

Article

# Volume index of UK capital services (experimental): estimates to Quarter 2 (Apr to Jun) 2017

Experimental estimates of capital services, which is a measure of the contribution of capital to production of goods and services

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# 1 . Main points

This article presents new estimates of capital services for the UK market sector, for 57 component industries and for 13 asset categories.

Capital services are the preferred measure of capital input into production and are widely used in productivity analysis and growth accounting. As well as much finer industry granularity than in previous releases, capital services estimates are now compiled quarterly rather than annually. This has involved substantial effort in assembling input data and streamlining production systems, and is a necessary prerequisite for publication of quarterly multi-factor productivity estimates, which will be published for the first time in April 2018.

These new, experimental estimates show that overall capital services grew by 1.9% in 2016 which is similar to the growth rates in 2015 and 2014 but lower than average growth rate in the decade leading up to the economic downturn.

Provisional estimates for the first two quarters of 2017 suggest that capital services continued to grow at roughly 2% on a year-on-year basis. We estimate that the real return on capital has now recovered to its highest level since 1989.

Despite large-scale revisions to sources and methods, revisions to previous estimates of overall capital services are fairly small, although there are some sizeable revisions to growth rates for component industries and assets.

## 2 . Introduction

### About this release

This article is the latest in a [series](#) which present experimental estimates of capital services. Capital services are the contribution of the accumulated stock of capital to production. Whereas measures of the capital stock are measures of wealth – placing a value on the total stock of assets at a point in time – measures of capital services reflect the value of the flow of services which those assets provide. The former concept, for instance, values a machine or vehicle at its resale value, while the latter concept captures the contribution that the same machine or vehicle makes to production in a particular time period. Under certain assumptions, these services are conceptually equivalent in value to the rental that a firm might pay for the use of an equivalent asset for that period. It is these capital services which firms combine with labour and intermediate inputs to deliver output of goods and services.

Capital services are the preferred measure of capital as an input in growth accounting. Growth accounting provides a decomposition of the growth rates of economic output and labour productivity into contributions due to changes in inputs of factors of production (labour and capital) and a residual component described as multi-factor productivity (MFP). MFP estimates will be published in a forthcoming article on 6 April 2018 using the capital services estimates in this release.

The estimates in this release are presented for 57 component industries, for 13 asset classes and for the aggregate market sector. For the first time, estimates have been compiled on a quarterly rather than annual frequency. As in recent releases, we do not present estimates for the non-market sector, where the relationship between capital accumulation and production differs from the classic production function framework. This means that we also do not present estimates for capital services for the whole economy.

The data published in this release pertain to the “experimental productive capital stock” measure (henceforward productive capital stock). This is an experimental estimate of the capital stock which calculated under different methods to the national accounts. These methods are more appropriate for measuring capital as an input into production. As well, this release incorporates a number of significant methods and data improvements compared with earlier releases. These reflect the intermediate results of a number of development programmes, including a comprehensive review of gross fixed capital formation (GFCF) used in capital stocks and development work on the UK National Accounts’ main capital stock system, as well as a number of other methodological improvements. For these reasons, users should be aware that the data in this release carry an “experimental” badge. In particular, the data published here are conceptually different and not directly comparable to those published as part of our official estimates of [Capital stocks, consumption of fixed capital in the UK](#) last published in November 2017, nor with those published as part of the [Business Investment](#) release, last published in December 2017.

## Layout of article

Section 3 lists, briefly, the impacts of revisions to the capital stock compared with the previous capital services release and the differences compared with the national statistic capital stocks. A separate methods article will provide more detail on methods changes to capital stocks, as will future [methods articles](#) published in advance of the Blue Book. Section 4 shows the current values for volume index of capital services (VICS). Section 5 shows revisions to VICS compared with the previous publication. Section 6 gives robustness checks and sensitivities showing the implications of different assumptions made in the modelling of VICS. Section 7 recaps the main conclusions and sets out next steps.

## 3 . Things you need to know about this release

Compared with the previous capital services release, this release incorporates a number of significant methods and data improvements. These include the intermediate results of development work on the input data and on new systems, which may change further over the coming months. These outputs are consequently badged as “experimental” and are subject to further revision in future releases. As with all of our outputs, the Productivity Group seek user feedback on both the uses and usefulness of these data, which should be directed to our inbox: [Productivity@ons.gov.uk](mailto:Productivity@ons.gov.uk).

The investment data used in this release represent the intermediate results of an ongoing and comprehensive review of the gross fixed capital formation (GFCF) which are used in the construction of capital stocks. These data have been updated for methods revisions made in Blue Book 2017, and include improvements to GFCF detailed in the September 2017 business investment publication, which was the first to fully incorporate the new GFCF estimation system (data back to Quarter 1 (Jan to Mar) 2016 were included in the February 2017 publication). It also included a [number of revisions to various assets](#), particularly on purchased software.

The back-series of the investment data has also been re-examined. The new GFCF data for software and hardware have been extended back to 1970 and telecommunications equipment have been extended back to 1920. The price indices which are needed to cover this extended period have been sourced from the US Bureau of Economic Analysis deflators for pre-packaged software, a weighting of indices for computer hardware and a series used for telecommunications equipment. These are adjusted to sterling values using historical exchange rates. Alongside these changes, there are several other revisions, such as improvements to the conversion to SIC 2007 and reducing discontinuities at the linking point in Quarter 1 (Jan to Mar) 1997. More detail on the GFCF and capital stock revisions will be given in future methods articles.

