

## **Documentation of the GDP indicator**

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**by**

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## 1. About calculation of the GDP indicator

The GDP indicator (GDP45) provides a flash estimate of the seasonally adjusted quarterly growth for the gross domestic product (GDP) for the most recently closed quarter. The GDP indicator is published about 45 days after the end of the quarter, which is 15 days before than the first full version of the Quarterly National Accounts, which is issued about 60 days after the end of the quarter (QNA60). In order to attain the best possible estimate, the calculation of GDP45 is based, as far as possible, on the same sources and methods as QNA60. However, it is necessary to deviate from the usual method of calculation behind QNA60 in a number of areas, as other sources have to be used and consequently other methods. In order to make the calculation of the GDP indicator sufficiently fast, it includes only 15 industries and fewer and less detailed data. The calculation of the GDP indicator only includes GDP from the production (supply) side and accordingly does not include all information from the approximately 1,500 indicators that are usually included in QNA60. Without a calculation from the demand side, it is not possible to systematically take into account information on foreign trade, consumption and investment. Neither is it possible to balance supply and demand (use) in the economy.

### 1.1. Estimation of production value

As a rule, calculation of GDP45 starts by extrapolating the time series for production in the Quarterly National Accounts with the growth in the source data that is available about 35 days after the end of the quarter. In some cases, where data is not yet available, econometric estimations are used (now-casting<sup>1</sup>). The calculation is made for each of the following 15 industries:

- Agriculture, forestry and fishing
- Mining and quarrying
- Manufacturing
- Utility services
- Construction
- Trade
- Transport
- Hotels and restaurants
- Information and communication
- Financial and insurance
- Real estate activities and renting of non-residential buildings
- Dwellings
- Other business services
- Public administration, education and health
- Arts, entertainment and other services

### 1.2. Deflating, chain-linking and price model

In order to calculate the real growth rate, the value of production must be calculated in constant prices, i.e. prices from a fixed base year. Changes in production at constant prices indicate the real growth rate in production. This gives growth adjusted for price developments. The indicator for an individual industry indicates the development at either constant or current prices. Indicators at constant prices (based on developments in quantities) are primarily used for agriculture, mining and quarrying, utility services and construction. If the indicator used for production is at current prices, the indicator is deflated as much as possible using the same price index as that applied in QNA60. Calculation at

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<sup>1</sup>Now-casting in this context means estimating data for a period that has already passed, but for which data is not yet available.

constant prices is completed in the same way as for QNA60 at a level of detail for production industries corresponding to the [National Accounts 69 classification](#). In this way, undesirable composition effects are eliminated to the extent possible. Production at constant prices is represented by a chain index established using the same method as in the national accounts; see the memo [Chain-linking and Seasonal Adjustment](#).

In some industries, an input-output-based price model is used to calculate price developments for intermediate consumption. The price model weighs detailed price indices for production divided into the 69 industries mentioned above and imports divided into 115 goods and services using an input-output table from the Annual National Accounts. The price model is described in more detail in section 4.1 of the documentation of the Quarterly National Accounts [Quarterly National Accounts Inventory](#).

### **1.3. Calculation of intermediate consumption and taxes less subsidies on products**

GDP indicates gross value added at market prices and it is closer conceptually and numerically to gross value added at basic prices (GVA) than to the whole production. In order to calculate the gross value added (GVA) of an industry, the consumption of goods and services by the industry as input to production (intermediate consumption) must be deducted from the value of production. The intermediate consumption can be supplied by the industry itself, by other Danish industries or from abroad as imports to the industry. Therefore, it is important to estimate the industry's intermediate consumption. The same applies for taxes and subsidies on products which determine the difference between market prices and basic prices.

As a rule, intermediate consumption is assumed to comprise the same percentage of production at constant prices as for the same quarter in the preceding year. This assumption takes account of seasonal patterns. This assumption also entails that the annual real growth in gross value added (GVA) corresponds to the annual real growth in production at detailed industry level.

For some industries, other methods are used to calculate intermediate consumption. For example, accounts figures are used for consumption of goods and services by the public sector. When the calculation of intermediate consumption is made at current prices, the input-output-based price model mentioned above is applied to deflate the value and calculate the real growth of intermediate consumption.

