

Article

# Experimental estimates of investment in intangible assets in the UK: 2015

Experimental estimates of investment in a broad set of intangible assets.

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Release date:  
7 February 2018

Next release:  
To be announced

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# 1 . Summary

This report provides experimental estimates of investment in intangible assets by the UK market sector. Estimates are based on the framework and approach first developed by Corrado, Hulten and Sichel (2005) and previously applied in the UK by Goodridge, Haskel and Wallis (2014).

Our main findings are:

- current price investment in intangible assets in the UK was £134.2bn in 2015, compared to £141.7bn for investment in tangible assets
- the largest intangible investments were in training (£31.8bn), organisational capital (£24.9bn), software (£20.2bn) and R&D (£19.2bn) in 2015
- industries which invested most in intangible assets relative to tangible assets were professional and scientific activities (M), financial services (K), information and communication (J), and manufacturing (C) in 2015

## 2 . Authors and acknowledgements

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The authors are grateful for the contribution of Dr Peter Goodridge who provided advice on data and methodology and comments on an earlier draft of this article. Any mistakes or omissions remain our own.

## 3 . Introduction

Intangible assets, also known as knowledge assets or intellectual capital, are assets that do not have a physical or financial embodiment. This definition encompasses assets such as software, reputation and branding, design, and research and development which contribute to the long-term accumulation of a firm's knowledge capital. Such assets complement physical (tangible) capital, such as buildings, equipment and machinery, in driving economic growth.

While economists have long recognised the role of tangible capital in production, the importance of intangible capital has grown with the shift from capital-intensive to knowledge-intensive production. Growth in advanced economies is increasingly dependent on innovation and knowledge capital which also drives productivity ([OECD, 2013](#)).

Measuring these assets is an area of growing importance for ONS in its efforts to provide a more complete picture of the UK economy. Recent changes to the UK National Accounts – which capitalised spending on some intangible assets such as Research and Development – have gone some way towards addressing this change in the nature of production<sup>1</sup>. However, there is a growing body of economic literature which has established a measurement framework to capture investment in a broader set of intangible assets which are not currently capitalised in the UK National Accounts.

[Recent evidence](#) for the UK suggests that investment in intangible assets has been greater than tangible investment since the early 2000s and was more resilient during the economic downturn. Empirical work has also examined the [role of intangible assets in explaining the UK's productivity puzzle](#). Current measurement of productivity, based on the narrower, national accounts definitions of capital and labour, may not fully account for variations in the contributions of these assets. Understanding more about intangible assets will help us to better understand the sources of growth.

This article presents updated experimental estimates of investment in intangible assets in the UK's market sector. It builds on the framework and approach first developed by Corrado, Hulten and Sichel (2005) and applied in the UK by Goodridge, Haskel and Wallis (2014)<sup>2</sup>. The first section describes the measurement framework. This is followed by a summary of the methods and data sources used and the results.

The final section outlines future plans for development. We have a programme of work to examine the current coverage and measurement of intangible assets and to identify where improvements could be made. These experimental estimates are the first stage of this work.

### Notes for: Introduction

1. This culminated in the recent reclassification of a number of intangible assets as capital items in the UK National Accounts under the European System of Accounts 2010. Current national accounts according to the SNA 2008/ESA 2010 standard record a range of specific intangibles under the asset category "intellectual property products", namely research and development (R&D), mineral exploration and evaluation, computer software and databases, and entertainment, literary and artistic originals.
2. This project began in 2005/6 funded initially by HMT, later Nesta and IPO. See references for papers.

## 4 . Measurement framework

Intangible assets are typically grouped into three categories, using a widely-cited framework developed by Corrado, Hulten and Sichel (CHS) (2005). These are:

- economic competencies such as firm-specific human capital, organisational know-how, and aspects of advertising and marketing
- innovative property including R&D, artistic originals and designs
- computerised information which include software and databases

Using this framework, we provide estimates for a broad set of intangible assets, as presented in Table 1.

**Table 1: Framework for measuring intangible assets**

Broad category	Type of Intangible Asset	Description (from CHS)	Capitalised in the National Accounts?
Computerised Information	Software and databases	This includes knowledge embedded in computer programmes and computerised databases.	Yes
	Research and development		Yes
	Mineral exploration and evaluation		Yes
Innovative Property	Entertainment, literary and artistic originals	This includes knowledge acquired through scientific research and development, product development and non-scientific inventive and creative activities.	Yes
	Design		No
	Financial product innovation		No
Economic Competencies	Branding		No
	Organisational capital	This includes knowledge embedded in firm-specific human and structural resources, including brand names.	No
	Firm-specific training		No

Source: Office For National Statistics

Some of these assets are already capitalised in the UK National Accounts, in line with international best practice. These are: software and databases; entertainment, literary and artistic originals; mineral exploration and evaluation; and, research and development (R&D). As such, spending on these assets is treated as investment and included within official estimates of Gross Fixed Capital Formation (GFCF).

Spending on other intangibles assets, set out in the CHS (2005) framework described above, is not currently treated as investment in the UK National Accounts. In some cases, this spending is captured as intermediate consumption – spending on goods and services that are used up in the production process, and so do not last longer than a year. Using the CHS framework we treat spending on these intangibles as investment. This would “reclassify” it from intermediate consumption to GFCF, reflecting that spending on long-lived knowledge assets contributes to production over a period longer than a year. In some cases, the framework identifies knowledge asset creation that will not be currently captured within the UK National Accounts as a transaction; this is most often the case with own-account investment, where the estimates imply the production of additional output.

