

Article

# National Accounts articles: Changes to the gross fixed capital formation methodology and processing

This paper describes changes to the gross fixed capital formation methodology and processing, used within the compilation of the UK National Accounts.

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# 1 . Summary of changes

A number of major improvements to the methodology and processing arrangements for calculating gross fixed capital formation (GFCF) estimates have been made. These are:

1. Improving the coherence and consistency of data through a review of the conversion of sources across different classifications.
2. Changes to the treatment for transfer costs on non-produced non-financial assets. This change will be introduced when Blue Book 2017 is published.
3. Improvements to statistical processing and methodology.

This article describes these changes in detail. These changes will be introduced in the next publication of business investment estimates on 22 February 2017 (estimate for October to December 2016). The application of the national accounts publication revision policy will mean that impacts will not be observed in the back data (pre-2016) until the publication of Blue Book 2017.

## 2 . Introduction

The purpose of this article is to provide an overview of changes to the methodology and processing of gross fixed capital formation (GFCF) which will be introduced as part of the forthcoming business investment statistical release on 22 February 2017. A separate article describing the impact of these changes will also be published on 22 February 2017. Information on changes related to Blue Book 2017 estimates will be published in a separate article on 16 February 2017.

In recent years, independent reports have recommended improvements to the GFCF methodology, the main 2 being the [Independent review of economic statistics](#) (Bean, 2016) and the [National Statistics Quality Review of the National Accounts and Balance of Payments](#) (Barker and Ridgeway, 2014). Detailed analysis of the recommendations and quality assurance of the outputs have occurred as part of the ongoing research programme within the Office for National Statistics (ONS).

An important stage in the production of national accounts estimates is to ensure that GFCF estimates are reconciled with other transactions in the economy, and for this reason a significant proportion of this paper is dedicated to explaining the relationships between GFCF and supply and use processing and how these relationships have been improved.

The article covers:

- compilation of GFCF
- explanation of the main changes that have been implemented
- work that will continue to assure the quality of sources and processing in the future

### **3 . What is gross fixed capital formation (GFCF)?**

GFCF consists of resident producers' acquisitions, less disposals, of fixed assets during a given period plus certain additions to the value of non-produced assets realised by the productive activity of the producer or institutional units. Fixed assets are produced assets used in production for more than 1 year, such as buildings, machinery, transport equipment, or intellectual property such as software or the results of research and development (Eurostat, 2013).

Published GFCF information comprises the institutional sectors of general government, public corporations and the private sector, which includes private, non-financial corporations, financial corporations, households and non-profit institutions serving households.

Analysts and policymakers are interested in the concept of business investment, which while it is not a national accounts concept, can be defined using the GFCF data. It includes investment by public non-financial corporations and all private sector institutions, but excludes expenditure on dwellings and the costs of ownership transfer on non-produced, non-financial assets.

For GFCF, see Tables C1 and C2 of the Second Estimate of GDP (ONS, 2016a) and Table F in UK Quarterly National Accounts (ONS, 2016b).

More broadly, gross capital formation is the total value of gross fixed capital formation, change in the level of inventories and the acquisitions less disposals of valuables, all measured at purchasers' prices (see Appendix B for detail on price basis).

### **4 . Description of changes**

In response to the previous reviews, and with additional updated data now available, the currently applied methods and approaches have been assessed and changes have been made where appropriate. The following sections cover specific areas.

#### **4.1. Conversion of sources across different classifications**

##### **4.1.1 Conversion of Capital Expenditure and Annual Business Survey data**

From Blue Book 2011 onwards, the UK National Accounts have been presented on the Standard Industrial Classification 2007 (SIC2007, equivalent to NACE rev 2) basis, and were previously presented using the SIC2003 (NACE rev 1) classification. Our business surveys have collected data on a SIC2007 basis since 2008 meaning that for all periods before this, conversion was done in order to present the estimates in a consistent way. Conversion is typically done by taking a snapshot of the interdepartmental business register (IDBR) where units feature on both classifications at a point in time and then using this relationship to apportion data on the old basis to the new basis. For Blue Book 2011, these conversion changes are described in Jones & Nolan (2011).

For particular industries, the conversion process did not provide full coverage, for example where particular industries had historically been collected from non-survey sources such as the extraction of crude oil and natural gas industry (industry 06). The new approach uses the fully reconciled annual estimates for the industry from the BB06 supply and use tables, which are used to derive quarterly information, and then aggregated from a classification of products by activity (CPA) to asset. A breakdown of information CPA is important because it is required for gross fixed capital formation (GFCF) for the dual purposes of balancing the use of assets with domestic and imported supply in the economy, and as a basis to deflate estimates of GFCF. It can be thought of as identifying more detailed capital products than the non-financial asset classification (AN).