As GDP is not calculated for the use side, taxes and subsidies on products cannot be calculated as in QNA60, where they are assumed to make up a constant percentage of the demand at constant prices at detailed level. For example, the tax on households' purchase of vehicles is a fixed percentage of the value of the purchase. In the absence of a use side from which to calculate taxes and subsidies on products, it has been decided to assume that taxes and subsidies on products increase in line with gross value added (GVA).

As mentioned above, GDP is calculated at market prices and therefore it comprises GVA at basic prices plus the taxes and subsidies on products. This means that the assumption of the same increase in GVA and taxes and subsidies on products contributes to the difference between the GDP growth rate in GDP45 and QNA60. In this case, the difference is due to the fact that the detailed calculation of taxes and subsidies on products in QNA60 implies that GDP grows faster or slower than GVA. For example, the difference in growth in GDP and GVA can be due to a significant change in private consumption of heavily taxed goods such as vehicles and energy. We are working to prepare an estimate of taxes and subsidies on

products for GDP45 using preliminary information on the development in consumption.

#### **1.4. Seasonal adjustment**

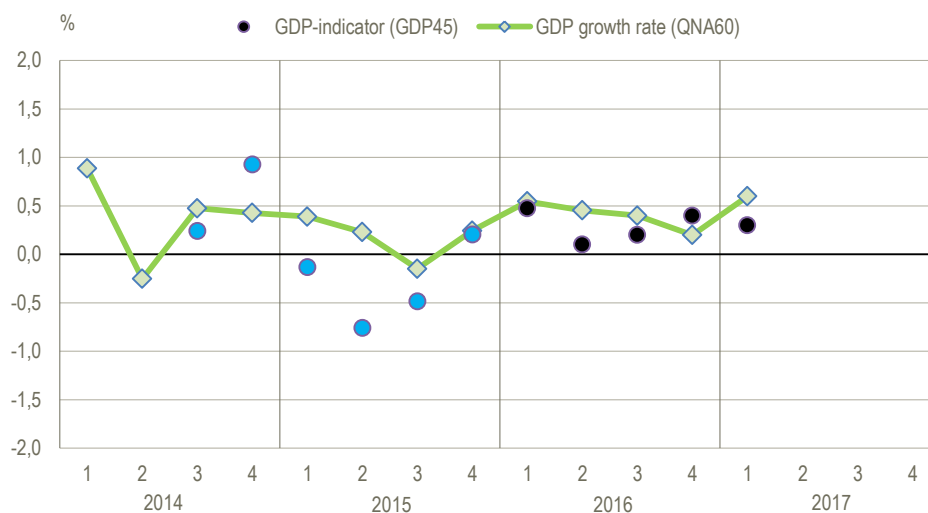
Seasonal adjustments are made using the same methods as those used to calculate seasonally adjusted GDP in the Quarterly National Accounts. Gross value added in chained values is seasonally adjusted for each of the 15 industries mentioned in section 1.2, and the 15 seasonally adjusted growth rates are aggregated subsequently to the total seasonally adjusted gross value added. See more (in Danish) in the memo [Det sæsonkorrigerede BNP](#). The GDP indicator differs from the seasonally adjusted GDP in QNA60, as there is no separate seasonal adjustment of taxes and subsidies on products in the GDP indicator. This is because of the assumption that these change in the same way as the seasonally adjusted gross value added.

#### **1.5. Revision and uncertainty**

As already mentioned, the GDP indicator is calculated to the extent possible using the same sources and methods as those used in the Quarterly National Accounts. However, calculation of the indicator will be different from the QNA60 calculation, primarily for two reasons. Firstly, there is less data available when the calculation is made at an earlier stage. Secondly, it is not possible to reconcile supply (production) and demand (use), as only the production side is calculated. Both factors contribute to increase the uncertainty compared to QNA60. A typical revision of the GDP growth from GDP45 to QNA60 could involve a revision of the growth in total production because more data has become available about production. A revision could also be made because the estimate of enterprises' intermediate consumption is adjusted in connection with the balancing process of the economy's supply and use. The estimated taxes and subsidies on products could also be changed in a revision because of new information about private consumption and other demand components.

