Office for National Statistics

Article

National Accounts articles: Latest developments and changes to capital stocks to be implemented in Blue Book 2019

National Accounts article on the impact of method changes on capital stock estimates and estimates for the lives of assets in Blue Book 2019.

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1 . Executive summary

This article examines the effects of methodological improvements on capital stock estimates, which are detailed in Changes to the capital stock estimation methods for Blue Book 2019 .

These methods and data improvements have resulted in the net capital stock estimates for 2017 being reduced by 12% to £4 trillion and capital consumption estimates being increased by 23% to £300 billion. These revisions are largely a result of estimates of asset lives being reduced.

New estimates of asset lives have been calculated to better reflect differences in asset lives between both assets and industries. For example, “other buildings” asset lives were estimated using a “building lifecycle model”, to estimate the life length of a buildings components and weight these together to determine the overall life length for “other buildings” for each industry. The new estimates of asset lives are now more in line with estimates of asset lives used by other national statistical institutes.

Where non-market output is measured using inputs: the increase in capital consumption (the cost of using up capital), results in an increase in non-market output and consequently an upward revision in gross domestic product (GDP). The effect on productivity through revisions to the Volume Index of Capital Services (VICS) will be covered in a future multi-factor productivity (MFP) release.

2 . Introduction

Capital stock is a measurement of physical capital within an economy at a point in time. Physical capital includes any non-financial assets that are used in the production of goods and services with a lifespan of greater than a year (for example, buildings and machinery). Capital stocks produce a flow of capital services into the production process. Net capital stocks are therefore closely related to the amount of goods and services that an economy can produce.

Several improvements have been made to capital stock estimates, which include a review of estimates of asset lives, a move away from linear depreciation and changes in the treatment of transfer costs. Changes to the capital stock estimation methods for Blue Book 2019 provides detailed background information on the changes made in producing capital stock estimates.

The largest change to capital stock estimates is as a result of changes to estimates of asset lives, which have been reviewed to ensure that they reflect how long assets are used for after a new asset has been purchased. For some assets, such as transport equipment, estimates of asset lives have been increased, but generally there has been a reduction in estimates of asset lives. The effect of shorter asset life estimates is to increase the rate at which capital depreciates; resulting in increases in estimates of capital consumption and decreases in estimates of capital stock.

There is now a more detailed breakdown in assets, for example, other buildings and structures are broken down into other buildings, other structures and land improvements. More detailed asset breakdowns enable more accurate estimations of capital stock, with other buildings having a shorter estimated asset life than other structures.

Depreciation is now calculated using a hyperbolic age-efficiency profile. This means assets tend to lose their productive efficiency at a faster rate towards the end of their asset life. Previously, linear depreciation was used where depreciation is constant, and for most assets this would not be an accurate reflection of how they depreciate. The effect of the change in depreciation, which is small in comparison to the effect of changes in asset lives estimates, depends upon when declines in productive efficiency occur.

The increase in estimates of capital consumption has implications for other economic measures. Non-market output is measured using either direct output measures of activities and services delivered or in the absence of market prices, indirect output measures using a sum-of-costs approach. The sum-of-costs approach assumes that output is equal to inputs, so increases in capital inputs measured using capital consumption will revise gross domestic product (GDP) estimates upwards. Profitability estimates, such as the net rate of return, will also increase as this is calculated by dividing net operating surplus by capital employed and the denominator (capital employed) will be lower.

The contributions to revisions in estimates of net capital stock and capital consumption will be broken down in Section 3. Section 4 will analyse the impact of changes to estimates of asset lives, followed by the effect of moving from linear depreciation to using a hyperbolic age-efficiency profile in Section 5.

All data referred to in this bulletin are annual estimates of chained volume measures (CVMs), which have had the effect of price changes removed (in other words, the data are deflated) and are referenced to 2016. Components of capital stock and consumption of fixed capital may not always add to totals. This is either because of rounding or because CVM data cannot be added together before the reference year.

3 . Revisions to Blue Book 2018 estimates

Net capital stock estimates have been revised down 12% (£540 billion) and capital consumption estimates revised up by 23% (£56 billion) for 2017. The reductions in estimates of net capital stock have almost entirely been driven by revisions to estimates of asset lives, as shorter estimates of asset lives increase the rate at which capital depreciates and therefore reduce the net capital stock.

“Other” changes provide a positive contribution to estimates of net capital stock from 2000. These changes consist of revisions to gross-fixed capital formation (GFCF) (a net investment concept used within national accounts) and deflators as well as improvements made to capital stock estimates.