These new investment data have enabled the compilation of capital stocks estimates at a more granular scale than previously. In particular, we are now able to provide a quarterly time series, based on quarterly capital formation and interpolation of annual values where these are only available in the historic period.

We have also disaggregated assets and industries. Compared with the previous capital services release, other buildings and structures has been split into, separately, other buildings, other structures and land improvements. ICT equipment (hardware) has also been split into telecoms and ICT hardware excluding telecoms. Meanwhile, the disaggregation over industries has been increased, from the A20 classification to most industries under the A64 classification. Different asset lives and deflators are used for each of these underlying assets, per industry, improving estimates of consumption of fixed capital and chain volume measure (CVM) stocks for these assets.

These developments are a considerable step forward, but the data are consequently highly experimental in nature, reflecting ongoing development work on both data sources and systems used in their compilation. For one, the data in this release only concerns the productive capital stock, which is conceptually a separate measure to the national accounts capital stock, and only used as a way of measuring the contribution of capital to production. While many of the methods improvements to modelling the productive capital stock used in this release are likely to be made to the official capital stocks in a future Blue Book, there remains work to be done – in particular at the lower level of industry aggregation. We therefore advise that users make only careful use of these lower-level data: in particular, we note that the estimates contained in this release are not substitutes for the official, National Statistics-badged estimates of either the capital stock or investment.

## **4 . Main results**

The volume index of capital services is an index of the growth in the productive stock of capital, weighted by the modelled rental cost of each item of capital. This “user cost” of capital is calculated from the deterioration of capital over time, the change in value and the rate of return to capital. When the series grows, it implies that the volume of capital applied in production is increasing. Conversely, when the series falls, the amount of capital used in the production process is estimated to have fallen.

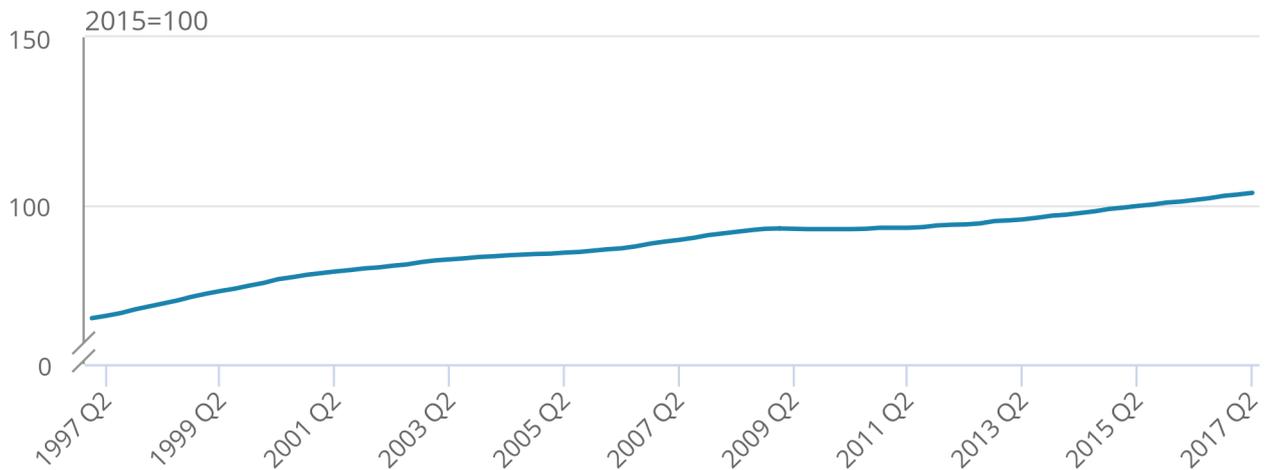
The volume of capital applied to production in the UK has increased in recent years – albeit at a slower pace than in the pre-downturn period. The market sector volume index of capital services grew by 0.4% in Quarter 1 (Jan to Mar) 2017 and by 0.5% in Quarter 2 (Apr to Jun) 2017 (Figure 1). This is in line with average quarterly growth of 0.4% over the period Quarter 1 2010 to Quarter 2 2017. Capital services growth in 2016 was 1.9%, higher than the average of 1.3% per year from 2010 to 2016. However, this growth rate is considerably lower than during the decade prior to the downturn, when capital services grew by 2.6% per year on average.

## Figure 1: Volume index of capital services

UK, market sector, Quarter 1 (Jan to Mar) 1997 to Quarter 2 (Apr to Jun) 2017

### Figure 1: Volume index of capital services

UK, market sector, Quarter 1 (Jan to Mar) 1997 to Quarter 2 (Apr to Jun) 2017



Source: Office for National Statistics

The relationship between capital services and the capital stock is governed in part by the rates of depreciation for different assets and their relative importance in the overall capital stock. For instance, the proportional depreciation of buildings and structures is low in any given year, but the proportional depreciation of software and ICT equipment is high for example capitalised software depreciates quickly and is modelled with an average asset life of five years. These relative rates of depreciation mean that in the volume index of capital services (VICs), for a given time period, a unit of software would receive a higher weight than a unit of structures, because more of the value of the software is used up over the time period through deterioration. Consequently, long-lived (short-lived) assets make a smaller (larger) contribution to VICs than to the capital stock as a whole.