## 4.1.2 Conversion of sources used to generate a product breakdown for balancing and deflation

The main source of data to generate the CPA breakdown of GFCF has historically been the Business Spending on Capital Items survey (BCIS), a survey which asks businesses detailed questions about the type of capital items they purchase (and dispose of) at a generally 3- or 4-digit CPA level of detail. These data are used by applying resulting proportions to the industry by asset estimates of GFCF in order to create a product breakdown. This product breakdown can then be used to balance GFCF in the supply and use tables and as a basis on which to weight up price indices and deflate GFCF. In Blue Book 2011, the production classification was converted from CPA2002 to CPA2008. The product breakdown has now been reviewed given the additional data available, and changes made, to improve consistency between product level and GFCF aggregates.

The product hierarchy is now expressed at the lowest level of detail at which the data on products are collected, and as such serves a dual purpose by providing the basis for deflating GFCF and for balancing it in the supply and use tables. Historically, the product breakdown for GFCF was at the level at which supply and use balancing took place (the 112 product breakdown), but this is not sufficient for identifying specific types of capital goods for a meaningful reconciliation, or for isolating the specific price evolution of different assets.

Ensuring a consistent use of the classification of products is important for coherence. Linking between the CPA classification and deflation means that for each product, estimates in the prices of the previous year can be compiled. Provided that the supply table is sufficiently disaggregated so that imports and domestic products destined for GFCF can be identified, along with estimates of distributors' trading margins and taxes less subsidies specific to those products, then GFCF transactions can be fully balanced in previous year's prices.

In order for such an approach to be robust, a reliable product breakdown must be available. The existing product breakdown has been reviewed, and as a result, has now been revised. The main data source is the BCIS survey. The approach used is to map questions in CPA2002 from this survey directly to CPA2008 products rather than to convert them from CPA2002 to CPA2008, as the questions asked were in almost all cases aligned with the CPA2008 classification at the low level. The results by industry were, however, converted from SIC2003 to SIC2007 using the standard approach of proportions of turnover. In some cases, supplementary information was used, for example from sources such as Ministry of Defence (MoD) data on military expenditure. For dwellings and other buildings and structures, data on types of building work were combined with the CPA classification in order to permit deflation and more informed balancing than was available using the CPA breakdown alone. This process resulted in a set of proportions which could be applied by industry, asset and institutional sector. There is an ongoing quality assurance process to reconcile the results of this product breakdown in the supply and use tables, and in particular, to reconcile the results of transfer costs on non-produced non-financial assets.

The following describes the process by which products are now processed in the GFCF system.

1. Current price data are compiled, unbalanced, by industry, asset, institutional sector, and by acquisitions and disposals.
2. A product breakdown compiled using sources described above is used to pro-rate the estimates described in (1) to the bottom level of the asset and product classification in current prices.
3. The current price data created in (2) are aggregated up the various hierarchies to top-level GFCF. A separate hierarchy is used to aggregate the estimates by highly detailed products to the level at which supply and use balancing is done (112 products). Many of the products used in the supply and use balancing process are not applicable to GFCF, so this process results in estimates for 29 products at this level of detail.
4. The annual 112 product breakdown is balanced in current prices by assessing the supply of these products and where they are used. Information describing the process of supply and use balancing can be found in the [ONS guide to the supply and use balancing process](#).
5. The annual current price data are returned to the GFCF system, and the quarterly current price estimates are benchmarked to the balanced annuals before being converted back into acquisitions and disposals.
6. Balanced, quarterly, current price estimates for each of the 29 balanced products are pro-rated down the unbalanced patterns of the product, industry and sector hierarchies, before being aggregated up the asset hierarchy to produce a full, balanced current price dataset.
7. Balanced, current price estimates by bottom-level product but at total sector, total industry and by acquisitions and disposals are deflated using specific CPA-level price indices, and are then unchained to current year's prices (CYP) and previous year's prices (PYP).
8. The balanced, current price pattern is used to pro-rate the CYP and PYP pattern to all industries and institutional sectors at bottom level, prior to aggregation up the asset hierarchy.
9. The data are now available to be chain-linked at the required levels.

