Article

National Accounts articles: Changes to the capital stock estimation methods for Blue Book 2019

Details the improvements to capital stock methods and estimates updated as part of the Blue Book 2019 to align our approach with the international best practices.

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Release date:
20 August 2019

Next release:
To be announced

Table of contents

1 . Executive summary

In UK National Accounts, the Blue Book 2019, we have made considerable progress in improving how we compile estimates of gross domestic product (GDP), where we have used the foundations of a new framework to inform headline GDP estimates.

This includes progress incorporating a wider set of more appropriate product deflators for each transaction, confronting these at a detailed level for the first time; full integration of the institutional sectors into the balancing process of the supply and use framework; and improving our estimates of current price GDP by using new data sources to give information on the diversification of the services economy and the costs incurred by businesses.

Further information appears in National Accounts articles: Blue Book 2019 impacts on GDP current price and chained volume measure estimates: 1997 to 2016, published on 20 August 2019.

There are also a number of methodological improvements that will be incorporated into this years' Blue Book, standalone articles for UK trade data impact assessment from new developments: 1997 to 2016; National Accounts articles: Impact of Blue Book 2019 changes on gross fixed capital formation and business investment ; and National Accounts articles: Improvements to the processing of non-profit institutions serving households (NPISH) published on 20 August 2019 provide further details of these.

2 . Introduction

As part of Blue Book 2019 (BB19), we have made the most significant changes to the measurement of capital stocks since the initial UK work covered in Dean (1964) and Redfern (1955). We have also improved the estimation of consumption of fixed capital and introduced estimates not previously measured in the UK related to stocks and flows of fixed assets.

This article explains these improvements as well as the steps we have taken towards providing a link between net capital stock and productivity measures, as recommended in the Organisation for Economic Co-operation and Development (OECD) manual on measuring capital (2009) (PDF, 2.11MB).

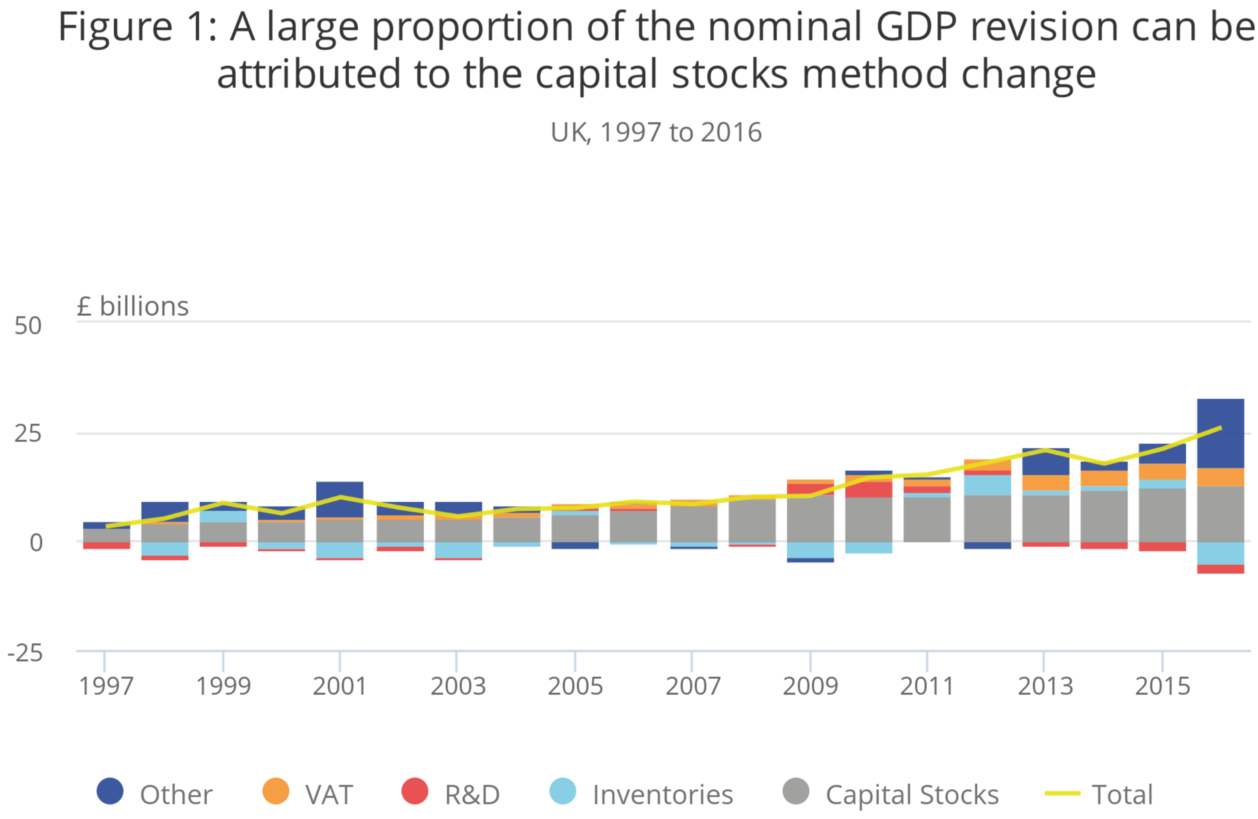
The most significant improvements to the estimates are:

- reviewing and updating the asset lives for non-financial assets such as buildings, and machinery and equipment; as such, for the majority of assets, their life lengths have been shortened, leading to a downward revision to capital stock estimates and an upward revision to estimates of the consumption of fixed capital
- replacing straight-line depreciation with a wider choice of depreciation patterns (for example, geometric, hyperbolic) that more appropriately capture the loss in value of assets as they age
- the treatment of costs of ownership transfer is updated so they are now written off over the period of ownership of the relevant assets instead of being written off as incurred
- improved treatment of consumption of fixed capital by assigning other volume changes such as bankruptcy, war losses and classifications to the appropriate accounts
- reviewing and improving the quality of the industry breakdown of historical gross fixed capital formation (GFCF) data in the redeveloped capital stocks system
- historical benchmark estimates covering certain institutional sectors, including government, public non-financial corporations and non-profit institutions have been replaced with newly estimated data

The improvements discussed in this article have the largest impact on current price GDP estimates in BB19 as can be seen from Figure 1 and discussed in previously published analysis. A second article detailing the impact of the capital stock changes will be published on 30 August 2019.

Figure 1: A large proportion of the nominal GDP revision can be attributed to the capital stocks method change

UK, 1997 to 2016



Source: Office for National Statistics

Notes:

1. ‘Other’ is treated as a residual, which captures the net effects of other methodological improvements in Blue Book 2019, the incorporation of latest survey and administrative information, enhanced data reconciliation and balancing.

3 . Background and scope

Capital stock is a measurement of fixed assets (non-financial assets) within an economy at a point in time. Capital stocks produce a flow of capital services into the production process, therefore net capital stocks are closely related to the amount of goods and services that an economy can produce.

Capital stocks are an important component of the national accounts and their estimation provide:

- estimated market values of the fixed assets of countries, accounting in general for the largest component of the balance sheet and therefore wealth of the UK

- consumption of fixed capital that is used, in the sum of costs approach, to estimate the output of non-market producers

- it allows national accounts aggregates such as domestic product, value added, disposable income, and others to be calculated in net rather than gross terms

- as capital services estimates are an input in the production function and are derived from capital stock estimates, it provides a link to the productivity dynamics of the UK

- related to productivity estimation, capital stock is a significant component of the estimation of the rate of return implicit in the UK's generation of income account

The main approach used to obtain capital stock estimates is presented in the European System of Accounts 2010 (ESA 2010) (PDF, 6.4MB) and 2008 System of National Accounts (2008 SNA) (PDF, 9.8MB) and uses the Perpetual Inventory Method (PIM). The PIM is a widely used method to estimate the capital stock values by accumulating investment flow data for fixed assets and writing down assets held in the accumulated stock for retirement and the consumption of fixed capital.

Estimates of capital stocks are calculated from the associated investment flows, by accumulating past purchases of assets over their estimated service lives to estimate a gross capital stock measure. A depreciation function is then specified to account for the fact that assets lose value over time as a result of being subject to wear and tear and obsolescence as the asset ages, which produces estimates of consumption of fixed capital and net capital stock.

The PIM model is most crucially dependent on flows of investment, depreciation profiles and asset life lengths. Regarding the importance of these components, the redevelopment of the estimates focused heavily on the asset lives and depreciation profiles that are derived from these asset lives – see Section 4: Other buildings, Dwellings and Other machinery and equipment, and Annex 3. These updates are consistent with recommendations given by the National Statistics Quality Review (NSQR) of the national accounts and balance of payments in 2014:

"We recommend that there is a Capital Stocks review to consider alternatives to the current linear depreciation, noting that many other countries have, after research, moved to some non-linear model. This review should also examine the average service lives in use in the UK as it has been noted that these are in some case much longer than the lives used in other economies. It would also be good to have a more complete description of how disposals and scrappage are estimated and used in both GFCF {gross fixed capital formation} and the stock estimates. The practice of using fixed proportions for sector estimates should also be reviewed."