This treatment of assets consequently means that the stock of capital and the magnitude of capital services can change at different rates, depending on the asset mix in the stock. The stock of capital in the UK market sector increased approximately sevenfold in volume terms between 1950 and 2017. However, the volume index of capital services has increased by a factor of approximately 11.

This finding implies that the mix of assets in the UK's capital stock has changed considerably over time – away from long-lived assets and towards shorter-lived assets – and that these assets have made a bigger contribution to VICs growth than to the capital stock as a whole over this period (Figure 2). In particular, between Quarter 1 1990 and Quarter 2 2017, software and databases accounted for 4.7% of the increase in the market sector productive capital stock. However, software and databases accounted for 6.6% of the increase in VICs over the same period. Similarly, research and development contributed 3.6% of the increase in the productive capital stock, but 5.9% of the increase in VICs, over the same period.

The opposite is other machinery and equipment, which made up 14.8% of the growth in the productive capital stock, but 12.4% in the growth in VICS, when weighted by user costs. Buildings other than dwellings is the largest asset in the market sector capital stock, and since Quarter 1 1990 has contributed 48.4% of the total increase in the productive capital stock, and 48.2% of the increase in VICS. While buildings have longer asset lives, this is mitigated by other factors in the user cost model, and so the contributions to the growth in the capital stock and capital services are similar.

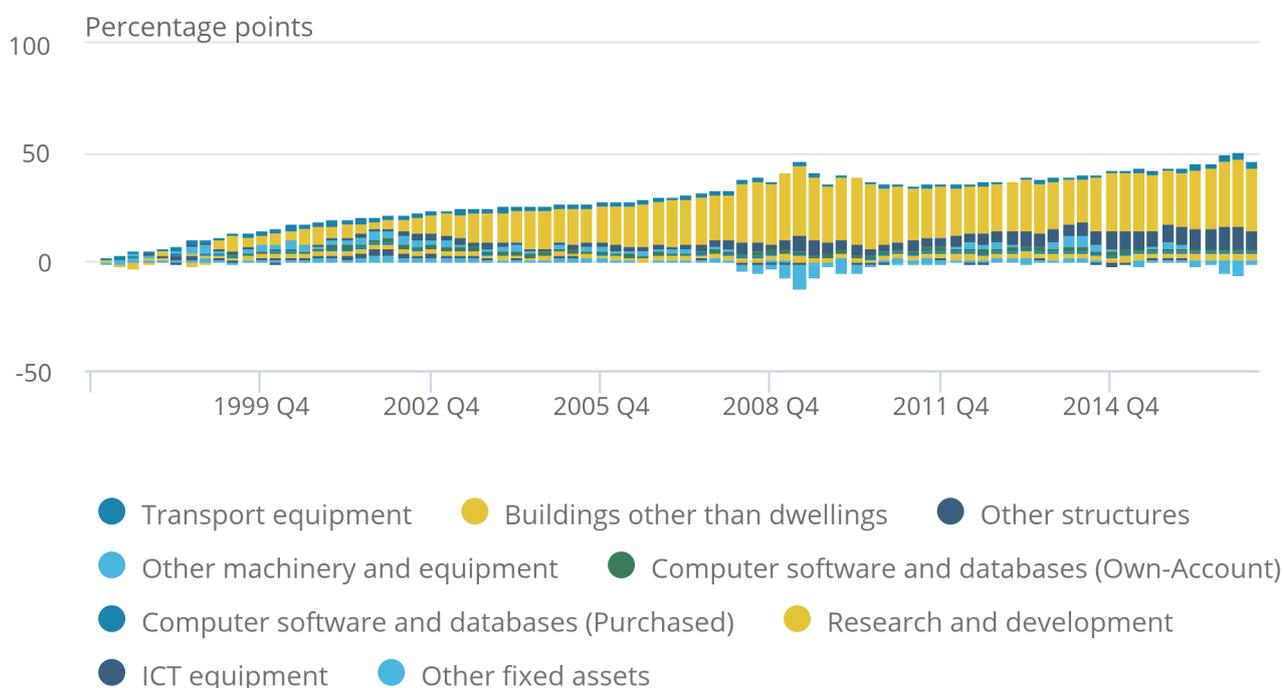
Figure 2 shows the contributions to the growth in VICS, for the largest asset classes over the last two decades.

### Figure 2: Cumulative contributions to growth in capital services by asset

UK, market sector, Quarter 1 (Jan to Mar) 1997 to Quarter 2 (Apr to Jun) 2017

## Figure 2: Cumulative contributions to growth in capital services by asset

UK, market sector, Quarter 1 (Jan to Mar) 1997 to Quarter 2 (Apr to Jun) 2017



Source: Office for National Statistics

### Capital services by industry

In this release we have increased the granularity of capital services estimates from 15 industries to the 62 industries (57 after suppressions for further quality assurance), and shifted from an annual to a quarterly frequency. Table 1 shows the average annual growth of the volume of capital services for selected periods at a higher level of industrial aggregation. Since the economic downturn, C (manufacturing) and J (information and communications) have experienced the largest falls in capital services, while D (electricity and gas) has experienced the largest increase. Among the service industries, section M (professional, scientific and technical activities) has seen the strongest growth.