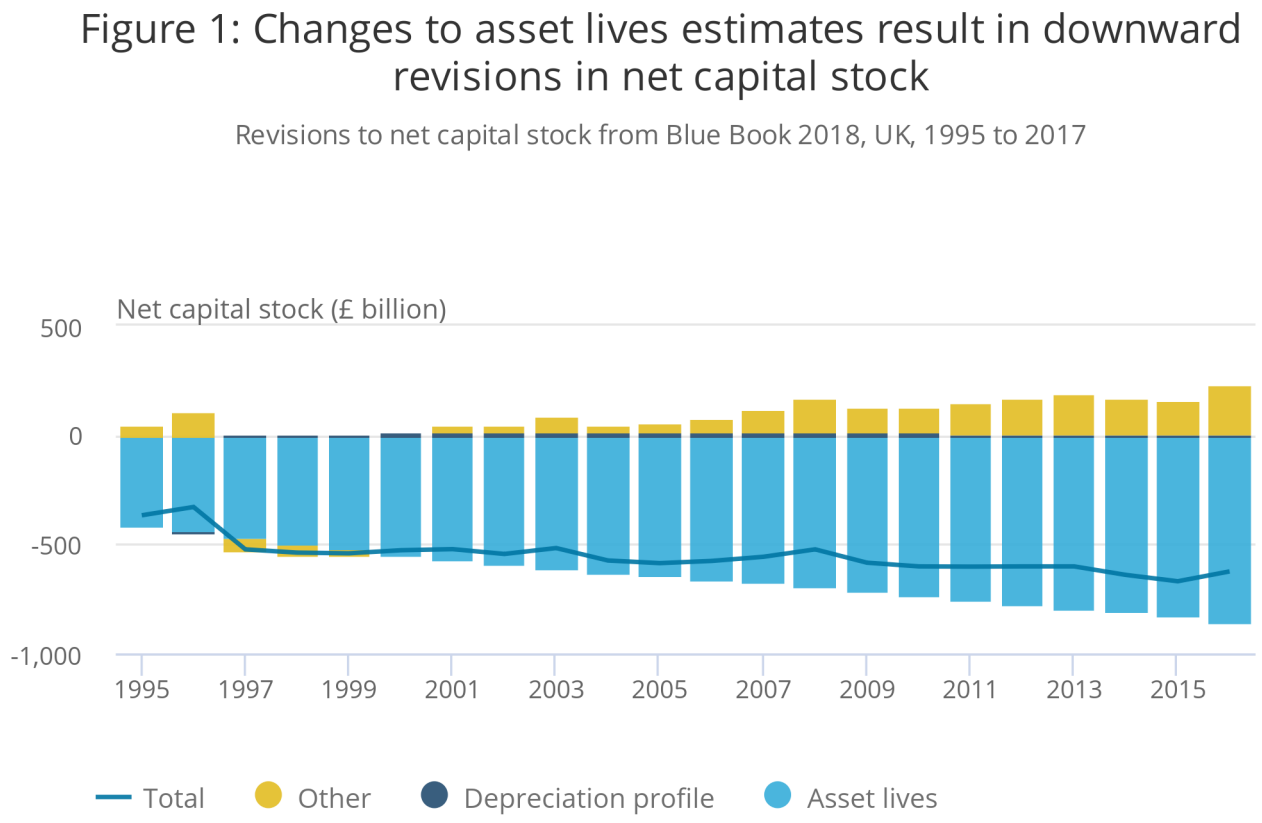
There has been an increase in net capital stock as a result of using improved data sources to more accurately capture transfers between sectors. For example, the transfer of roads from central to local government, which is now consistently captured across sectors.

A further improvement is that capital stock estimates for general government, non-profit institutions serving households (NPISH) and public corporations are no longer forecast from 2010. Using up-to-date GFCF estimates has resulted in an increase in the growth of estimates for net capital stock and capital consumption for NPISH.

The change in depreciation profile from linear depreciation to using a hyperbolic age-efficiency profile has a relatively small impact on estimates of net capital stock and capital consumption.

Figure 1: Changes to asset lives estimates result in downward revisions in net capital stock

Revisions to net capital stock from Blue Book 2018, UK, 1995 to 2017



Source: Office for National Statistics

Notes:

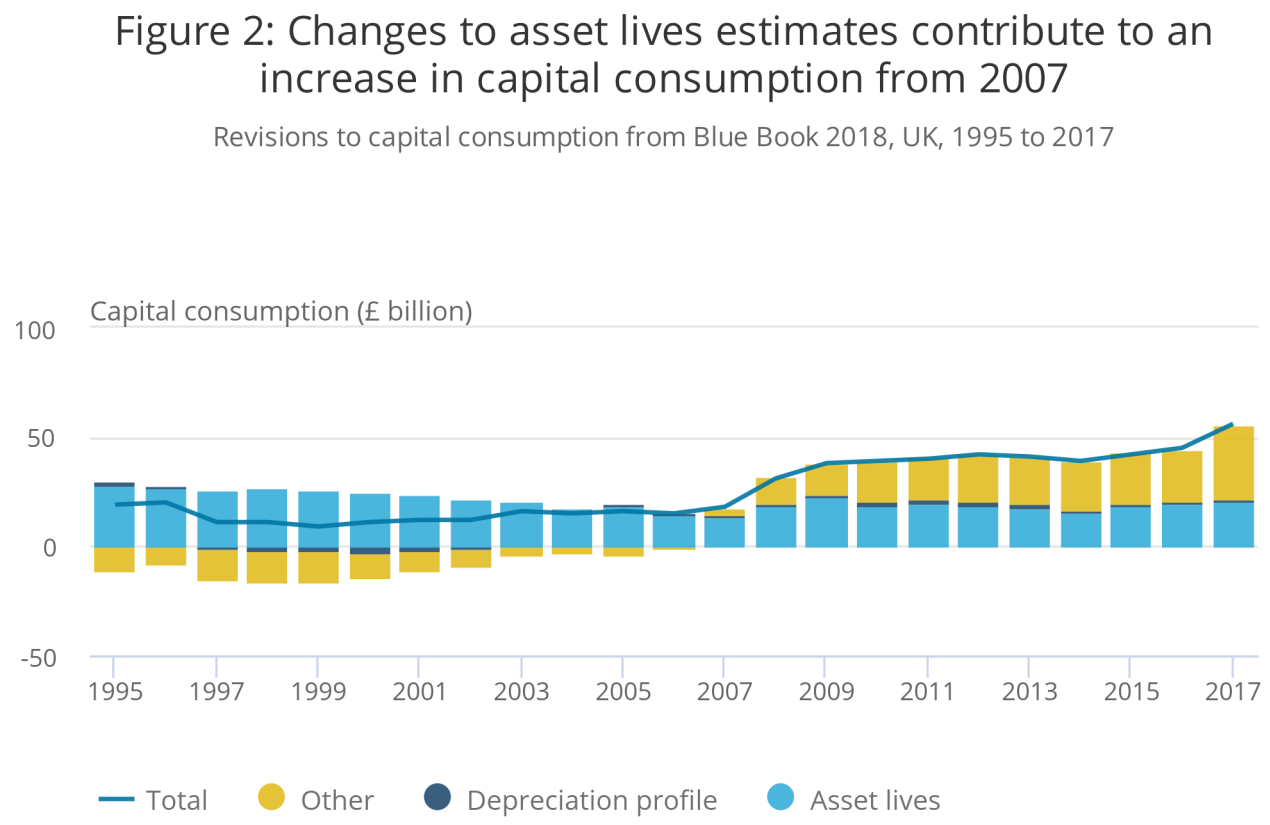
1. These are chained volume measures (CVMs) and the components may not add up to the total as they are not additive prior to the reference year.

