

UK INNOVATION INDEX: MEASURING THE CONTRIBUTION OF INNOVATION TO ECONOMIC GROWTH, AND HOW THIS VARIES ACROSS SECTORS

Better innovation metrics are important for sound policymaking

Innovation is more than R&D, yet the measurement of innovation relied for a long time just on R&D metrics. This led to innovation policies that were overly focused on R&D. To overcome this, the UK government asked Nesta to develop a new Innovation Index that captures wider forms of innovation beyond R&D.

This research brief summarises the main findings from the third release of Nesta's Innovation Index, covering the period from 1990 to 2009. The full results are described in the Nesta Working Paper 12/09, *UK Innovation Index: Productivity and Growth in UK Industries*, by Peter Goodridge, Jonathan Haskel and Gavin Wallis, available at Nesta's website (www.nesta.org.uk/workingpapers_wp12-09).

The UK invested £124 billion in intangible assets in 2009, more than in tangible assets

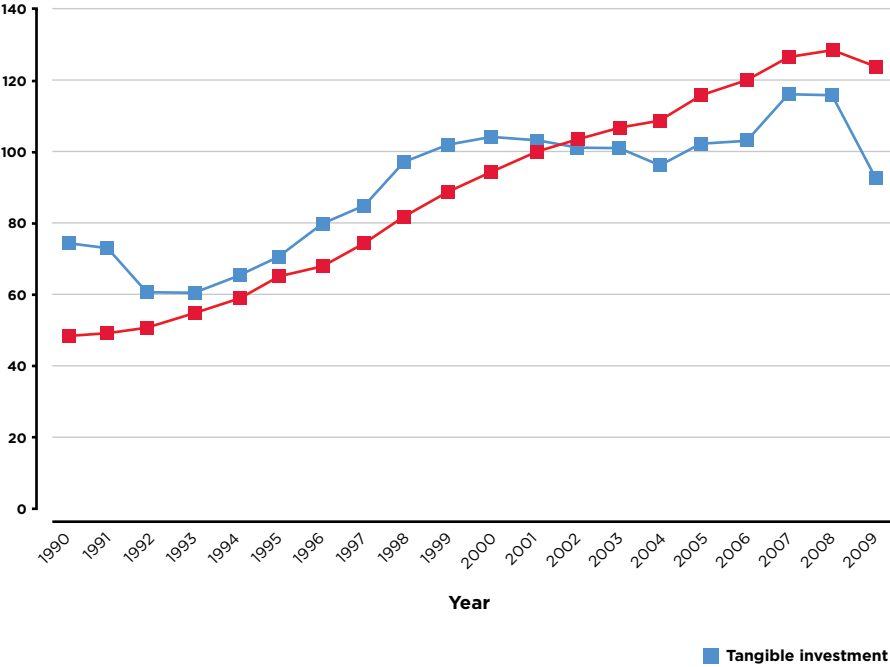
UK investment in intangible assets has been greater than that for tangible assets since the early 2000s. In 2009, investment in intangibles stood at £124 billion, as opposed to £93 billion for tangible investment (which includes physical assets such as machines, equipment and buildings). Respectively, these represent 12 per cent and 9 per cent of gross value added in the private sector (Figure 1).¹

Investment in intangibles fell during the recession, but by less than tangible investment

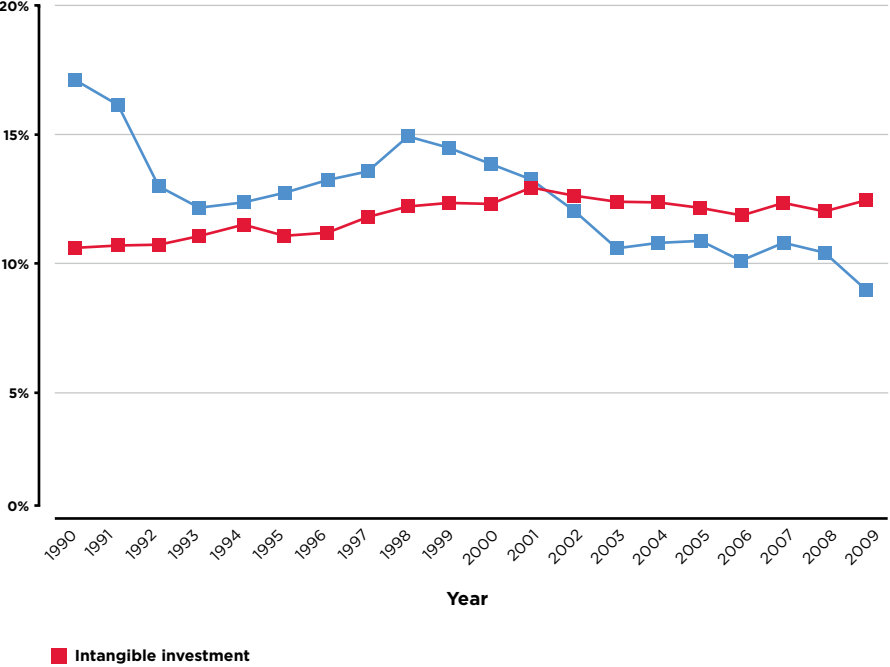
In 2008 and 2009, investment in tangible assets fell sharply, whilst investment in intangibles experienced a much smaller fall.^{2,3} Looking at the full decade reveals a steady decline in UK investment as a share of value added, falling from approximately 27 per cent in 1999 to 21 per cent in 2009 (23 per cent in 2007, prior to the recession). This decline is driven by investment in tangible assets, which declined from almost 15 per cent of value added in 1998 to 9 per cent in 2009 (11 per cent in 2007). Instead, investment in intangibles as a share of value added rose steadily throughout the 1990s, peaking at almost 13 per cent in 2001 and declining very slightly since then to 12 per cent in 2009.