Comparing the eight years prior to the downturn with the 2009 to 2016 period suggests that industries have differed in their responses to the economic downturn. In particular, industries C (manufacturing) and E (water supply and sewerage) experienced similar rates of capital services growth rate over these two periods, while D (electricity and gas) has experienced much stronger capital services growth in the periods since the economic downturn. By contrast, capital services growth in the services industries has slowed across all industries at this level of aggregation. For the majority of these industries, capital services growth has slowed markedly in recent years as compared with that achieved in the latter half of the twentieth century.

**Table 1: Average annual growth in volume index of capital services, UK, market sector, percentage points, 1951 to 2016**

	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2008	2009-2016
A	4.1%	3.1%	1.8%	-0.5%	0.7%	1.4%	2.4%
B	6.1%	4.4%	11.4%	3.4%	0.8%	-1.3%	2.3%
C:10-22	5.0%	4.6%	3.1%	1.1%	1.7%	-0.9%	-1.1%
C:23-33	4.1%	4.1%	4.2%	2.0%	2.1%	-0.8%	-0.3%
D	6.4%	6.1%	-1.2%	-0.3%	1.4%	1.9%	6.3%
E	3.2%	5.1%	4.2%	1.9%	7.2%	2.2%	2.1%
F	6.5%	7.0%	2.6%	3.4%	3.5%	3.8%	2.4%
G	5.2%	6.8%	6.9%	5.9%	5.6%	3.4%	1.8%
H	1.6%	1.8%	2.2%	0.5%	6.1%	4.5%	-0.0%
I	7.6%	10.0%	7.0%	5.2%	6.7%	2.2%	1.4%
J	5.5%	7.2%	6.0%	7.8%	10.2%	3.2%	-0.5%
K	5.0%	12.9%	10.3%	10.2%	3.3%	3.3%	0.8%
L	4.1%	6.1%	3.8%	7.5%	3.6%	3.0%	0.3%
M	25.1%	7.5%	10.7%	13.7%	6.7%	5.0%	3.3%
N	4.3%	4.4%	9.9%	9.9%	7.8%	3.2%	1.6%
RS	3.1%	3.8%	5.7%	8.4%	4.6%	0.9%	0.5%
Market Sector	4.7%	5.0%	4.3%	3.9%	4.4%	2.1%	1.3%

Source: Office for National Statistics

Notes:

1. A, agriculture, forestry and fishing; B, mining and quarrying (including extraction of crude petroleum and natural gas); C, manufacturing; D, electricity and gas; E, water supply and sewerage; F, construction; G, wholesale and retail trade; H, transport and storage; I, accommodation and food services; J information and communication; K, finance and insurance; L, real estate; M, professional, scientific and technical activities; N, administrative and support activities; RS, arts, entertainment, sports, recreation and other.

## Rates of return

One component of the weights of VICS is the real rate of return on capital. This is calculated for the whole of the market sector as the net operating surplus in real terms (net of depreciation and real holding gains or losses) divided by the productive capital stock. For several smaller industries the productive capital stock is small or volatile and leads to implausible values for a rate of return calculated at the industry level. The market sector rate of return is consequently applied to all industries and assets.

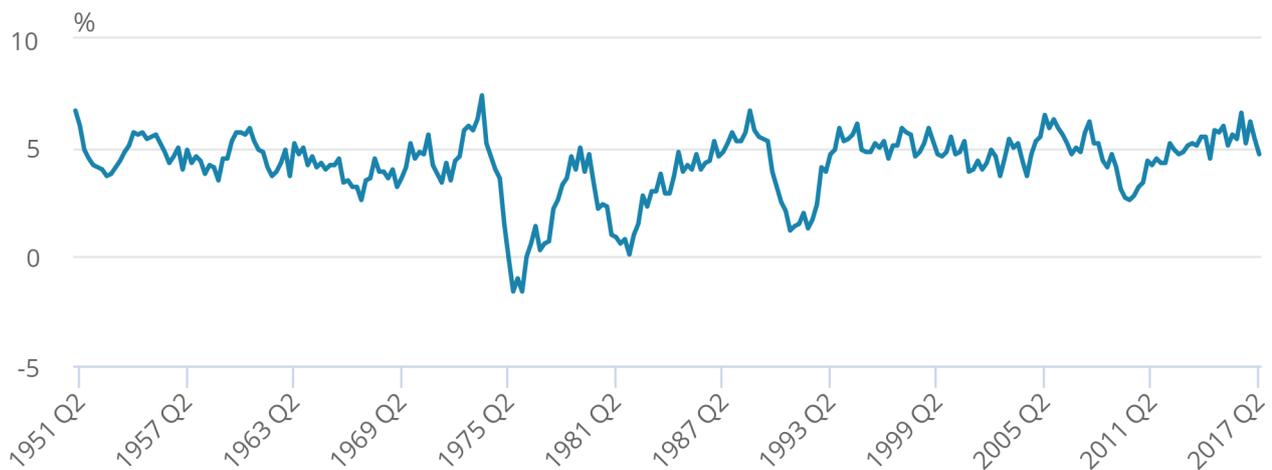
Figure 3 shows the market sector quarterly real rate of return from 1951. It suggests that on this basis, the real rate of return has varied between 4% and 6% per quarter over much of this period. The main exceptions to this, otherwise quite stable picture, occur around large inflationary movements. In particular, the real rate of return fell markedly following the oil price shocks in the mid- and late-1970s. More recently, the real rate of return fell during the recent economic downturn – which also followed a similar, albeit more modest rise in the rate of inflation.