In both cases, the identification of new investment has implications for gross domestic product (GDP). In the case of reclassifying spending from intermediate consumption to GFCF, this increases the gross value added (GVA) of the investing business, which thus raises GDP. With new asset creation, the situation is simply that new output (through output for own final use) is identified with no additional inputs, thus raising GDP.

Given the experimental nature of the estimates presented here and ONS' plans to further develop the methods used in their calculation, the main aim of this work is to stimulate further debate on the importance of intangibles in the UK economy, to provide evidence which will feed into discussions on future international statistical regulations, and to provide inputs for future experimental growth accounting work. ONS has no current plans to incorporate these estimates of investment in intangible assets into the UK National Accounts. Further details of the conceptual framework can be found in CHS (2005) and Goodridge, Haskel and Wallis (2014).

## 5 . Methodology and data sources

The methodology used to estimate intangible investment in this report is consistent with estimates developed by [Goodridge, Haskel and Wallis \(2014\)](#). The measurement approach is designed to be consistent with the UK National Accounts and official measures of output, income and expenditure.

This section presents a brief description of the methodologies and data sources used for each asset. We also highlight the main changes since previous estimates were produced using data to 2014. Further details of the methodology with references can be found in Annex A.

In general, the measurement of investment in these assets can be approached in two ways<sup>1</sup>:

- the value of expenditure, as reported by firms, and as collected by ONS through business surveys
- the sum of costs of production, modelled using information on the wages of the relevant occupations involved in creating the asset, adjusted for the costs of non-labour inputs

Business surveys are generally better able to capture the investment in assets that arise from purchases by firms, and so these data are generally the source for the estimation of investment in the purchased components of intangible assets. The sum of costs approach is generally used for the estimation of the own-account investment components, such as own-account software and own-account design, since these assets are not purchased by firms explicitly, and so are more difficult to capture in business surveys.

## Capitalised intangible assets

The estimates in this paper are based on data from the UK National Accounts for assets already capitalised. These include software and databases (both purchased and own-account), R&D, mineral exploration and evaluation, and entertainment, literary and artistic originals. An overview of the methods and data sources used for each asset is provided in Table 2 below.

**Table 2: Methods and data sources summary by asset, capitalised assets**

Asset	Methods	Updated data sources
Software and databases	Based on survey data for purchased component, and modelled primarily using ASHE data for own-account component.	Gross Fixed Capital Formation (ONS), 2015
R&D	Based on survey data from specialised surveys and detailed modelling. Excludes research and development of original software to avoid double counting. Includes both scientific and non-scientific R&D.	Gross Fixed Capital Formation (ONS), 2015
Mineral exploration and evaluation	Based on survey data.	Gross Fixed Capital Formation (ONS), 2015
Entertainment, literary and artistic originals	Based on estimates by Goodridge (funded by IPO) to 2009.	Gross Fixed Capital Formation (ONS), 2015

Source: Office for National Statistics

The estimates presented here incorporate the latest estimates for [business investment in the UK](#), consistent with the UK National Accounts, Blue Book 2017 edition. This includes several methodological and data changes<sup>2</sup> which affect the investment data series since the estimates were last produced. The main changes are:

- a downward revision to Purchased Software data over the period 1997 to 2015 (around £3.8bn annually), following the correction of an error in the methodology used to calculate purchased software within GFCF which led to some double counting
- revisions to back series for Artistic Originals, due to taking on revised estimates for data in 2009, causing an increase in the level from this point in the series

## Non-capitalised intangible assets

For the non-capitalised assets, a distinction is made between purchased and own-account components. Table 3 provides a summary of methods and data sources used. The own-account component is calculated by a “sum of costs” approach. The purchased component often uses supply and use data on intermediate consumption, or other available data sources.

**Table 3: Methods and data sources summary by asset, non-capitalised assets**

Asset	Methods	Updated data sources
Design	Purchased component based predominantly on Supply and Use expenditure data (Intermediate Consumption and GFCF). Own-account component uses sum of costs approach, modelled using ASHE data.	Supply and Use (ONS), 2015; Annual Business Survey (ONS), 2015; Annual Survey of Hours and Earnings (ASHE) (ONS), 2015
Branding: Advertising and Market Research	Based predominantly on Supply and Use expenditure data (Intermediate Consumption and GFCF).	Supply and Use (ONS), 2015; Annual Business Survey (ONS), 2015
Training	Based on data from multiple waves of the National Employer Skills Survey, extended using Supply and Use data.	UK CES Employer Skills Survey (DfE), 2015; Supply and Use (ONS), 2015
Organisational capital	Purchased component based predominantly on data from the Management Consultancy Association. Own-account component uses sum of costs approach, modelled using ASHE data.	Supply and Use (ONS), 2015; Annual Business Survey (ONS), 2015; ASHE (ONS), 2015
Financial product innovation	Sum of costs approach, modelled using ASHE data.	ASHE (ONS), 2015

Source: Office For National Statistics

As well as using the latest data we have made some methodological changes to the latest estimates. This includes the exclusion of non-scientific R&D as a separate asset, as investment in this type of R&D is already counted in R&D estimates capitalised in the UK National Accounts. This was previously estimated to be roughly an additional £0.5bn per year. There are also some upwards revisions to training and own-account estimates due to changes in methods. These include:

- an increase in estimates for training (around £4bn per year on average) due to the inclusion of health and safety and induction training within the estimates – these had previously been excluded;
- an increase in estimates for own-account organisation capital (around £1bn per year on average) due to refinements to modelling which better reflect the full cost of investment and improve the accuracy of estimates when grossed up to the total population.