This approach has a number of advantages. It permits thorough reconciliation of GFCF with other transactions in the economy and provides consistency between price types and the CPA classification. From a processing point of view, it means that statistical functions such as unchaining, chaining and benchmarking are applied at an appropriate level. It also ensures that price indices implicit in the industry by asset by sector data are specific to the types of capital good used by the institutional units engaged in that activity. The direct relationship between product level balancing and price indices also meets another objective, to allow the balancing of GFCF estimates in PYP and CYP terms. This is a crucial step in balancing GFCF in the supply and use tables in volume terms, and therefore is a required step towards our future goal to balance the national accounts in volume terms through the supply and use tables as noted in the [National Accounts medium term work plan 15-18](#).

## 4.2 Compliance with international concepts

### 4.2.1: Transfer costs on non-produced non-financial assets

Transfer costs on non-produced, non-financial assets are unique in gross fixed capital formation (GFCF) in that they represent a part of the purchaser's price of non-produced assets (for example, land is an example of a non-produced asset). Non-produced assets are by definition not part of GFCF or of gross domestic product (GDP) as they do not represent any type of production. The act of transferring assets, by way of the legal, architectural or accountancy fees associated with the transfer, does represent a type of production. The question arises as to how transfer costs on disposals of assets are treated, and this question is specifically raised in section 4.2.6 of the National Statistics Quality Review of the National Accounts (Barker and Ridgeway, 2014). After a detailed review of the issues, we have concluded that there is an additive relationship between transfer costs on acquisitions and disposals, meaning that negative transfer costs are not conceptually possible. The explanation for this result is detailed in full in McLaren and Murphy (2017, forthcoming). In order to adhere to the national accounts revisions policy, this change will not be implemented until the production of Blue Book 2017.

## 4.2.2 General government data

Typically, central and local government administrative data are available at a very low level of detail. This approach has been improved by using actual proportions from the HM Treasury Online System for Central Accounting and Reporting (OSCAR) database (on networked assets, ICT equipment, and furniture and fittings) and in some cases the Business Spending on Capital Items survey (BCIS) survey.

## 4.3 Statistical methodology and processing

### 4.3.1 Statistical functions

The gross fixed capital formation (GFCF) dataset is comprised largely of capital expenditure data from the quarterly acquisition and disposal of capital assets survey (QCAS). The nature of the GFCF information is that it is inherently sparse, but contains genuine data. This is because capital expenditure occurs when it is required, such as at the start and end of identified work; and in some industries a period of no work. So in practice, the collected data may contain zero returns where no activity has taken place. Data are collected on an acquisition and a disposal basis, before the data is created on a net basis where net equals acquisitions minus disposals. Where zero values are common for periods of time, this can pose challenges for statistical calculations, such as benchmarking, chain-linking and seasonal adjustment; particularly for estimates at greater detail.

Chain-linking calculations (see Drew, Lewis and McLaren, 2016), as used in other national accounts compilation systems such as Index of Production and Index of Services, has been used, where the total for each product in current prices is deflated to obtain volume measures, then unchained to produce highly aggregated current year's prices (CYP) and previous year's prices (PYP) data. As CYP and PYP data retain the required index number relationships when added and subtracted from each other, it is then possible to use the current price data as a pattern to pro-rate the estimates across the other dimensions – industry and sector. This produces a set of volume estimates which can be aggregated and chain-linked. This ensures consistency but also ensures that the implicit price indices are reflective of the specific types of assets used by different types of institutional units.

### 4.3.2 Seasonal adjustment processing

Seasonal adjustment has previously been applied to the chain-linked (CVM) data by asset, sector and by acquisitions and disposals. This resulted in 152 CVM time series being seasonally adjusted. The current price data were previously seasonally adjusted by industry (at the A\*32 level of detail, which includes letter level industries with a further breakdown of manufacturing), as well as by sector, asset and acquisitions and disposals. This resulted in 1,591 time series being seasonally adjusted.

There is an established trade off between the level of detail at which seasonally adjusted estimates are additive and the quality of the seasonal adjustment.

In order to address this issue, seasonal adjustment will now be done at the highest level at which legal requirements dictate, while adhering to the national accounts principle of additivity across dimensions. This imposes the condition that a set of bottom-level, seasonally adjusted estimates by asset and sector can be added together to equal a total. Seasonal adjustment will be undertaken at the level of industry total, asset bottom level and sector bottom level, by acquisitions and disposals. This means that the level of detail for CVM is unchanged, but that the level of detail for current price is reduced to match that of the CVM data, at 152 time series.

Seasonal adjustment of business investment is calculated for 2 sectors (public and private) and 32 industries. Providing consistency between the seasonally adjusted versions of these data for the purpose of business investment and for compiling gross domestic product (GDP) is necessary and choices in one should not impede the quality of the other.

