

The Innovation Index

Measuring the UK's investment
in innovation and its effects



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Foreword

Good policy requires sound evidence. The field of innovation is no exception. Robust measures of innovation and the benefits it brings to the UK economy will help guide and improve innovation policy, and make the UK a more prosperous place.

The Innovation Index was designed to meet this challenge. It measures a broad range of innovative activity, from the R&D that lies behind innovative technologies to the service design and organisational innovations that power the UK's service industries. And by linking investment in innovation clearly to productivity improvement, it underscores the central importance of innovation to economic growth.

This report presents the pilot version of the Innovation Index, and is the result of 18 months of work with a group of leading innovation experts, practitioners, policymakers and economists. Over the next year, we will be refining the methodology and extending the scope and detail of the Index.

As always, we welcome your comments.

Jonathan Kestenbaum

Chief Executive, NESTA

November, 2009

NESTA is the National Endowment for Science, Technology and the Arts.

Our aim is to transform the UK's capacity for innovation. We invest in early-stage companies, inform innovation policy and encourage a culture that helps innovation to flourish.

Executive summary

This report presents the pilot version of NESTA's Innovation Index. The aim of the Innovation Index project is to provide a basis for better policymaking about innovation by developing and deploying significantly improved measures of innovation in the UK.

Until now, public debate on the UK's innovation performance has disproportionately focused on the science base and investment in scientific research and development. These factors will remain important to the UK's economy in the future. But the UK's economic success will depend on its ability to commercialise and profit from research and ideas, and to innovate in the service sector and the creative industries. The investments needed to make this happen range from product and service design to developing innovative skills and organisational innovation.

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 national productivity. This headline indicator is supported by two complementary tools: a company-level measure of innovation, which can be used as a measure of the innovation activity of individual sectors; and an assessment of how favourable a climate the UK provides for innovation based upon available internationally comparable data.

The pilot findings of the Index show the scale of innovation investment in the UK: the private sector invested £133 billion in innovation in 2007 (the most recent year for which data are available), or around 14 per cent of private sector Gross Value Added. Over three-quarters of this was in 'hidden innovation' – investment in areas other than traditional research and development. Although international estimates are, in some cases not totally comparable, it seems that the UK invests more in innovation than many developed economies.

This investment in innovation made a significant contribution to the UK's economy. Our interpretation of these results is that innovation was responsible for two-thirds of the UK's private-sector labour productivity

growth between 2000 and 2007, increasing productivity by an average of 1.8 percentage points per year. Again, a significant part of this productivity increase came not from traditional research and development but from other types of investments in innovation, such as design, the development of innovative skills, brand equity and organisational innovation.

The pilot Index also examines the innovative performance of individual firms and sectors, demonstrating a link between innovation and firm growth, and showing how firms in several 'low innovation' sectors as measured by R&D spending in fact undertake significant amounts of innovation. The pilot surveyed 1,500 firms across nine sectors, and provides a methodology to expand this measurement more widely.

Finally, the analysis of the wider conditions for innovation shows that the UK is a relatively good place to innovate, but identifies shortcomings in a few key areas, in particular access to finance, the role of demand (and in particular government procurement) in stimulating innovation, and the availability of appropriate skills. This component of the Index draws together a suite of indicators that can be used to track seven vital conditions for innovation over time. These seven conditions are linked to one another through a straightforward model of how the innovation process occurs, and compared to six other leading economies. (In some areas, available internationally comparable data are more complete than in others.)

The development of the Index is a two-year project; the publication of this pilot version represents a half-way point. The next 12 months will be used for the gathering of more detailed data, the exploration of a number of new analyses and conceptual questions, the incorporation of feedback received on the pilot, and the extension of the Index to incorporate public sector innovation. It is envisaged that the Index will then be refreshed with new data each year, providing an ongoing account of the UK's innovation performance.

