Compiling annual and quarterly national accounts main aggregates for the European Union and the euro area

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1. Introduction

Compiling national accounts for supranational entities such as the EU must follow the same set of internationally agreed definitions and rules as those for any single country. These principles are set out in the European System of National and Regional Accounts, or ESA95 for short.

The source data however is quite different: Member States' accounts are built from grass-root level, using a vast array of sources such as administrative data from tax authorities and social insurance schemes, censuses, and surveys of businesses and households. In contrast, the accounts for the EU accounts are built from Member States' accounts, without direct reference to the original source data or to the EU equivalents of national sources.

This document gives information on the compilation of national accounts main aggregates such as GDP, investment or consumption, for the EU and the euro area. It does **not** deal with specific fields inside the accounts such as the government accounts, sector accounts, regional accounts or input-output-tables.

2. Annual accounts

2.1 General issues in annual accounts

Annual EU accounts are derived from **aggregating** the respective annual national accounts data of Member States. The type of aggregation depends on the variable concerned: level series usually require summation across Member States, while growth rates and index series need aggregation via a weighted average. By default, Eurostat aggregates national **level** series by summation, without consolidation of flows between Member States. Other series such as growth rates, indices and ratios are by-products of the levels rather then direct aggregations of national growth rates, indices and ratios.

Deriving European aggregates by summing up Member States' data demands two prerequisites to be met. The first condition is that Member States **coverage** must be complete.

> Member States are legally required to transmit complete national accounts to Eurostat within certain deadlines. Where single Member States' figures are lacking, Eurostat may

still provide an estimate for the European aggregates, for example by using unpublished estimates for missing countries. The most frequent case is for the latest year to be missing. In that case, Eurostat regularly uses forecast values (based on growth forecasts from the European Commission's Directorate General for economic and financial affairs (DG ECFIN) which are replaced by actual accounts as the latter are published by Member States.

The second condition is that Member States data must be expressed in a **common currency**.

This issue is settled in a straightforward way by converting all national figures to ECU/Euro before aggregation. Please note that the summation is done on figures expressed in ECU/Euro, not on figures expressed in national currencies, even if, in the case of euro area Member States, they use the Euro as a common currency. This is because euro area Member States express their national series in "fixed Euro", i.e. their former national currency converted to Euro using the irrevocably fixed conversion factor for all years, while "ECU/Euro" are done from a time-varying exchange rate for years before 1999 (2001 in the case of Greece). Aggregating "fixed Euro" series for years before 1999 is as meaningless as summing figures expressed in "French Francs" and "Deutsche Mark". From 1999 onwards, however, the two units "ECU/Euro" and "fixed Euro" coincide.

Exchange rates are supplied by the European Central Bank. The exchange rates used are annual averages of the reference period. For chain-linked data, the exchange rates of the reference year apply to the whole series. For data at previous year's prices, exchange rates of the previous year apply.

With these two conditions fulfilled, the compilation of EU national accounts usually reduces to summing Member States levels expressed in ECU/Euro, so there is no need for assigning **explicit weights** to **Member States**. Their weight will be implicitly fixed by the level of their national accounts series and simply be their share in the total. Weights will thus be different between variables, and, at current prices, also between years.

The EU aggregates must satisfy some basic coherence requirements:

Geographical coherence designates coherence of data for a geographical aggregate (such as the EU or the euro area) with data for its constituent components. The form of coherence to be expected depends on the variable, the usual form for level data being identity of the EU total with sum of Member States' figures. This is regularly ensured for the EU accounts by virtue of their derivation, except for items touched by measures to assure the accounting coherence outlined below. Please note however that the EU accounts are updated only at fixed intervals, while data for Member States on Eurostat's online database are updated immediately after their national release, which means there may be a difference between the European aggregate and the appropriate sum of national data in between updates.

Accounting coherence designates the respect of equations which should hold between several accounting variables by definition. The most prominent of these equations is the representation of GDP by means of expenditure components:

GDP = consumption + investments + exports - imports

Accounting coherence of this type is not necessarily assured from summing Member States' data. It is therefore enforced for EU annual accounts wherever it can be expected to hold, i.e. at current prices and at previous year's prices. For chain-linked volume series, series are – by definition – coherent only in the reference year and the year following the reference year.