**Figure 3: Real rate of return on capital**

UK, market sector, Quarter 1 (Jan to Mar) 1951 to Quarter 2 (Apr to Jun) 2017

Figure 3: Real rate of return on capital

UK, market sector, Quarter 1 (Jan to Mar) 1951 to Quarter 2 (Apr to Jun) 2017



Source: Office for National Statistics

## 5 . Revisions

As set out in Section 3, this release incorporates the intermediate results of a number of ongoing development programmes designed to improve data, systems and methods used in the calculation of the capital stock. While these changes are improvements, they remain in development, and may consequently be subject to revision in future releases.

## Revisions to source data

For this release, the gross fixed capital formation (GFCF) estimates by industry, asset and sector which are used in the calculation of productive capital stocks have been comprehensively reviewed, including re-visiting series prior to 1997<sup>1</sup>. One consequence of this review is that the GFCF estimates used in this release differ from other GFCF data published by ONS, including [business investment](#). The main reason is that the new GFCF data are fully sectorised, allowing investment by non-profit institutions serving households (NPISH) by asset and industry to be identified and removed in arriving at investment by the market sector. By contrast, our headline business investment release includes all investment by NPISH other than on dwellings. This is the main source of revisions since our last capital services publication in January 2017, and is larger than revisions to published business investment between Blue Book 2016 and Blue Book 2017.

Users should note the experimental nature of the estimates used here. While the improvements reflected in the data used here may be included in the UK National Accounts in a subsequent Blue Book, users should note that our preferred measure of investment remains that included in the National Statistics-badged Business Investment release.

Users will be aware that utilising a new GFCF dataset that is inconsistent with the UK National Accounts may create a potential inconsistency when we come to use these capital services estimates to compile estimates of multi-factor productivity (MFP) as scheduled for April 2018. We justify this course of action on two grounds. Firstly, the new GFCF dataset constitutes a major step forward in terms of coherence with source data, including much improved coherence of deflator movements which feed directly into compilation of capital services as well as improved alignment of historical data.

While further work on methods and data remains to be done – including for some of the more detailed industries published here – we believe there is merit in using these data to get feedback from users. Secondly, what matters for MFP is growth rates rather than levels, and differences in growth rates between the GFCF dataset used in this release and our published business investment series are comparatively modest.

Mostly reflecting the exclusion of NPISH, the overall level of GFCF in this release is around 7% lower in current price terms than total business investment since 1997 (and around 6% lower than in our previous release), annual average real growth since 1997 is 1.3%, compared with 1.0% for business investment. Notable revisions to GFCF since our last release include the following.

Tangible investment has been revised upwards. This reflects sizeable upward revisions to investment in transport equipment and computer hardware and telecoms equipment. Investment in buildings and structures and other machinery has been revised down since last year.

Intangible investment has been revised sharply downwards. All intangible components are lower than a year ago, with especially large downward revisions in software and research and development (due to the exclusion of NPISH).

GFCF deflator growth has been revised down a little. For all assets included in capital services (that is, all investment by the market sector other than dwellings and capitalised transfer costs), annual average deflator growth between 1997 and 2015 has been revised down from 1.2% to 1.0%. This reflects lower deflator growth for a number of intangible assets, including purchased software (from negative 1.2% pa to negative 2.7% pa) and with mineral exploration and evaluation (from 3.2% pa to 1.2% pa). On the other hand, deflator growth for transport equipment has increased from negative 0.5% pa to negative 0.1% pa.

Coverage has increased. The experimental estimates published with this release cover 62 industries (57 after suppressions for further quality assurance) and 13 asset classes, at quarterly periodicity. For many series quarterly paths have been interpolated before 1997, although this does not matter much when using the series for aggregating the capital stock over time.

## Revisions to asset lives

We commissioned the National Institute of Economic and Social Research (NIESR) to review asset lives and their report was published in [January 2017](#) (Rincon-Aznar, Riley and Young, 2017). NIESR found that ONS asset life assumptions are, in many but not all cases, longer than those assumed in other countries. We will communicate plans to improve asset lives in light of the NIESR review with users ahead of implementation, which is currently scheduled for a future Blue Book. For this release we continue to adopt the same asset lives as those used in our official capital stock estimates.

## Revisions to capital stock estimates

The [dataset](#) published alongside this article contains estimates of market sector experimental productive capital stocks by asset and industry compiled as an intermediate step for this release. We refer to these as productive capital stocks, to distinguish them from the wealth-based measures of capital published as part of the [Capital stocks \[and\] consumption of fixed capital](#) release, last published in November 2017.

Figure 4 compares experimental productive capital in this release with last year's values, expressed in common price terms. This shows that stocks of capital have been revised downwards in this release in levels terms, although the time series properties of the two series are very similar. The downward revision to levels partly reflects the removal of NPISH investment noted above, as well as the introduction of an allowance for retirement of assets around their average life length. One advantage of the new production platform is that it will allow more flexible modelling of asset accumulation under a range of assumptions relating to asset lives, deterioration profiles and retirement functions.

