Estimates of the volume of capital services

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This article presents estimates of the volume of capital services for the United Kingdom as a whole as well as by industry. This experimental measure complements the wealth measures presented in the National Accounts and builds on the work done to improve these measures. The volume index of capital services weights together the growth in the net stock of assets using shares that reflect the relative productivity of the different assets that make up the capital stock. The article describes the method used to do this and explores the impact of treating ICT goods separately. Data related to current work and results are available at the National Statistics website: http://www.statistics.gov.uk.

Introduction

The Office for National Statistics (ONS) recently published improved estimates of the wealth measures of the capital stock and associated series such as capital consumption. Apart from chain-linking the volume estimates of capital stock, ONS's work provides greater industrial detail in the measures and also includes a long time-series of capital formation by industry and broad asset group (see Vaze, Hill, *et al.*, 2003). These data can be used when calculating new measures of the capital stock, including those that take account of different productivity of different asset types.

How the capital stock impacts on growth has become a topic of much interest. The link between productivity growth and investment has been discussed with particular reference to the recent large investments in assets related to the new economy, such as computers. While discussion and analysis continues, there has been a parallel debate about the measurement of capital. ONS wealth measures of capital value the replacement cost of the stock of capital as if new (gross capital stock) or taking account of the loss of value due to depreciation (net capital stock). However while these measures are useful for productivity work, there is a growing body of work proposing alternative measures that quantify the flow of input from the capital stock into production. Using these measures for capital input, analysts have 'accounted' for growth quantifying that part attributable to the input of capital. For the United Kingdom, recent examples of research in this area have been Oulton (2001) and O'Mahony and de Boer (2002).

Defining and measuring the contribution of capital to production has been a controversial issue, but a measure of international agreement has been reached in recent years. The issues involved and ways forward have been detailed in a recent manual by the Organisation of Economic Co-operation and Development (OECD, 2001). One suggested development is to disaggregate capital formation into a number of asset types. Research has indicated the sensitivity of UK capital stock measures to the separate treatment of assets with a short life-length, such as computers (Oulton and Srinivasan, 2003). Currently, the ONS quarterly-published investment series separates the main tangible assets as new building work, plant and machinery, and vehicles in both current and chain-linked volume measures. More detail in terms of assets is available in current prices in ONS supply-use tables and in capital formation surveys.

This article gives the results of the ONS work on an index of capital services to provide a measure of capital input into production and to complement the current wealth measures. The raw data for this is identical to ONS net and gross capital stock measures: long time-series of capital formation by asset, deflators by asset and defined assumptions about the asset decay and retirement pattern. The model employed owes much to work undertaken at the Bank of England, using the methodology described in Oulton and Srinivasan (2003).

Measuring capital input

The methodology to calculate a Volume Index of Capital Services (VICS) is described by Oulton and Srinivasan (2003) and the OECD Capital Stock manual also provides an invaluable resource (OECD, 2001). In summary, the stages are:

- aggregating the history of each asset's capital formation by industry over time with the different vintages of assets added together in a manner reflecting decay;
- pricing asset's services using the estimated rental for each asset;
- aggregating across assets, weighting the stocks in an index reflecting their input into production.

Generally, there is a decline in the productive potential of an asset as it decays over time. So it is better to add together the assets using weights that reflect this decay with newer assets having a higher weight. The decay of an asset over time is approximated by its age-efficiency profile. A function such as straight-line decay has sometimes been used, but a 'smooth' function used here is the infinite geometric decay function. This has some elegant mathematical properties, which greatly simplify the analysis of the capital services – the box indicates two of the implications. But most of the decay occurs at the start of the asset's life, which can be questioned.

Given a decay function, it is possible to convert time-series data about the volume of purchases of assets into a stock measure. The stock measure reflects the sum of the assets, weighted together to reflect the different efficiencies of the various vintages of the assets. For example, if the selected age-efficiency profile is geometric with 10 per cent decay per annum, then 90 per cent of the asset will remain after the first year, 81 per cent in two years and so on. In calculating decay rates, we use the average life-length in years assumed for each asset and each vintage in the ONS national accounts stock models, converted into a rate using a method explained in the annex.

A second area is the pricing of an asset's services over time, given by the rental. Rentals are the payments made for the year's service of a capital good. An efficient firm would equate the marginal returns of the services of an asset in a period to the rental of the asset. In some circumstances, there is a rental market and the rentals may be directly observed. For example, this is the case in office space and some machinery. However, for many goods, the rentals are not observed and a model is used to impute the asset's rental. The basis for this is asking the question what would the owner of an asset expect to be paid for a year's use of the asset?

There are three costs associated with renting an asset and an adjustment reflecting the taxes and subsidies that accompany an investment. Firstly, over the year, the asset loses value due to decay or ageing and some part of the rental will reflect this. To model the value of this component, the decay rate used in calculating the stock measure is used. A second part of the rental is due to changes in the price of a new asset. These are the holding gains or losses reflecting the value change of an asset in the year due to aspects other than ageing, such as capital gains in property. A final cost is the cost of capital.