To ensure the highest quality business investment aggregate estimate, the data will be seasonally adjusted, and the components of business investment will also be seasonally adjusted.

### 4.3.3 Statistical processing

The statistical processing of GFCF now adheres to strict architectural principles, designed to be applicable to the production of all components of the national accounts. Under these principles, the processing system is broken into building blocks where each concept formally progresses through the following stages:

- collection of data sources
- validation of data sources
- compilation of unbalanced, current price not seasonally adjusted data
- balancing of current price, not seasonally adjusted data, deflation of balanced current price data
- seasonal adjustment of balanced data
- compilation of derived outputs, finalisation and dissemination

This modular approach significantly streamlines the compilation process.

## 5 . Summary

In this article, we have described a number of major improvements to the methodology and processing arrangements for measuring gross fixed capital formation (GFCF). The changes are a response to previous independent reviews of this topic area, and are part of an ongoing research programme of work (see Appendix A). The introduction of the changes described in this paper will be implemented in the forthcoming business investment statistical release on 22 February 2017. A separate article detailing changes for Blue Book 2017 will be available on 16 February 2017. The application of the national accounts publication revision policy will mean some impacts will not be observed in the back data (pre-2016), but will be observable once the earlier periods are next open for revision.

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## 6 . Appendix A: Summary of ongoing work plan

Development work is continuous and consequently there is a work plan in place to address remaining issues identified in previous reviews. The following section outlines these issues and describes the likely scenarios under which they will be addressed. Any future changes will be communicated before they are introduced into the published estimates.

### A.1 Intellectual property products

Intellectual property products are produced assets which have no physical form but are used in production; provide a storage of wealth; and which depreciate normally due to foreseeable obsolescence. The challenge with measuring these assets is that many are produced on own account, meaning that valuation can only be achieved by modelling. Examples include: a) software and databases produced by an institutional unit for their own use; b) entertainment assets such as the original copy of a film which production companies may charge fees for broadcasters to use but not sell; and c) research and development, much of which is done for own use. In general, estimates are created by summing the costs of production, but the methods of doing this vary considerably between assets. OECD (2010) describes the approaches that can be used to estimate expenditure on different types of intellectual property products. The research and development (R&D) asset is an example of where the internationally agreed approach is implemented fully within our estimates. Each of the costs of production are measured by business and government surveys, and summed to create estimates of investment in R&D (Ker, 2014). Information describing the concepts, sources and methods used internationally to capitalise R&D in the national accounts can be found in the Frascati manual (OECD, 2002).

Ideally, the approach used for R&D would be used for all intellectual property assets, but the sources for the others are less complete. For example, software uses estimates of wage costs of particular professions in each industry from the Annual Survey of Hours and Earnings (ASHE) and assumptions about proportions of time that these professionals spend on developing software for own use along with an assumed “mark up” for the cost of capital services and intermediate consumption, but this is not based on any direct source and the approach used to estimate R&D should be used. Entertainment, literary and artistic originals are estimated using a model created by Imperial College London (Goodridge and Haskel, 2011).

We are currently reviewing the compilation methods used to estimate intellectual property products as part of a wider programme of work on measuring intangible assets (including, for example, non-produced intellectual property such as marketing assets). The results of this review will form the basis of future compilation arrangements.



## **A.2 Sub-sectorisation of the private sector**

As is the case with many of our business surveys, the private sector is sampled by industry and by employment sizeband. Information is available on the interdepartmental business register (IDBR) about the legal status of the institutional unit, and this is useful in informing the institutional sector, for example, where industries are dominated by a particular legal status. The fact that business survey sampling is normally stratified by industry and employment sizeband and not legal status means that low-level results across all sectors cannot be taken to be the same as estimates by institutional sector.

Historically, estimates of private sector gross fixed capital formation (GFCF) have been split into lower-level sub-sectors by assuming a constant proportion of private, non-financial corporations, households and NPISH (where the financial institutional sectors are identified in the industry classification).

In some cases, it is likely that business surveys are not exhaustive in measuring household activity, particularly in industries where self employment makes up a high proportion of overall employment and where proprietors are likely to own their own assets.

The sub-sectorisation of the private sector is of increasing importance in the national accounts and the ideal scenario would be for survey sampling to be stratified in such a way that distinctions could be made at the required level of detail, or alternatively a method whereby a majority principle can be applied to certain low-level industries where institutional units other than non-financial corporations are dominant.