## Tangible assets

Updated estimates of investment in tangible assets are also included in the paper for comparison. These include buildings and structures other than dwellings, ICT equipment, other machinery and equipment, cultivated assets and transport equipment. Data are consistent with the UK National Accounts, Blue Book 2017 edition. [The latest data](#) incorporate methodological and data changes which have resulted in some revisions including a large increase in the level of investment in transport equipment from 2013 onwards.

## Notes for: Methodology and data sources

1. In a steady state, it can be assumed that the price of an asset is determined by the sum of its costs, plus a mark up for normal profits of the producer and any taxes. Further, if total supply equates to total demand, then the sum of costs of production will equate to the total value of investment in a period.
2. For further details see Section 3 of the statistical bulletin and article on summary of changes.



## 6 . Intangible investment over time

This section presents results for investment in intangible assets in the UK market sector<sup>1</sup> (excluding public sector and real estate). Estimates are presented in current prices unless otherwise stated.

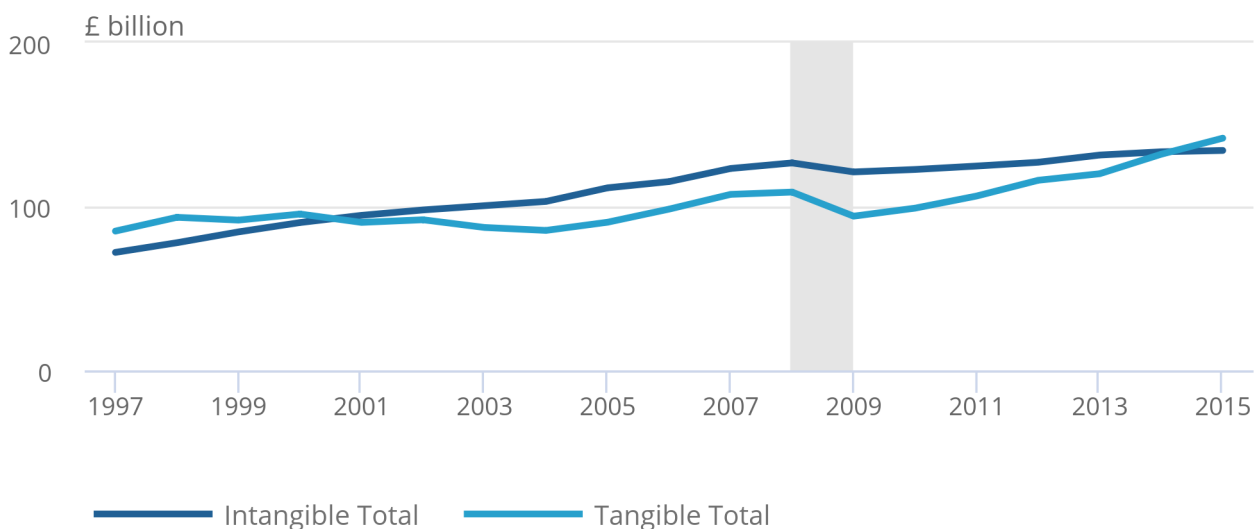
Figure 1 shows current price investment in intangible and tangible assets in the market sector between 1997 and 2015. In 2015 investment in intangible assets was £134.2bn, compared to £141.7bn for investment in tangible assets. This is the first time since 2000 that intangible investment is estimated to have been lower than tangible investment. Intangible investment has grown steadily over the period, falling only slightly during the economic downturn. Tangible investment fell more sharply during the economic downturn, but has since seen a relatively strong recovery.

**Figure: 1 Market sector intangible and tangible investment in current prices**

UK, 1997 to 2015

Figure: 1 Market sector intangible and tangible investment in current prices

UK, 1997 to 2015



Source: Office for National Statistics

Notes:

1. Economic downturn 2008 to 2009.

Figure 2 shows total intangible and tangible investment as a percentage of market sector output (gross value added (MSGVA)) between 1997 and 2015, where output has been adjusted for the capitalisation of additional intangible assets.

In 2015 investment in intangible assets was 10.9% of MSGVA, compared to 11.5% for tangible assets. Intangible investment maintained a steady share of MSGVA from 1997 to 2008, but has since fallen slightly.