Consistency issue 1: Linking price of a capital asset with the decay of capital

The decay model geometric, light bulb, straight-line and so on – allows us to model the future volume of an asset's capital services over its lifetime. That model allows the analyst to predict the future productive behaviour of the asset. We can link that with the price of the capital services (the rentals) to calculate a series for the future values of capital services. The present value of the future stream of the asset's capital services could be calculated, taking the decay of the asset into account. This present value would equal a measure of the net stock of the asset. Changes in the present value as assets age would be depreciation. In some statistical systems, such as that in Australia, the net stock measures and depreciation are consistent with the decay function that is used in asset modelling. Here, the net stock used in the volume index of capital services is consistent with the rentals measure, but the measures used in the UK wealth measures, published in the national accounts, uses straight-line depreciation.

Consistency issue 2: Rates of return and operating surplus

The sum of the value of capital services is a measure of the operating surplus. If the rentals are calculated assuming a rate of return on capital – such as a government bond rate – it is unlikely that the total value of the capital services will equal the observed operating surplus. However, it is possible to calculate an ex post rate of return such that the rate of return to exhaust the operating surplus in the economy. The rate of return is then calculated endogenously. Here dwellings are not modelled as part of the productive capital stock and the part of operating surplus attributable to dwellings has been deducted from the total gross UK operating surplus, as measured by owner-occupier imputed rents and the depreciation of the stock of dwellings. It would be possible to calculate industry-specific rates of return using industry operating surpluses. But this has not been done in the present analysis and instead one rate is assumed across all industries.

The owner of the asset could have sold the asset and put the monies into an alternative interest-bearing financial asset. The rental ought to compensate the owner for this opportunity cost. The sum of these three costs is adjusted for taxes or subsidies available on investments.

Having calculated the stock of an asset and the rental for that asset, it is now possible to multiply the rentals by the stock of capital to give the value of capital services provided by an asset over a year. This is done for each of the assets and then added together. The sum of the value of capital services is a measure of the total value added by capital goods in the production process. It would be a current price gross measure rather than net, as it would include the depreciation of the capital stock and could be compared with the gross operating surplus given in the production accounts of the national accounts.

The volume of capital services is the volume or real measure of these capital services and is calculated by an index aggregating the growth in the stock of individual asset (volumes) using appropriate weights. The index used here – the chain-linked Laspeyres – has not been found to give significantly different results to the Tornqvist (for example, used in Oulton (2001)) and is consistent with the current UK chain-linked macroeconomic aggregates. The weights used in the index are the shares of the assets in the value of capital services in the previous year. Under an assumption of profit maximisation and market competitiveness, it can be shown that these shares approximate the elasticity of output to the volume of capital services inputting into the production process.

ONS work on capital services has some particular features. Firstly, the model estimates stocks and rentals at a very disaggregated industrial and asset level. For each asset and industry, a long time-series of investment is used to derive stocks and these are weighted together using shares based on rentals modelled for each asset. Thirty-five industries and between one and six assets for each industry have been modelled. This very disaggregated modelling is also a feature of O'Mahony and de Boer (2002), which provides some comparison.

The ONS model allows the depreciation rate of the assets to vary over vintage, that is, the life-length of an asset will vary depending on the year of purchase. Although changes across time are infrequent, a general observation is that life-lengths of assets have lessened over time. This reflects both shortening in the life-length of assets due to reviews of the assumptions made by ONS and also a shift to short-lived assets.

Investment in computers

The heightened interest in measuring capital has particularly focused on the role of investment in information and communication technology (ICT) goods and services in recent years. The level and growth in ICT investment has to be seen in the light of two key features of ICT capital. Firstly, ICT assets have shorter life-lengths than the other main asset types. (For example, in the United Kingdom, the vehicles asset type has one of the shortest assumed life-lengths, but computers and software typically last less than half this length of time at about five years.) A second feature common to ICT goods and services is large annual falls in prices due largely to improvements in quality.

The shorter life-lengths and the rapid falls in prices have led to analysts separating out the ICT assets in their capital stock models (Oulton, 2001; O'Mahony and de Boer, 2002; OECD, 2001). ONS is also moving in this direction – ONS introduced into its wealth measures of the capital stock a new category of numerically controlled machinery in the 1990s and computers are modelled separately in these measures. In modelling capital stock, long time-series of investment data by asset is needed. Estimates of computer investment have been improved as part of the current work. This has been achieved through using the detailed product breakdown available in the investment tables included in the supply-use tables, produced by ONS. The supply-use tables accompanying *Blue Book 2002* provide annual data from 1992 onwards giving the 123-product breakdown and 35 industries.

For the years before 1992, there are a number of measurement issues surrounding the long time-series history of capital formation in computers that is needed. Suitable Input-Output data is available from 1979. But different industrial classification systems were used over the period and the tables were produced infrequently prior to 1989. Information to convert between different vintages of the standard industrial classification (SIC) was used to make a consistent SIC92 series for computers. Where input-output tables are not available, the share of computers in plant and machinery was interpolated and this was then applied to the annual data available in national accounts on plant and machinery investment.