"The data sources and methods for estimating cost 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 the capital stock estimates."

However, the redevelopment project does not only focus on the PIM components but also on expanding and improving other aspects of the capital stock estimation process such as the frequency of the estimates as recommended by Sir Charles Bean in an independent review:

"Currently the Volume Index of Capital Services is published on an annual basis, but the production of quarterly estimates is under consideration. This would be a welcome step, as it would enable production of quarterly estimates of multi-factor productivity shortly after the publication of the quarterly national accounts, as opposed to the current annual frequency."

The review suggests producing quarterly multi-factor productivity estimates to provide more timely growth accounting estimates to policy-makers. As the productive stock, used in the capital services estimates, is adjusted for the loss in productive efficiency of the assets contained within it, quarterly multi-factor productivity requires that quarterly capital stock data are estimated.

Figure 2 shows the transition from the previous practice to the redeveloped model in BB19. As mentioned before, this aims to account for capital stock losses in productive efficiency and to work towards aligning the capital stock model to the capital services estimation methods, which is a step towards a fully integrated system.

Figure 2: The changing suite of capital measurements from the 1993 to 2008 System of National Accounts (SNA)

Source: Office for National Statistics

Whereas the 1993 SNA model provides the net stock values function that are used to arrive at net balancing items in the institutional sector accounts, the integrated version seeks to provide a single, consistent suite of estimates, which link net value added and productivity by adding the age-efficiency profile to the model.

While the previous production system only had the capability to use a linear age-price function, the new system provides more options and can accommodate different depreciation patterns such as geometric and hyperbolic. The new model allows for adjustments in the asset contribution to production and captures realistically its productive efficiency.

The retirement, age-efficiency and age-price profile can be changed and can take a number of different forms (discussed in Section 4). The retirement function is applied to the GFCF data and is calibrated to the average life length that represents the peak of the distribution. After the GFCF data are adjusted for retirement and age-efficiency or age-price and accumulated over time, it yields the productive or net stock, depending on the chosen age-profile applied. The productive stock represents the accumulated investment flows corrected for retirement and the loss in the productive efficiency as the asset ages. The net stock represents the accumulated investment flows corrected for retirement and the loss of value of the assets.

From an income perspective, the difference between gross operating surplus (the balancing item of the generation of income account) and consumption of fixed capital gives the net operating surplus that is equivalent to the return on capital to be used to estimate a rate of return. This relationship provides an important link and consistency check throughout the accounts, linking the production and generation of income accounts to the balance sheet as described in Ahmad (2004) (Word, 285KB).

4 . Description of changes to capital stock

Overview of asset life changes

Asset lives represent the expected service life of an asset in the process of production, reflecting the whole period between the purchase of an asset (when it is new) until it is completely obsolete [1].

The majority of the assumed asset lives in the UK dated back to at least 1964, when early estimates of the UK capital stock were compiled by Geoffrey Dean. Some of the estimates Dean used can be traced back even further, to estimates compiled by Philip Redfern in 1955.

As a result of technological development and the increased computerisation of the capital stock, these initial estimates can no longer provide a reliable estimate of the economic lives of assets in the UK today. Moreover, other buildings and structures have heterogeneous components and construction methods depending on their function and location. As such, the accuracy of data on these assets is dependent on them being sufficiently disaggregated and these differences can be taken into account by the use of different life lengths.

The work done towards the redevelopment of the asset lives aims to improve the quality of the estimates and bring them closer to those used by other countries. Table 1 uses data from the 2017 review (PDF, 4.16MB) conducted by the National Institute of Economic and Social Research (NIESR), which compared the asset lives used by the UK with other countries.

Table 1: Blue Book 2018 UK asset lives compared with other countries

Asset	Asset life used by country (Years)					
	United Kingdom	Germany	France	Netherlands	New Zealand	South Korea
Dwellings	59	40 - 95	-	75	70	55
Other buildings	19 - 100	15 - 100	25 - 30	30 - 50	45 - 65	47 - 55
Other structures	19 - 100	25 - 150	60	25 - 55	25 - 110	30 - 65
Land improvements	19 - 100	-	-	1	30 - 58	17
Machinery and equipment	10 - 30	5 - 30	9 - 21	5 - 35	4 - 33	5 - 15
Transportation equipment	9 - 25	8 - 25	7 - 15	5 - 30	5 - 32	6 -30
Computer software and databases	5	5 - 30 [1]	5	3	4	6
R&D	4 - 12	5 - 30 [1]	10	-	10	9 -11

Source: Office for National Statistics

Notes

1. Life refers to total intangible assets. Back to table

The life lengths presented in Table 1 are applied across a wide range of industries – and in some cases extreme estimates were used, such as the life of 100 years for railways and works that are not representative of the general case for asset lives.

To provide a more meaningful comparison, Table 2 compares weighted averages of the old and the new asset lives. The values are weighted based on investment flows (gross fixed capital formation – GFCF) for each industry and the corresponding asset life. A detailed explanation of the methods used to obtain the new values is presented in Section 4 and Annex 3.

Table 2: Comparison between the old and the new asset lives

Asset description	Last estimation	Weighted old lives (years)	Weighted new lives (years)	New-old life (years)
Dwellings	Dean, 1964	59	50	-9
Other buildings	Dean, 1964	65	37	-28
Other structures	Dean, 1964	65	48	-17
Land improvements	Dean, 1964	65	20	-45
Transport equipment	Dean, 1964	11	15	4
Telecommunication equipment	NIESR, 1993	9	18	9
Computer hardware	Vaze, 2001	5	5	0
Machinery and equipment	Dean, 1964 and NIESR, 1993	26	21	-5
Weapons systems	Based on other countries, 2014	20	20	0
Cultivated Biological Resources	ONS	10	6	-4
Computer software and databases	Vaze, 2001	5	5	0
Entertainment, literary and artistic originals	Goodridge, 2008	15	10	-5
Research & Development	ONS, 2014	7	9	2
Mineral exploration and evaluation	ONS	10	15	5

Source: Office for National Statistics

Table 2 shows that shorter life lengths are being introduced in Blue Book 2019 for most of the assets. This leads to a downward revision to capital stock estimates and an upward revision to estimates of the consumption of fixed capital (CFC). In the absence of market prices to values those goods and services that are provided for free, the sum-of-costs approach is used to estimate the output of non-market producers. This is where the cost of production is said to equal the value of that output, which includes the cost of using up capital (such as wear and tear). As such, higher estimates of CFC will lead to higher estimates of gross domestic product (GDP), all else the same.

The biggest impact on the total net capital stock estimates [2] comes from “other buildings”, “dwellings” and “other machinery and equipment”. Even though “other structures” and “land improvements” have big differences between the old and new asset lives, these asset categories do not have a major impact on total capital stock estimates as they are in general smaller asset classes.

The following sub-sections: Other buildings, Dwellings and Other machinery and equipments and Annex 3 give more detail about the methods used to calculate the asset lives.

Other buildings

As “other buildings and structures” account for roughly 35% of the total stock and have one of the largest changes in asset lives, they contribute heavily to the revision of the data. Before Blue Book 2019 (BB19), “other buildings and structures” had a very large range of life lengths because of the variety of different assets (“buildings”, “structures” and “land improvements”) included. These were treated separately for the first time as part of BB19.

“Other buildings” is a highly heterogenous asset class that consists of many types of buildings with different materials and construction methods. Therefore, we have used a granular analysis of this asset by building type as recommended by the 2017 NIESR review (PDF, 4.16MB):

“In collecting this information, it is important to classify assets at the lowest possible level of aggregation, which should help improving the accuracy of the asset lives estimates."

The method used to update the asset life lengths and provide more variation among buildings is called the “building lifecycle model”. It calculates the overall service life of a building by estimating the life of each of its elements and its sub-elements and weighting them together to determine the overall life length of the building. This reflects the fact that each component of the building may depreciate at a different rate. Moreover, the building will undergo multiple cycles of major repairs and maintenance over its life and these cycles must be taken into account to ensure that the consumption of fixed capital is estimated appropriately.

The data for the cost models were sourced from a variety of construction consultancies including the Aecom engineering MESH, which use information specified by real projects. All cost models follow the format and classifications of the Building Cost Information Service (BCIS) (PDF, 2.43MB) and represent an average of the building type considered. Each component includes labour and plant hire costs associated with each element of the work.

The service life of building components was obtained from the Royal Institute of Chartered Surveyors (RICS) and included information on the minimum, average and maximum life expectancy for 305 sub-components (for example, Columns and Beams: Steel (Grade 43): Concrete encased; UBs and RSCs primed; 50 millimetres cover). As both the source of the cost models (BCIS) and the life lengths (RICS) use a similar structural pattern to describe building components, it was possible to match building components across the two sources to combine them together. The weighted total life expectancies ensured that elements that have a larger proportion of cost are represented more heavily in the overall life length estimates.

As buildings are complex assets, the weights of each component will vary from one type of building to another. For example, in the case of London offices the external walls comprise the largest weight (25.6%) with the highest cost represented by “Unitised curtain walling system with solid spandrel panels and high-performance glass”. As this type of building has a large number of components and sub-components (149) the average life will be dependent on a large amount of evidence for the different parts of the building. A simplified cost model for this type of service building is presented in Annex 5.