The way of enforcing coherence varies from equation to equation, with either one variable being used as a balancing item which takes up any discrepancy, or the discrepancy being distributed proportionally between variables. The former approach is most notably used with changes in inventories plus net acquisition of valuables

(P52+P53) for the expenditure presentation of GDP and gross operating surplus and mixed income (B2G+B3G) for the income presentation. The latter approach of distributing a discrepancy (if any) among all components is used with the output presentation. As regards national income, accounting consistency is also established via balancing items, or more exactly by deriving some variables directly from the accounting equations, rather than aggregating them directly. This is the case for K1 (consumption of fixed capital), D5+D6+D7 (other current transfers with the rest of the world, B8N (Net saving) and D9 (capital transfers with row).

The same type of coherence is enforced for breakdowns by industry, investment product or COICOP.

It should also be noted that so far, no **consolidation** of flows between Member States is done in aggregating to EU levels. This means in particular that the level of exports and imports for the EU (or euro area) includes flows within the EU (or euro area). The external balance however is not affected, because the non-consolidated flows in exports and imports cancel each other out in the balance.

2.2 Annual accounts volume measures

Volume figures have traditionally been expressed in **constant prices** (COP) of a base year (commonly moved ahead every five years, 1995 or 2000 being the most recent ones). In view of producing more accurate measures of volume growth, the price base is now updated every year, giving data in **previous year's prices** (COPPY). Since the price base changes for every observation, a series of observations at previous year's prices does not establish a true time series, and growth rates cannot be derived directly from the series. The **current prices** (CUP) series are then additionally required to provide the correct basis for the calculation of volume growth rates.

Multiplying successive growth rates starting from a reference year's level will give a true **chain-linked volume** (CLV) time series. Choice of reference year for the chain-linking is arbitrary and a mere convention (unlike the choice of the fixed base year for a series in constant prices). Chain-linking was introduced into the EU accounts end-November 2005, with 2000 as reference year.

To illustrate the concept, the CLV value with reference 2000 for the observation year 2002 is derived via chaining as follows:

$$CLV(2002) = CUP(2000) * [COPPY(2001) / CUP(2000)] * [COPPY(2002) / CUP(2001)]$$

Putting "growth rate (t)" for COPPY(t) / CUP(t-1), this gives

$$CLV(2002) = CUP(2000) * \text{growth rate (2001)} * \text{growth rate (2002)}$$

The CLV value for 2003 is then derived by joining another link (ie growth rate) to the chain:

$$CLV(2003) = CLV(2002) * \text{growth rate (2003)}$$

$$= CUP(2000) * \text{growth rate (2001)} * \text{growth rate (2002)} * \text{growth rate (2003)}$$

A fundamental feature of chain-linking is the **loss of additivity** for all years except the reference year and the year directly following. This means that (apart from those two years) neither geographical nor accounting coherence can be expected in the EU accounts chain-linked volume series. Consequently, the default aggregation for EU accounts, i.e. summing up Member States' level data, is not suitable for chain-linked series. Instead, the EU accounts are derived at previous year's prices by summing up Member States' previous year's prices series, and the resulting EU values at previous year's prices are subsequently chain-linked, without recourse to Member States' chain-linked data. For those few Member States that still use constant prices (of a fixed base year), Eurostat internally approximates previous year's prices series for use in the aggregation by "unchaining" the COP series using annual deflators derived from COP and CUP:

$$COPPY(t) \approx CUP(t-1) / COP(t-1) * COP(t)$$

This ensures that this country's growth rate enters correctly into the EU aggregate, which is built from summing up the national COPPY series, regardless whether originally supplied by the country or approximated by Eurostat.

The loss of additivity also prevents easy calculation of **custom (higher) aggregation levels**. For example, the chained-volume series of domestic demand, defined as the sum of consumption expenditure and capital formation, cannot be simply derived from summing the two chain-linked component series. Instead, the values at previous year's prices have to be summed and then chain-linked.