Computer prices have been falling much faster than other assets. This partly reflects the improvements in quality measured using an option-cost method since the late 1990s and a hedonic regression since the start of 2003 (Ball and Allen, 2003). To measure the productive capital stock, some account of these prices falls must be taken and to allow this the current work has separately deflated the investment in computers using the price index (ONS code PQEK). The current work has also then removed this PPI from the industry-specific deflators for plant and machinery having a positive effect on asset price growth. This has been done for all years after 1995.

Technology assets such as computers largely motivate the need for measures of the capital stock that take account of the different productivity of assets. The rationale can be seen by comparing computers with a long-lived asset such as buildings. A similar value of investment in the two assets would both provide different patterns of services to a business for a period beyond the year the investment takes place. In the case of computers, the life-length being shorter and falling prices both mean that current price investment would need higher returns for computers and the VICS recognises this by attributing a higher productivity for computers.

A second significant impact of the price falls seen in computers is observed in the growth in the stock of computers. As old vintages of computers are being retired, new, more powerful computers are replacing them. The growth in the net stock for this asset reflects the increasing current price expenditures on computers. However, even in years where the current price growth is modest or falling, an upward impact on the constant price net stock of computers occurs due to the replacement of old computers with new more powerful ones.

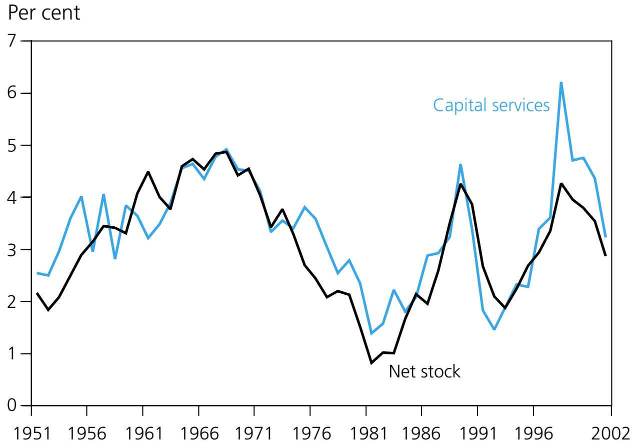
Analysing capital services

Table 1 presents a series for the volume index of capital services for UK whole economy and by industry. The results currently cover the period up to 2002. Figure 1 indicates the growth rates of volume index of capital services for the whole economy during the period 1950–2002. The early periods show strong and sustained growth in the input of capital goods into production, particularly in the second half of the 1960s. However, this early period suffers from one notable measurement issue – quantifying the one-off loss of capital stock due to the Second World War (Dean, 1964, provided the official estimates of this, which is used here). The period of the 1970s however saw more modest growth reaching a low in 1982, a period when investment in many industries was below replacement levels. The 1980s and 1990s have similar patterns in both decades beginning with low growth rates, but the second half of each decade seeing strong investment and so strong growth rates for the VICS.

Also included on the figure is the change in the net capital stock excluding dwellings. The close fit is to be expected given both measures weight together the changes in the net stock. Net stock measures are underpinned by the same datasets, namely the long time-series investment by asset, price indices and assumed life-lengths. However, some differences are expected due to the different construction of the indices, particularly the weighting of asset growth by their profit shares in the VICS, rather than in asset value terms in the net stock. The most pronounced differences occur when this effect would be high – primarily, in the late 1990s. During this period, investment in computers was growing fast and the price of computers falling markedly. The latter would make the share of computers in the index high. This combines with growth in computer investment to raise the VICS above the net stock measure. In 1998, the VICS grew by 6.2 per cent, higher than the net stock growth of 4.3 per cent. The slowdown of investment in computers in the first years of this decade would reverse the growth in VICS as the weight of computers would remain high, but this being associated with slower growth in the net stock.

The VICS model endogenously generates the rate of return that exhausts the operating surplus. This methodology is noted in the box and is identical to that used in Oulton (2001). Comparisons between the current estimates of rate of return with Oulton (2001) indicate that there is little difference even though there has been a disaggregation into more industries and other differences in the two models. The estimated rate of return, which is a nominal measure, is then used in calculation of the rentals. It is common in such modelling that the estimated rentals sometimes are

Figure 1
Annual growth in measure of capital stock, 1950–2002



negative, and some assumption has to be made to remove such anomalies. In the current work, where negative rentals are estimated, the previous positive rental is used instead.

Capital services by industry

Figures 2 and 3 give the volume index of capital services by industry, indicating the average chained (Laspeyres) volume of capital services input for each industry. Also, for most industries, the minimum and maximum growth rates observed are also given, though for some industries these have been suppressed. Table 1 gives the time series of VICS for whole economy and by industry.