Figure 1: Total investment in intangible and tangible assets in the UK private sector

(a) Current prices, £bn



(b) Share of private sector gross value added



Box 1: The methodology behind the index, and main improvements regarding prior versions

At the heart of the Index is a wider and more complete measure of how much the UK invests in innovation, and what the benefits of this are to productivity. This headline indicator is supported by three complementary tools: an assessment of how favourable a climate the UK provides for innovation based upon available internationally comparable data,⁴ a company-level innovation measurement tool,⁵ and a public sector innovation index.^{6,7}

The Innovation Index uses investment in intangible assets as the main measure of innovation investment. Therefore, the Index measures not only scientific R&D, but the downstream co-investments needed to commercialise and profit from new ideas. Specifically, it includes R&D, design, organisational improvement, training and skills development, software development, advertising and market research, and other knowledge investments (e.g., copyright development and mineral exploration).⁸

A growth accounting approach is then used to estimate the contribution of innovation to productivity growth, in a consistent way with the UK national accounts. Specifically, the contribution of innovation includes two components: (a) the direct contribution of investment in intangibles to productivity growth and (b) Total Factor Productivity (TFP), which is a measure of economic growth not accounted by increases in factor inputs, such as tangible and intangible capital or labour quality, and therefore captures the spill-over benefits of innovation investment, but also short term fluctuations in capital utilisation and measurement error.

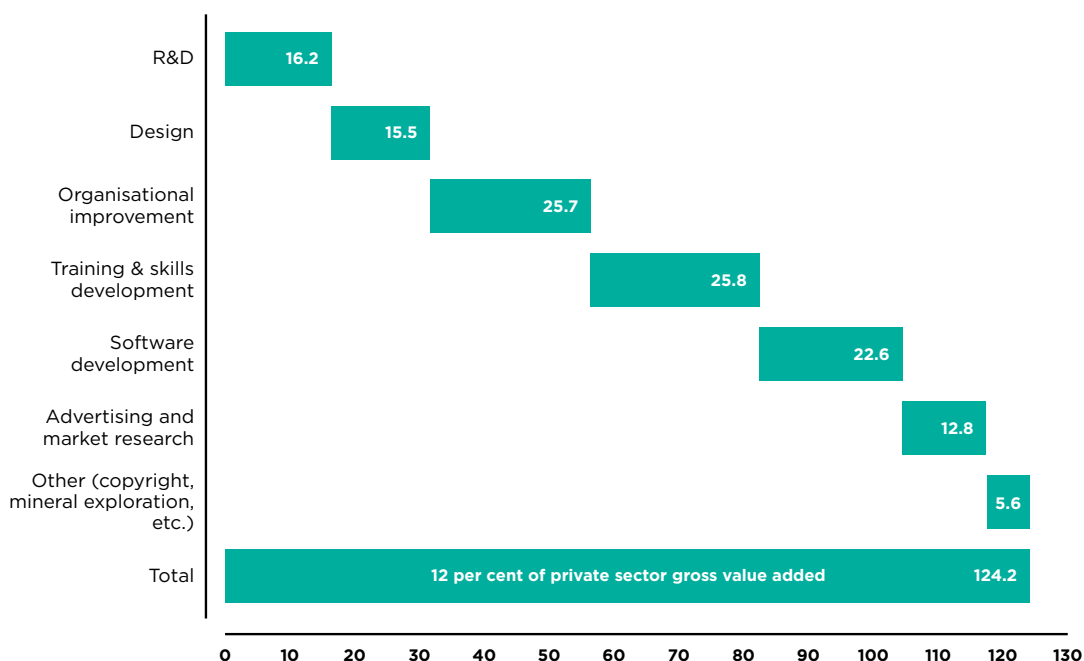
Work has continued to improve the methodology behind the Index since its first publication. Relative to the prior release, these are the main changes introduced in this latest version of the Index:⁹

1. More comprehensive industry-level data, providing industry-level estimates of investment in intangibles, growth accounting decompositions at the industry level and estimates of the contribution of each sector to aggregate productivity growth.
2. Improved estimates of investment in intangibles, building on data from the Nesta-ONS Intangible Assets Survey (IAS),¹⁰ eliminating potential double-counting from outsourced activity, and incorporating new estimates of UK investment in artistic originals.¹¹ Tax adjustment of rental prices has also been incorporated to the growth accounting analysis.
3. Estimates using the most up-to-date official data, the ONS 2011 Blue Book, with data up to 2010 and detailed input-output data up to 2009. EUKLEMS data up to 2007 has also been used in the industry analysis.
4. A wider coverage of the UK private sector, with the new inclusion of the range of consumer, personal and recreational services contained in section 'O'. The private sector data presented here therefore excludes the public sector, private delivery of public services such as education and health, and dwellings (actual and imputed rents).

4 UK INNOVATION INDEX:

Measuring the contribution of innovation to economic growth, and how this varies across sectors

Figure 2: Investment in intangibles by type, £billion, 2009



Note that a wide definition of R&D is used here, which includes scientific R&D (£14bn), non-scientific R&D (£0.8bn) and financial products development (£1.5bn).

R&D represents only 13 per cent of all investment in intangible assets

The private sector only invested £16.2 billion in R&D, approximately an eighth of all investment in intangibles. Training by firms and organisational capital accounted for 21 per cent each, followed by software (18 per cent), design (12 per cent) and advertising and market research (10 per cent), reinforcing the important role of 'hidden innovation'.¹²

Most of intangible investment happens within firms. Specifically, 70 per cent of investment is classified as own account, that is, it is not bought externally in the market.