From 2012 onwards, the largest contribution to increases in capital consumption estimates are from “other” changes. Improvements made to estimates of own-account software and databases have resulted in an increase in GFCF for software and databases, which have contributed to increases in capital consumption.

Software and databases have a relatively short mean asset life of five years and consequently GFCF revisions have a greater impact on capital consumption estimates than net capital stock.

Figure 2: Changes to asset lives estimates contribute to an increase in capital consumption from 2007

Revisions to capital consumption from Blue Book 2018, UK, 1995 to 2017



Source: Office for National Statistics

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4 . Changes in estimates of asset lives

Capital stock estimates are calculated using a perpetual inventory model (PIM), which takes gross-fixed capital formation (GFCF) and calculates capital stock estimates using assumptions about the lifespans of assets and the pattern of depreciation. Asset lives estimates have a large impact on capital stock estimates as these determine the rate at which capital depreciates. Most assets have had their estimated lifespans reduced, which has increased capital consumption. As capital depreciates at a faster rate, estimates of the net capital stock have decreased.

Table 1: Comparison between the old and the new estimations of 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

The treatment of transfer costs has been updated in line with international guidance. Transfer costs on the ownership of land are now classified as land improvements and are written off over the period of ownership, as opposed to immediately. This increases the estimated asset life for transfer costs on land from 0 to 15 years (the average period of ownership). It is therefore now included in estimates of net capital stock.

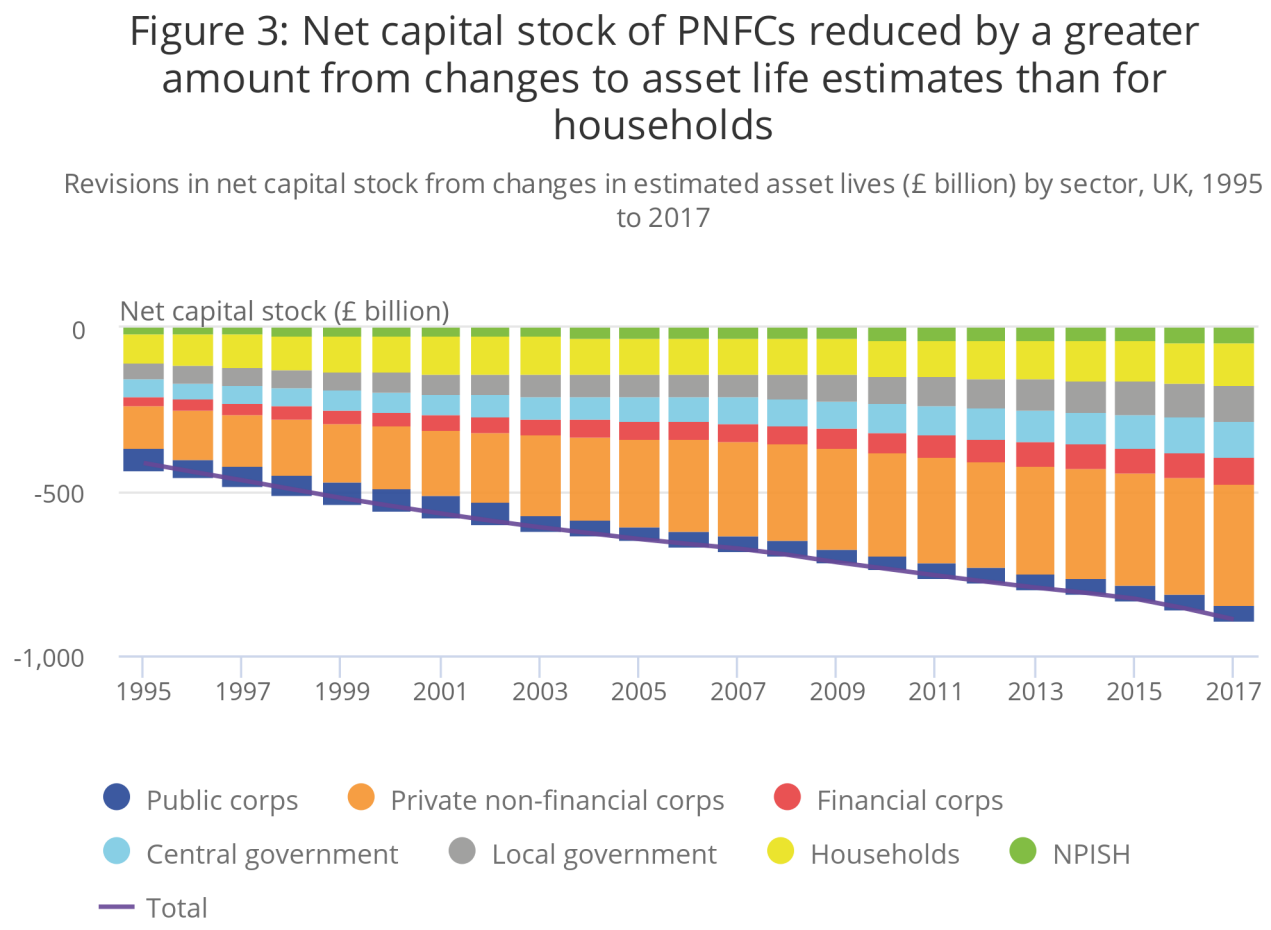
By sector

The impacts of changes to estimates of asset lives are calculated using linear depreciation.

The reduction in net capital stock by sector largely reflects the proportion of net capital stock and capital consumption within that sector. However, differences in the assets held within a sector do alter the impact of changes to asset life estimates. Households predominantly own dwellings and given that the fall in estimated asset life from 59 years to 50 years is lower than average, households had a comparatively lower fall in net capital stock from £1.59 trillion to £1.46 trillion in 2017. By contrast, the reduction in net capital stock for general government is higher than other sectors, as they hold a high proportion of other buildings, where the estimated asset life has fallen from 65 years to 37 years.