In the manufacturing industries displayed in Figure 2, over the period all have average growth below five per cent. There is some similarity in the growth rates observed in the output of industries and in the VICS. Industries that have seen a marked decline over the period – such as Basic metal products or Textiles – have also seen low growth in the volume of capital services used. Industries related to the oil and chemicals sector have shown stronger growth, as have those industries associated to information technologies, Electrical and optical equipment and Pulp, paper, printing and publishing, for example.

Figure 3 shows the contrast with services industry: all but six of the industries have VICS growth rates above five per cent. The picture is of generally high growth in capital services, reflecting strong investment over the period. All the major service industries where output is primarily provided by private businesses – retail, finance and other business services being the largest – indicate strong growth in capital services during the period. Table 1 shows when the maximum and minimum growth rates from Figures 2 and 3 occur. It can be noted that the strong annual rises in the VICS in the late 1980s were associated with strong growth in finance. The late 1990s growth in the VICS has a strong contribution from this industry. However, it is the growth in the post and telecommunications industry that is most pronounced with the VICS for this industry reaching 18 per cent growth in 1998.

Figure 2
VICS growth rates by production industry, 1950–2002

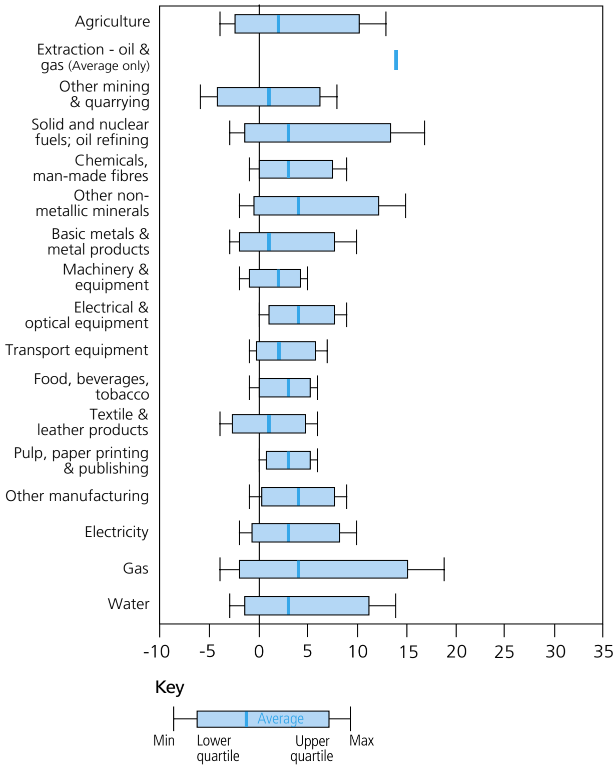
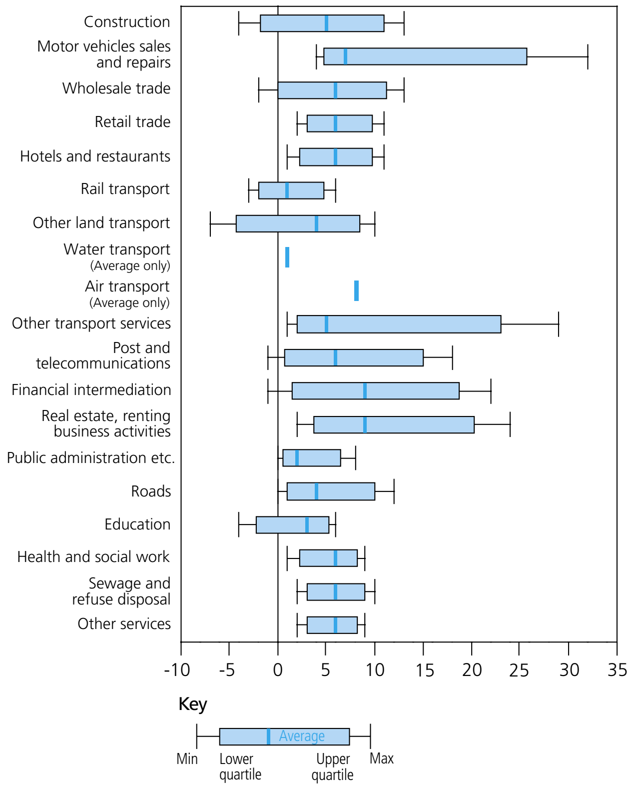


Figure 3
VICS growth rates by services industry, 1950–2002



Profit shares by asset

The weight of each asset in the volume index of capital services is the share of the total gross operating surplus attributable to each asset. These profit shares reflect a business's need to cover the decay of the asset (higher for short-lived assets such as computers) and to make a rate of return on finance tied up in the asset stock. Also, the business may gain from capital gains reducing the need for profits (as is sometimes the case in buildings), but may also see asset value lowered by factors other than depreciation.

