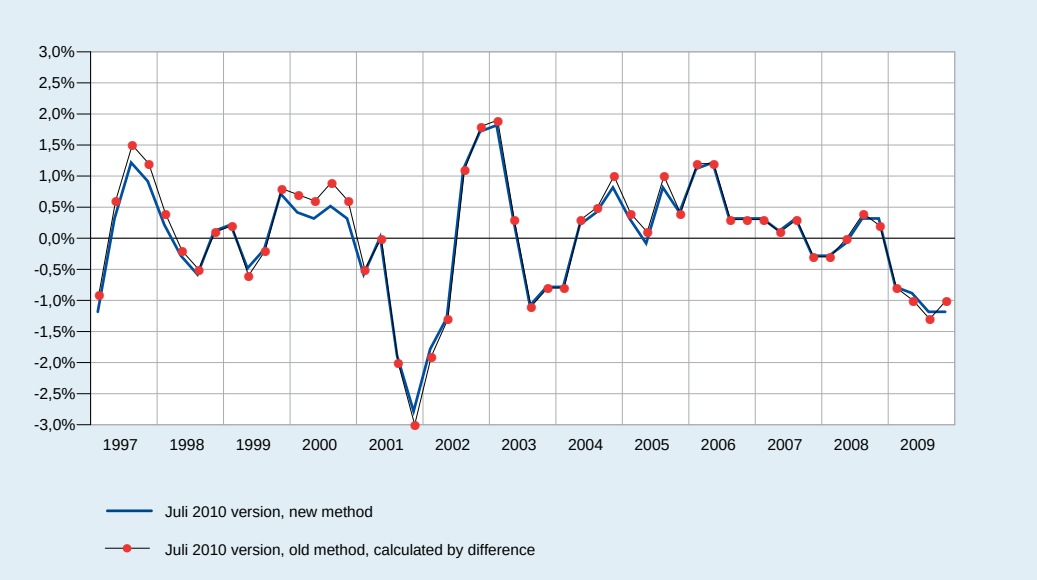
CHART 6 **CALCULATION REVISION OF CONTRIBUTION OF CHANGE IN STOCKS[1] TO YEAR-ON-YEAR VOLUME GDP GROWTH**



Source: NAI
1 Seasonally and calendar adjusted data.

It is larger for year-on-year contributions (chart 6), which, as has been analysed in the case of net exports, stems mainly from the fact that the contribution of change in stocks is calculated by difference (i.e. between GDP growth and contributions of all the components of domestic and foreign demand[1]), and no longer based directly on the level of the incorrectly chained balance.

CHART 7 CONTRIBUTION OF CHANGE IN STOCKS[1] TO YEAR-ON-YEAR VOLUME GDP GROWTH: COMPARISON BETWEEN THE NEW METHOD AND THE OLD METHOD APPLIED TO FLOWS



Source: NAI
1 Seasonally and calendar adjusted data.

That is illustrated in chart 7: after calculating by difference using the old method, the gap between the old and new result has almost disappeared. The remaining difference between the two series comes from the adjustment factors to compensate for non-additivity of the original CLV series.

5. Conclusions

The levels of the quarterly series of chain-linked volume estimates for net exports and change in stocks (levels in chained euros), which appeared in the tables annexed to the hard-copy brochure as well as in the Belgostat database, will no longer be published. Since these balance series cannot be calculated correctly, they provide rather shallow information in absolute terms, and movements in these data are not always relevant for, nor reconcilable with trends in their constituent aggregates.

For calculating contributions to quarterly GDP growth, which is the only relevant way of presenting and analysing these balances, the new formula as described above has been applied and published in the Belgian quarterly accounts since the end-July 2010 edition.

1. See page 3 for the formula for calculating the contribution of change in stocks to GDP growth by difference.