Figure 3: Net capital stock of PNFCs reduced by a greater amount from changes to asset life estimates than for households

Revisions in net capital stock from changes in estimated asset lives (£ billion) by sector, UK, 1995 to 2017



Source: Office for National Statistics

Notes:

1. These are chained volume measures (CVMs) and the components may not add up to the total as they are not additive prior to the reference year.

Table 2: Net capital stock using new and old asset lives estimated (£ billion), by sector

Asset Lives	Sector	1995	2000	2005	2010	2015
New	Non-financial corporations	1144	1351	1484	1580	1720
	Financial corporations	53	68	76	76	75
	General government	302	312	367	452	513
	Households & NPISH	1177	1250	1381	1445	1469
	Total	2646	2975	3305	3553	3778
Old	Non-financial corporations	1332	1607	1799	1939	2110
	Financial corporations	85	109	129	140	151
	General government	400	434	511	623	718
	Households & NPISH	1280	1381	1517	1588	1626
	Total	3059	3519	3950	4289	4605

Source: Office for National Statistics

Notes

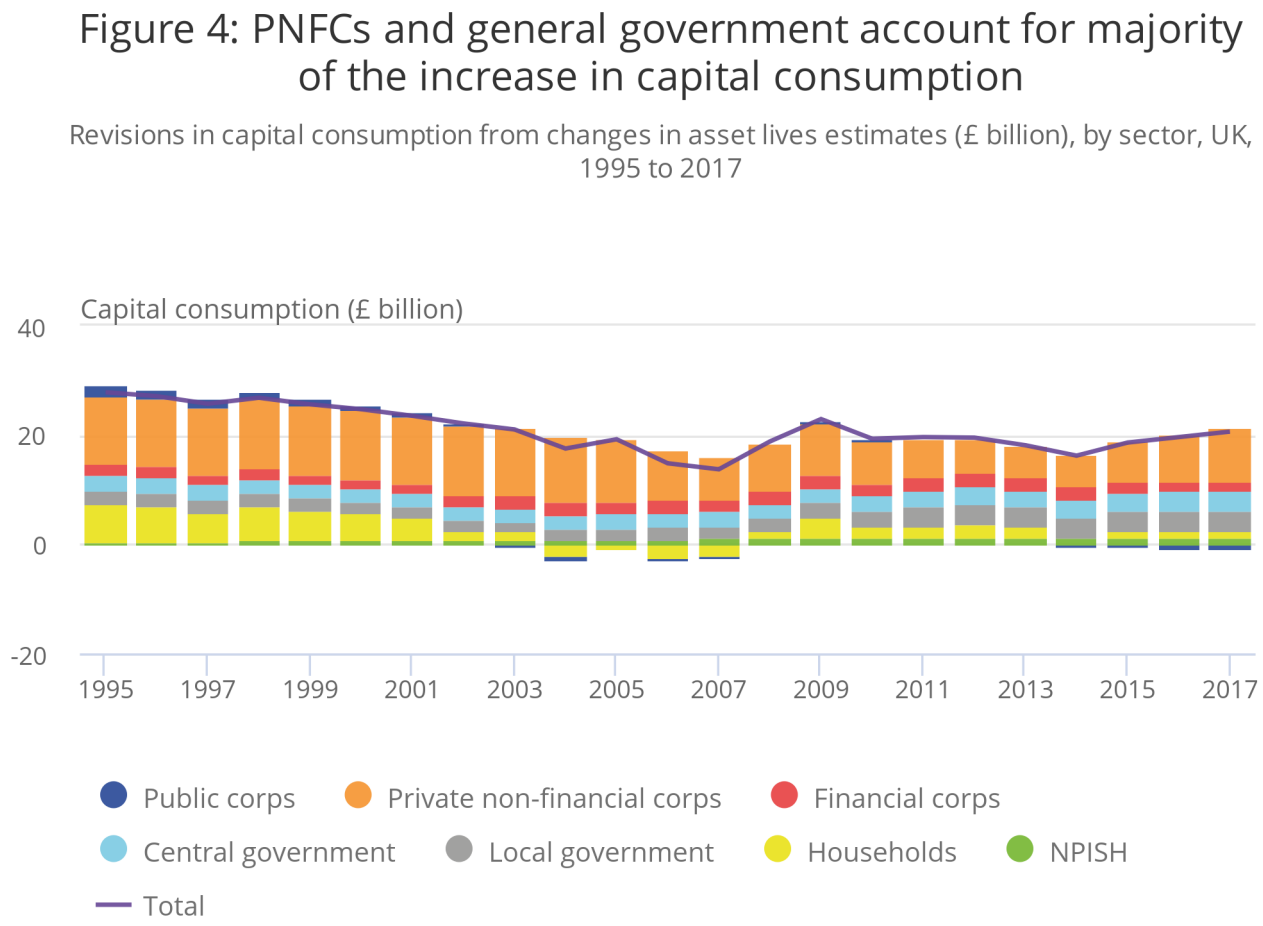
1. These are chained volume measures and the components may not add up to the total as they are not additive prior to the reference year. Back to table

Sectors that hold a large proportion of other buildings, such as general government, have had a larger percentage increase in capital consumption. The increase in capital consumption for general government and non-profit institutions serving households (NPISH) raises estimates of gross domestic product (GDP) where non-market output is measured using a sum-of-costs approach.

Private non-financial corporations (PNFCs) have seen the largest increases in capital consumption, as well as the largest falls in net capital stock. While net capital stock estimates have fallen every year for each sector as a result of changes to asset life estimates, there are some years in which some sectors had a decrease in capital consumption. This is the case with households where capital consumption for households decreased between 2004 and 2007 as a result of an increase in the estimated asset life for the transfer costs of land ownership.