National accounts variables that can take on negative as well as positive values – such as residual and balancing items - cannot be expressed as chain-linked volumes. Amongst the commonly used national accounts variables, this concerns mainly **changes in inventories** and the **external balance**. For these, the only volume expression available is at previous year's prices.

Contributions to GDP growth show how a change in GDP can be attributed to changes in its components, combining information on both a component's dynamics and size. Contributions to GDP growth can be calculated straightforward from COPPY and CUP series. For gross fixed capital formation (GFCF) for example, the contribution is calculated as

$$\text{Contribution of GFCF to GDP growth (t)} = [\text{GFCF COPPY(t)} - \text{GFCF CUP(t-1)}] / \text{GDP CUP(t-1)}.$$

Since contributions are derived from data at previous year's prices, they are additive. The contribution for the external balance is calculated as the difference between the contributions of exports and imports, and the contribution of changes in inventories is derived as a residual contribution.

2.3 Specific issues in annual accounts

- An indication of price developments ("inflation") is given by **implicit deflators**. For a given variable, these are derived from current prices and volume measures. An index with the same reference year as the CLV series is calculated as

  $$\text{Deflator Index (t)} = CUP(t) / CLV(t)$$

  This deflator is implicit in the sense that it is derived from independently compiled nominal and volume accounts, not from direct observation of price data. Directly observed price data however feeds into the sources for the compilation of national CUP and CLV series. Note that in European national accounts, no volume series are derived by application of explicit deflators to nominal (current prices) data. Implicit deflators are calculated for any variable for which both a nominal and a volume level are available

- Subsequent years may differ slightly in the number of **working days** they comprise. Annual accounts do not include a working day adjustment. This type of adjustment is common in quarterly accounts (see below), but very rare in annual accounts, where differences are supposed to be too small in relation to the total number of working days in the year to justify the application of an additional adjustment. Still, for the interpretation of annual growth rates one should keep in mind that they may, in part, be due to differences in the number of working days.

- The EU annual national accounts aggregates are subject to the following **revision policy**: Aggregates are updated with every regular release of quarterly national accounts. Dates for those are published in Eurostat's release calendar. Currently, there are eight regular releases each year, and hence eight updates of annual EU accounts, roughly four to six weeks apart. In between Eurostat releases, Member States may revise their figures; Eurostat publishes the new Member States' accounts but does not recalculate the EU accounts until the next scheduled EU release. Geographical coherence will be lost for a brief period. In turn, a

certain stability of annual aggregates is assured, and annual and quarterly EU aggregates will by default be coherent.

- Two-year-ahead **forecasts** are published by Eurostat for a number of variables, both for the EU accounts and for Member States. These are based on forecasts prepared by DG ECFIN and published regularly on their website. Those forecasts are updated (at least) twice a year. No other forecasts are used, in particular none produced by national sources, nor does Eurostat produce forecasts of its own. However, DG ECFIN's forecasts are dynamically applied to the latest available national accounts. This is done by using forecasted growth rates rather than forecasted levels. Growth rate forecasts are applied to whatever is the latest actually available level value, resulting in updated level forecasts when the actual series are revised.

3. Quarterly accounts

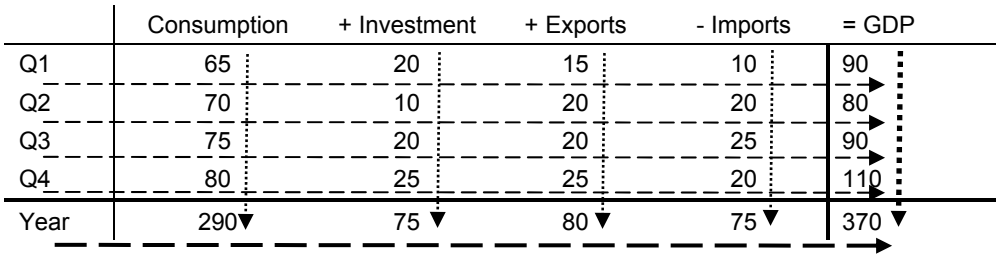
3.1 General issues in quarterly accounts

All EU Member States compile quarterly accounts. EU totals could thus, in principle, be obtained through the aggregation of the data from each Member State, as is the case for annual data. In the case of quarterly data however, the situation is somewhat more complicated. Some differences between the quarterly national account systems of EU Member States still persist, particularly as regards the quarterly coverage, publication delays, revision policies and seasonal adjustment procedures.