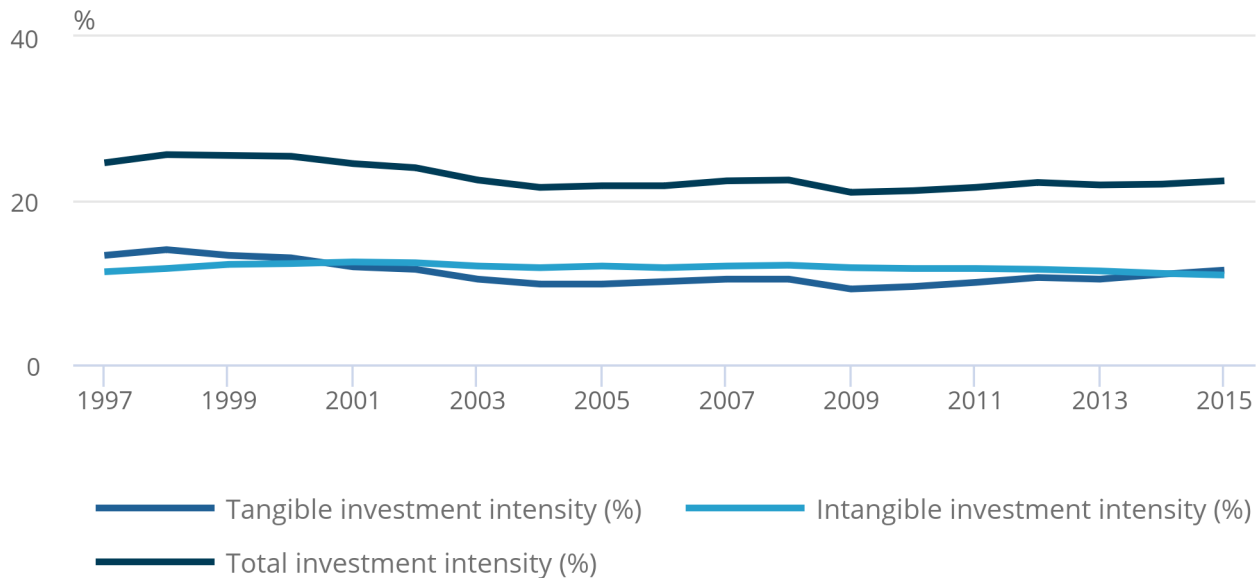
Total investment (intangible and tangible) as a share of MSGVA fell from its 1998 peak when, total investment accounted for 25.6% of total MSGVA, to 21.0% in 2009. Since then total investment has grown steadily to 22.4% in 2015. This is consistent with wider trends in [business investment in the UK](#).

**Figure 2: Market sector intangible and tangible investment as a percentage of (adjusted) market sector output (gross value added)**

UK, 1997 to 2015

Figure 2: Market sector intangible and tangible investment as a percentage of (adjusted) market sector output (gross value added)

UK, 1997 to 2015



Source: Office for National Statistics

These findings are similar to [trends in the US and EU](#). Data up to 2013 show that while tangible investment fell during the economic downturn, intangible investment was relatively resilient. Between 2011 and 2013, both tangible and intangible investments have increased steadily in the US, with tangible investment growing faster than intangibles in 2013. However, compared to the US, intangible investment grew at a slower pace in the EU14 between 2011 and 2013.

### Notes for: Intangible investment over time

1. The definition of the market sector in this article includes sections A to K, M to N and R to T in the Standard Industrial Classification (SIC) 2007. It excludes Real Estate (L), Public Administration and Defence (O), Education (P) and Health and Social Work (Q). Note that this is different to the standard ONS definition which is based on any unit selling at an economically significant price is operating in the market. Not all of P and Q are non-market, and there are non-market parts of other industries. L is excluded due to the future focus on growth accounting.

## 7 . Intangible investment by asset

Table 4 and Figure 3 provide a breakdown of investment in intangibles by asset over time. In 2015 the largest investments were in training (24% of total investment in intangibles), organisational capital (19%), software (both purchased and own-account investments) (15%), and research and development (14%). Mineral exploration and financial product innovation had the smallest proportions of total investment in 2015, together accounting for less than 2% of total intangible investment over this period.

Training and organisational capital are consistently the largest assets invested in over the period. Software has fallen as a percentage of total investment in intangibles (from 19% in 1997 to 15% in 2015) and the share of organisational capital has increased (from 13% to 19%).

**Table 4: Intangible investment by asset, 1997 2007, and 2015, current prices**

Asset	1997		2007		2015	
	£bn	%	£bn	%	£bn	%
Software	13.4	18.7	19.0	15.4	20.2	15.0
Purchased Software	5.6	7.8	7.0	5.7	8.0	6.0
Own-account Software	7.8	10.8	12.0	9.7	12.2	9.1
Mineral Exploration	1.1	1.5	0.8	0.6	0.8	0.6
Artistic Originals	4.6	6.5	5.9	4.8	5.7	4.3
Research and Development	9.7	13.5	16.9	13.7	19.2	14.3
Design	7.9	11	12.6	10.3	14.7	11.0
Purchased Design	5.0	6.9	8.7	7.1	10.3	7.6
Own-account Design	3.0	4.1	3.9	3.2	4.5	3.3
Branding	7.5	10.4	13.2	10.7	15.0	11.2
Organisational Capital	9.5	13.2	20.3	16.5	24.9	18.6
Purchased Organisational Capital	2.3	3.1	5.0	4.1	6.2	4.6
Own-Account Organisational Capital	7.3	10.1	15.3	12.4	18.7	14.0
Training	17.7	24.6	33.2	27	31.8	23.7
Financial Product Innovation	0.4	0.5	1.2	0.9	1.7	1.3
Total	72.0	100	123.2	100	134.2	100

Source: Office for National Statistics

Notes:

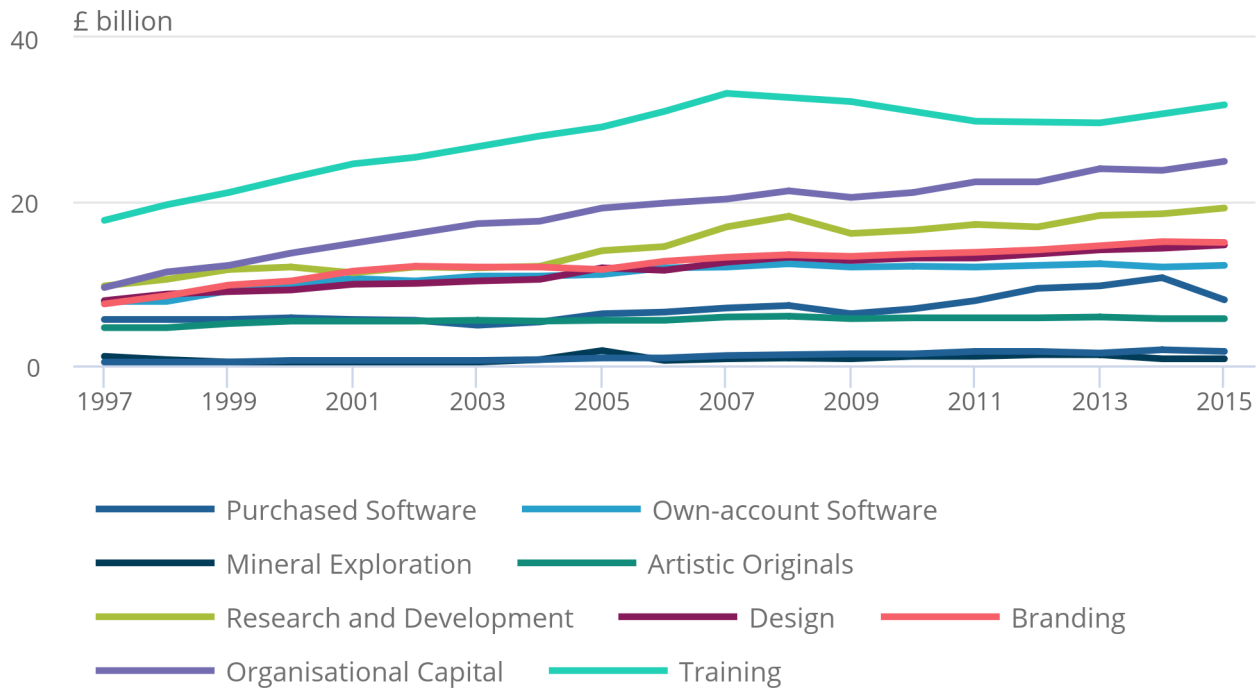
1. Parts may not sum to totals due to rounding.

**Figure 3: Investment by intangible asset, current prices**

UK, 1997 to 2015

Figure 3: Investment by intangible asset, current prices

UK, 1997 to 2015



Source: Office for National Statistics

These estimates suggest that a majority of investment in intangible assets remains to be capitalised, as it lies outside of the current international guidance on the measurement of investment. Table 5 groups intangible assets based on whether or not they are currently capitalised in the UK National Accounts (see Table 1 for more information), and shows the total investment in capitalised and non-capitalised intangibles. It indicates that non-capitalised assets represent approximately two-thirds of total intangible investment in recent years. This means that in 2015, there is an estimated £88.3bn investment in intangible assets in addition to the £45.9bn in assets capitalised in the UK National Accounts.

**Table 5: Capitalised and non-capitalised intangible assets, 1997 to 2015, UK**

Year	Capitalised		Non-capitalised	
	£bn	%	£bn	%
1997	28.9	40.2	43.1	59.8
1998	29.2	37.5	48.7	62.5
1999	31.9	37.8	52.5	62.2
2000	33.6	37.2	56.7	62.8
2001	33.2	35.1	61.4	64.9
2002	33.6	34.3	64.3	65.7
2003	33.6	33.4	66.9	66.6
2004	34.3	33.2	68.8	66.8
2005	38.6	34.7	72.8	65.3
2006	39.0	33.9	76.1	66.1
2007	42.6	34.6	80.6	65.4
2008	44.7	35.3	81.9	64.7
2009	41.0	33.8	80.2	66.2
2010	42.4	34.6	80.2	65.4
2011	43.9	35.2	80.8	64.8
2012	45.6	35.9	81.4	64.1
2013	47.6	36.3	83.8	63.7
2014	47.7	35.8	85.7	64.2
2015	45.9	34.2	88.3	65.8

Source: Office for National  
Statistics

## 8 . Intangible investment by industry

Table 6 provides a breakdown by industry of investment in intangible assets for 2015. For the market sector overall, the ratio of intangible to tangible investment is approximately balanced in 2015 (there is just under £1bn of investment in intangible assets for every £1bn of investment in tangible assets). Industries which invest strongly in intangibles (where more than £1bn is spent on intangible assets for every £1bn spent on tangible assets, illustrated in Table 6) are professional and scientific activities (M), financial services (K), information and communication (J), and manufacturing (C).

Investments in intangible assets by the manufacturing and professional and scientific activities industries are made up largely by investments in Research and development (R&D), accounting for approximately a third of the industry totals over the 1997 to 2015 period. In the case of the financial services industry, a large part of the intangible investment is in organisational capital, driven by a large number of highly paid managers in this industry. The intangible investment of the information and communications industry is largely in entertainment, literary and artistic originals, which make up about 30% of the intangible investment in this industry.

The industries investing most in tangible assets as compared to intangible assets (those with the lowest ratios in Table 6) are electricity, gas and water supply (DE), agriculture, forestry and mining (AB), construction (F) and transportation and storage (H).