The method behind the GDP indicator is still under development, and because of the short time series it is not yet relevant to calculate a measurement of uncertainty for the indicator. During development of the indicator, there were attempts to complete calculations of the indicator for the period from Q3 2014 to Q4 2015, and final test calculations have been made for Q1 and Q2 2016. The results are illustrated on the figure below. The figure shows GDP growth according to GDP45 and QNA60. It is difficult to calculate the GDP45 estimates for quarters in 2014 and 2015 because it is not possible to fully reproduce the relevant dataset as it would have been at that moment. The calculations for the period before 2016 should therefore be regarded as uncertain (light-blue dots in the figure).

## Real GDP growth



The quarterly GDP growth in the National Accounts is revised regularly after the QNA60 release. For the first time, 90 days after the end of the quarter and the last time in connection with the publication of the final annual figures, which takes place almost three years after the end of the reference year.

## 2. Sources and methods for individual areas

The GDP indicator builds on a calculation of production and gross value added at constant prices in 15 industries. The following section is about how the calculation uses econometric models on source data, and there is a brief description of the most important source materials behind the calculations. The description of the source material is based on eight main areas of source data, spread over the 15 industries, as shown in the table below.

**Level of detail for calculation of the GDP indicator**

|  | Percentage of GVA in 2015 | Source area              |
|--|---------------------------|--------------------------|
| 1 A Agriculture, forestry and fishing                              | 1.1                       | agriculture              |
| 2 B Mining and quarrying   | 1.6                       | energy                   |
| 3 C Manufacturing  | 14.7                      | manufacturing            |
| 4 D_E Utility services   | 2.4                       | energy                   |
| 5 F Construction   | 4.5                       | construction & dwellings |
| 6 G Trade  | 11.9                      | VAT                      |
| 7 H Transport  | 5.4                       | transport                |
| 8 I Hotels and restaurants   | 1.5                       | VAT                      |
| 9 J Information and communication                                  | 4.6                       | VAT                      |
| 10 K Financial and insurance                                       | 6.4                       | finance                  |
| LA Real estate activities and renting of non-residential buildings | 2.5                       | VAT                      |
| 12 LB Dwellings  | 7.8                       | construction & dwellings |
| 13 M_N Other business services                                     | 8.8                       | VAT                      |
| 14 O_Q Public administration, education and health                 | 23.1                      | public sector            |
| 15 R_S Arts, entertainment and other services                      | 3.6                       | VAT                      |
| <b>16 Total gross value added (1+...+15)</b>                       | <b>100.0</b>              |                          |
| 17 D.21-D.31 Product taxes minus product subsidies                 | 15.6                      |                          |
| <b>18 Gross domestic product (16+17)</b>                           | <b>115.6</b>              |                          |

### 2.1. Projections with econometric models

Bringing the GDP calculations forward to an earlier date has reduced the amount of available data. This usually results in a lack of data for the final month in the quarter and in some cases data for the whole quarter. When there is a lack of data, econometric time series methods are applied to generate a nowcast. It has been decided to use ARIMA models or models within the ARIMA family (e.g. reg-ARIMA and ARIMAX). These are models that use the historical observations in the data series itself to produce an estimate. The models entail that the correlation of the series with previous periods is measured for each period and the correlation pattern is used to estimate how the series is likely to develop. The models chosen can also incorporate any explanatory time series available at the time of calculation. The models are regularly evaluated on the basis of statistical tests, and the estimates are reviewed in order to prevent model errors. It is likely that production estimates for an industry will be partly model-based and partly based on estimates. In connection with selection and evaluation of models, the aim is to maximise the consistency of the modelling method across industries.

### 2.2. Agriculture

The estimation of activity in *agriculture, forestry and fishing* mainly covers production of crops and animal products. The source data from the first full version of the QNA for crop production is available for this calculation. So far, the estimation of the production of animal products has been based on a simple extrapolation of quarterly production statistics using the growth rate of the same quarter last year. This method has now been refined so that the quarterly animal production statistics can be estimated using monthly production statistics as input. The last month of the quarter is not available for any of the production indicators



when GDP45 is calculated. For this reason, the third month is estimated using an ARIMA model for each of the production indicators.

## 2.3. Energy

### 2.3.1. Mining and quarrying

Source data for *mining and quarrying* is based on data from the Danish Energy Agency (ENS). Production information from ENS' monthly supply statistics is incorporated for the first two months in the quarter. It is not possible to use this data for the third month in the quarter. Instead ENS' preliminary energy statistics are incorporated. If the preliminary energy statistics are not available, production is estimated using ARIMA models.