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The Innovation Index

Measuring the UK's investment in innovation and its effects

1. The Oslo Manual details a number of non-R&D-based forms of innovation. See OECD (2005) 'Oslo Manual: Proposed Guidelines for Collecting and Interpreting Innovation Data, Third edition.' Paris: OECD.
2. OECD (2002) 'Frascati Manual 2002: Proposed Standard Practice for Surveys on Research and Experimental Development.' Paris: OECD.
3. European Commission (2002) 'More Research for Europe: Towards 3% of GDP.' Brussels: European Commission.
4. See BERR (2008) 'BERR's role in raising productivity: new evidence.' London: BERR.
5. In this respect, NESTA welcomes the attention paid to non-R&D innovation in Innovation Nation, the White Paper in which the intention to develop the Index was expounded. The Innovation Nation White Paper is available at: http://www.dius.gov.uk/reports_and_publications%20HIDDEN/~//media/publications/S/ScienceInnovation_web
6. For the years 2001-2008; these are OECD figures not adjusted for intangibles. 2.0% compared to 1.3% and 1.1% respectively.
7. The UK Innovation Survey (the UK's component of the CIS) has for some years asked about some types of non-R&D innovation, but has not drawn these together into a single number that is compatible with the national accounts.

Better measurement shows the importance of innovation – and helps guide policy

Innovation sits at the heart of debates over economic growth, and encouraging an innovative economy is high on the wish-lists of many governments. NESTA's Innovation Index, the pilot form of which is presented in this report, is a major project to demonstrate the contribution of innovation to economic growth in the UK, and to complement this with a measure of growth at a company level and an assessment of the wider national conditions for innovation.

Measuring innovation effectively is important because policy is affected by how we measure results. Lord Kelvin's adage "if you cannot measure it, you cannot improve it" has an important implication: if something needs to be improved, it must first be measured correctly.

There is a particularly pressing need for good measures in the field of innovation. The most familiar and most widely accepted metrics of innovation still relate to a linear model of innovation based on science and technology and tailored to manufacturing industries. Despite the inclusion of aspects of non-technological innovation in surveys such as the EU's Community Innovation Survey, internationally agreed indicators such as expenditure on research and development (R&D), patent production, and numbers of science and technology graduates still loom large in public debate.¹

This measurement bias has shaped innovation policy. After several decades of measurement of R&D,² many countries have formulated policies to encourage more of it. The Lisbon

European Council set a target that EU member states should spend the equivalent of 3 per cent of GDP on R&D.³ Having identified innovation as one of the five levers of productivity,⁴ and thus part of a key PSA target, the UK government introduced R&D tax credits as a means of increasing it.

NESTA's Innovation Index is an attempt to provide a measurement of innovation that reflects how innovation really happens, and one that can both quantify the importance of innovation and act as a guide to better policy.⁵

The Index – key findings

The improved measures of innovation deployed in the pilot Index have highlighted a number of important phenomena:

The UK invests more heavily in innovation than R&D measures would suggest. Private sector businesses invested £133 billion in innovation in 2007 (the most recent year covered by the Index), representing 14 per cent of private sector output. Although international estimates are not totally consistent, this compares favourably with the data available for countries like France and Germany, and is similar to the US. This may be one reason why the UK has enjoyed higher productivity growth in recent years than France or Germany despite concerns over its investment in R&D.⁶

Most of this investment takes other forms than traditional scientific R&D. Traditionally, R&D expenditure has been used as proxy for innovation investment.⁷ However, R&D represents only 11 per cent of the investment in innovation measured by the Index,

which includes a range of complementary investments needed to commercialise ideas, including product design, training in new skills, organisational innovation, developing new customer offering and brands, and copyright.

The findings of the Index to date show that innovation may be responsible for the lion's share of the UK's productivity growth from 1990-2007. Two-thirds of UK private sector productivity growth between 2000 and 2007 (1.8 percentage points of productivity growth per year) was a result of innovation.⁸ These first three findings on innovation investment and productivity constitute the headline messages of the Index.

Innovation is strongly linked to business growth across a range of sectors. It may come as no surprise that innovative software firms enjoyed a much faster growth rate than non-innovative ones (13 per cent average revenue growth per year compared to just over zero per cent). But this relationship held true even in sectors like legal services, where innovative firms enjoyed average revenue growth of over 10 per cent, while non-innovative firms' revenues shrank on average.