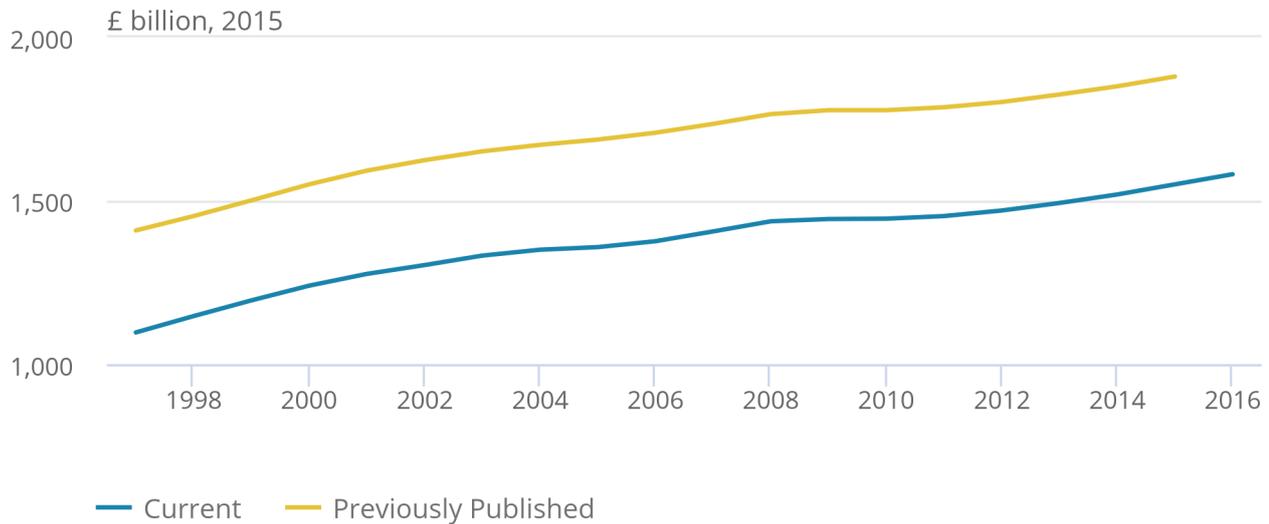
Note that these are experimental estimates of the productive capital stock, which are conceptually different and not directly comparable with those included in the official, National Statistics-badged Capital Stocks and consumption of fixed capital release, which remain our preferred measure of the overall capital stock.

## Figure 4: Revisions to productive capital stocks

UK, market sector, 1997 to 2016

### Figure 4: Revisions to productive capital stocks

UK, market sector, 1997 to 2016



Source: Office for National Statistics

## Revisions to capital services estimates

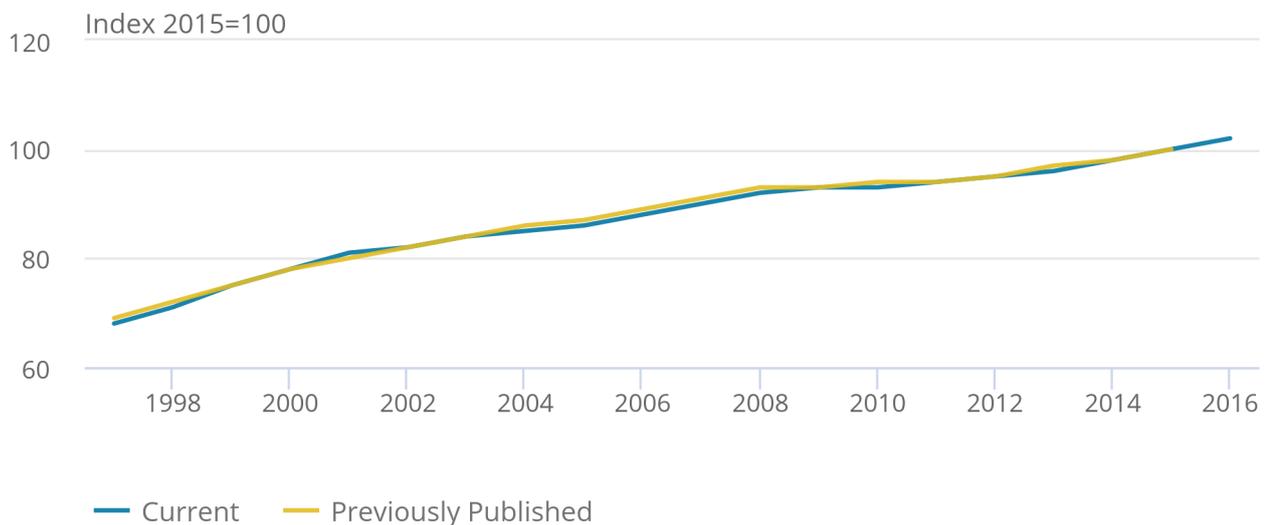
Figure 5 shows aggregate capital services for the market sector in this release alongside the equivalent series from the published in January 2017, both indexed to 2015. Despite significant revisions to source data and to methodology, the series track one another closely. There is no revision to average growth of capital services since the economic downturn (both series grow at 1.1% pa between 1997 and 2008). Between 1997 and 2008, growth in capital services is now estimated at 2.9% pa, compared with 2.7% pa previously.

## Figure 5: Revisions to capital services

UK, market sector, 1997 to 2016

### Figure 5: Revisions to capital services

UK, market sector, 1997 to 2016



Source: Office for National Statistics

This top-level comparison masks some larger revisions at the industry level. The recent growth of capital services has been revised up sharply in industries AB (agriculture, mining) and M (professional services). The largest downward revisions to growth are in industries H (transportation and storage), L (real estate) and N (administrative and support activities).