In contrast, the cost model “energy from waste”[3] (Table 3) is an industrial type of building and therefore it tends to be more simplistic. It has a smaller share of short-lived components such as finishes, and its final life length is heavily influenced by the substructure, which comprises 61.5% of the weight. This increases the overall life of this building to 52 years, which is significantly higher than the new average building life of approximately 40 years (Table 2).

Table 3: Simplified cost model for energy from waste

High level RICS components	Component	Cost (£thousands)	Cost weight (%)	Asset life (years)
Substructure	Buildings shell	34,812	62	67
Internal finishes	Finishing and fit-out works	1,830	3	36
Services	Building service installation	11,493	20	22
External works	Ancillary building works	2,641	5	30
	External works	5,540	10	40
	Total	56,316	100	52

Source: Building.co.uk, Office for National Statistics calculations

In order to provide the level of detail described in the NIESR review, a sample of 50 different buildings with distinct uses was taken (for example, energy from waste – as described previously) and applied across a range of industries (Annex 4). The mapping to the corresponding industry followed the UK Standard Industrial Classification 2007 (SIC 2007). In cases where a simple mapping was not suitable the following approaches were taken:

- for industries with no allocated buildings, an asset life average of all industrial or commercial buildings was assigned
- some cost models are applicable to numerous industries (for example, global manufacturing centres) were applied to all manufacturing industries
- for industries where two or more building types were relevant, these were assigned to the corresponding sub-industry; a weighted average of the life expectancy of each building was taken using the proportion for capital expenditure data from the Annual Business Survey (ABS); a detailed example can be found in Annex 1

However, this asset life was not taken as a final value since the concept of GFCF should include not only the value of new assets (the building identified in the cost models) but also major repair and maintenance (R&M).

International guidance on national accounting clarifies that major repair and maintenance, which extends the life of assets and/or increases its productive capacity, should be treated as fixed capital formation. In the context of buildings, examples of major repair and maintenance could include replacement of internal walls, repair of roofs, and addition of cladding to external walls. Minor repair and maintenance should be treated as intermediate consumption (current expenditure). Examples include clearing of gutters, painting and decorating, and routine maintenance checks.

Adjustment for R&M makes the final asset life more realistic as during the life length of a building elements like fixtures and fittings are likely to be replaced. The calculation of repair and maintenance uses data from the Construction Output Survey and is explained further in Annex 2.

The entire estimation process described previously is demonstrated by using industry 64 (Financial service activities, except insurance and pension funding) as an example (Figure 3).

Two cost models were used for industry 64: London offices and commercial office towers, which have an estimated life length of 45 and 49 years, respectively. The two buildings have been allocated on a 50/50 basis to the industry according to ABS data after they were assigned to the corresponding sub-industrial category. The weighted asset life is therefore the average of the two (47 years) and represents the asset life of new construction work in the industry. To account for R&M, an asset life relevant to building refurbishment (office refurbishments) that has a life length of 31 years was used. For 2017, the R&M ratio (0.34) was taken from the Construction Output Survey and multiplied by the R&M life. This was added to the product between the (1-R&M ratio) and the weighted asset life to get the final estimate for the industry (41 years).

Figure 3: Industry asset life – calculation for year 2017

Source: Office for National Statistics

However, introducing the changes abruptly in either 2016 or 1948 is undesirable. Even though there is limited evidence about the changes in building asset lives over time, it seems likely that they declined slowly between 1948 and 2016, rather than changing abruptly in any given year.

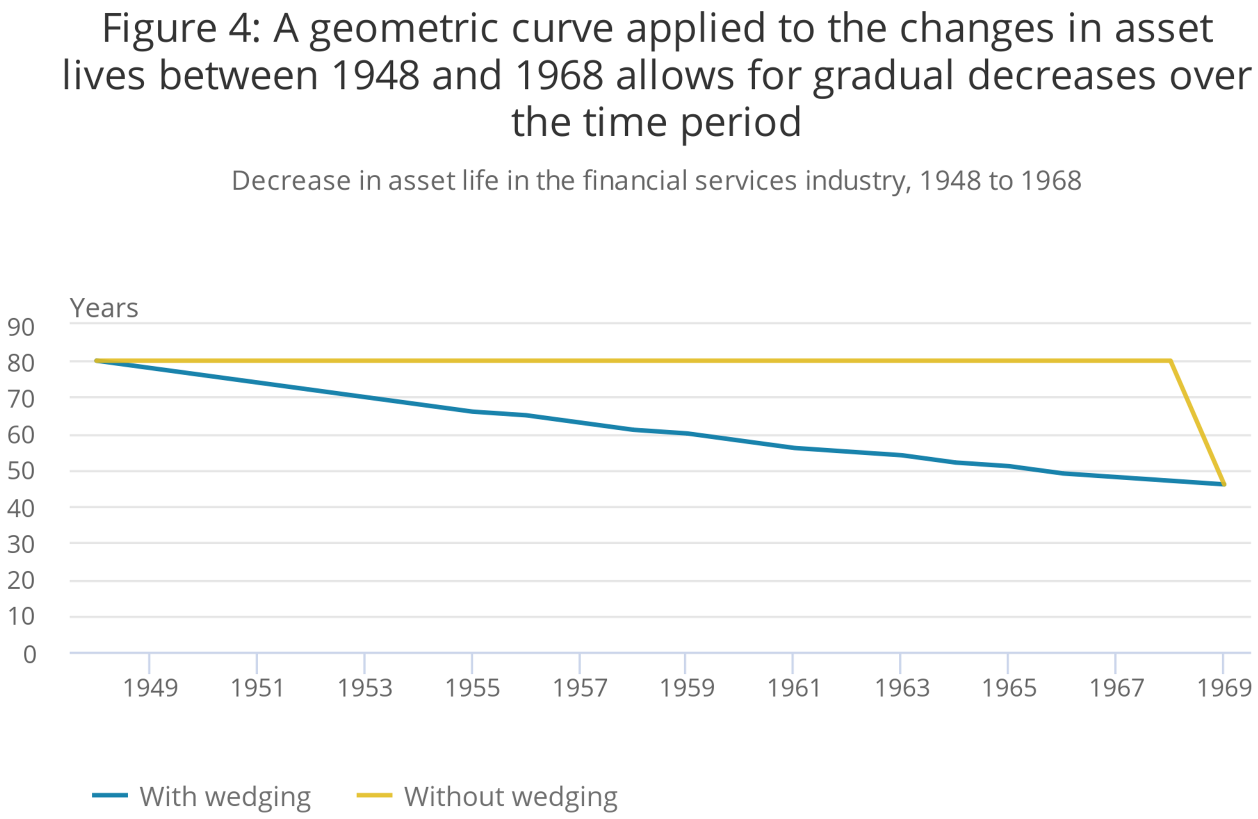
Successive Acts of Parliament relating to public health led to the increased take-up of indoor sanitary and ventilation installations, which have much shorter lives than other building components, reducing the average asset life. Additionally, the materials and purposes of buildings have changed over time, increasingly reflecting the need for office working, and being more concerned with worker comfort. As noted previously, the share of R&M in total GFCF has also increased over time, supporting a gradual fall in the overall asset life.

To this end, the changes in asset lives between 1948 and 1969 (exclusive) were smoothed using a geometric [4] curve. This allowed for a sharper wedge to account for the large changes in building specification, attributed to Public Health Acts, and the increasing use of sanitary, ventilation and electrical fittings in building construction after the Second World War. In contrast, from 1969 to the most recent period, the life lengths were reduced by small amounts due to the increasing share of R&M in GFCF because R&M tends to have shorter lives.

Figure 4 plots the results of this method compared with a sudden fall in asset lives at a point in time. The constant decline (blue line) is more realistic as it allows for gradual decreases over the period.

Figure 4: A geometric curve applied to the changes in asset lives between 1948 and 1968 allows for gradual decreases over the time period

Decrease in asset life in the financial services industry, 1948 to 1968



Source: Office for National Statistics

Dwellings

The service life for dwellings has been calculated using the same estimation method as “other buildings”. The data were sourced from the Royal Institute of Chartered Surveyors (RICS) and the cost models used for dwellings were “detached houses” and “apartment blocks”.

Other machinery and equipment

The focus for this asset class was on other machinery and equipment from services industries whose main component was office furniture and equipment. The Annual Acquisitions and Disposals of Capital Assets Survey (ACAS) provided a breakdown of capital expenditure estimates (acquisitions and disposals) by detailed product. A weighted cost based on the expenditure data was calculated for each of the products and applied to the life lengths for the corresponding products. The service life estimates were taken from large companies’ accounts.

We have not made any adjustments regarding the manufacturing industry but recognises the need for a review of these asset lives to be included in the future workplan.

Changes to the PIM model and increased coherence with capital services measures

Another change made regarding the Perpetual Inventory Method (PIM) model refers to the age-price function, which shows the loss in value of a capital good as it ages, capturing the decline in value due to normal obsolescence and wear and tear of the asset.