The UK is a relatively good place to innovate, but has some important shortcomings. On the basis of available internationally comparable data, the UK appears to be a mid-table performer when it comes to the wider conditions for innovation compared to other leading economies (including the US, France, Germany, Japan, South Korea, and Finland). Although there is scope to develop these data further, they suggest that the UK performed less well on three important indicators: access to finance, demand for innovation (in particular the use of government procurement to encourage innovation), and skills for innovation.

The Index builds on a range of existing attempts to measure innovation

NESTA is not alone in its desire to improve the measurement of innovation. The Index builds on a wide variety of research that has sought to measure national investment in innovation, how innovative firms are, and the innovation-friendliness of different countries.⁹

The task of defining innovation has been the subject of detailed work, in particular by the OECD in successive versions of the Oslo

Manual.¹⁰ These definitions have expanded over time from a narrow focus on technological product and process innovation to include a much wider range of activities, including marketing and organisational innovations, and to take account of innovation in services and low-technology sectors. A recent definition proposed by the US Advisory Committee on Measuring Innovation in the Twenty-First Century Economy is indicative of this broader definition; it describes innovation as "the design, invention, development and/or implementation of new or altered products, services, processes, systems, organizational structures, or business models for the purpose of creating new value for customers and financial returns for the firm".¹¹

The OECD's definition has played a central role in framing the Community Innovation Survey (CIS). This business-level survey, which has been conducted since 1991 by EU member states and Eurostat, asks businesses across the EU about their innovation activities. Six waves of the CIS have now been completed, providing an increasingly comprehensive view of innovation at the firm level, including product, process, organisational and marketing innovations.

The European Innovation Scoreboard (EIS)¹² further evaluates conditions for innovation at the national level. It is a composite of a large number of indicators used to rank EU countries (and a number of others, including the US) in order of innovation-friendliness. Similar collections of indicators have been developed elsewhere, for example for the State of Massachusetts.¹³

Research has also taken place to address the wider question of the impact of innovation on economic growth, as reflected in GDP. Particularly important to this have been macroeconomists' attempts to measure investment in intangible assets and their impact on economic growth. Intangible assets have been described as investments in knowledge capital, as distinct from physical capital or labour, the two factors of production at the heart of the traditional growth accounting approach which is consistent with national accounts. A way of measuring these investments was set out in 2006.¹⁴ Some early estimates have been made of the levels of intangible investment in developed countries.¹⁵ The exponents of the original research have argued that it offered a way of calculating the effect of innovation on the economy.¹⁶ These approaches are now being developed by the US Bureau of Economic Analysis.¹⁷

8. Based on a combination of the direct benefits of innovation investment captured by firms, plus the broader benefits of innovation as captured by Total Factor Productivity. This methodology is described in more detail later in the report.
9. Smith, K. (2005) Measuring Innovation. In Fagerberg, J., Mowery, D. and Nelson, R. (Eds) 'The Oxford Handbook of Innovation.' Oxford: Oxford University Press.
10. OECD (2005) 'Oslo Manual: Proposed Guidelines for Collecting and Interpreting Innovation Data, Third edition.' Paris: OECD.
11. The Advisory Committee on Measuring Innovation in the 21st Century Economy (2008) 'Innovation Measurement: Tackling the State of Innovation in the American Economy.' A Report to the Secretary of Commerce. Washington, DC: Department of Commerce.
12. See PRO INNO Europe (2008) 'European Innovation Scoreboard 2007: Comparative Analysis Of Innovation Performance.' Available at: www.proinno-europe.eu/admin/uploaded_documents/European_Innovation_Scoreboard_2007.pdf
13. John Adams Innovation Institute (2009) 'Index of the Massachusetts Innovation Economy.' Westborough, MA: John Adams Innovation Institute.
14. Corrado, C.A., Hulten, C.R. and Sichel, D.E. (2006) 'Intangible Capital and Economic Growth.' NBER Working Papers 11948. Cambridge, MA: National Bureau of Economic Research.
15. Barnes, P. and McClure, A. (2009) 'Investments in intangible assets and Australia's productivity growth.' Staff working paper. Melbourne: Australian Government Productivity Division.
16. Corrado, C. (2007) 'Comment submitted to the Advisory Committee on Measuring Innovation in the 21st Century Economy.' Available at: <http://www.innovationmetrics.gov/comments/051107FederalReserveBoard.pdf>
17. Aizcorbe, A., Moylan, C. and Robbins, C. (2009) 'Toward Better Measurement of Innovation and Intangibles.' Bureau of Economic Analysis Briefing. Available at: http://www.bea.gov/scb/pdf/2009/01%20January/0109_innovation.pdf