**Table 6: Intangible investment by industry, 2015, UK**

Industry	Intangible		Tangible		Intangible to Tangible Ratio
	£bn	%	£bn	%	
Agriculture, forestry and mining.	2.6	1.9	13.5	9.7	0.19:1
Manufacturing	23.4	17.4	12.9	9.2	1.81:1
Electricity, gas and water supply	3.0	2.2	16.7	11.9	0.18:1
Construction	6.8	5.1	22.4	16.0	0.3:1
Wholesale and retail	18.6	13.8	13.5	9.7	1.37:1
Transport	5.7	4.3	18.2	13.0	0.31:1
Accommodation and food services	5.1	3.8	5.7	4.1	0.89:1
Information and communication	17.8	13.3	8.3	5.9	2.16:1
Financial services	16.9	12.6	6.0	4.3	2.82:1
Professional and scientific activities	19.5	14.6	6.8	4.9	2.86:1
Administrative services	8.6	6.4	10.7	7.7	0.8:1
Arts, household and other services	6.2	4.7	5.0	3.6	1.25:1
<b>Total</b>	<b>134.2</b>	<b>100</b>	<b>139.8</b>	<b>100</b>	<b>0.96:1</b>

Source: Office for National Statistics

Notes:

1. Parts may not sum to totals due to rounding.
2. Totals for tangible assets are not the same as estimates for UK market sector due to treatment of suppressed values.

Table 7 splits total intangible investment by capitalised and non-capitalised assets for each industry. Industries which invest comparatively more in intangible assets which are not currently capitalised in the UK National Accounts are Accommodation and food services, Construction and Transport. Nearly two-thirds of intangible investment in Accommodation and Food Services is for Training. In Construction, Training and Design are the main assets (each accounting for around a third of total investment in intangibles). For Transport, investment is mainly in Branding and Training which together account for over half of intangible investment in that industry.

**Table 7: Capitalised and non-capitalised intangible investment by industry, 2015, UK**

Industry	Capitalised		Non-capitalised	
	£bn	%	£bn	%
Agriculture, forestry and mining	1.1	41.4	1.5	58.6
Manufacturing	11.3	48.3	12.1	51.7
Electricity, gas and water supply	1	35.3	1.9	64.7
Construction	0.5	7.6	6.3	92.4
Wholesale and retail	4.4	23.7	14.2	76.3
Transport	1	17.5	4.7	82.5
Accommodation and food services	0.2	4.4	4.9	95.6
Information and communication	10.4	58	7.5	42
Financial services	3.2	19	13.7	81
Professional and scientific activities	9.5	48.6	10	51.4
Administrative services	1.7	19.9	6.9	80.1
Arts, household and other services	1.6	25.8	4.6	74.2
Total	45.9	34.2	88.3	65.8

Source: Office for National Statistics

Notes:

1. Parts may not sum to totals due to rounding.

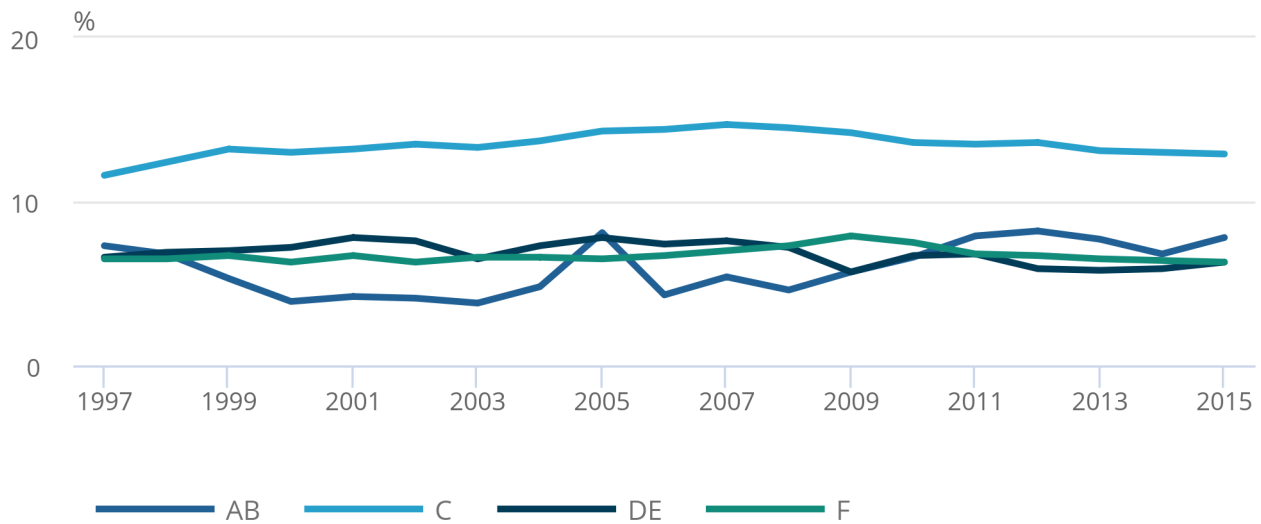
Figures 4 and 5 show total investment in intangibles by industry as a percentage of adjusted industry gross value added (GVA) between 1997 and 2015, for the production industries and for the services industries respectively<sup>1</sup>. Among the Production industries, manufacturing was the most intangible intensive industry on this measure in 2015. Among the services industries, information and communication (16%), professional and scientific services (14%) and financial services (13%) were the most intangible intensive. Information and communication is consistently high across the whole period, as is professional and scientific activities. By contrast, the share in financial services peaks in the early 2000s and then falls back, while there is also fall in the intangible intensity of accommodation and food services since 2010.