Figure 4: PNFCs and general government account for majority of the increase in capital consumption

Revisions in capital consumption from changes in asset lives estimates (£ billion), by sector, UK, 1995 to 2017



Source: Office for National Statistics

Notes:

1. These are chained volume measures (CVMs) and the components may not add up to the total as they are not additive prior to the reference year.

Table 3: Capital consumption using new and old estimations of asset lives (£ billion), by sector

Asset Lives	Sector	1995	2000	2005	2010	2015
New	Non-financial corporations	91	112	127	140	152
	Financial corporations	5	6	8	10	10
	General government	22	23	27	34	39
	Households & NPISH	44	51	58	68	75
	Total	161	192	222	251	276
Old	Non-financial corporations	77	99	116	132	145
	Financial corporations	3	5	6	7	8
	General government	16	19	22	28	32
	Households & NPISH	37	45	58	65	72
	Total	134	168	202	231	258

Source: Office for National Statistics

Notes

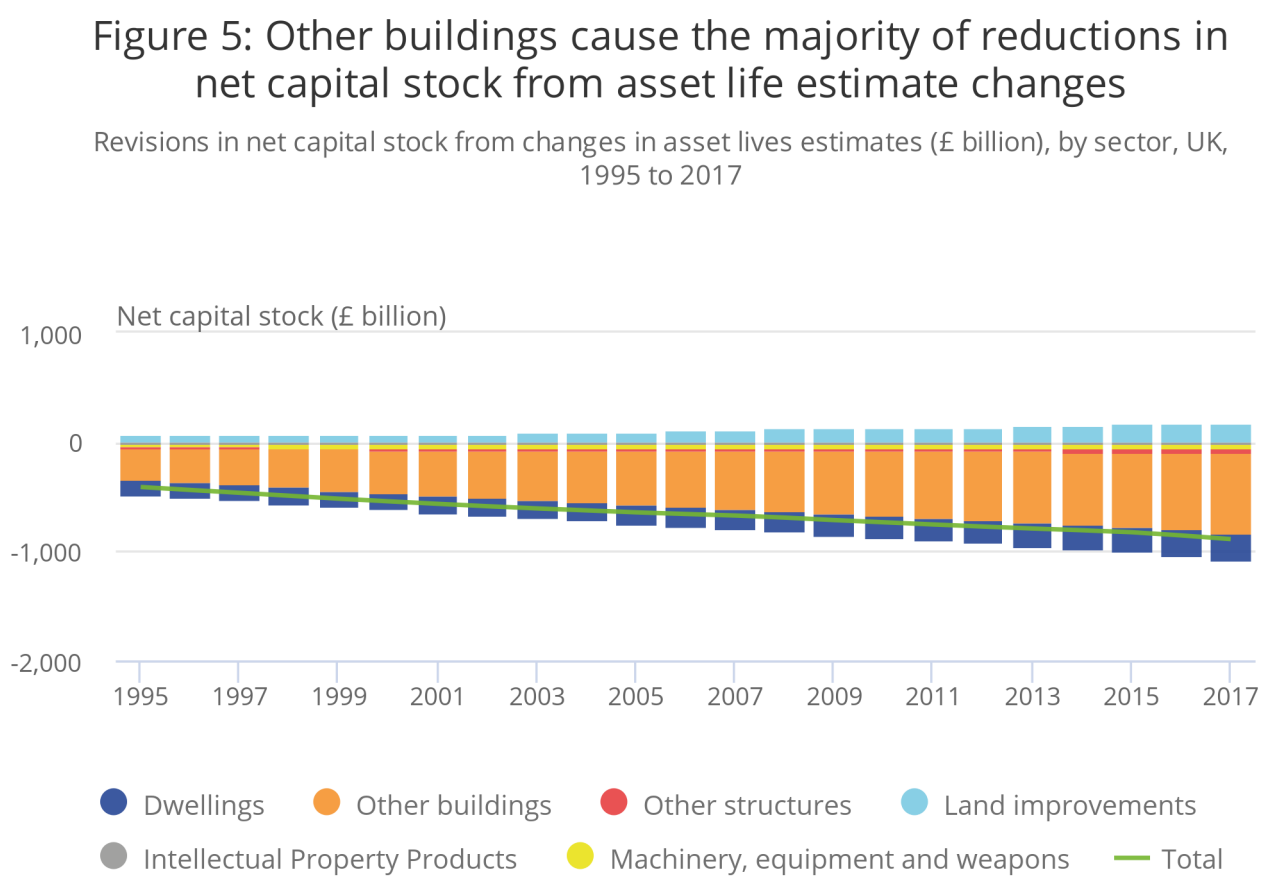
1. These are chained volume measures (CVMs) and the components may not add up to the total as they are not additive prior to the reference year. Back to table

By asset

The largest impact of changes to estimates of asset lives on net capital stock is for other buildings, as the mean asset life estimate has been reduced from 65 years to 39 years and other buildings accounted for 27% to 28% of the net capital stock using old asset lives estimates.

Figure 5: Other buildings cause the majority of reductions in net capital stock from asset life estimate changes

Revisions in net capital stock from changes in asset lives estimates (£ billion), by sector, UK, 1995 to 2017