Figure 4 and Table 2 indicate a change in the composition of the profit shares. Broadly over the period, the weight of buildings has declined as the share of plant has increased. The increase in the importance of plant and machinery – in its broadest senses including ICT – has motivated the breakdown of this asset into more categories. Since the mid-1980s the profit share attributable to computers has risen to approximately six per cent. The asset 'intangibles' is dominated by own-account software and contributes approximately 3 per cent of profits. However, this underestimates the importance of software as plant and machinery includes purchased software. The share of profits attributable to buildings has declined over the period, though it can be seen that the first half of the 1990s saw a steep rise in the share of this asset in profits. This reflects the positive impact on rentals of the modest growth and – in some years – decline in the price of buildings.

Computer investment and capital services

The investment in computers and other ICT assets observed in the 1990s motivates the modelling of the productive capital stock. To indicate the importance of this in the current analysis, the VICS model was run aggregating computers with plant and machinery. The combined asset of plant and machinery and computers was modelled with a set of life-lengths and price indices for each industry, which weighted together the measures for the two assets appropriately. The effect was to create an asset with a life-length between that of plant and machinery and computers. The price index of computers used in the VICS is identical to that for the rest of plant and machinery for the period to 1995. However, after this, a separate price measure is used for computers, which falls faster than the prices seen in plant without computers. These two indices were combined for each industry to give a plant deflator including computers.

Figure 5 compares the VICS with one calculated without computers as a separate asset (VICS ex computers). The period when investment in computers has been separated from other plant and machinery is 1980 onwards and the period until 1995 reflects the effect of having different life-lengths but the same price index for both assets. The indices track each other quite closely. However, after 1995, with a separate price index for computers being used to deflate the current price investment in this asset, the VICS diverges from the VICS modelling computers with plant. The third section gives some of the reasons why the VICS is greater if

Figure 4
Profit shares by asset, 1950–2002

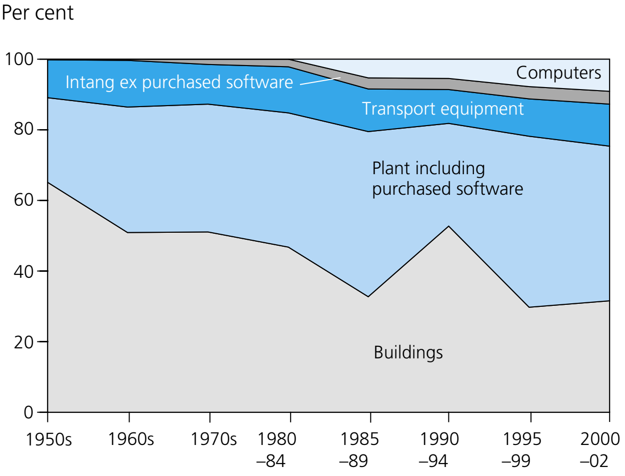
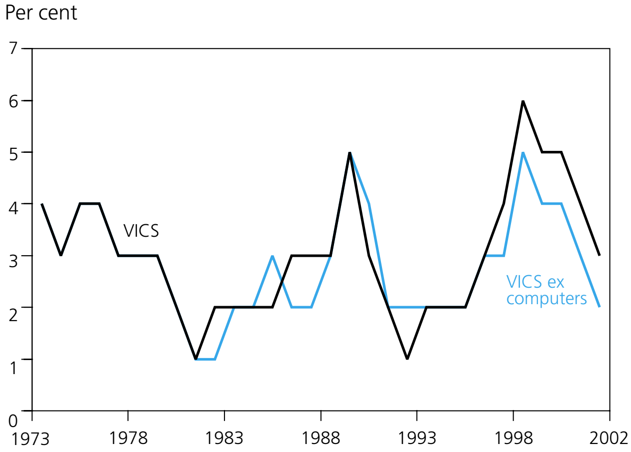


Figure 5
Impact of computers on VICS annual growth, 1972–2002



computers are modelled separately and so it is unsurprising that this proves the case.

Conclusions

This article accompanies the release of a volume index of capital services for the United Kingdom. The release is experimental and builds on continuing work improving ONS measures of the capital stock. This article has described some of the steps in measuring capital services and comments are welcome. While the VICS measure is related to the existing ONS capital stock measures, it should be noted that they are not a replacement. There is on-going work on the wealth measures of capital stock – net stock and gross stock – which will be reported on separately.

The results on capital services in this article show the importance of the correct treatment of the new economy assets in measures of the productive capital stock. Such results indicate the sensitivity of stock measures to the assumed life-lengths and to the deflators. Life-length assumptions and the deflator associated with an asset form the basis of weighting the stock of a particular asset in the capital services measure. Both these variables behave very differently in the new economy assets and the capital services measure is therefore sensitive to these assets.

Recently, ONS has reviewed the stock measures it produces. This is associated with two initiatives. Firstly, the completion of a new system to be used in the calculation of wealth measures of the capital stock has allowed much easier analysis and development. Capital services measures are a new product that this work has allowed. Building on this, ONS is reviewing other aspects of the model, such as the appropriate asset breakdown and the level at which modelling should take place. Secondly, the *Blue Book* in 2003 uses annual chain-linked volume indices. Volume measures are sensitive to the index used in construction, particularly to the timeliness of weights and particularly where sub-aggregates are changing rapidly, such as in ICT assets. Annually updating weights allow the chain-linked volume measures of capital services to be merged with the output measures and other input measures to calculate multi/total factor productivity.