**Figure 4: Intangible investment intensity (% adjusted GVA), production industries**

UK, 1997 to 2015

Figure 4: Intangible investment intensity (% adjusted GVA),  
production industries

UK, 1997 to 2015



Source: Office for National Statistics

Notes:

1. AB = Agriculture, forestry and mining; C = Manufacturing; DE = Electricity, gas and water supply; F = Construction.
2. Industry GVA has been adjusted for the capitalisation of all intangible assets.

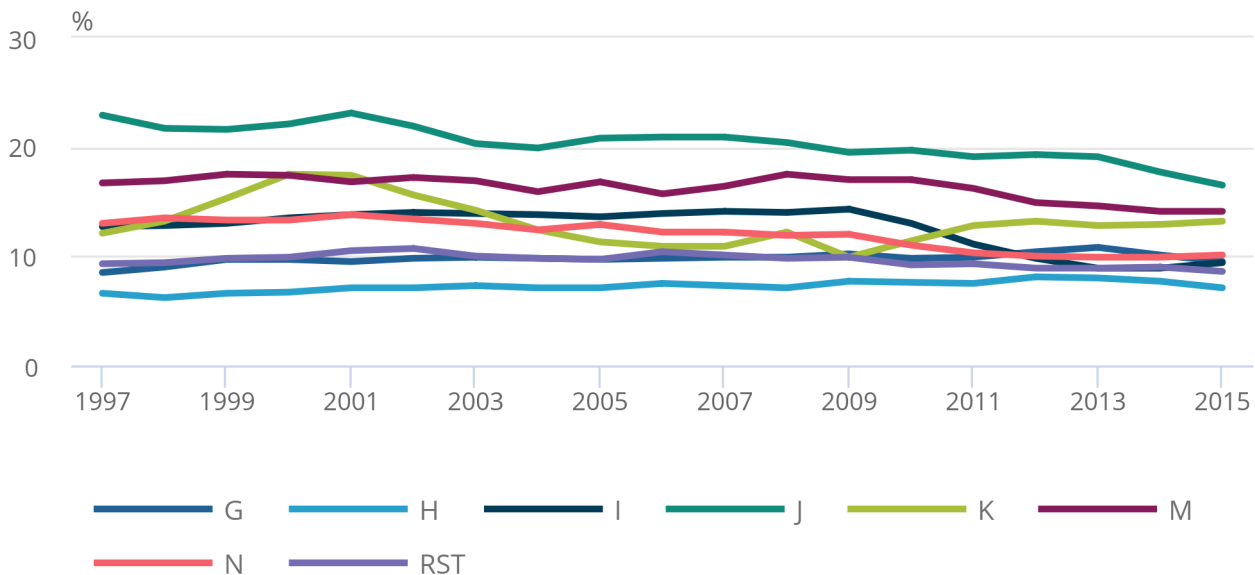


**Figure 5: Intangible investment intensity (% adjusted GVA), services industries**

UK, 1997 to 2015

Figure 5: Intangible investment intensity (% adjusted GVA), services industries

UK, 1997 to 2015



Source: Office for National Statistics

Notes:

1. G = Wholesale and retail; H = Transport; I = Accommodation and food services; J = Information and communication; K = Financial services; M = Professional and scientific activities; N = Administrative services; RST = Arts, households and other services.
2. Industry GVA has been adjusted for the capitalisation of all intangible assets.

## Notes on: Intangible investment by industry

1. As with Figure 2, Industry GVA has been adjusted for the capitalisation of all intangible assets.

## 9 . Further development work

This article provides an updated set of estimates of market sector investment in intangible assets, based on existing methodology developed by Goodridge, Haskel and Wallis. They are presented as experimental estimates which are published to involve users and stakeholders in their development.

We intend to carry out further development work on these estimates. Building on earlier work<sup>1</sup>, some areas for further development have been identified including:

- further research to support the methods and assumptions for calculating own-account design, financial product innovation and organisational capital, this involves research into the fraction of working time spent in occupations who work on them (for example, time spent by managers working on organisational capital) and the additional overheads costs in doing so
- investigation of wider data sources, including better use of data from the Management Consultancy Association on purchases of management consultancy services
- further refinement of the training estimates using micro-data analysis of the National Employer Skills Survey (NESS)
- updating estimates of artistic originals, which were last updated by Goodridge, Haskel and Mitra-Kahn (2012)

This is part of a wider programme of work to examine the coverage and measurement of intangible assets. Earlier work found that there are some differences in the estimates derived using this methodology with those arising from surveys, including the ONS and Nesta Intangible Asset Survey. We will be undertaking further research to understand and reconcile these differences. The [Intangible Assets Survey](#), carried out in 2010 and 2011, investigated a wide set of intangible assets<sup>2</sup>. Some of these estimates were comparable to those from other sources, including the UK Innovation Survey and estimates constructed previously by Goodridge, Haskel and Wallis. However, several components were strikingly different, notably spending on design and organisational capital, indicating further work is needed in these areas.