Eurostat **estimates** the quarterly EU accounts from annual EU accounts using Member States quarterly information as available. The main reason for this approach is the strong demand for timely quarterly accounts. Business cycle analysis requires quarterly results for the EU25 and in particular the euro area much earlier than the arrival of data for the last of twenty-five Member States. Another reason is that quarterly accounts add another dimension to coherence requirements, i.e. coherence between quarterly and annual results.

Quarterly accounts have to be both time consistent with the annual accounts (for example the sum of quarterly values of the GDP must be equal to the annual value of GDP) and respect the accounting identities (for example, the sum of quarterly values of the GDP expenditure components should be equal to the corresponding quarterly value of GDP). The figure below illustrates these requirements for GDP and its expenditure components.

Figure 1: GDP and expenditure components, quarterly and annual relations between components



The sum of the four quarterly values for each component must be equal to the annual corresponding value (So for consumption, 65 + 70 + 75 + 80 = 290 – coherence in time).
Each quarter, the sum of the quarterly values of the components must be equal to the corresponding value of GDP (So for Q1, 65 + 20 + 15 - 10 = 90 – accounting coherence).
Finally, the sum of the annual values of the components, which are the sums of the corresponding quarterly values, must be equal to the GDP annual value (290 + 75 + 80 – 75 = 370), which is at the same time expected to be the sum of quarterly GDP (90 + 80 + 90 + 110 = 370).

Time consistency is a fundamentally *univariate* problem since it involves only one variable, albeit at two frequencies (annual and quarterly). Accounting coherence and time consistency combined exhibit a *multivariate* dimension, since they involve several variables linked by a contemporaneous constraint (in the case above, this is quarterly GDP which "constrains" the sum of the quarterly component values), with each of the variables subject to their own univariate temporal constraint.

Eurostat uses the approach described below to compile three estimates of quarterly EU accounts at around 45, 65 and 105 days after the end of the quarter, respectively.

3.2 The quarterly estimation procedure

The information available for the estimation of quarterly EU accounts is

a) the respective annual totals (the compilation of which has been described above) and

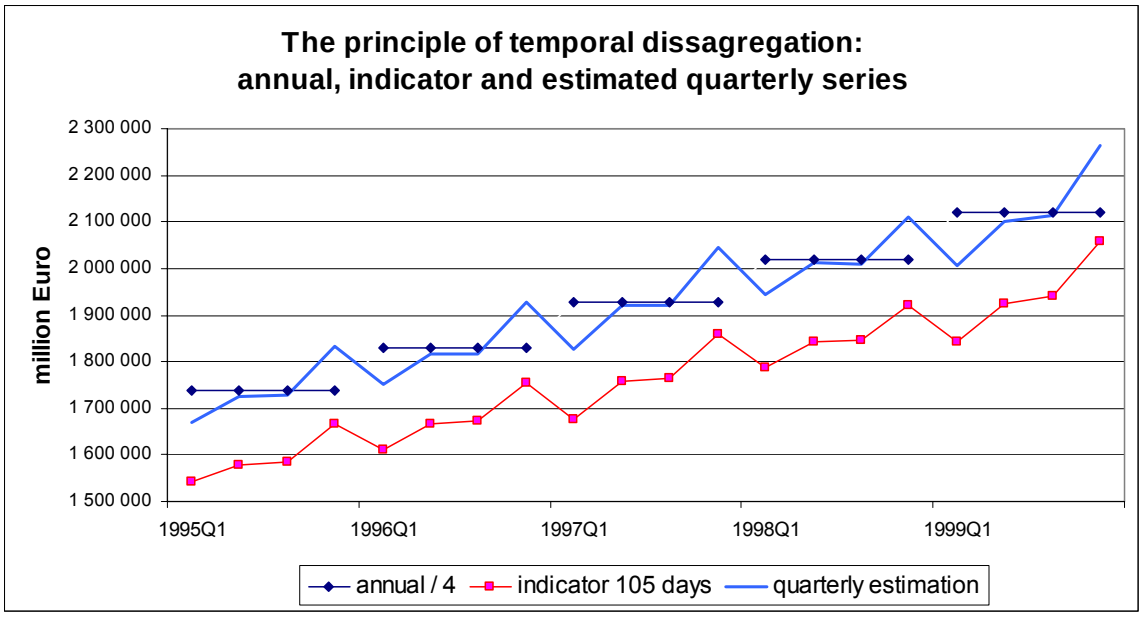
b) the quarterly figures of those Member States for which data are available. The share of the total represented by the available countries depends on when and for which variable the estimation is done. In practice, for GDP, this figure ranges broadly between 75% and 99%.