Manufacturing, finance and personal services are the most intangible-intensive industries

Financial services had the highest intangible intensity in the late 1990s and early 2000s, investing 26 per cent of their value added in intangibles (mostly software) in 2001, but has since fallen back to 15 per cent^{13 14} Manufacturing has the highest intangible-intensity (17 per cent), closely followed by personal services (16 per cent). At the other extreme, agriculture is the least intensive (6 per cent), as seen in Figure 3.

There are also large differences in the composition of investment by sector. Figure 4 reports the ratio of intangible investment relative to tangible investment. Financial services, manufacturing, construction and business services invest between two and three times more in intangible assets than in tangible assets, while at the other end utilities and agriculture and mining invest significantly more in tangible assets (a 1:3 ratio).

5 UK INNOVATION INDEX:

Measuring the contribution of innovation to economic growth, and how this varies across sectors

Figure 3: Investment in intangibles relative to gross value added in the sector, 1997-2007

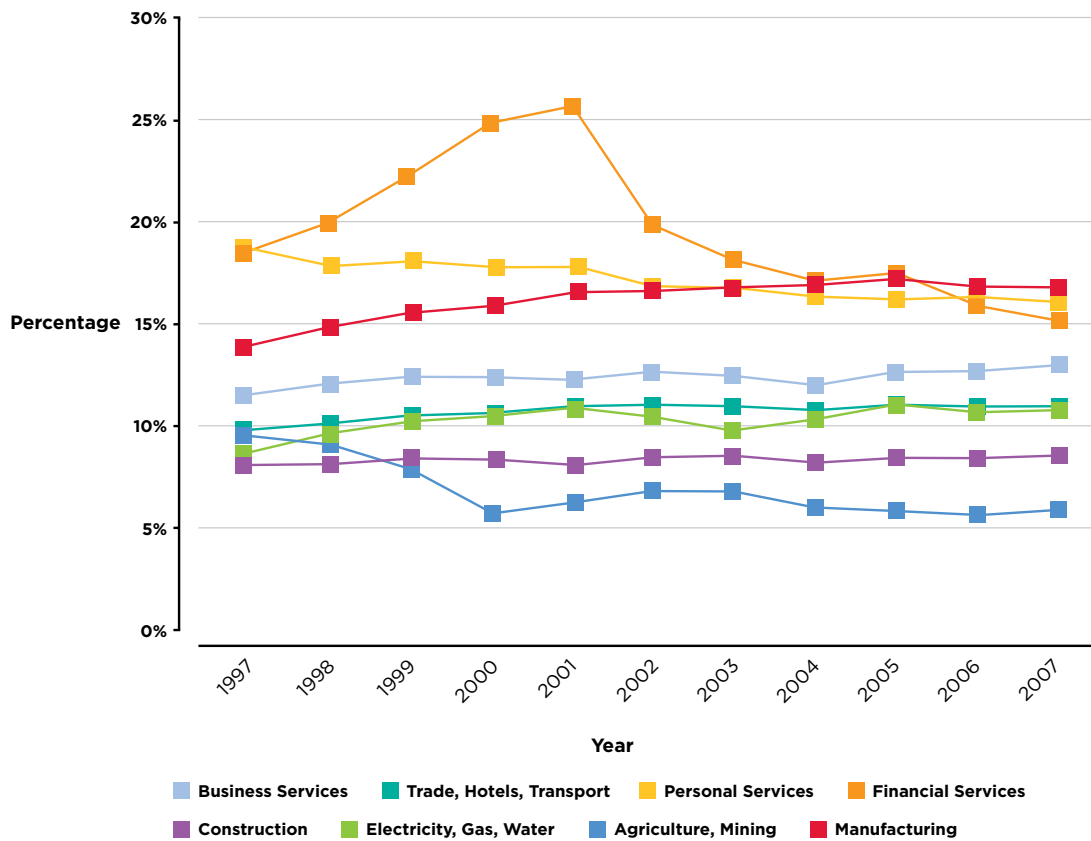


Figure 4: Intangible-tangible investment ratio by sector, 2007