In addition, ONS intends to expand the analysis to incorporate estimates of intangible investment in a growth accounting framework. This will enable us to analyse the impact on growth and productivity of measuring a broad range of intangible assets. This will require further research on the depreciation rates and prices of intangible assets. It will again build on the approach of Goodridge, Haskel and Wallis (2014) who have presented estimates of the contribution of intangible assets to growth and investigated how this may inform the productivity puzzle.

## Notes for: Further development work

1. See Goodridge, Haskel and Wallis (2016) for a further discussion of the accuracy of intangible investment estimates.
2. Training, design, business improvement, branding, software, and R&D.

## 10 . Annex A – Further information on methods

This Annex provides a summary of the methods and main changes since previous estimates were produced. Further details about methods used previously can be found in [Estimating UK investment in intangible assets and Intellectual Property Rights](#).

### Software and databases

Software and databases are already capitalised in the UK National Accounts (AN.1173). This asset consists of computer programs and supporting materials for both systems and application software, and computerised databases. Total investment in software and databases comprises both purchased and own-account investment. Data on investment in purchased software are collected through business surveys. Own-account data are modelled using a sum-of-costs approach, based on the wage bill of employees in computer software occupations, adjusted downwards for the fraction of time spent creating new software (as opposed to, say, routine maintenance) and then upwards for associated overhead costs.

## Research and development (R&D)

Research and development (R&D) is already capitalised in the UK National Accounts (AN.1171). This is the value of expenditure on creative work to increase the stock of knowledge, which developers can market or use for their own benefit when producing goods and services.

As compared to estimates in previous reports, separate estimates for non-scientific R&D have been removed. Research and development in social sciences and humanities is already captured in the gross domestic expenditure on research and development (GERD) surveys and therefore included in R&D Gross Fixed Capital Formation (GFCF). This is a step forward from the previous method and eliminates a source of double-counting.

## Mineral exploration and evaluation

Mineral exploration and evaluation is already capitalised in the UK National Accounts (AN.1172). This is the value of expenditure on exploration for petroleum and natural gas and for non-petroleum deposits and the subsequent evaluation of the discoveries made.

## Entertainment, literary and artistic originals

Entertainment, literary and artistic originals is already capitalised in the UK National Accounts (AN.1174). This consists of the original films, recordings, manuscripts, tapes and so on, in which drama performances, radio, television programmes, sporting events and other originals are recorded and embodied. The data are based on estimates constructed by Goodridge (2014)<sup>1</sup> which ran up to 2009.

## Architectural and engineering design

Estimates for investment in design include both purchased and own-account components.

Estimates of investment in purchased design are based on intermediate consumption for the relevant product from the supply-and-use tables. Purchases by the industry itself are excluded to avoid double counting (as some of these purchases include outsourcing and subcontracting arrangements).

Own-account design estimates use the own-account software method. Own-account investment in design is the wage bill of architects, engineers (excluding software engineers) and general designers, multiplied by a mark-up for other non-labour costs, multiplied by the fraction of time those occupations spend on building long-term projects.

Data and methods are largely unchanged from those in previous reports, with small changes to better reflect the full cost of investment and improve the accuracy of estimates when grossed up to the total population.

## Financial product innovation

The measurement of investment in the development of new financial products in the financial industry follows the methods used for the measurement of own account software. Investment is measured as the wage bill for economists, statisticians and researchers in the financial industries, multiplied by a mark-up for non-labour costs, multiplied by the fraction of time those occupations spend on creating long-lived financial products. Data and methods are largely unchanged from those in previous reports, with small changes which better reflect the full cost of investment and improve the accuracy of estimates when grossed up to the total population.

## Branding

The method for estimating investment in branding is unchanged from previous reports. Advertising and market research are separately estimated using data on purchases of the relevant products from the supply-and-use tables. As with design, purchases by the industry itself are excluded to avoid double-counting. The method assumes that own-account investment in market research is of approximately the same magnitude as that which is outsourced. The components are combined to form an estimate for branding.

## Organisational capital

Estimates for organisational capital include both purchased and own-account components.

Estimates for purchased organisational capital follow the approach in previous reports. This uses data from the Management Consultancy Association, available for the years 2002 to 2005 and 2009 to 2010. Estimates for other years are interpolated and extrapolated using data on the turnover of the management consultancy industry from the Annual Business Survey. Adjustments are made to include only the creation of long-lived assets.

Own account organisational capital investment estimates follow the own-account software method, using the wages of managerial occupations, and applying capitalisation factors and mark-ups for non-labour costs.

Data and methods are largely unchanged from those in previous reports, with small changes which better reflect the full cost of investment and improve the accuracy of estimates when grossed up to the total population.

## Training

Investment in firm specific human capital (training) is estimated using data from successive waves of the National Employer Skills Survey from 2007 to 2015. The series is interpolated and backcast using the compensation of employees series from the supply-and-use tables.

The main methodological change for this asset is to include the cost of health and safety and induction training in estimated investment. Previously it was only included within the production sector. It has therefore been assumed that such training is long-lived and contributes to production over a period longer than one year, in services industries as well as in production industries.

## Notes for: Annex A – Further information on methods

1. <https://spiral.imperial.ac.uk/handle/10044/1/12918>

## 11 . References

Corrado, Hulten and Sichel (2005), Measuring Capital and Technology: An Expanded Framework

Corrado, Haskel and others (2016), Intangible investment in the EU and US before and since the Great Recession and its contribution to productivity growth

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