Deterioration in the value of an asset in this way is recorded in the national accounts as consumption of fixed capital. The shape of the function has historically been linear, assuming that an equal amount of the value of the asset cohort is lost over each period. In addition to being able to accommodate other depreciation patterns apart from linear and geometric, the BB19 redevelopment is also introducing an age-efficiency profile that is used to derive the corresponding age-price profile. This is a step forward towards having a fully coherent model between capital stock and capital services.

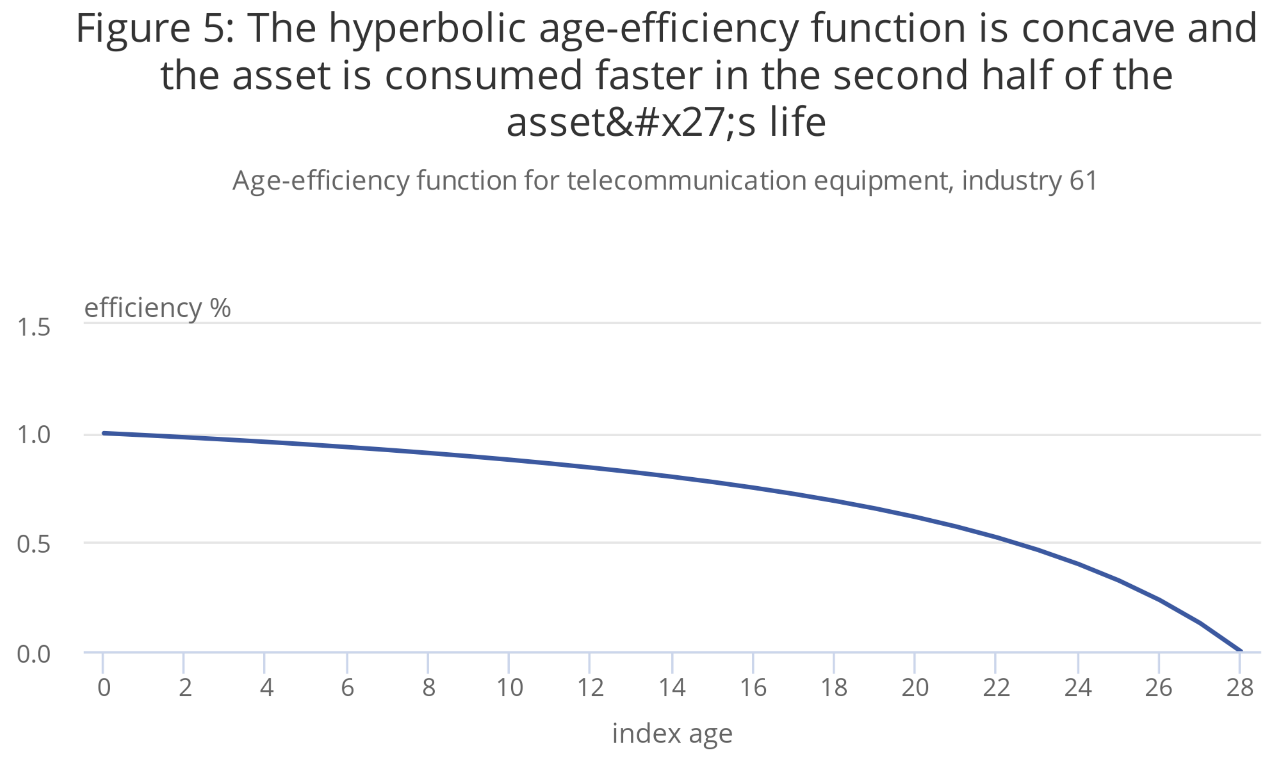
An age-efficiency function describes the decline in productive efficiency of an asset relative to its purchase price due to ageing – and the shape of the function can take many forms, including hyperbolic, geometric, linear or constant (implying no efficiency loss). Linear implies constant amounts and geometric constant rates and therefore are not representative for some assets like other buildings or entertainment, literary and artistic originals. In contrast, the hyperbolic function is more plausible as it has a slow rate at the beginning of the asset that increases towards the end of it.

The choice of applying a hyperbolic depreciation rate is also consistent with many other statistical offices including the US Bureau of Labor Statistics (1983), Australian Bureau of Statistics (2000) and Statistics New Zealand (2006).

The method is described by using telecommunication equipment from industry 61 (Telecommunications) as an example. “Telecommunication equipment” has a mean asset life of 10 years, a retirement age (T) of 28 years and beta[5] equal to 0.75. The asset cohort is at full efficiency (1) in year 0 when it is new and, reaches zero efficiency at its retirement life (year 28). When plotting the values of the function [6] on a graph (Figure 5), the age-efficiency function has a concave shape to the origin, showing that the efficiency of the asset is consumed quicker in the second part of the asset’s life.

Figure 5: The hyperbolic age-efficiency function is concave and the asset is consumed faster in the second half of the asset's life

Age-efficiency function for telecommunication equipment, industry 61



Source: Office for National Statistics

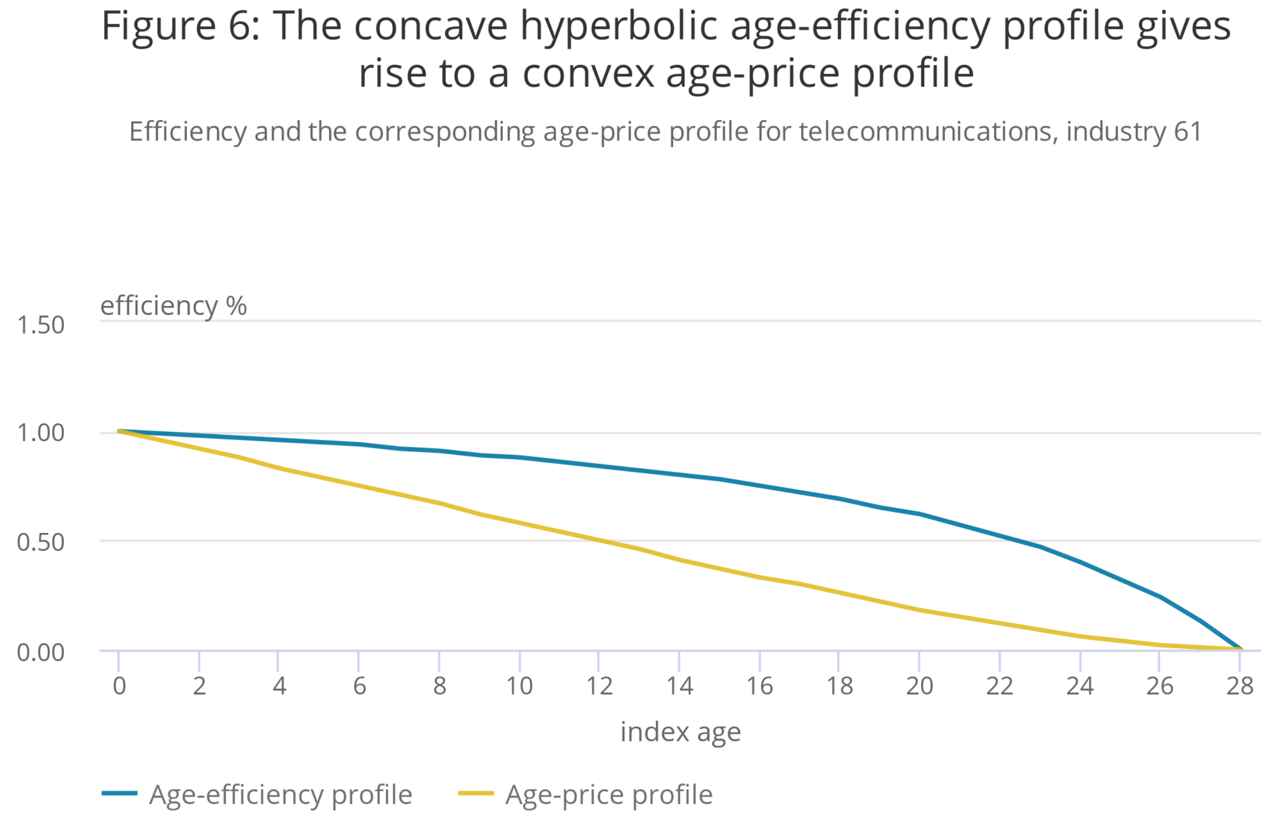
As presented in the capital stock integrated model (Figure 2), the age-efficiency function is then combined with the retirement function[7] to get the family of age-efficiency functions in the cohort. These two in combination provide a sequence of prices for capital services discounted to the beginning of the start year price (assets used in the production process) over time.

Furthermore, by using the net present value[8] approach, the age-price function is derived coherently from the age-efficiency profile. The age-price function is applied to yield a series of the consumption of fixed capital for a particular cohort. This is consistent with the method recommended by the OECD Capital Manual (PDF, 2.11MB).

The PIM allows flexibility on discount rates choice but a rate of 1% real per quarter has been chosen for all assets and industries, which leads to an approximate rate of 4% per year. This is consistent with the HM Treasury guidance regarding discount rates presented in the Green Book. The resultant age-price function for the hyperbolic age-efficiency profile in Figure 5 is convex to the origin. Figure 6 shows the shape of both functions for telecommunications equipment, industry 61 (Telecommunications).