The initial idea for a UK index to measure innovation was proposed by the DTI Innovation Unit in 1994, but was not implemented. The *Innovation Nation* White Paper of 2008 tasked NESTA with designing an Innovation Index, taking into account a broad definition of innovation. This pilot Index represents the first substantive output of that work.

The pilot Index has three components

The overall aim of the Innovation Index is to offer a significantly better basis for government policy that affects innovation. The pilot Index does this in the following ways:

1. Its most important component is a measure of the amount of investment in innovation in the UK economy, and the effect that this has on economic growth and productivity.
2. Its second component is a tool to understand innovation at the firm level that captures hidden innovation and reflects the different ways that innovation occurs in different sectors.
3. Its third component is a set of metrics that can be tracked to assess how favourable a climate the UK is for innovation.

Finally, it is intended to provide a measure of innovation in the public sector. The measurement of public sector innovation has not been carried out as part of the pilot Index, but will be included in the 2010 version of the Index.

The remainder of this report considers these three components in turn. In each case, the report identifies the work that has been done, the findings of the Index, and what will be done to develop the revised version of the Index.

Component 1: A measure of how much the UK invests in innovation and the economic impact of this

This is the most important and ambitious aim of the Index. The impact of innovation investment on economic growth, and specifically productivity, is of central concern to the Government. It is captured in the productivity Public Service Agreement Target shared by HM Treasury and the Department

for Business, Innovation and Skills, the aim of which is to close the UK's productivity gap with the US, Germany and France. Innovation has been identified as one of the five levers to close this gap, but existing innovation metrics do not relate directly to productivity.

The pilot Index has generated a good working figure for the size of UK investment in innovation from 1990 to 2007, and the contribution this makes to GDP. The next phase of work between now and November 2010 will refine the precise types of investment included, improve the underlying data – partly through primary data collection through a new intangible investments business survey – and provide a further year of data and a replicable process for generating future years' figures.¹⁸

A. What was done

A working definition of innovation investment as investment in new knowledge assets was adopted

The first challenge is defining what investments to count as investments in 'innovation'. Despite the work of the OECD and others to define innovation, existing definitions do not provide a simple distinction between 'innovation-related' and 'non-innovation-related' investments suitable for applying at the level of the national accounts;¹⁹ moreover, with the exception of spending on software, the national accounts do not treat spending on innovation as an investment.

For the purposes of the pilot Index, it was decided to define innovation investments as investments in knowledge, or, as macroeconomists would put it, intangible assets. This means that the Index measures not only scientific research and developments, but the downstream co-investments needed to commercialise and profit from new ideas.

This definition has two advantages:

First, it follows the approach for measuring innovation being considered by the US statistical authorities,²⁰ and therefore increases the chances of obtaining directly comparable data from other innovation measurement exercises. Other developed countries have also undertaken some work to estimate the investment in intangibles, providing initial early points of comparison.

18. This research was led by Professor Jonathan Haskel of Imperial College, London, and Tony Clayton of the Office for National Statistics. A detailed interim report has been published as NESTA (2009) 'Innovation, knowledge spending and productivity growth: interim report for NESTA Innovation Index project.' London: NESTA.

19. CIS data have been used as the basis for micro econometric analysis by BIS and its predecessor departments, by NESTA and by others, but do not read across directly to the national accounts.