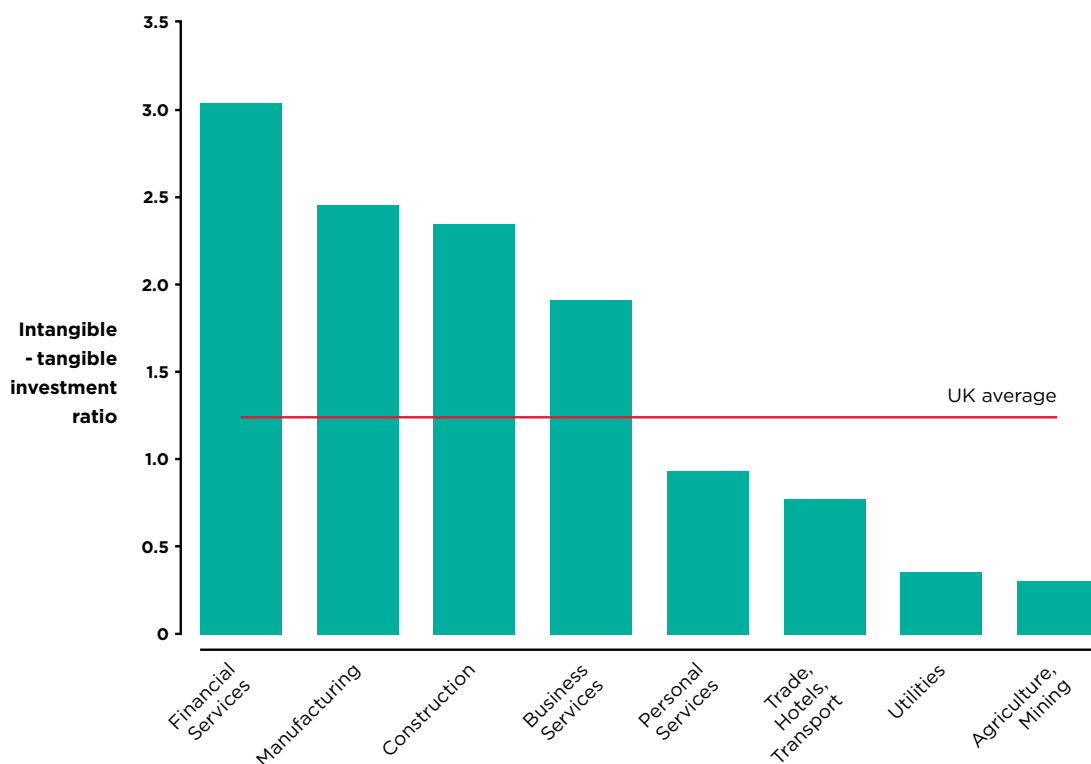
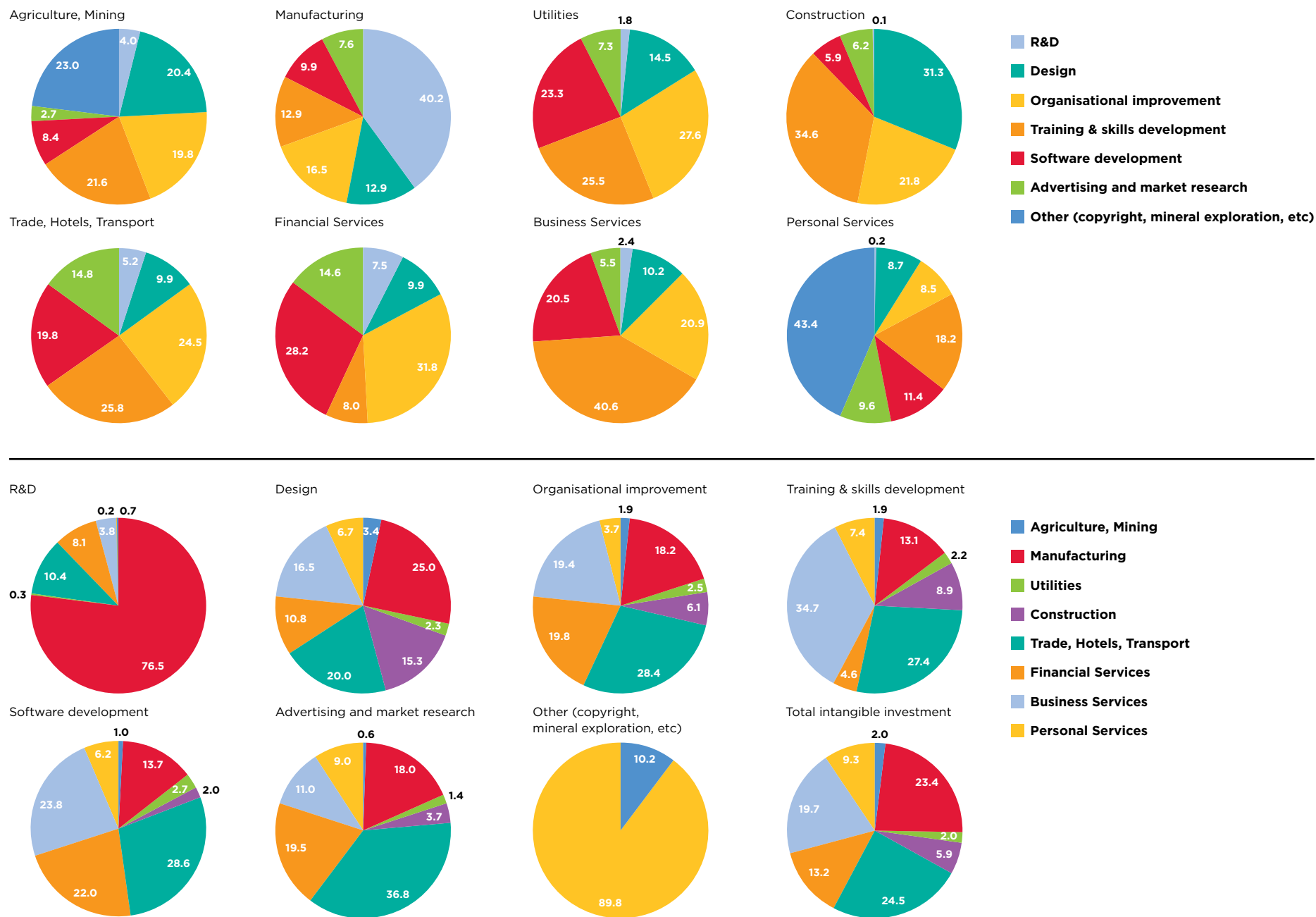


Figure 5: Share of intangible investment by type and sector, 2007



Intangible investment is much more prevalent in services than R&D, and also much less concentrated in a few firms

Manufacturing accounts for more than three-quarters of total R&D investment, while it represents less than a quarter of total intangible investment (Figure 5). Investment in intangible investment is much more widely distributed across the different sectors of the economy. This is why looking at wider measures of innovation such as investment in intangibles can provide a better picture of innovation in services.

For instance, financial services invest disproportionately more in software and organisational capital than the average industry (almost two-thirds of their intangible investment), while business services invest a large amount on training and skills development for their workers (41 per cent of intangible investment in the sector). Construction intangible investment is more focused on both design and training (two-thirds), while investment in intangibles in the trade, hotels and transport sector is more evenly spread across different categories (spending more on advertising and market research than any other sector).