Figure 6: The concave hyperbolic age-efficiency profile gives rise to a convex age-price profile

Efficiency and the corresponding age-price profile for telecommunications, industry 61



Source: Office for National Statistics

The same method is applied to all assets apart from research and development (R&D), which uses a Weibull distribution for retirement and a geometric function[9] for age-efficiency that results in both age-efficiency and age-price coinciding. R&D has not been changed since its implementation in 2014 but we will seek to review whether to bring the R&D estimates in line with other assets.

Quarterly multi-factor productivity estimates

Further, the Bean Review recommendation to produce estimates of capital stocks and multi-factor productivity[10] that are timely and frequent has also been implemented. In order to achieve this a quarterly set of input data for the parameters were created by converting the inputs into a quarterly series and processing them in the PIM in largely the same manner as annual data.

Changes to the treatment of costs of ownership transfer

Following international guidance, costs of ownership transfer are treated as GFCF and consist of charges regarding delivery, professional charges or commissions incurred and taxes payable by the new owner of the asset. Depending on the type of asset, non-produced or fixed, they are shown differently in the national accounts balance sheet.

In previous Blue Books, costs of ownership transfer on produced assets were identified as costs of ownership on non-produced assets. Moreover, transfer costs were written off as incurred on non-produced assets and over the full life length for produced assets.

The improvements to costs of ownership transfer implemented in this Blue Book align the Office for National Statistics (ONS) methodology with the international standards proposed by the 2008 SNA (PDF, 9.8MB) and ESA 2010 (PDF, 6.4MB). This improvement also addresses the process recommendation made by NSQR, as discussed in Section 3.

Costs of ownership transfer on non-produced assets

Non-produced assets represent natural resources (including land before improvements), contracts, leases and licences, and goodwill and marketing assets. Initially, in the UK the costs of ownership transfer on non-produced assets included transfer cost. However, transfer costs on land should be part of the costs of ownership transfer on produced assets, classified as land improvements.

Even though land itself is a non-produced asset, 2008 SNA (PDF, 9.8MB) states that: “In the case of land, costs of ownership transfer are treated as a part of land improvement, which is itself treated as a produced asset”. Therefore, the redevelopment aligns our methods to this recommendation and correctly assigns the costs of ownership transfer to the category to which they relate.

Another improvement relates to the consumption of fixed capital on land that is now written off according to the average period of ownership on land rather than fully in the period in which they incurred. To calculate the average duration of land ownership, data from HM Land Registry on all property transactions between 1995 and 2017 were used. This was validated against information from the English Housing Survey on tenure period and resulted in an average value of 15 years.

Costs of ownership transfer on produced assets

Costs of ownership transfer on produced assets were generally in line with the valuation principles recommended in the 2008 SNA and ESA 2010 as transfer costs are being presented at purchasers’ prices plus the costs of ownership transfer on those fixed assets.

However, the full value of an individual fixed asset was written down at a single rate, meaning that the costs of ownership transfer are implicitly treated as having an economic life equal to the asset in question. The 2008 SNA states that: “Costs of ownership transfer on acquisition of an asset should be written off over the period the asset is expected to be held by the purchaser rather than over the whole life of the asset. Costs of ownership transfer on the disposal of an asset should also be written off over the period the asset is held.”

Compared with the previous method, the transfer costs are now separately capitalised and are accumulated and written off over the asset average life as presented in Table 4.

Table 4: Comparison between the old and the new method – transfer costs

Old method	New method	
Expenditure on asset =[1] £1,000	Expenditure on asset = £800	Expenditure on TC = £200
Service life of asset & TC = 15 years	Service life of asset = 15 years	Service life of TC = 12 years

Source: Office for National Statistics

Notes

1. This could possibly include some expenditure on transaction costs as part of the purchase/provision of the asset. Back to table

The method used to estimate the service life of the asset is presented in Section 4 under Overview of asset life changes. To identify the transfer costs on produced assets two main sources were used: the proportion of expenditure on the fixed asset (that is applied through PIM separately from the service life in question) and an asset life that reflects the average ownership period for which the cost of transfer is written off. A commodity flow approach was taken[11] to estimate the breakdown and proportions used to split expenditures for the actual assets and the corresponding installation services.

Moreover, a resale ratio was used to estimate the life length for which the transfer cost is written off. Table 5 presents the calculation of the resale ratio and life of transfer costs.

Table 5: Calculation of the life length for transfer costs on machinery and equipment

Acquisitions (£)	acq	1,000
Disposals (£)	dis	200
GFCF (£)	GFCF = acq - dis	800
Resale ratio	Ratio = 1 - dis/acq	0.8
Economic life of asset (years)	LLM	21
Life of transfer costs (years)	TCLLM = ratio * LLM	17

Changes to valuation of stock estimates

After a review of the valuation of stocks included in the capital stock model and the corresponding flows, it was found that the prices used to value these stocks should be updated due to differences in required valuation for flows and stock positions in the balance sheet. This led to inaccuracies for holding gains and losses, and current price valuations of the net and gross stock being incorrectly timed.

For instance, investment flows have historically been calculated in average prices of the period. This has resulted in net stock valued in quantities at the end of the period but prices at the average of that period, whereas both price and quantity should be those of the end of the period. Stocks are by convention, evaluated as positions at the end of a reference period rather than representations of activity that takes place over a period.

ESA 2010 (PDF, 6.4MB) recommends that:

“the values recorded should reflect prices observable on the market on the date to which the balance sheet relates. When there are no observable market prices, which may be the case if there is a market but no assets have recently been sold on it, estimates should be made of what the price would be if the assets were acquired on the market on the date to which the balance sheet relates.”

The method used to adjust for this inconsistency is in line with the OECD 2009 manual (PDF, 2.11MB) that recommends using a price index that is adjusted to the prices at the end of the period, which represents the midpoint between the average price of the current and the next period [12] . The average price index of the investment flows was forecasted by one period to calculate a price index in the price at the end of the period. Annex 6 shows valuation of stocks, consumption of fixed capital and holding gains or losses based on a hypothetical example where prices are rising.

Introduction of revaluation and other changes account

Regarding the sequence of accounts, further changes have been made with a focus on the capital account, other changes in volume account and revaluation account. In the capital account, the consumption of fixed capital included estimates for bankruptcy rates and war losses from 1941.

ESA 2010 (PDF, 6.4MB) defines consumption of fixed capital as: “the decline in value of fixed assets due to normal wear and tear and obsolescence”. In the definition, obsolescence refers to expected obsolescence and, in this case, bankruptcy and war losses are unexpected obsolescence that should be part of the “other changes in volume” account. Having the two included would generally lead to an overestimation of consumption of fixed capital. This was adjusted by moving them to the relevant subsections in the “other changes in volume” account, which are “other changes in volume not elsewhere classified” for bankruptcy and “catastrophic losses” for war losses.

Another change regarding the capital stock estimation process focuses on reclassifications, which are part of the “other changes in volume” account. The reclassification of an institutional unit involves moving its entire balance sheet at that point in time, with the consumption of fixed capital on the assets it owns to the new sector.

In the previous production system the values and the impact on the sector were manually estimated and added or subtracted to the stock. Also, the share of the institutional unit from the whole sector was difficult to approximate without having any impact on the overall sector. The PIM model has been updated to allow for a certain value of stock to be added or subtracted from a particular sector at a point in time without that value being included in GFCF. The updates allow interaction between accounts as recommended by the 2008 SNA. Table 6 presents a simplification of this relationship between public and private non-financial corporations.

Table 6: Example of a reclassification between sectors

		Public non-financial corporations (S.11001)	**Private non-financial corporations (S.11002-3)**	**All non-financial corporations**
	Opening stock (£)	3,000	5,100	8,100
Capital account	+ GFCF (£)	150	340	490
Changes in volume account	- Consumption of fixed capital (£)	(200)	(500)	(700)
	± K.1 - K.5 (£)	-	-	-
	± Reclassifications (K.6) (£)	(2,300)	2,300	0
Revaluation account	± Nominal holding gains/losses (£)	-	-	-
	= Closing stock (£)	650	7,240	7,890

Source: Office for National Statistics

Further improvement was also done regarding the revaluation account. In the old method, nominal holding gains and losses were not explicitly calculated with no further breakdown for the neutral and real values. To address this, ESA 2010 (PDF, 6.4MB) recommendation was taken as a guideline, where “the general price index to be applied for the calculation of neutral holding gains is a price index for final expenditure”. This implies that to separate real and neutral holding gains or losses, a general price index must be specified.

In this case, the implied deflator for GDP at market prices was used and the further breakdown for neutral holding gains and losses[13] (NG) was estimated by multiplying the percentage change in deflator by the opening stock [14] . Moreover, the value for real holding gains was calculated by subtracting neutral from nominal holding gains or losses.