The basic principle of the estimation is to break down the **known complete annual** EU aggregate into a quarterly figures by using the sum (or whichever aggregation is appropriate) of the only **partially available quarterly** country data as an indicator. This approach is known as temporal disaggregation of time series. In practice, this involves two steps:

1. For a given variable, say GDP, a quarterly indicator is constructed by summing up across Member States as far as available. By default, no explicit estimations are done for missing values (or whole series) of Member States in the construction of the quarterly indicator series. There are some exceptions to this rule, for instance in the case that a country is available for the non-seasonally adjusted indicator, but no seasonally adjusted series is available. Eurostat may then apply a seasonal adjustment to the national series in order to increase the coverage of the indicator. None of these Eurostat estimates of national figures are published.
2. The known annual value of the variable is disaggregated into a quarterly series which gives the correct annual sum while reflecting the quarterly movements of the indicator. This is done by applying the Chow-Lin method, relating the unknown quarterly figures to some quarterly indicator series by a regression model. For the latest quarters a corresponding annual value may not yet be available - for example, no data for the year 2005 is available when the first estimations of the second quarter 2005 are published in September 2005 well before the year is even finished. For these latest quarters, the Chow-Lin method provides an extrapolation based on the quarterly indicator using the model estimated from that time span for which the annual series and the indicator are both available.

   For getting reliable results from this temporal disaggregation, it is important that the quarterly indicator series is a plausible proxy for the path of the variable of interest. This certainly is the case for the EU estimations, where the indicator series are a true part of the target series and for which coverage is usually good, i.e. the available countries represent more than 75 % of the EU total.

The figure below illustrates the approach. It shows annual GDP at current prices for the EU25 for a five-year period, the unadjusted quarterly indicator series available at the second regular GDP estimate (at t+105 days), and the resulting estimate of the quarterly GDP series derived from the former two. Please note that the annual values have been divided by four to present them on the same scale as the quarterly series.



The two steps as stated above are performed for GDP and for all other series to be estimated. Estimations are calculated independently for seasonally adjusted and unadjusted quarterly series in cases where both series are available. The procedure uses all information (i.e. quarterly and annual time series for all countries) available at the time of the estimation. A Member State for which no quarterly data is included at all will still have an influence on the quarterly European aggregate because its annual values enter into the model. There is arguably a tendency for smaller Member States' to have higher growth rates and to publish later and less complete quarterly accounts data than larger Member States. In that case, the quarterly indicator would be biased towards too low growth. This will however not translate into a bias in the EU estimates, as the constraining annual data does always contain all Member States, and the estimated regression parameters will take this effect into account.

These univariate estimations are calculated independently of each other, and results will hence normally not fulfil any **accounting constraints**. In order to enforce the accounting constraints on the results received, the discrepancy between the quarterly value of GDP and the quarterly sum of the components estimates is distributed among the components. The exact method applied varies between different parts of the accounts. In most cases and in particular for the expenditure components of GDP, the multivariate Denton method is applied. The aim of this technique is to distribute the discrepancies among the components while maintaining the time consistency and keeping intact, as much as possible, the growth rates of the series. For other accounting constraints, differences may be distributed proportionally, or single variables may be assigned the whole discrepancy. The same applies when passing to accounting constraints below the level of GDP.