## **A.3 Costs of ownership transfer on non-produced, non-financial assets**

Barker and Ridgeway (2014) under process recommendation 9 state that: "The data sources and methods for estimating costs of ownership transfer that are to be capitalised should be reviewed to ensure they are in line with international standards and that they appropriately enter capital stock estimates".

To address this recommendation McLaren and Murphy (2017, forthcoming) focused on the treatment of transfer costs on disposals of non-produced, non-financial assets, and whether they are to be added to or subtracted from estimates of similar transfer costs on acquisitions. The broad conclusion of that work is that the relationship specific to all transfer costs is additive. A new institutional sector breakdown has been created using proportions based upon the amount of investment in other buildings and structures and dwellings purchased and sold by different institutional sectors. This change will be introduced when Blue Book 2017 is published.

More generally, the costs of ownership transfer on non-produced non-financial assets currently include costs of ownership transfer on land, though these should be recorded separately, under land improvements. The asset should conceptually include transfer costs on contracts, leases, permits and other types of non-produced assets, but these are currently not captured. This presents a problem where, for example, legal fees are balanced in the supply and use tables, because their supply is recorded under production surveys such as the Annual Business Survey, but their use is not recorded and will likely be balanced across use transactions such as household final consumption expenditure and intermediate consumption.

While the costs of ownership transfer on land should not be included in this asset category, another issue arises from the source data on most types of fees. They are in general not available by industry or by sector, and are currently assigned to real estate activities and pro-rated across institutional sectors using proportions based on purchases and sales of buildings. This is because in general, transactions such as land registry fees and stamp duty are available from the perspective of the authority that collects these fees, and not from the point of view of the institutional unit that should record the expenditure in the national accounts.

## **A.4 Land improvements**

The only currently available source data for land improvements (other than those of the costs of ownership transfer on land) are data from the Annual acquisitions and disposals of capital assets survey for years 2014 and 2015. In future, the ACAS data will be used to create historical series for land improvements and the components currently used to compile costs of ownership transfer on non-produced non-financial assets related to land should be reclassified as land improvements.

## **A.5 Existing buildings and land**

Other buildings and structures have traditionally been estimated using expenditure on new construction work and major improvements to existing buildings. Expenditure on existing buildings is not included but should be, as this represents important changes by the industry and institutional sector. However, the value of land sold in connection with existing buildings should not be included as it is not a produced fixed asset and should be in the non-produced assets component of the capital account. Apart from the costs of ownership transfer, transactions in existing buildings sum to zero across all sectors, meaning that their inclusion does not affect overall GFCF. However, they have an impact on the consumption of fixed capital and the balance sheets of different sectors over time, through interactions with the perpetual inventory model. The estimation of land is complex and a recent OECD taskforce (Eurostat-OECD, 2015) considers this in greater detail. Data on existing buildings and land are available from the Annual Business Survey, and these will be used in order to estimate these transactions as part of future development work.

## **A.7 Price indices**

The price indices currently used to compile the produced tangible assets such as other machinery, transport equipment and ICT equipment, are import price indices (IPI) which are compiled as part of input producer prices. This means that they are essentially weighted indices of the materials and fuels used to produce products, but are not indices of those products themselves. In effect, they are the prices that occur at an early stage of the production process, covering the prices of some types of intermediate consumption used to produce some manufactured products. The use of more conceptually appropriate price indices in compiling estimates of GFCF is important as it directly impacts upon the quality of volume estimates of business investment and GDP. Another dimension to this requirement concerns the coherence of prices in the supply components, such as domestic production, imports and distributor's trading margins, and the use of relevant products as GFCF.

## **Appendix B: Definition of terms**

### 1. Basic prices

The basic price is the amount receivable by the producer from the purchaser for a unit of a good or service produced as output minus any tax payable, and plus any subsidy receivable, on that unit as a consequence of its production or sale; it excludes any transport charges invoiced separately by the producer.

### 2. Gross fixed capital formation

Gross fixed capital formation is measured by the total value of a producer's acquisitions, less disposals, of fixed assets during the accounting period plus certain additions to the value of non-produced assets (such as subsoil assets or major improvements in the quantity, quality or productivity of land) realised by the productive activity of institutional units.

### 3. Purchasers' prices

The purchaser's price is the amount paid by the purchaser, excluding any deductible VAT or similar deductible tax, in order to take delivery of a unit of a good or service at the time and place required by the purchaser; the purchaser's price of a good includes any transport charges paid separately by the purchaser to take delivery at the required time and place.

### 4. Import price indices (IPIs)

IPIs measure the prices of imported materials and fuels purchased for use in UK production processes.