Source: Office for National Statistics

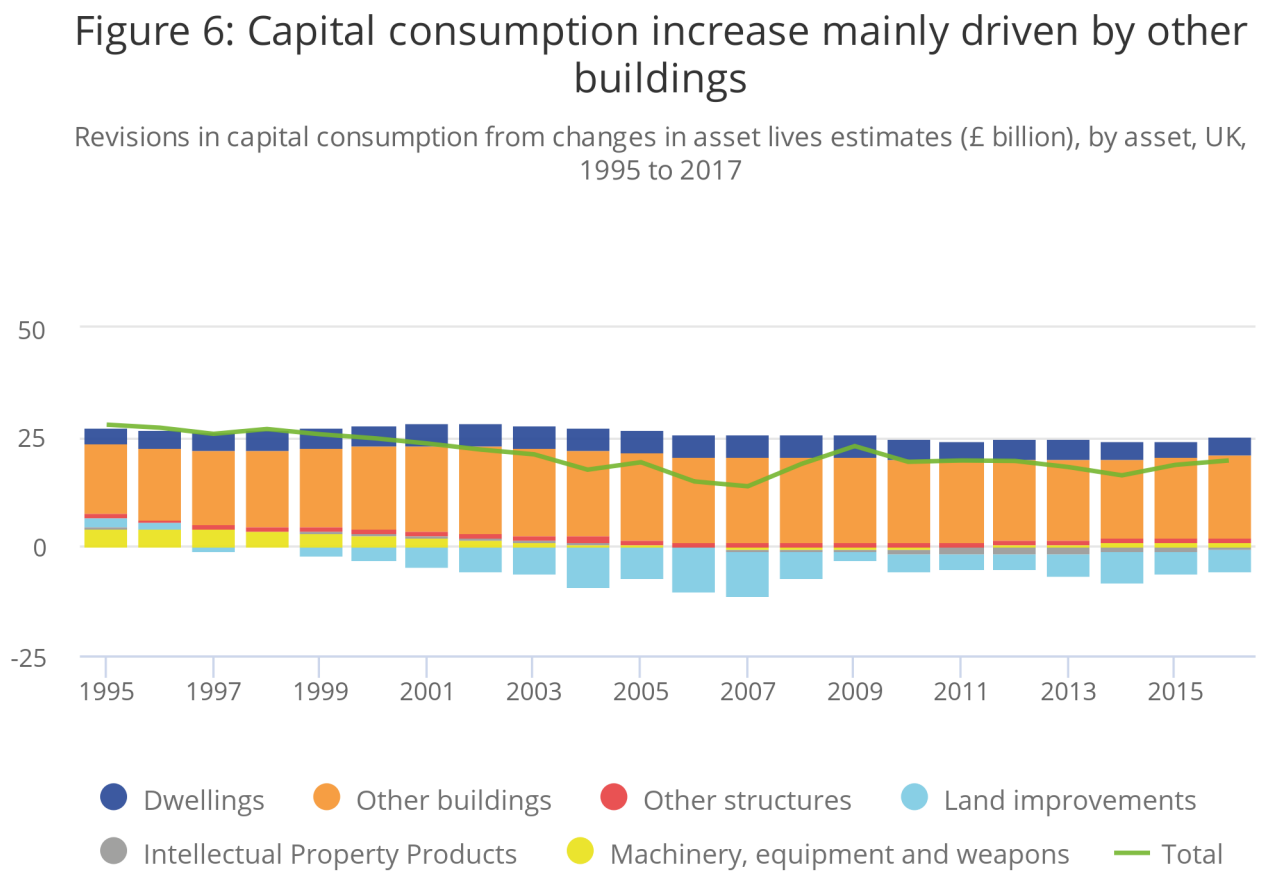
Notes:

1. These are chained volume measures (CVMs) and the components may not add up to the total as they are not additive prior to the reference year.

With transfer costs on land being included in net capital stock, there has been an increase in net capital stock for land improvements and a reduction in capital consumption for land improvements. Previously, writing off transfer costs immediately would result in volatility, caused by fluctuations in land transactions (for example, during an economic downturn). As transfer costs of land are written off over the period of ownership, there is much less volatility in capital consumption.

Figure 6: Capital consumption increase mainly driven by other buildings

Revisions in capital consumption from changes in asset lives estimates (£ billion), by asset, UK, 1995 to 2017



Source: Office for National Statistics

5 . Hyperbolic depreciation

An age-efficiency function describes the decline in productive efficiency of an asset relative to its purchase price resulting from ageing. The shape of the function can take many forms, including:

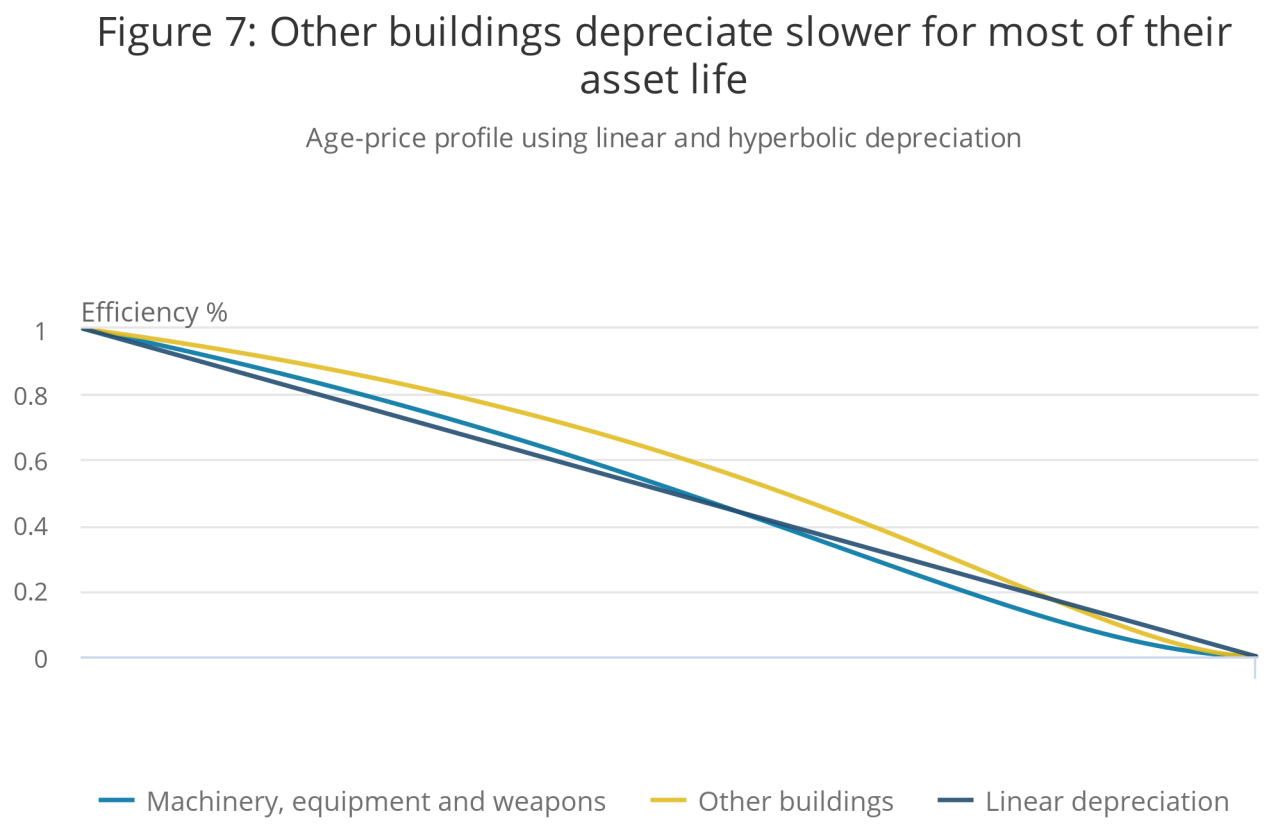
- hyperbolic
- geometric
- linear
- constant (implying no efficiency loss)