Improvements to historical data

Inconsistent investment flows input data over long periods of time can be a major cause of lower-quality capital stock estimates. Therefore, the data between 1828 and 1997 were reviewed and adjusted at a detailed level to explain and eradicate any discontinuities over time. The importance of having a high-quality capital stock data arises from the issues that can appear due to its suboptimal treatment. These can be negative net stocks and net operating surplus, very high or low rates of return on fixed assets and less precise estimates of multi-factor productivity at the industry level.

Institutional sector classification

Since Blue Book 2011, the institutional sector dimension in the capital stocks estimates were imposed after the PIM was run at asset and industry level. The sector splits were based on historical GFCF data from 1948 to 2009 on a SIC 2003 basis, and they were held constant over time. As a result, the consumption of fixed capital of general government and NPISH feeding into the estimation of non-market output was extrapolated from a benchmark value.

The redevelopment project has allowed changes in the classification of input data from 1997 to be allocated to institutional sectors: private non-financial corporations (S.11PR), households (S.14) and NPISH (S.15) based on legal status, rather than apportioned according to historical proportions. Other sectors were already available in GFCF source data.

Industrial classification

The industrial classification for private sector organisations from 1997 onwards is based on SIC 2007. The data prior to 1997 were converted from SIC 2003 to SIC 2007 using a weighted correlation between employment and turnover sourced from the Inter-Departmental Business Register (IDBR). However, the IDBR data cannot be applied to other sectors as in general they do not cover public sector units and SIC 2003 and SIC 2007 include industries in which no general government activity takes place. As a result, large discontinuities were present in the inputs for these sectors.

In the case of public corporations, the historical data were specified for individual units that make up that sector and were directly classified to the industry related to their main activity. The remaining units were generally small and hard to identify, and map from one industry to another so a turnover-based conversion was done using the universe of public corporations.

In the case of the government bodies, the historical data were allocated to a hybrid between the classification of the functions of government (COFOG) and industry (SIC 2003). This has now been updated and allocated directly to COFOG items for all categories except general administration that was mapped on a many-to-many basis. As the vast majority of government activity is in health, defence, education and roads, this results in a good quality concordance between the historical (1828 to 1996) and post 1997 data. This allocation was mapped and split according to proportions from the post-1997 data (Table 7).

Table 7: Allocation of historical COFOG hybrid classification to COFOG level

Historical activity classification	COFOG divisional code	Divisional description
Defence	02	Defence
Roads	04.5	Transport other than other buildings
Transport	04.6	Communication
Housing	06	Housing and community amenities
Health	07	Health
Education	09	Education
Admin/general public services	01, 03, 04 (excl. 04.5 & 04.6), 05, 08, 10	General public services, pubic order and safety, economic affairs (excluding 04.5 and 04.6), environmental protection, recreation, culture and religion, social protection

Source: Office for National Statistics

Classification by asset

Over time the asset classifications have become more detailed to separately identify new and important assets, such as information and communication technology (ICT) equipment, and added new categories (for example, R&D and weapons systems) where expansions were made to the asset boundary. Generally, a further level of detail in a classification helps correct for considerable heterogeneity between different assets regarding their life length and changes in prices, both of which have significant effects on the valuation of the capital stock.

In order to reflect the changes in the asset boundary, historical GFCF data were needed to show a full time series of the new assets from their introduction to the present. The modelling of the stock changes for R&D and weapons systems were estimated back to 1955 and 1950 respectively. Initially, some items included in the asset category “weapons systems” were included in transport equipment as “military dual use” reflecting military assets that also had a civilian purpose. In order to avoid double-counting that would result in a discontinuity from 1997 onwards, the “weapons systems” values were excluded from the historical data of the initial category.

Apart from the two assets (R&D and weapons systems), the change in the asset classification required further breakdowns for assets like “machinery and equipment” and “other buildings and structures”.

Over the historical period, GFCF data included in the “plant” asset are now separated into “ICT hardware”, “purchased software”, “telecommunications equipment” and “other machinery and equipment”. The life lengths and price indices of these assets differ significantly from traditional assets such as buildings and therefore they must be separately identified. To estimate historical proportions to break down the GFCF data before 1997, historical supply and use and input output tables were used.

These historical input-output tables were used to estimate a GFCF breakdown at the whole economy level and the industry split was applied from the period of the first supply and use tables (1992). Assets like software and hardware were separately identified from these sources from 1974, other machinery and equipment from 1954 and telecommunication equipment from 1920.

Furthermore, a straight-line interpolation was used between periods for which input-output tables were available. For example, software and computer hardware were gradually interpolated back to a value of 0 in 1970, when the first commercial computers were used in a meaningful way in production, to avoid a sudden material value in 1974.

Regarding the “other buildings and structures” category, it was recommended to split the asset further into “buildings other than dwellings”, “other structures” and “land improvements” that include the costs of ownership on land. However, even the new categories present a high level of heterogeneity as their sub-components (for example, retail buildings, commercial buildings and warehouses for buildings; roads, railways, sewers and telecommunications lines for other structures) have different life lengths and prices that are variables affecting the aggregation of different vintages of assets in the PIM model.

These assets have been split by industry using proportions based on the ACAS survey relationship between “new buildings” and “civil engineering”. As the sample of the survey is relatively small, comparisons were made using the “type of work” breakdown for the construction and output survey as well as the annual accounts of several large infrastructure-owning enterprises to ensure that the supply side was broadly consistent with the use side.

Notes for: Description of changes to capital stock

1. Note that this differs from the accounting notion of "useful lives", which refer to the amount of time an enterprise expects to own an asset before selling or otherwise disposing of it, which as discussed in the OECD manual on measuring capital, can be chosen for many reasons other than to provide accurate estimates of depreciation.

2. When isolating the effects of asset life changes.

3. Energy from waste is defined as an industrial building that is used in waste management and uses thermal processes (for example, incineration) as well as numerous thermal and chemical gasification techniques that produce gas and liquid fuels.

4. The form of this geometric reduction was applied according to the OECD Capital manual (PDF, 2.11MB) suggestion, to calculate a decrease percentage (z), which could be applied to each year to bridge the gap between 1948 and 1969. The formula applied was based on n*=ln(X/100)/ln(1–), where is the rate of depreciation, n* is the number of years and X is the percentage (loss) of asset life value. Further, the result is applied to each year between 1948 and 1969 by using the following formula
$$\text{new asset value for year y} = \frac{\text{start year value}}{{}_{z}(\text{y - start year})}$$
In the formula, y is the year the new asset life is calculated for, and similarly to the previous one, start year is 1948 and the start year value is the value in 1948.

5. Beta is a parameter that shapes the function and that is smaller than or equal to 1.

6. The values are calculated according to the 2009 Capital Manual (PDF, 2.11MB) recommendations by using the formula for age-efficiency profile
$$g_n\ (\text{hyperbolic}) = \frac{\text{T max - n}}{\text{T max - b*n}}$$
where n is the index age, T the age of the asset and b is beta. In the equation both T and b are constant and vary between assets.

7. The retirement distribution uses a probability density function. This is truncated on the left tail of the distribution at 1 and at a value equal to mean+4* St.Deviation on the right tail.

8. NPV formula applied:
$$V_t = \sum_{\tau=1}^{Nt} \frac{RR\ t + \tau}{(1 + r_t)^{\tau}}$$
, where V^t is the value of the asset of time t; N is the asset life: RR is the resource rest; and r is a nominal discount rate.

9. g_n(geometric)=$(1\text{-})^n$

10. Multifactor productivity is calculated by assuming a geometric age-price and age-efficiency profiles.

11. The application of it is given by GFCFx = outputx + importsx – exportsx, where x is a given product (for example, installation).

12. $$P = \frac{pt\ \ + \ pt + 1}{2}$$
, where pt is the average price of the current period and pt+1 the average price of the next period.

13. Neutral holding gains or losses describe the difference between opening and closing balance sheet excluding changes in the general price level.

14. $$NG = p_0.q\left(\frac{{}^{r}t}{r_0\text{ - }1}\right)$$
, where p_0.q denotes the current value of the asset at time 0 and ${}^{r}t/r_0$ gives a factor of the change in the price index between the two points in time given by t and 0.

5 . Conclusion

The capital stock methods and estimates were reviewed and updated as part of the Blue Book 2019 to align our approach with the international best practices. The main improvements cover:

- changes in the asset life estimates that led to generally lower life lengths for most assets; the assets that had the biggest impact on the net capital stock were “other buildings”, “dwellings” and “other machinery and equipment”; each of these were calculated using different methods
- implementation of a hyperbolic age-efficiency profile from which the age-price profile is derived; this accounts for the loss in productive efficiency of the asset and takes a step towards having an integrated model of capital stock and capital services
- introduction of quarterly multi-factor productivity estimates and capital stock respectively to provide more timely growth accounting estimates to policy-makers
- improved treatment of costs of ownership transfer on non-produced assets by writing them off over the period over which they are owned by a user
- stock estimates being valued at prices and quantities at the end of the period; this was done by using a price index that is adjusted to the prices at the end of the period, which represents the midpoint between the average price of the current and the next period
- improvements to historical data to provide a detailed level of breakdown in terms of the institutional sector classification, industrial classification and classification by asset

6 . Authors and acknowledgments

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The authors are grateful to Leigh Perryman, Laura Dimond, Tom Penberthy, Josh Martin, Rasa Valentinaviciute, Jack Howe, Ben West, Graham Parsons, Emily Carpenter and Sam Aggrey for their assistance in the methods and research work described in this article, and to Josh Martin and Sumit Dey-Chowdhury for their editorial contribution.