Investment in intangibles makes an important contribution to growth

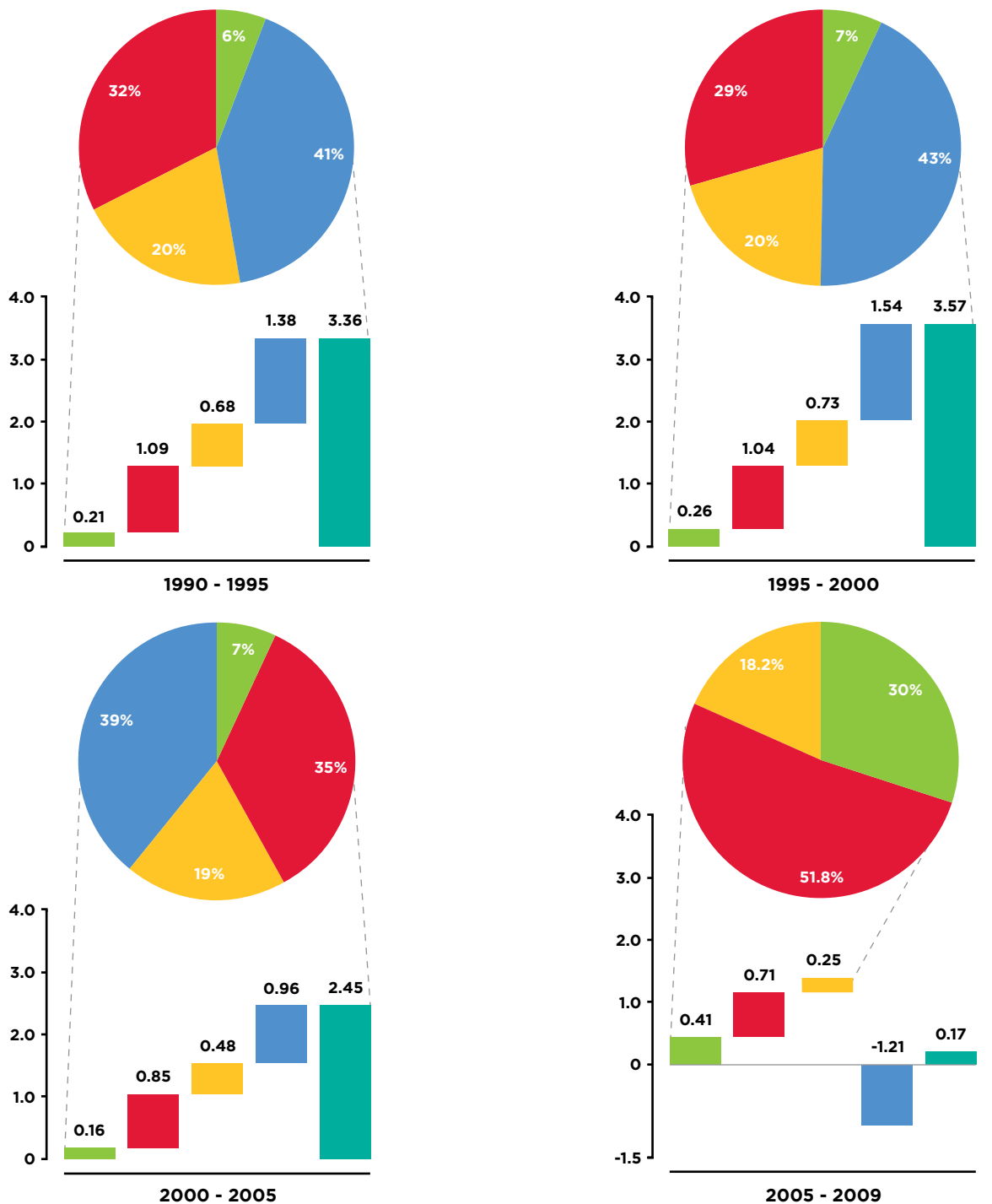
The Innovation Index not only measures investment in intangible assets, but also uses a growth accounting approach to estimate their contribution to labour productivity growth (measured as value added per hour worked).

UK productivity growth slowed down in the early 2000s, even before the outset of the recession. While it averaged 3.5 per cent per annum in 1990–2000, it fell to 2.45 per cent during 2000–05 and 0.17 per cent in 2005–09 (Figure 6).

Intangible investment accounted for a fifth of UK productivity growth between 1990 and 2005, while TFP growth accounted for two-fifths. The remainder is explained by investment in tangible assets (i.e., tangible capital deepening) and improvements in the quality of workers.

A very different picture emerges when considering the latest period, 2005–2009, which coincides with the recession. A collapse in TFP growth, that became negative, brought productivity growth to a virtual standstill (0.17pa). So tangibles, intangibles and labour quality account for larger shares of productivity growth, but with a much smaller overall number.

Figure 6: Average annual labour productivity growth by period and source, 1990-2009



Labour quality Tangibles Intangibles TFP Total (Labour productivity growth)

Figure 7: Average annual labour productivity growth by sector and source, 2000-2007