There are also some large revisions to capital services by asset, including upward revisions to mineral exploration and evaluation and downward revisions to computer hardware and telecoms (aggregated in last year's release) and to cultivated assets. More information on revisions is available in the [dataset](#) published alongside this article.

## Notes for Revisions

1. GFCF input data are now quarterly, although quarterly paths are generally interpolated before 1997.

## 6 . Sensitivity to modelling assumptions

Tables 2 and 3 show the growth in the volume index of capital services under different model specifications. It should be noted that volume index of capital services (VICS) is an experimental statistic, and that the different specifications presented here are intended only to give users information of the importance of modelling choices to the statistics.

The holding gains component of the user costs – the modelled cost of employing the asset over a given period, rather than selling it at the beginning of the period – does not have a large impact on VICS at an aggregate level.

**Table 2: Comparison of average per annum growth rates of the volume index of capital services under different model specifications, market sector, UK, 1951 to 2016**

	Current experimental estimates			No holding gains or user cost floor		
	1951-1980	1981-2000	2001-2016	1951-1980	1981-2000	2001-2016
A	3.0%	0.1%	1.9%	2.9%	-0.0%	1.8%
B	7.4%	2.1%	0.5%	7.1%	2.0%	0.4%
C:10-22	4.2%	1.4%	-1.0%	4.0%	1.2%	-1.0%
C:23-33	4.1%	2.0%	-0.5%	3.8%	1.7%	-0.5%
D	3.7%	0.6%	4.1%	3.6%	0.4%	4.0%
E	4.2%	4.6%	2.1%	4.2%	4.6%	2.1%
F	5.3%	3.4%	3.1%	5.2%	3.3%	3.0%
G	6.3%	5.8%	2.6%	6.0%	5.4%	2.5%
H	1.9%	3.3%	2.3%	1.8%	3.0%	2.2%
I	8.2%	5.9%	1.8%	7.9%	5.8%	1.7%
J	6.3%	9.0%	1.3%	6.1%	8.4%	1.2%
K	9.6%	6.8%	2.1%	9.2%	6.1%	1.8%
L	4.7%	5.5%	1.7%	4.6%	5.4%	1.6%
M	14.1%	10.2%	4.2%	13.9%	9.6%	4.0%
N	6.3%	8.8%	2.4%	5.8%	8.4%	2.2%
RS	4.2%	6.5%	0.7%	3.9%	6.3%	0.7%
Market Sector	4.7%	4.1%	1.7%	4.5%	3.8%	1.6%

Source: Office for National Statistics

Notes:

1. See notes to table 1

The second element of the user cost weights in VICS is the rate of return to capital, which represents equivalently the cost of financing the asset and the opportunity cost of holding the asset instead of investing in financial assets. The experimental VICS model imposes a single rate of return for the market sector as a whole. It is possible to calculate the real rate of return at the industry level. This produces estimates of VICS with slightly higher average growth rates, as shown in Table 3. However, the level of disaggregation necessary for industry level rates of return is less accurate for the pre-1997 period. Unsurprisingly, many industries return implausibly high rates of return: likely there is additional operating surplus generated from assets not included in the productive capital stock, such as intangible assets other than those in the asset boundary, inventories or non-produced assets, or other factors such as market power.

**Table 3: Comparison of average per annum growth rates of the volume index of capital services under different model specifications, market sector, UK, 1951 to 2016**

	Current experimental estimates			Industry-level rate of return		
	1951-1980	1981-2000	2001-2016	1951-1980	1981-2000	2001-2016
A	3.0%	0.1%	1.9%	2.8%	0.1%	3.1%
B	7.4%	2.1%	0.5%	7.3%	2.1%	0.4%
C:10-22	4.2%	1.4%	-1.0%	5.6%	2.1%	-0.8%
C:23-33	4.1%	2.0%	-0.5%	5.6%	2.8%	0.1%
D	3.7%	0.6%	4.1%	4.3%	0.9%	3.9%
E	4.2%	4.6%	2.1%	4.9%	4.3%	2.4%
F	5.3%	3.4%	3.1%	5.1%	3.4%	3.1%
G	6.3%	5.8%	2.6%	7.5%	5.8%	2.6%
H	1.9%	3.3%	2.3%	5.1%	6.1%	2.4%
I	8.2%	5.9%	1.8%	8.2%	6.0%	1.9%
J	6.3%	9.0%	1.3%	7.8%	9.8%	1.5%
K	9.6%	6.8%	2.1%	9.9%	6.1%	1.7%
L	4.7%	5.5%	1.7%	4.6%	5.3%	1.5%
M	14.1%	10.2%	4.2%	11.6%	10.1%	4.6%
N	6.3%	8.8%	2.4%	6.9%	9.2%	1.5%
RS	4.2%	6.5%	0.7%	9.5%	7.2%	0.7%
Market Sector	4.7%	4.1%	1.7%	7.0%	5.5%	2.0%

Source: Office for National Statistics

Notes:

1. See notes to table 1

## 7 . Conclusions and next steps

Following methods improvements, we are able to publish experimental estimates of capital services at a higher periodicity and lower level of industry aggregation than was previously published. These methods changes still do not change the overall narrative of the capital services contribution growing, but less strongly than before the economic downturn.