7 . Annex 1: Example of industry asset life calculation with more than one relevant building types

Industry 91 – Libraries, archives, museums and other cultural activities is defined in the Annual Business Survey (ABS) by four components at the four-digit Standard Industrial Classification level:

- Library and archive activities (91.01)
- Museum activities (91.02)
- Operation of historical sites and buildings and similar visitor attractions (91.03)
- Botanical and zoological gardens and nature reserve activities (91.04)

The cost models allocated to this industry ("libraries", "museums", and "museums and galleries") do not cover all its sub-sectors. Therefore, the total expenditure for sub-sectors 91.03 and 91.04 were added up and divided equally between 91.01 and 91.02 according to the ABS estimates for museums and libraries.

Table 8: ABS calculation example for industry 91

Industry code	**Industry description**	**Total net capital expenditure (£ million)**	**Total net capital expenditure – adjusted (£ million)**	**Weighted values (%)**
91	Libraries, archives, museums and other cultural activities	503	503	100
91.01	Library and archive activities	62	162	32.2
91.02	Museum activities	241	341	67.8
91.03	Operation of historical sites and buildings and similar visitor attractions	56	-	-
91.04	Botanical and zoological gardens and nature reserve activities	144	-	-

Source: Annual Business Survey, Office for National Statistics

Approximating the weighted value (Table 8), the ratio decided on was 70:30 and because two different cost models cover industry 91.02, they were split equally having 35:35 weight. The weighted asset life of the industry was the sum of the weighted life lengths of each of the buildings (41 years).

8 . Annex 2: Repair and maintenance (R&M) calculation

All buildings apart from "office refurbishments" and "shopping centre refurbishments" were mapped to the corresponding industry in Standard Industrial Classification 2007, and the following formula was applied (after 1969):

- asset life * (1 - R&M ratio) + R&M life * R&M ratio

In the equation, the asset life is the final value of the building from the cost model, the R&M ratio is calculated based on the "Construction Output Survey" and the R&M life is the life for either "office refurbishments" or "shopping centre refurbishments" depending on which was most appropriate. The two building types were assigned to the equivalent industries or, in case none of them were relevant, the average of the two was used. For example, industry 82 (Office administrative and support activities) used office refurbishments and industry 93 (Sports activities and amusement and recreation activities) used an average of the two.

As no data were available from the point of view of those doing the investment, the R&M ratio was calculated by using supply-side data – Construction Output Survey. The use of the ratio reflects that more R&M is done now than new construction work relative to the past.

Until 2010, repair and maintenance work on infrastructure was included in "other structures" so the R&M ratio in Table 9 was calculated to exclude it. The 2010 R&M value (30.4%) was used in 2009 as well to exclude the spike of 48.7%.

Table 9: Construction Output survey, 2019

Year	Repair and maintenance (£ million)		Private new work (£ million)		Total private new work (£ million)	R&M[1]	R&M ratio [2] - excluding infrastructure (%)
	Infrastructure	Private R&M work	Private commercial new work	Private industrial new work			
2004	-	12,291	25,509	5,210	30,719	40.0	25.0
2005	-	13,027	26,325	5,610	31,935	40.8	25.5
2006	-	13,794	30,121	6,308	36,429	37.9	23.6
2007	-	15,807	34,404	6,438	40,842	38.7	24.2
2008	-	16,165	35,190	5,339	40,529	39.9	24.9
2009	-	14,165	25,558	3,515	29,073	48.7	30.4
2010	6,841	82,90	23,710	3,551	27,261	30.4	30.4

Source: Construction Output survey, Office for National Statistics calculations

Notes

1. The R&M column is calculated by dividing the “private R&M work” column by “total private work”. Back to table

2. The R&M ratio was calculated backwards using the 2010 values that excluded infrastructure. Therefore, the R&M ratio for year t is (R&M ratio)t+1*R&Mt/R&Mt+1 which is consistent to the OECD splicing method. Back to table

3. Back to table

9 . Annex 3: Description of methods used for assets life calculation

Other structures

The expenditure on other structures was separated from the asset “other buildings and structures” by using data from the Annual Acquisitions and Disposals of Capital Assets Survey (ACAS). The asset life data for other structures were predominantly taken from companies accounts because most of the assets of this type are owned by a small number of large enterprises operating in specific services and utilities industries such as mining and quarrying, water and sewerage, and telecommunications services.

For example, for water and sewerage, detailed information was available in company accounts about the life lengths of sewers, reservoirs, and similar assets. The asset life values were weighted against the expenditure share for each product to calculate an overall asset life for this category.

Land improvements

Land improvements covers improvements to land such as clearance and land contouring, which increase its value.

Previously, “land improvements” was also included in “other buildings and structures” and it predominantly covered both the cost of ownership transfer and land improvements. The new method estimates a separate average life length (for non-transfer costs) for this category based on company accounts of large enterprises operating in industry 81 – Services to buildings and landscape activities and other agriculture-related companies. This resulted in an average life of 20 years.

The method used for determining the asset life for costs of ownership transfer on land is described in Section 4: Costs of ownership transfer on non-produced assets.

Transport equipment

This asset class covers equipment used for moving people and objects, and includes road transport equipment, rolling stock, aircraft, ships and boats, amongst other assets. The methods used to update these asset lives differ:

- for road transport equipment, administrative data on vehicle registrations from the Driver and Vehicle Licensing Agency (DVLA) and the statutory off-road notices (SORN) were used; SORN provided the average service life of a car when it gets deregistered, which was weighted against DVLA data to estimate the asset life
- for railway and rolling stock the asset lives data were sourced from the Office of Rail and Road (ORR)
- the water transport (ships and boats) data were based on other countries’ estimates
- for data on aircraft, a report published by Boeing (PDF, 287KB) that contained data on the fleet survival rates of various single-aisle passenger models of aircraft was used; the analysis focused on both commercial and cargo aircraft and therefore even if one of the models (727) is no longer used for commercial purposes it is still relevant to the research; when making a comparison with the historical data, the overall fleet asset life is one of the few that has increased, which could be due to improved production methods and lessons learned from materials research

Similarly, to other structures, the ACAS survey was used to determine a proportion of each industry for the overall transport equipment asset class. As the survey showed that most of the expenditure was spent on road transport equipment (12 years life length), the overall life length decreased despite having a higher service life for aircraft (25 years) and ships and boats and railway locomotives.

Hardware, software and computer databases

The service lives of these assets have been reviewed but we have decided that the estimates are still accurate and therefore have not been updated since the recommendations by Vaze (2002) were introduced. This is in line with the life lengths used by other countries.

Telecommunications

Around three-quarters of telecommunications equipment is owned by the telecommunications services industry and it includes many kinds of equipment such as that found in exchanges and operating the mobile and fibre networks:

- for industry 61 (Telecommunications), the Office of Communications (OFCOM) provided investment data and service lives for mobile networks, fixed asset fibre, fixed core network and fixed asset copper; these components account for different models such as mobile call termination, wholesale local access and narrowband charge control; the investment and life length values were weighted against each other to determine an average asset life of 20 years for telecommunications equipment in this industry
- for other industries, as there is no readily available evidence to suggest that the life length of telecommunications equipment asset varies by industry an asset life of 10 years is used in line with other countries estimates and companies accounts

Weapons systems

The Ministry of Defence (MoD) accounts were used to get a service life estimates for aircraft, ships, submarines and land equipment. These were weighted with the corresponding equipment expenditure data to get the average life of 20 years in 2016. The average asset life can vary over time depending on the amount of expenditure on different types of equipment.

Cultivated assets

The asset life of cultivated assets (six years) was based on a recommendation by the UK Department for Environment, Food and Rural Affairs (Defra). This asset class is prevalent in one industry (01 – Crop and animal production, hunting and related service activities) and the overall service life represents a weighted estimate of the life lengths of different kinds of livestock focusing on dairy cattle and animal resources.

Research and Development (R&D)

The life lengths used for R&D have not been changed as a significant effort was made to estimate these as part of Blue Book 2014 when the asset was introduced to the national accounts. These methods were consistent with the ones described by Daniel Ker (PDF, 831KB).

However, Table 2 shows a change in the weighted asset life from seven to nine years. This change arises because of inconsistent application of asset lives to some industries that do R&D. These were reviewed and adjusted for, increasing the overall R&D weighted asset life.

Mineral exploration and evaluation

As coal mining in the UK is no longer material, the asset lives used in recent periods represent only oil and gas exploration. A 50-year asset life was re-introduced for historical exploration conducted by public corporations. No exploration of this type is recorded after 1990.

A model based on data of new discoveries and physical extraction rates of North Sea oil and gas deposits was used to estimate the asset lives for oil and gas exploration, which accounts for the vast majority of exploration in the UK. This was relevant as the life length of exploration is conceptually the same as the amount of time the results of that exploration will remain useful. The data are available from the Oil and Gas Authority.