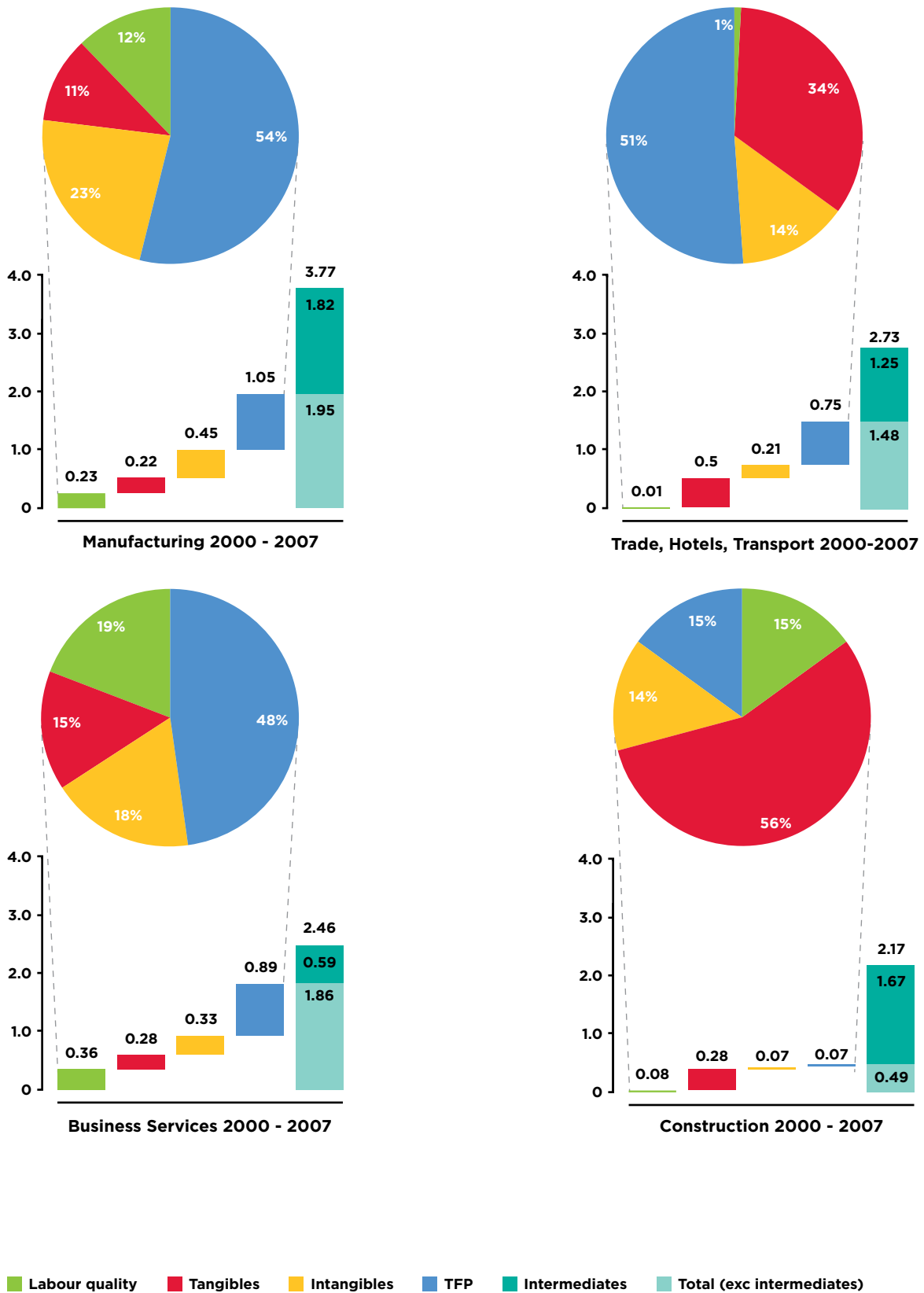
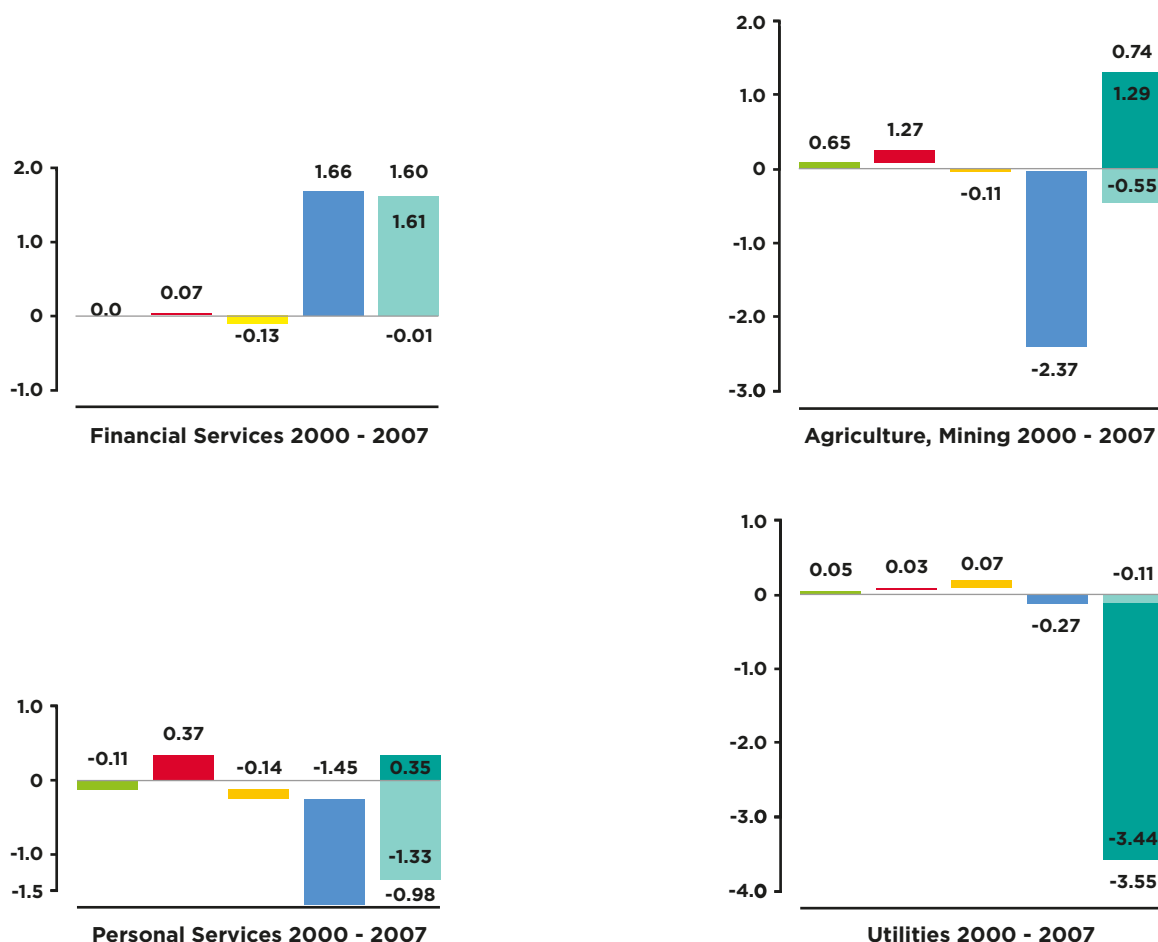