Linear implies constant amounts of depreciation and is not representative for some assets like other buildings and entertainment, literary and artistic originals. The hyperbolic function is more plausible as it has a slow rate of depreciation at the beginning of the asset's life that increases towards the end of its life. The choice of applying a hyperbolic depreciation rate is also consistent with many other statistical offices including the U.S. Bureau of Labor Statistics (1983), Australian Bureau of Statistics (2000) and Statistics New Zealand (2006).

An age-price profile is derived from the age-efficiency profile (further details of this can be found in Changes to the capital stock estimation methods for Blue Book 2019). Figure 7 shows the age-price profile or depreciation using linear and a hyperbolic age-efficiency profile for machinery, equipment and weapons and other buildings. The parameters chosen for a hyperbolic age-efficiency profile determine the extent to which depreciation takes place across the life of an asset. Other buildings lose most of their efficiency at the end of their lives and therefore depreciate much slower (that is, they lose less efficiency) than under linear depreciation at the start of each cohorts asset's life. The parameter chosen for "machinery, equipment and weapons" means efficiency takes place more evenly over their lives than for other buildings. "Machinery, equipment and weapons" depreciate slightly slower at the start of their lives than under linear depreciation, but they depreciate much quicker than using linear depreciation at the end of their lives.

Figure 7: Other buildings depreciate slower for most of their asset life

Age-price profile using linear and hyperbolic depreciation



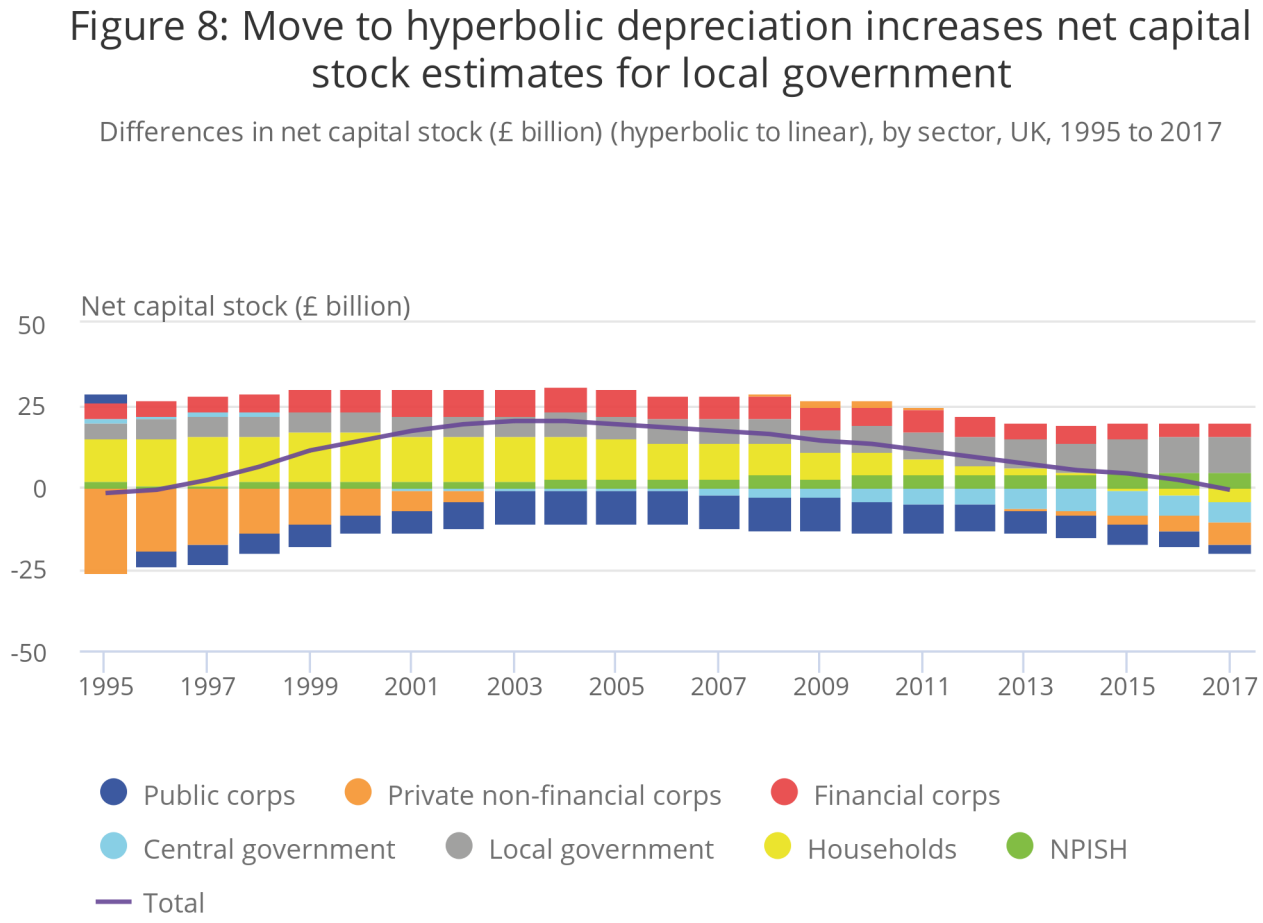
Source: Office for National Statistics

By sector

The effects of changes in depreciation are calculated using new asset lives. The revision in depreciation by sector depends upon the pattern of previous gross-fixed capital formation (GFCF) and the assets held in that sector. The capital stock held by financial corporations mainly comprises other buildings and given that depreciation tends to take place later in that asset's life (except at the tail), the net capital stock has increased as a result of moving to hyperbolic depreciation.