By virtue of their construction, the quarterly estimations are then both **coherent with regard to accounting constraints** and **coherent in time** with the annual accounts (see below for the issue of working-day correction). Due to limited availability of complete Member States' data **geographical coherence** is not a major issue. However, under the current estimation approach, geographical coherence will only be guaranteed if all Member States accounts are internally fully accounting coherent and coherent in time.

The summation of national values into the indicator series requires them to be expressed in a common currency, i.e. the ECU/Euro as for the annual aggregates. For current price estimations, quarterly **exchange rates** are used. For the members of the euro area, these rates are equal to the irrevocable euro conversion rates for all quarters after their entry into the euro area, but they are the ECU rates for earlier quarters. For chain-linked volumes, the average exchange rate of

the reference year applies to the whole series. For data at previous year's prices, average exchange rates of the previous year apply.

There are **no fixed weights** attributed to each country in the estimation of the European totals, weights are derived implicitly in the course of the estimation process and vary between variables. They will largely coincide with the share each country has in the annual total. It should however be noted that the indicators' movement for the latest quarter, where results may still be missing for a number of countries which are otherwise available for all previous quarters, will largely depend on the quarterly figures of those countries available at the time of the estimation. The influence of those countries reporting early is thus somewhat bigger for determining the very latest quarter's figure.

3.3 Quarterly accounts volume measures

Quarterly accounts volume series are estimated just as outlined in the previous section. The indicator for the quarterly volume estimation is built from quarterly Member States' data at previous year's prices, as only those – and not the chained series – are additive. This makes the construction of the quarterly indicator in step 1 somewhat more complicated:

1a. In the case that previous year's prices (COPPY) figures are not available for a specific country, but chain-linked volume series (CLV) are, COPPY are artificially constructed by unchaining the CLV series via the annual deflator. More precisely, for year t and quarter j

$$COPPY(t,j) = CLV(t,j) \times \text{annual deflator}(t-1)$$

This procedure is regularly required for the estimation of seasonally-adjusted quarterly EU accounts: Most Member States apply a seasonal adjustment to the chain-linked series only and not to the COPPY, as the COPPY does not constitute a proper time series and time series techniques are hence not applicable.

1b. If neither COPPY nor CLV series are available, but series at constant prices of a fixed base year (COP) are, the COP series is interpreted as a CLV series and unchained as outlined in the previous point.

1c. The COPPY indicator is then derived from simple summation of all countries available for the whole period to be covered by the estimation.

1d. A chain-linked volume indicator is calculated from the previous year's prices indicator by applying the **annual-overlap** technique. This requires the calculation of an annual average of the quarterly value at current prices (ACUP), and in addition, for the first year to be estimated, the calculation of quarterly values at average prices of the same year (COPSY). ACUP are simply derived by summing the four quarters of a year at current prices and dividing that sum by four, COPSY are derived by inflating the COPPY value with the annual deflator. The chain-linking then uses quarterly rates of change with respect to the average of the previous year. For year t and quarter j:

$$Rate(t,j) = COPPY(t,j) / ACUP(t-1)$$

Note that the annual sum of the four quarterly rates as just defined will be the annual rate of growth COPPY(t) / CUP(t-1).

Starting the chain now from the first available year t=1 with

$$\text{Chain-linked index } (1,j) = COPSY(1,j) / ACUP(1) \times 100$$

the chain is built from

$$\text{Chain-linked index } (2,j) = Rate(2,j) \times (\Sigma_i \text{ Chain-linked Index } (1,i) / 4) = Rate(2,j) \times 100$$

$$\text{Chain-linked index } (3,j) = Rate(3,j) \times \text{Annual Rate}(2) \times 100$$

$$\text{Chain-linked index } (4,j) = Rate(4,j) \times \text{Annual Rate}(3) \times \text{Annual Rate}(2) \times 100$$

and so on. The name “annual overlap” comes from the use of the annual rates of change for building the chain for earlier years. The resulting chain-linked index series is re-referenced to 2000, and a chain-linked volume series is derived by multiplying the index series with the average quarter at current prices in 2000 (ACUP), and dividing by 100.