Figure 7 continued: Average annual labour productivity growth by sector and source, 2000-2007

Shares are not represented for these sectors due to the negative contribution of several factors.

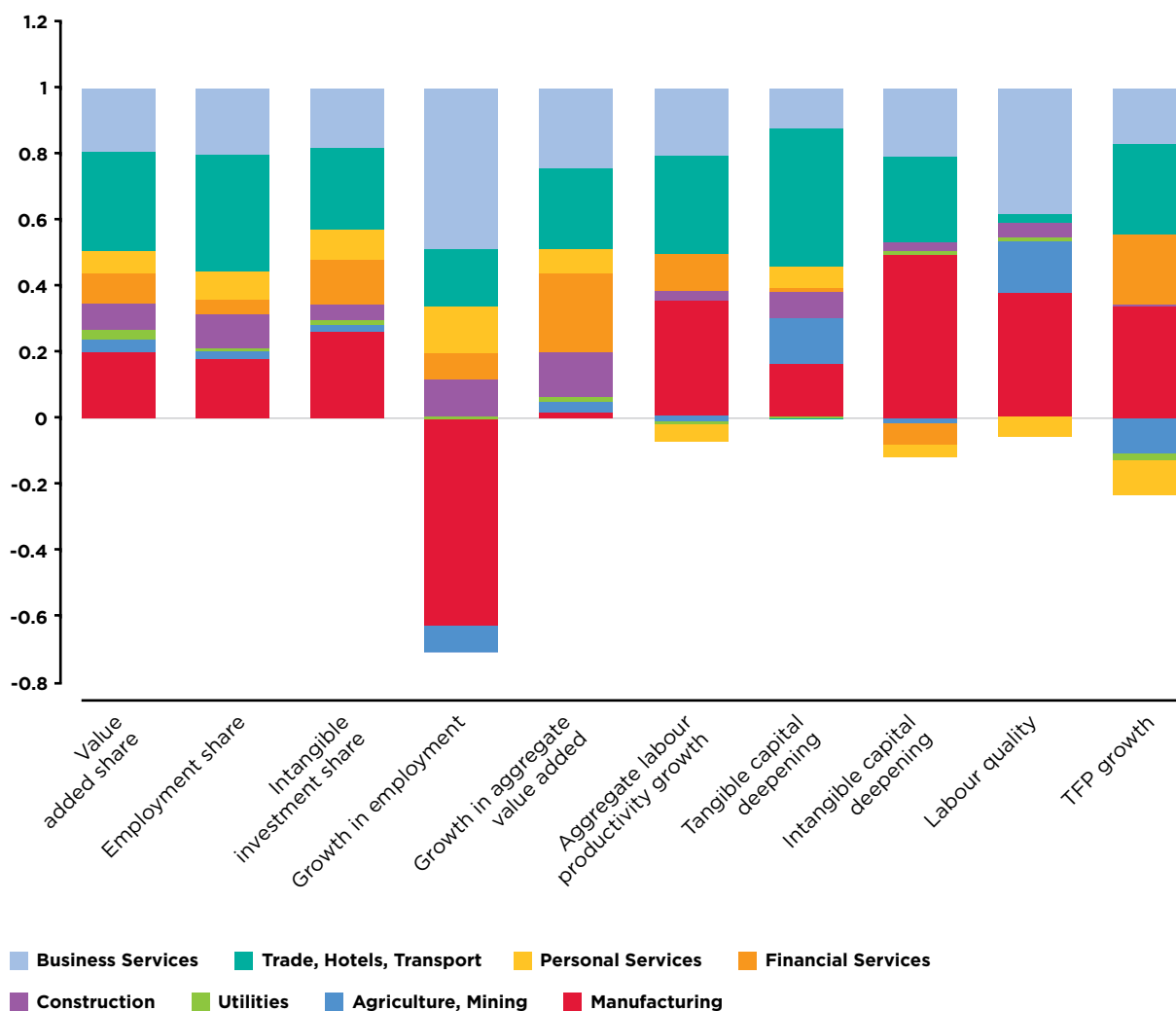
■ Labour quality ■ Tangibles ■ Intangibles ■ TFP ■ Intermediates ■ Total (exc intermediates)

There are large differences in the main contributors to productivity growth across sectors

It is possible, even if more difficult, to undertake the same growth accounting exercise at the industry level, including intangible assets as well (Figure 7).¹⁵ There were significant divergences in productivity growth during the period across different sectors. It was negative in personal services, agriculture and mining and utilities, while it was fastest in manufacturing.

Figure 8: Industry contributions to the UK economy 2000-07

Contribution of each industry to aggregate value added, employment (hours) and intangible investment (2000-07 average) and to employment growth, aggregate value added growth, aggregate labour productivity growth, tangible capital deepening, intangible capital deepening, labour quality composition and TFP growth (2000-07)



Shares relative to the total contribution of all sectors that make a positive contribution to that particular metric (i.e., sectors that make a negative contribution are excluded from the total).