### 2.3.2. Utility services

Like *mining and quarrying*, data for *utility services* is based on monthly supply statistics from ENS for the first two months, whereas production for the third month is estimated using ARIMA models.

## 2.4. Manufacturing

In general, the same method as in QNA60 is used to calculate the gross value added in *Manufacturing*. The *Manufacturing production and turnover* statistic is the basis for manufacturing turnover. A preliminary internal version of the *Changes in inventories* statistics is used in the calculation of changes in inventories. The sum of turnover and changes in inventories makes up manufacturing production. This industry-specific production is deflated by relevant price indices; usually from the *Producer price index for commodities*. Differences between GDP45 and QNA60 may occur for two reasons. Firstly, there is an adjustment for manufacturing production in calculations of QNA60 in accordance with an internal preliminary result for the *Manufacturers' sales of goods* statistics, and this is not possible in the calculation of GDP45. Secondly, there may be changes in the *Changes in inventories* statistics compared with the preliminary internal version used for GDP45.

## 2.5. Construction and dwellings

Calculation of the gross value added in *Construction* is carried out almost in the same way as in QNA60. The two primary sources for this calculation are the floor area under construction (m<sup>2</sup>), calculated on the basis of the *Construction* statistics, and the *Employment in the construction industry* statistics, both of which are available at the time of calculation. The only difference with regard to QNA60 is that the construction price index and the construction cost index for residential buildings are not available at the time of calculation. The missing figures for the two quarterly indices are estimated using ARIMA models.

Production in the *Dwellings* sector is calculated in the same way as for QNA60, and it is based on a projection of the stock of residential property. Intermediate consumption in the industry is assumed to follow the production in repair and maintenance, a sub-industry of *Construction*.

## 2.6. Market services (VAT)

*Purchases and sales by firms*, also called the VAT statistics, is the primary source for the market services sector and it makes up more than 30% of GVA. This means that the VAT statistics are very important in the calculation of the GDP indicator. The VAT statistics are used in the calculation of production by the services industries for both GDP45 and QNA60. Production at current prices in the

individual services industries is projected using the quarterly growth in the VAT statistics, and these are the only statistics available as an indicator for growth in these businesses. Actual growth is calculated subsequently by deflating by a relevant price index; usually the same index as is used in QNA60.

A legislative amendment on 1 January 2014 relaxed the requirement for enterprises to submit VAT returns to the Central Customs and Tax Administration (SKAT). The relaxation has reduced the percentage of total turnover reported in returns and this affects the calculation of both GDP45 and QNA60. This also exacerbates the need to estimate the turnover of a large number of enterprises. After relaxation of the reporting requirement, the method of estimation previously applied has become inadequate and it has been necessary to estimate turnover at industry level for QNA60 and use for test calculations of the GDP indicator. As there is less time to make calculations and estimates for GDP45 than for QNA60, there is greater uncertainty for GDP45 than for QNA60. An example of the uncertainty in the statistics for Purchases and sales by firms is that the total turnover in Q4 2014 was revised by DKK 8-13 bn. per month. This should be evaluated against a level of about DKK 285 bn. per month; i.e. a revision of about 3-4.5 percent. In connection with test calculations of the GDP indicator, which should be considered with caution, revisions in VAT sources have impacted the quarterly growth in GDP by about 0.2 percentage points on average.

The frequency with which an enterprise submits VAT returns depends on the size of the enterprise. From 1 January 2014, small enterprises with an annual turnover of less than DKK 5 million have to report VAT on a six-monthly basis. Medium-sized enterprises, with an annual turnover of between DKK 5 and 50 million have to report VAT quarterly. Large enterprises with an annual turnover of more than DKK 50 million have to submit VAT returns monthly, at least 25 days after the end of the month, although not for June, as the deadline has been extended so that it does not fall in the middle of the summer holiday period.

The monthly statistics for Purchases and sales by firms therefore build on data for large enterprises. Turnover for small and medium-sized enterprises in the statistics for Purchases and sales by firms are based on estimates until returns are available. The particular uncertainty regarding turnover for June because of the extended deadline means that Statistics Denmark has cancelled publication of the June edition of the statistics for Purchases and sales by firms. Furthermore, the need for estimates in the statistics for Purchases and sales by firms to calculate GDP45 varies from industry to industry, as the percentage of large enterprises in an industry varies.