Our next step is to combine the estimates in this release with estimates of quality adjusted labour inputs (QALI) in order to compile estimates of multi-factor productivity (MFP). The MFP release scheduled for 6 April 2018 will be the first to provide quarterly estimates. The development of quarterly MFP estimates will be on the agenda of a user group event on 16 March 2018 in London. If you are interested in attending this event, please email [productivity@ons.gov.uk](mailto:productivity@ons.gov.uk).

Looking further ahead, our development priorities for 2018 are as follows.

## **Incorporate non-produced assets and inventories**

Currently we compute a single endogenous rate of return across the market sector, using capital income from the UK National Accounts and our estimates of the depreciation and real price change elements of the Hall-Jorgenson expression for user costs of capital. This ensures that, for our estimates of productive capital stocks, the rate of return fully exhausts our estimates of capital income.

We recognise a likely inconsistency between the asset boundaries on the top and bottom of the rate of return calculation. In particular it seems likely that some capital income recorded in the UK National Accounts reflects returns to holdings of items such as:

- non-produced assets, such as land, mineral resources, radio spectra, contracts, leases and licences, and goodwill and marketing assets – which are within the asset but not the production boundary
- inventories, such as goods for resale, works in progress, finished goods, and materials and supplies – which are produced, but not fixed assets
- own production of intangible assets other than those in the national accounts asset boundary

Such holdings are non-trivial. We estimate that at the end of 2016, market sector holdings of land were worth around £950 billion, and holdings of inventories were worth a further £280 billion. These figures compare with around £1.6 trillion for the stock of productive fixed assets in the market sector.

There are practical and conceptual issues in incorporating land into our estimates of capital services. On the practical side, we have estimates of total land holdings by the market sector producers, but we do not have splits by industry, nor any information on volumes and prices. And although we do have industry holdings of associated assets (buildings and structures, and cultivated assets) it is unlikely that there is a single relationship between values of these assets and values of the associated land holdings, because land values vary dramatically according to location, quality and other factors.

On the conceptual side, there is no internationally agreed method of incorporating land. One recognised issue concerns land prices, which to the extent that they are measurable, suggest periods of extreme volatility. The OECD Measuring Capital manual suggests that in light of this, expected real holding gains and losses should be set to zero, implying that on average, land prices are expected to evolve in line with the general price level. But in the UK, the value of land held by the market sector increased by 234% since 1995. We do not have information on the change in volume over this period (for example as more land is brought into development), but land volumes in the US, which is a much larger country with often fewer restrictions on planning, show that land volumes in the US business sector increased by only 6% between 1995 and 2015 (the last year for which US data have been published). This suggests that most of the increase in land values in the UK is likely to reflect rising land prices, and given that the increase in the general price level was only 52% over this period, this would suggest a very substantial increase in the real price of land. One explanation is that while the overall amount of land in the UK is effectively fixed, the amount of different types of land is not fixed. Thus the average price of land will increase when agricultural land is reclassified as land for commercial development.

Accounting for inventories would seem to be more straightforward because we have evidence on inventory holdings at detailed industry level from our Annual Business Survey. However, the OECD Measuring Capital manual outlines a number of conceptual issues, including consistency between the treatment of inventories in the context of capital services and their treatment in the UK National Accounts, where the change in inventories is a component of aggregate demand.

In a similar vein, our data suggest that the market sector held dwellings valued at around £227 billion (excluding the value of the underlying land) at the end of 2016. While we are comfortable with our assumption that dwellings do not constitute productive capital in terms of a conventional production function, it is nonetheless entirely plausible that income from holdings of dwellings shows up in the capital income figures.

## Accounting for utilisation of capital

Development of quarterly capital services estimates and the forthcoming publication of quarterly multi-factor productivity (MFP) estimated has led to renewed focus on measuring utilisation of capital. This is because we would expect firms to respond to demand and supply shocks in the short term by varying their utilisation of factors of production, for example by asking their workers to work longer hours and working their fixed assets more intensively (for example by changing the number of shifts), rather than immediately changing their headcount or levels of investment. While we would pick up changes in average hours in our labour statistics, currently we have no means of capturing changes in utilisation of fixed assets.

John Fernald (2014) has produced quarterly, utilisation-adjusted series on total factor productivity for the US business sector. Fernald (2014) follows the utilisation adjustment in Basu, Fernald and Kimball (2006) and uses observed average hours per worker as a proxy for the overall unobserved short-term utilisation adjustments made by firms. We are investigating repeating this analysis for the UK, in order to publish UK utilisation-adjusted MFP in addition to the general MFP statistics.

## 8 . Authors and acknowledgements

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## 9 . References

Basu, S, Fernald, J, Kimball, M (2006), "Are Technology Improvements Contractionary?", *American Economic Review*, 96, 5

Fernald, J (2014), "A Quarterly, Utilization-Adjusted Series on Total Factor Productivity", *Federal Reserve Bank of San Francisco Working Paper 2012-19*

Reinsdorf, M, Diewert, W, Ehemann, C (2002), "Additive decompositions for Fisher, Törnqvist and geometric mean indexes", *Journal of Economic and Social Measurement*, 28

Rincon-Aznar, A, Riley, R, Young, G (2017), "Academic Review of Asset Lives in the UK", *NIESR Discussion Paper No. 474*

OECD (2009) *Measuring Capital*, OECD Manual