Figure 8: Move to hyperbolic depreciation increases net capital stock estimates for local government

Differences in net capital stock (£ billion) (hyperbolic to linear), by sector, UK, 1995 to 2017



Source: Office for National Statistics

Notes:

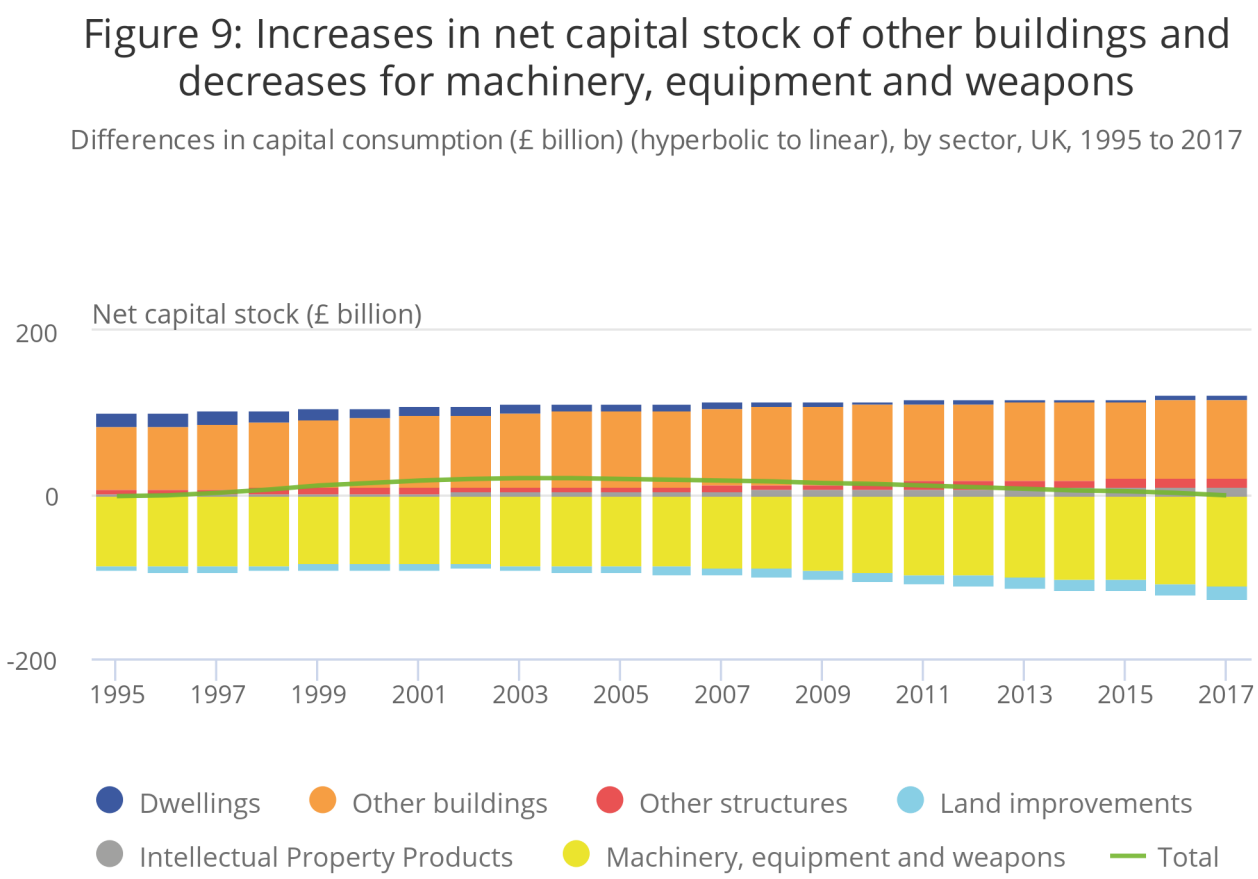
1. These are chained volume measures (CVMs) and the components may not add up to the total as they are not additive prior to the reference year.

By asset

The effect of the move to hyperbolic depreciation has been an increase in the net capital stock of other buildings, as other buildings depreciate slower than under straight-line deprecation for most of their lives (see Figure 7). Although machinery, equipment and weapons depreciate slightly slower at the beginning of each cohorts asset's life than under straight-line deprecation, the quicker depreciation towards the end of each cohorts asset's life results in a reduction in the net capital stock of machinery, equipment and weapons.

Figure 9: Increases in net capital stock of other buildings and decreases for machinery, equipment and weapons

Differences in capital consumption (£ billion) (hyperbolic to linear), by sector, UK, 1995 to 2017



Source: Office for National Statistics

Notes:

1. These are chained volume measures (CVMs) and the components may not add up to the total as they are not additive prior to the reference year.

6 . Conclusions

The review of estimates of asset lives to ensure that these reflect the productive life of assets has had the largest impact on changes to the net capital stock. These are now more in line with other national statistical institutes, increasing estimates of capital consumption and reducing estimates of net capital stock.

There have been improvements in capital stock estimates, including transfers between different sectors, and these transfers are now applied consistently. A hyperbolic age-efficiency profile is now used instead of linear depreciation, which better reflects how assets depreciate.

As a result of increases in estimates of capital consumption for the non-market sector, there are upward revisions to gross domestic product (GDP). This is because of areas of non-market output are measured using a sum-of-costs approach, where output is equal to input and therefore the increase in capital input results in increased output.