There are also large differences in the sources of growth across sectors. TFP growth accounts for half of productivity growth in manufacturing, trade, hotels and transport, while only for 15 per cent in the construction sector (it even makes a negative contribution for personal services, utilities and agriculture and mining). Differences also emerge when looking at investment in intangibles, which made a large contribution in manufacturing but a negative contribution in financial services. Investment in tangible assets, from ICT to machines to buildings, makes a positive contribution to productivity growth in all sectors, and as expected is disproportionately important in the construction sector.

Finally, if we rank sectors based on the shares of gross output-based labour productivity growth accounted for by intangible spend, improvements in labour composition plus TFP growth, the most innovative sectors on this criteria are financial services, business services and manufacturing.

Manufacturing was the main contributor to UK productivity growth...but with fewer workers

Figure 8 summarises the contribution to the UK economy of each sector during 2000-2007, considering several indicators. The difference matters. Manufacturing accounted for a fifth of the UK's private sector gross value added on average during the period, but made only a very marginal contribution to UK value added growth (less than 2 per cent of UK value added growth during the period is accounted by manufacturing). It also experienced a large fall in employment (more than one job was lost in manufacturing for each two jobs being created in the other sectors of the economy).¹⁶ That meant that manufacturing made a disproportionate contribution to UK labour productivity growth (being responsible for 36 per cent of it). This was driven by investment in intangibles, improved labour quality (better paid and more skilled workers) and faster TFP growth, all of them closely associated with innovation.

Specifically, manufacturing alone accounted for half of intangible capital deepening in the UK private sector (i.e., the direct contribution intangible investment to productivity growth), almost two-fifths of labour quality composition improvements, and more than a third of TFP growth, despite representing only a fifth of UK value added and an even lower (and shrinking) share of employment,

What of the other industries? The other large contributors to intangible capital deepening are trade, hotels and transport and business services, which account for 25 per cent and 21 per cent respectively. Turning to labour quality composition improvements, manufacturing and business services alone account for 76 per cent of it. Finally, on TFP growth, after manufacturing, trade, hotels and transport is responsible for 27 per cent, so that just these two sectors combined account for 61 per cent of UK TFP growth.

The financial sector represents less than 10 per cent of gross value added in the UK private sector, and only 5 per cent of the jobs, yet it accounted for almost a quarter of value added growth and a fifth of TFP growth in the UK private sector.

Summary

This new release of the Innovation Index reinforces the need to look at measures of innovation that go beyond R&D. While this is particularly important for services, the Index also uncovers the disproportionate role that intangible investment plays in manufacturing, highlighting the changing nature of innovation in the sector.

The Index reveals as well the large differences emerging across different sectors over the last decade, in their performance, in the composition of their innovation investment, and in the contributions these have made to productivity growth.

Finally, the Index confirms the important contribution that innovation makes to UK productivity growth. Because of this, over the coming months Nesta will release its key recommendations on how to stimulate innovation and put the UK on the path towards sustainable long term economic growth.

This research summary is based on Nesta Working Paper 12/09: *UK Innovation Index: Productivity and Growth in UK Industries*, by Peter Goodridge, Jonathan Haskel and Gavin Wallis, available at Nesta's website (www.nesta.org.uk/workingpapers_wp12-09).

This summary was written by Albert Bravo-Biosca and Brian MacAulay.

ENDNOTES

1. Specifically, private sector gross value added refers to market sector GVA adjusted for a capitalisation of all intangibles. Note that the incorporation of intangible assets increases GVA, since they are now treated as a form of investment rather than intermediaries.
2. However, intangible assets depreciate significantly faster than tangible assets. Thus a relatively small slowdown in intangible investment turns out to generate the same fall in capital stock as a steep fall in tangible spend, so the changes in resulting capital services are similar.
3. Preliminary estimates based on the 2011 wave of the Nesta-ONS Intangible Assets Survey suggest that investment in intangibles has continued to fall since then, but by less than investment in tangible assets.
4. The initial report was updated and new metrics suggested. See Allman, Edler, Georghiou, Jones, Miles, Omidvar, Ramlogan and Rigby (2011) 'Measuring Wider Framework Conditions for Successful Innovation'. London: NESTA.
5. Roper, Hales, Bryson and Love (2009) 'Measuring Sectoral Innovation Capability in Nine Areas of the UK Economy'. London: NESTA.
6. Hughes, Moore and Kataria (2011) 'Innovation in Public Sector Organisations'. London: NESTA.
7. Note that these three complementary components are not updated regularly.
8. This is based on Corrado, Hulten, and Sichel. (2005) *Measuring Capital and Technology: An Expanded Framework*. In 'Measuring Capital in the New Economy.' Vol. 65 (Eds., Corrado, C. A., Haltiwanger, J. C. and Sichel, D. E.) Chicago: The University of Chicago Press.
9. Note that because of these improvements, the numbers presented here can be different from those reported in prior versions, even if they refer to the same period.
10. Awano, Franklin, Haskel and Kastrinaki (2010) 'Investing in Innovation.' London: NESTA.
11. Goodridge, P. and Haskel, J. (2011) 'Film, Television & Radio, Books, Music and Art: UK Investment in Artistic Originals.' CERIBA working paper. Goodridge, P., Haskel, J. and Mitra Khan, B. 'Updating the value of UK copyright investment.' Newport: Intellectual Property Office.
12. (2007) 'Hidden Innovation'. London: NESTA.
13. Intangible investment in the financial sector continued to grow in nominal terms, but less quickly than gross value added and the price level in the sector.
14. Investment in intangibles at the industry level is only available up to year 2007.
15. This exercise at the industry level requires more data, and therefore it is only undertaken for the period 2000-2007.
16. Note that 'jobs' is used as shorthand for the number of hours worked in the sector.

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