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Table 1:
Growth in Volume Index of Capital Services, 1980–2002

Description	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
						Annual change (%)						
By production industry												
Agriculture, forestry and fishing	–0.2	0.2	0.4	0.6	–0.4	0.1	–0.7	–2.4	–4.0	–3.2	–4.5	–2.9
Extraction – oil and gas	6.5	6.0	3.5	–2.2	–0.4	–1.2	0.2	–1.7	–4.7	–6.4	–3.1	–2.4
Other mining and quarrying	–5.5	–4.6	–4.3	–2.4	–4.9	–4.0	–4.6	–4.5	–3.7	–4.2	–3.2	–3.6
Solid and nuclear fuels; oil refining	–0.6	–2.1	0.1	10.1	2.3	–1.1	–0.1	–0.2	–0.1	–0.7	2.2	2.2
Chemicals, man–made fibres	1.2	0.4	0.1	1.2	0.5	1.5	1.4	3.6	1.2	–0.2	–0.3	–0.7
Other non-metallic minerals	–1.7	–2.1	–1.4	–1.2	1.1	2.6	0.4	1.4	2.4	–0.3	–0.3	0.1
Basic metals and metal products	–2.4	–2.9	–1.1	–1.0	–0.9	–0.1	0.4	2.0	–1.9	–3.0	–1.8	–1.4
Machinery and equipment	–0.2	–1.6	–2.3	–0.7	–0.1	–0.4	0.4	2.6	–0.8	–1.6	–0.9	–0.9
Electrical and optical equipment	–0.4	–0.5	1.6	4.0	6.4	4.7	8.9	5.3	2.0	5.4	3.6	0.1
Transport equipment	1.7	–0.5	–1.4	–0.5	1.2	1.7	6.1	3.1	2.7	0.2	2.5	0.4
Food, beverages, tobacco	1.0	0.4	0.2	–1.3	0.0	0.2	0.7	2.0	1.9	0.4	0.0	–0.2
Textile and leather products	–2.3	–1.9	–1.8	0.0	–0.8	0.6	–0.8	1.1	–1.8	–2.8	–2.9	–3.6
Pulp, paper, printing and publishing	2.8	0.4	1.7	2.7	2.8	1.0	1.5	2.9	1.7	2.6	1.9	0.7
Other manufacturing	–0.6	0.9	0.3	0.3	2.0	4.8	2.8	2.0	1.9	1.3	0.0	–0.4
Electricity	2.7	3.9	2.8	2.2	–0.5	–1.6	–0.4	–0.2	0.5	0.1	–0.2	–1.1
Gas	4.7	5.3	2.1	0.2	1.9	–3.7	–3.4	0.6	–0.4	10.2	8.1	3.5
Water	11.9	9.7	8.8	7.0	7.2	11.2	14.0	7.5	6.3	2.7	5.5	–0.6
Construction	–3.6	–3.0	0.4	4.9	1.1	–1.1	5.4	4.2	6.5	6.6	1.2	9.0
By service industry												
Motor vehicles sales and repairs	5.7	3.8	3.7	4.2	5.2	3.7	5.6	9.0	6.4	9.3	10.2	9.4
Wholesale trade	–1.8	–0.8	1.3	1.5	3.1	1.2	8.8	12.6	6.6	2.8	4.7	2.3
Retail trade	1.6	2.2	3.2	3.1	4.9	2.5	3.1	10.7	5.3	5.4	5.9	5.4
Hotels and restaurants	2.2	2.9	1.3	1.1	4.1	5.5	4.3	5.1	5.7	5.7	6.9	4.3
Rail transport	3.1	6.2	4.6	1.7	–1.2	–2.6	–3.4	–0.8	–1.0	–1.4	–0.8	–1.7
Other land transport	–6.8	–1.6	3.0	7.0	4.3	–1.6	0.9	2.2	3.7	1.5	1.9	0.7
Water transport	–2.5	–3.2	0.0	2.8	3.6	1.1	–2.5	–2.2	–0.3	8.7	–0.7	–1.0
Air transport	–2.8	8.0	22.3	33.6	–10.1	8.2	47.1	19.1	11.7	15.8	15.6	19.1
Other transport services	3.6	3.1	1.9	5.4	5.5	8.3	29.1	7.4	7.7	12.2	11.9	9.0
Post and telecommunications	0.8	–0.6	0.0	2.1	6.7	10.9	11.6	17.9	13.8	16.2	13.8	5.6
Financial intermediation	3.0	0.1	–1.3	0.8	5.1	14.3	2.3	14.1	6.5	8.6	6.4	5.9
Real estate, renting, business activities.	6.8	1.8	2.0	3.7	5.1	9.8	6.3	24.0	17.0	12.0	12.7	7.7
Public administration, etc.	1.7	1.4	2.1	1.8	1.6	0.4	0.4	0.9	1.3	0.9	1.7	2.0
Roads	3.0	4.0	4.5	4.5	3.3	2.0	0.1	1.1	0.4	0.7	0.7	1.1
Education	–3.8	0.6	1.5	1.6	1.3	1.0	2.0	2.7	1.5	1.9	3.7	3.4
Health and social work	8.5	6.3	4.1	3.8	4.1	3.1	1.1	3.1	4.5	4.2	3.0	4.4
Sewage and refuse disposal	3.7	3.2	1.7	2.0	3.9	6.1	9.8	8.7	8.5	6.7	6.0	3.4
Other services	3.6	2.4	3.1	4.7	4.4	6.3	7.2	7.3	8.3	7.7	2.5	4.7
By type of asset												
Buildings	3.3	3.4	3.1	2.7	2.3	2.4	2.4	2.4	2.3	2.7	2.3	2.2
Plant including purchased software	1.6	1.0	0.5	0.7	1.6	2.6	2.2	3.4	3.9	3.7	2.4	0.7
Computers	3.6	–4.5	–3.2	4.0	10.3	17.2	18.7	38.4	23.5	23.9	24.3	15.7
Vehicles	–3.1	–3.4	–1.2	1.6	0.2	1.5	3.1	7.5	3.0	–0.4	2.6	3.4
Intangibles excluding purchased software	1.9	1.2	1.8	3.0	2.3	1.6	1.7	4.2	1.7	2.7	0.6	3.2
Whole economy	1.8	1.5	1.9	2.3	2.3	3.4	3.6	6.2	4.7	4.8	4.4	3.2