Eurostat runs the quarterly volume estimation as explained in the five steps above by disaggregating the annual COPPY series following the COPPY indicator (see 1c. above). The resulting estimations at previous year’s prices are then chain-linked (using the annual-overlap technique) to derive quarterly CLV series. Running a temporal disaggregation on COPPY series has the drawback of applying a dedicated time series technique on data which do not constitute a true time series. Eurostat has therefore produced in parallel a second estimation by disaggregating the annual CLV series using the quarterly CLV indicator (see 1d. above). Note again that neither the annual nor the quarterly European CLV can be directly derived from the national CLV due to their lack of additivity. Since both estimations give very similar results, Eurostat has opted for estimating the COPPY first and deriving the CLV by chain-linking, as this gives a fully coherent set of estimations. On the other hand, estimating the CLV series first would require substantial additional work to achieve coherence.

As in the annual case, quarterly chain-linked volumes are **not additive**, but the quarterly COPPY series are. **Custom aggregations** must therefore be built from summing COPPY series and chain-linking them separately.

Again as in the annual case, **changes in inventories** and the **external balance** (and any other variable that can take on negative and positive values) cannot be chain-linked. For these, the only volume expression available is at previous year’s prices.

Contributions to quarterly GDP growth are derived from the quarterly series at prices of the previous year. For contributions to quarter-on-quarter growth in quarters 2, 3 and 4, the calculation is straightforward (as sketched for the annual contributions in section 2.2). For quarter 1 and for all year-on-year contributions, the comparison will involve quarters from different years. In these cases, the COPPY values for quarters from the earlier year are inflated with the annual deflator. As for annual contributions, a contribution for the external balance is approximated as the difference between the contributions of exports and imports, and a contribution of changes in inventories is derived as a residual contribution.

3.4 Specific issues in quarterly accounts

- **Seasonal adjustment** of European series is currently not done directly by applying an adjustment routine to raw European data, but rather **indirectly** by estimating the seasonally adjusted series from seasonally adjusted Member States data. Of course, this means that the final result is a mix of several adjustment procedures as MS use various procedures for seasonal adjustment).
- For most, but not all, Member States the seasonal adjustment comprises also a **working-day correction** because differences in the number of working days between subsequent quarters can significantly affect growth rates. The EU quarterly accounts, being derived via an indirect adjustment approach, hence include a partial working-day correction. Given that all of the bigger Member States apply a working-day correction, no significant working-day effect should remain in the EU quarterly accounts. As outlined above, the unadjusted EU quarterly accounts are coherent in time with the published EU annual accounts. The adjusted EU quarterly accounts do contain a working-day correction, and hence their sum excludes the annual working-day effect. In practice, annual accounts including a working-day correction are used for estimating quarterly adjusted series in the disaggregation technique outlined above. These annual accounts including a working-day correction are not published by Eurostat (but can be reproduced from summing the quarterly series).
- Quarterly EU accounts are released according to the following **revision policy**: Three releases are published each quarter: The first at 45 days is a flash estimate and consists of GDP growth for the latest quarter only. No other series are revised, nor is GDP growth for

previous quarters. The flash is followed by a first regular release at around 65 days, covering GDP and its basic breakdowns (only domestic employment is released at around 75 days instead). All EU quarterly and annual accounts series for all reference periods are open to revision with this release. The second regular release is scheduled at around 105 days after the end of the quarter, adding some more detailed breakdowns for the new quarter, and again all quarterly and annual series are opened to revision.

- **Forecasts** are not given for quarterly EU accounts. The European Commission's Directorate General for economic and financial affairs (DG ECFIN) however regularly publishes an indicator-based GDP growth forecast on the occasion of every EU QNA release.