Work is ongoing to implement a new estimation model that can improve the estimates of the turnover of small and medium-sized enterprises, but this work is being complicated by the short length of the relevant time series.

## **2.7. Transport**

In general, the same sources and methods as for QNA60 can be used to calculate gross value added in *Transport*. However, sources may be more preliminary for carriage by sea (water transport), which accounts for around one-half of the GVA in the industry. A preliminary version of the statistics for *international trade in services* is used to calculate growth in turnover, and this may differ from the version incorporated in QNA60. Price developments for carriage by sea may also differ, as figures in the appendix of tables for financial statements available to the public from the largest companies in the industry are used to calculate freight rates for GDP45. Preliminary submissions to Statistics Denmark for calculation of the Producer price index for services are typically incorporated in QNA60. The VAT turnover is used as an indicator for two subgroups in the transport industry. This is

why production by the two subgroups is subject to particular uncertainty when calculating GDP45 - see the description of the VAT statistics under section 2.6.

## **2.8. Financial sector**

Data for the production of the financial sector is based on data of interest income in the financial sector and published financial statements from a selection of financial institutions. Using information from financial statements, an indicator is calculated for production of directly paid bank services. The indicator is used to project production information for other financial activities. Deflation is carried out as for QNA60. Additional information on deflation of production in the financial sector is available in the memo [Danish National Accounts, Sources and methods, 2003](#). The price index from the input-output price model, see section 1.2, is used to deflate intermediate consumption.

From Q3 2016 and onwards, the same method is used to estimate the GVA for the sector in the calculation of QNA60. More detailed production data is not available until the revised statement of the quarterly national accounts is published. The accounts are published 90 days after the end of the quarter.

## **2.9. Public sector**

In the first full version, production and gross value added in *public administration, education and health* are calculated using a preliminary internal version of *Quarterly Government Finances*. This internal version has been advanced such that it is available for the advanced flash estimate as well. This means that the method for calculating and deflating production in general government can be maintained. As branches within general government sector is extrapolated using the sum of the expenditure components adjusted for the development in wages and prices, an indicator for intermediate consumption is also available, and, hence, an indicator for gross value added. Intermediate consumption can be deflated using the price model, see section 1.2. An ARIMA estimate of the indices of earnings in the public sector is used to deflate compensation of employees. The remaining price indices used in the calculation of GDP45 are the same as those applied for QNA60.

### **3. Concluding assessment and adjustment of the indicator**

When the first version of the GDP indicator is calculated, the overall result is assessed by a working group at Statistics Denmark. Initially, the calculations are evaluated for each industry. Any econometric estimation is evaluated on the basis of statistical test sizes and compared with other available information about the area, such as tendency surveys or employment statistics. Where possible, the results of the seasonal adjustment are compared with seasonally adjusted results in the source statistics. Statistical test results, analysis data, etc. from the seasonal adjustment procedure are also used to evaluate the estimated GVA for the 15 industries.

Following the individual review of the industries results, the overall GDP estimate is evaluated and compared with known forecasts and with current available expectations. The result is also compared with the general impressions of the working group regarding the economic situation and with signals from other publications of economic tendency from Statistics Denmark. If these supplementary observations primarily support the estimated growth in GDP, the growth rate figure is accepted. If the calculated growth in GDP seems to conflict with other known information, the detailed calculations will be reviewed again. This review can lead to adjustments in estimates for some industries in order to reduce the discrepancy between the calculated growth in GDP and the supplementary information mentioned before. For example, intermediate consumption by industry estimates is uncertain without accounts statistics, and if intermediate consumption of a given industry is revised downwards, its gross value added is revised upwards. The working group can also decide to keep a “surprising” result, if the differences from the supplementary information can be explained.

As mentioned above, it is too early to state a measure of the uncertainty in the GDP indicator, but of course it is important to monitor the difference between the indicator growth in GDP and, primarily, GDP growth in QNA60, but also in the subsequent versions of the Quarterly National Accounts. It is expected that GDP estimates from Statistics Denmark will be revised when new information is available, but it is important to avoid a systematic distortion. The GDP indicator should not have a systematic tendency to under-estimate or over-estimate GDP growth.