Table 2:
Profit shares, 1990–2002

Description	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
						Parts per thousand							
By production industry													
Agriculture, forestry and fishing	41	44	32	20	37	30	33	26	27	24	36	34	56
Extraction – oil and gas	53	66	53	40	48	46	61	47	36	39	46	45	34
Other mining and quarrying	17	12	9	8	12	10	14	11	7	8	9	7	7
Solid and nuclear fuels; oil refining	8	8	15	3	6	10	9	8	7	8	8	8	6
Chemicals, man-made fibres	32	20	17	12	32	40	33	34	35	34	33	30	27
Other non-metallic minerals	8	6	5	5	7	8	7	7	6	7	7	7	6
Basic metals and metal products	29	20	9	11	24	29	30	25	23	22	21	23	18
Machinery and equipment	18	13	11	11	17	21	17	17	17	16	14	13	12
Electrical and optical equipment	18	15	13	13	20	27	23	23	23	23	20	21	18
Transport equipment	27	20	17	60	53	31	24	26	27	27	25	24	26
Food, beverages, tobacco	29	24	17	14	28	29	25	30	29	27	29	27	26
Textile and leather products	10	11	9	7	12	13	14	12	14	13	9	8	8
Pulp, paper, printing and publishing	25	18	16	18	19	27	27	21	22	27	24	21	20
Other manufacturing	15	13	12	8	14	18	54	48	44	19	15	13	22
Electricity	48	43	37	23	59	70	63	54	59	55	55	48	41
Gas	11	11	10	11	11	10	7	11	9	7	10	10	9
Water	7	8	7	9	9	6	5	11	10	7	13	11	8
Construction	14	10	7	8	11	14	15	14	13	15	14	15	17
By service industry													
Motor vehicles sales and repairs	5	5	6	4	5	7	6	6	6	7	6	7	8
Wholesale trade	31	30	28	25	27	33	28	27	28	32	27	29	31
Retail trade	41	41	40	42	44	47	42	38	41	45	37	43	54
Hotels and restaurants	20	23	22	23	21	17	19	17	19	19	19	25	30
Rail transport	20	14	15	23	16	12	10	17	11	8	13	15	13
Other land transport	21	16	16	16	15	21	18	17	16	16	21	18	20
Water transport	9	22	5	5	7	10	6	4	4	1	5	2	4
Air transport	6	4	2	7	8	9	8	10	11	15	17	18	21
Other transport services	14	13	12	15	13	12	11	16	14	12	19	18	17
Post and telecommunications	49	60	24	38	28	67	61	64	67	79	71	88	94
Financial intermediation	60	63	50	61	52	50	52	53	51	76	80	51	61
Real estate, renting, business activities	85	103	102	105	86	92	82	77	105	114	108	138	112
Public administration, etc.	80	67	162	131	104	60	66	84	74	66	53	46	39
Roads	51	27	69	70	29	32	39	49	42	33	26	20	16
Education	26	64	69	69	45	27	28	28	29	27	30	28	35
Health and social work	12	30	30	25	27	18	19	17	18	18	20	22	22
Sewage and refuse disposal	24	18	17	21	18	11	9	19	17	14	23	18	17
Other services	36	36	34	39	35	36	36	31	36	40	37	44	45
By type of asset													
Buildings	389	515	639	653	441	206	315	375	334	257	312	315	322
Plant including purchased software	388	306	205	167	390	572	457	407	471	513	444	412	457
Computers	66	64	39	52	50	68	77	78	76	89	92	108	73
Vehicles	125	94	89	92	80	117	112	108	91	104	116	126	113
Intangibles excluding purchased software	32	21	28	36	38	37	39	32	28	36	37	39	34
Whole economy	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000

Annex

The volume index of capital services combines the long time-series of capital formation data and asset life-lengths underpinning the ONS wealth measures of capital stock with an alternative model taking the different productivity of the assets into account. Here, some background to the data and more detail regarding the VICS model is given. Data related to current work and results are available at the National Statistics website: http://www.statistics.gov.uk.