It is assumed that the extraction rate is constant and that it uses up a certain percentage of the currently exploitable reserves. The model divides the physical quantity extracted each year by the discovered stocks from which those extractions are drawn.

Entertainment, literary and artistic originals

An asset life of 15 years was originally used for entertainment, literary and artistic originals. This has been adjusted to 10 years to meet the Organisation for Economic Co-operation and Development (OECD) recommendations for all industries and institutional sectors.

A wide retirement distribution is used to reflect the fact that while most originals will have lost their economically useful property of being able to generate royalties over a period between 5 and 10 years, notable originals can be exploited economically until their copyright expires up to 70 years after their creation.

10 . Annex 4: Buildings assigned to industries at A88 level

Table 10: Annex 4: Buildings assigned to industries at A88[1]

Industry code (A88)	Industry name	Buildings included in asset life calculations	
1	Crops and animals	Industrial building average	
2	Forestry	Industrial building average	
3	Fishing	Industrial building average	
5	Mining of coal	Industrial building average	
6	Extraction of oil	Industrial building average	
7	Mining of metal	Industrial building average	
8	Other mining	Industrial building average	
9	Mining support	Industrial building average	
10	Manufacturing of food	Global Manufacturing Site	Small industrial units
11	Manufacturing of beverages	Global Manufacturing Site	Small industrial units
12	Manufacturing of tobacco	Global Manufacturing Site	Small industrial units
13	Manufacturing of textiles	Global Manufacturing Site	Small industrial units
14	Manufacturing of wearing apparel	Global Manufacturing Site	Small industrial units
15	Manufacturing of leather	Global Manufacturing Site	Small industrial units
16	Manufacturing of wood products	Global Manufacturing Site	Small industrial units
17	Manufacturing of paper	Global Manufacturing Site	Small industrial units
18	Printing	Global Manufacturing Site	Small industrial units
19	Manufacturing of petroleum products	Global Manufacturing Site	Small industrial units
20	Manufacturing of chemicals	Global Manufacturing Site	Small industrial units
21	Manufacturing of pharmaceuticals	Global Manufacturing Site	Small industrial units
22	Manufacturing of rubber	Global Manufacturing Site	Small industrial units

23	Manufacturing of mineral products	Global Manufacturing Site	Small industrial units	
24	Manufacturing of basic metals	Global Manufacturing Site	Small industrial units	
25	Manufacturing of fabr. metal products	Global Manufacturing Site	Small industrial units	
26	Manufacturing of computers	Global Manufacturing Site	Small industrial units	
27	Manufacturing of electrical equipment	Global Manufacturing Site	Small industrial units	
28	Manufacturing of machinery nec	Global Manufacturing Site	Small industrial units	
29	Manufacturing of vehicles	Global Manufacturing Site	Small industrial units	
30	Manufacturing of other transport	Global Manufacturing Site	Small industrial units	
31	Manufacturing of furniture	Global Manufacturing Site	Small industrial units	
32	Other manufacturing	Global Manufacturing Site	Small industrial units	
33	Repair and installation of machinery	Industrial building average		
35	Electricity, gas, etc.	Industrial building average		
36	Water supply	Industrial building average		
37	Sewerage	Industrial building average		
38	Waste treatment	Energy from waste	Incineration plant	
39	Remediation activities	Industrial building average		
41	Construction of buildings	Tall Buildings	Residential timber	Non-residential overall building average
42	Civil engineering	Manufacturing Centre Warwick University		
43	Specialised construction	Overall building average		
45	Retail of cars	Car showroom	Distribution centres	
46	Wholesale	Distribution centres	Retail distribution centres	

47	Retail	Food retail	Out of town retail	Convenience stores	
49	Land transport	Overall building average			
50	Water transport	Overall building average			
51	Air transport	Overall building average			
52	Warehousing	Small industrial units	Distribution centres	Retail Distribution Centres	Airport terminals
53	Postal and courier	Distribution centres			
55	Accommodation	Hotels	Budget hotels	Student residences	
56	Restaurants and catering	Commercial buildings average			
58	Publishing	London Offices	Commercial Office Towers		
59	Motion pictures, TV	TMT Offices	Cinema		
60	Programming and broadcasting	TMT Offices	London Offices		
61	Telecoms	TMT Offices	Data centres	London Offices	
62	Computer programming	TMT Offices	Data centres	London Offices	
63	Information service activities	Data centres			
64	Financial services	London Offices	Commercial Office Towers		
65	Insurance	London Offices	Commercial Office Towers		
66	Auxiliary finance	London Offices	Commercial Office Towers		
68	Real estate	London Offices	Commercial Office Towers		
69	Legal and accounting	London Offices	Commercial Office Towers		
70	Head offices, management consultancy	London Offices	Commercial Office Towers		
71	Architectural and engineering	Overall building average			
72	R&D	Laboratories	Research laboratory	Manufacturing Centre Warwick University	
73	Advertising and market research	London Offices	Commercial Office Towers		
74	Other professional services	Commercial buildings average			

75	Veterinary	Private health care	Primary Care	LIFT healthcare	Operating theatres
77	Rental and leasing	Small industrial units	Distribution centres		
78	Employment activities	Commercial buildings average			
79	Travel agency	Visitor Centres			
80	Security	Commercial buildings average			
81	Services to buildings, landscaping	Commercial buildings average			
82	Office admin and support	Convention centres	Scottish gas headquarters	London Offices	Commercial Office Towers
84	Public admin and defence				
85	Education	Schools	School design & tech block	School science block	
86	Human health	Private health care	Primary Care	LIFT healthcare	Operating theatres
87	Residential care	Palliative Care	Extra care housing	Nursing homes	
88	Social work	LIFT healthcare			
90	Entertainment activities	Theatres	Performing arts buildings	Indoor arenas	
91	Libraries, museums	Libraries	Museums and galleries	Museum	
92	Gambling and betting	Commercial buildings average			
93	Sports and recreation activities	Swimming pools	Football Stadiums		
94	Membership organisations	London Offices	Commercial Office Towers		
95	Repair of household goods	Out of town retail	Convenience stores		
96	Other personal services	Commercial buildings average			

Source: Office for National Statistics

Notes

1. SIC07 classification based on the NACE structure with 88 divisions Back to table

11 . Annex 5: London offices – cost model

Table 11: Annex 5: London offices - cost model

RICS	Component	Cost (£thousands)	Cost weight (%)	Asset life (years)
Substructure	Substructure	4372	10.2	81
Superstructure	Frame	6275	14.6	64
	Upper floors	1906	4.4	70
	Roof	1081	2.5	47
	Stairs	540	1.3	60
	External walls	11010	25.6	43
	Windows and external doors	230	0.5	33
	Internal walls and partitions	2120	4.9	51
	Internal doors	544	1.3	31
Internal Finishes	Wall finishes	1213	2.9	51
	Floor finishes	957	2.2	30
	Ceiling finishes	730	1.7	31
Fittings, Furnishings and equipment	Fittings/fitting out (excl loose furniture)	700	1.6	18
Services	Sanitary appliances	187	0.4	20
	Disposable installations	370	0.9	27
	Water installations	600	1.4	25
	Space heating and air treatment	3240	7.5	21
	Ventilation installations	600	1.4	14
	Electrical installation	2450	5.7	22
	Lifts and escalators	2130	5.0	23
	Protective installations	600	1.4	33
	Communication installations	515	1.2	19
	Special installations	650	1.5	23
Total		43019	100	45

Source: Building.co.uk, Office for National Statistics calculations

Notes

1. Due to rounding, totals may not sum to breakdown Back to table

12 . Annex 6: Valuation of net stocks, consumption of fixed capital, holding gains and losses

Table 12A: Annex 6: Valuation of net stocks, consumption of fixed capital, holding gains and losses

Transaction	GFCF	Price index	Price index	Price relative	GFCF
Prices	Current average (£)	2015 avge=100	2015 end=100	N/A	2015 avge (£)
2015	26,991	100	101.35	1.01	26,991
2016	29,793	102.7	103.7	1.01	29,010
2017	32,054	104.7	106.6	1.02	30,615
2018		108.5			
Calculation	a	b	c=(bt+bt-1)/2	d=c/b	e=a/b*100

Source: Office for National Statistics

Notes

1. Table 12A and 12B have been separated in two, for user accessibility. Back to table

Table 12B: Annex 6: Valuation of net stocks, consumption of fixed capital, holding gains and losses

Net stock	Net stock	Net stock	Net stock	Capital Consumption	Capital Consumption	Holding gains or losses
2015 avge (£)	2015 end (£)	Current average (£)	Current end (£)	2015 avge (£)	Current avge (£)	N/A (£)
509,705	516,586	509,705	516,586	25,406	25,406	13,354
513,229	518,227	527,086	532,219	25,485	26,173	19,253
518,183	527,586	542,537	552,383	25,661	26,868	25,351
f	g=f*d	h=f*b/100	i=h*d/100	j=ft-1-(ft-e)	k=j*b/100	l=it-it-1+a-k

Source: Office for National Statistics

Notes

1. Table 12A and 12B have been separated in two Back to table
2. for user accessibility. Back to table