Data used to calculate VICS

The dataset consists of long back history of the volume of investment, current price investment, assumed life-lengths, and implicit price indices. The series were taken from the ONS Perpetual Inventory Method (PIM) model system, which calculates capital stock and capital consumption for the National Accounts. The PIM works at a more disaggregated level than the present series, but it is not possible to publish this microdata, as it would disclose the investments of individual businesses. The current data aggregates these series, both in current and constant prices so that the industrial disaggregation is identical to that in the ONS Supply Use Tables giving a breakdown of 36 industries.

The asset breakdown is: buildings, plant (including purchased software but excluding computers), computers, vehicles and intangibles (excluding purchased software). The five assets expand on the series currently published in the quarterly capital expenditure surveys. Series are disaggregated to the supply-use table level of 36 industries found in the annual capital formation tables. The current price datasets are calculated for 1948 onwards, consistent with published national accounts 2003. The implicit deflator, which is calculated using the current price series and the volume series, is a derived series but for some assets – for example, computers after 1995 – take the value of a published dataset.

To calculate the stock of some assets, such as buildings, several decades of investment in volume terms is necessary. Because the microdata underpinning the PIM is at a very disaggregated level, a constant price (KP) summation is used to calculate the more aggregated KP series in the spreadsheet. It is well known that constant price series are additive only in the years after the base year. Constant price summation is used in almost all areas of the national accounts, so that long time-series of constant price data stretching over several base years can be aggregated taking account of the different prices in which the series have been compiled. Table 1 in ONS (2002) gives the base years and the periods they were used.

The life-lengths assumed in the ONS wealth measures provide the average years that the assets would last for the United Kingdom. To convert these into depreciation rates, the method employed by Oulton and Srinivasan (2003, p. 77) was used for buildings, plant and machinery and vehicles. The US Bureau of Economic Analysis (Fraumeni, 1997) has done considerable work to integrate geometric decay rates into their national income and product accounts, using Hulten and Wykoff's 1981 analysis of second-hand asset prices. In computers and intangibles, the method of double-declining balance is used.

In calculating rentals, the rate-of-return is set such that the total current price capital services equals the whole economy operating surplus less that operating surplus attributable to housing, owner-occupier imputed rent and capital consumption on dwellings. HM Treasury provided the results of their work on tax-subsidy ratios – providing a time-series for each asset.

Indices of capital services

The method used in the calculation of the volume index of capital services is based largely on Oulton and Srinivasan (2003), whose paper provides an excellent analysis of the sensitivity of the index to the assumptions underlying its calculation. The first of the three steps outlined in section 2 was to aggregate the history of investments to provide a net stock. In terms of terminology, the vintage of an investment is the year of purchase of an asset.

The calculation of the net stock uses a geometric PIM.

$$(1)\quad K^i_{a,t} = I^i_{a,t} + (1-\delta^i_{a,t-1})\cdot I^i_{a,t-1} + (1-\delta^i_{a,t-2})^2\cdot I^i_{a,t-2} + \ldots$$

In equation 1, K is the volume of net stock for a particular asset a, in an industry i, t is the year under consideration, I is the investment in a year and δ is the rate of decay for the asset purchased in a particular year. It should be noted that the assumed rate of decay for an industry/asset could vary over vintages.

The rental, r, for an asset is modelled using equation 2, the Hall-Jorgenson equation (Hall and Jorgenson, 1967), where p is the price of the asset, R is a rate-of-return and TS is the tax subsidy ratio, assumed the same across industries.

$$(2)\quad r^i_{a,t} = TS_a\left[\delta^i_a\cdot p^i_{a,t} + R_t\cdot p^i_{a,t-1} - (p^i_{a,t} - p^i_{a,t-1})\right]$$

The rentals are combined with the net capital stocks to give the value-added attributable to the stock of each asset in a particular industry. The value-added shares are used as weights, w, for the VICS. In equation 3, the weights in an industry VICS is defined, though it can be generalised for any aggregate (whole economy for example, or a particular asset).

$$(3)\quad w^i_{a,t} = \frac{r^i_{a,t-1}\cdot K^i_{a,t-1}}{\sum_a r^i_{a,t-1}\cdot K^i_{a,t-1}}$$

The weights can be seen to be base period shares so that a Laspeyres VICS can be calculated, here for a particular industry, i.

$$(4)\quad VICS^i_t = \sum_a w^i_{a,t-1}\cdot\frac{K^i_{a,t}}{K^i_{a,t-1}}$$