20. Aizcorbe, A., Moylan, C. and Robbins, C. (2009) 'Toward Better Measurement of Innovation and Intangibles.' Bureau of Economic Analysis Briefing. See also the position set out in Corrado, C. (2007) 'Comment submitted to the Advisory Committee on Measuring Innovation in the 21st Century Economy.' Available at: <http://www.innovationmetrics.gov/comments/051107FederalReserveBoard.pdf>

Second, it includes a number of investments that relate to important aspects of ‘hidden innovation’,²¹ such as organisational innovation, the investment in skills needed to provide new services, investment in product design, and investment in branding necessary to take an innovative product or service to market. Many of these, such as training and skills development and organisational improvement, are particularly relevant for innovative services businesses, and constitute the bulk of their investment in innovative offerings. Table 1 provides a number of examples of the practical importance of these types of investments to innovative firms and sets out the seven categories into which knowledge investment was divided.

Box 1 gives an example of how these different types of investment come together in practice in the real world to produce a recognisable innovation.

The next phase of the development of the Index will re-examine this definition of innovation and if necessary improve on it.

In particular, NESTA will consider (and invite comments on) whether some measure of innovative tangible capital (such as cutting-edge computers or high-tech machines²²) should be included, how to include knowledge investments by the public sector (such as state-funded training), and whether some aspects of intangible investment should be excluded (in particular, some aspects of training and skills development, and some aspects of brand investment).

The measurement of these has been significantly improved compared with previous estimates

Previous attempts have been made to measure the amount of intangible investment in the UK²³ and in other countries.²⁴ The pilot Index builds on them but goes further by improving the UK data in several ways. First, it developed new estimates of investment in design for the UK, which capture both the design services bought from external providers but also that developed in-house by firms themselves. The latter was achieved by counting the hours spent by employees in a wide range of in-

Table 1: Investment in innovation was divided into seven categories

R&D	R&D is ‘classic’ innovation investment: scientific research and development that produces new knowledge in the form of ideas or products that can be marketed by firms.
Design	Investment in design has been described by some macroeconomists as ‘non-scientific R&D’. These designs may be critical in the innovation process, as they play an important role in new product and service development. This category is also assumed to include those investments aimed at developing new services and financial products.
Organisational improvement	Organisational innovation drives the efficiency and effectiveness of organisations. Investing in this type of knowledge is critical to stay competitive and be able to leverage innovative ideas and commercially exploit them.
Training & skills development	Using our current definition, investment in workforce skills turns out to be the single most important source of investment in the UK. Therefore the investment in training and skills development is critical to the innovative capacity of firms; it is particularly important for service innovations: the most significant investment to realise these may be in human capital.
Software development	Resources invested in developing software and databases creates a valuable asset that prior to the 2007 Blue Book was not treated as such in the UK’s national accounts.
Market research & advertising	Market research is at the front end of innovation: to identify the market potential for new products companies must at the outset anticipate future demand. This category captures other investments made to develop brands in order to take products to market. Both are strategic elements of the innovation process.
Other (Copyright development and mineral exploration)	Investment in new knowledge of exploitable mineral sources and copyrighted ideas both lead to assets that firms can commercially exploit and which are frequently capitalised in firms’ financial accounts. These two apparently dissimilar types of asset are grouped together to reflect the way they are treated in the national accounts, but represent the smallest category of investment measured.

21. NESTA (2007) ‘Hidden Innovation: how innovation happens in six ‘low innovation’ sectors.’ London: NESTA.

22. Following Van Ark, B. and Hulten, C. (2007) ‘Innovation, Intangibles and Economic Growth: Towards a Comprehensive Accounting of the Knowledge Economy.’ Economics Program Working Paper Series. New York: The Conference Board.

23. Notably Giorgio Marrano, M., Haskel, J. and Wallis, G. (2007) ‘Intangible investment and Britain’s productivity.’ Treasury Economic Working Paper No.1. London: HM Treasury.

24. Barnes, P. and McClure, A. (2009) ‘Investments in intangible assets and Australia’s productivity growth.’ Staff working paper. Melbourne: Australian Government Productivity Division.

Box 1: Innovation investment in practice

In the words of one economist: “the average businessperson knows that R&D spending is an investment in the future capacity of the firm. He/she also knows that innovation goes beyond the upstream discovery of new inventions and technologies by scientists and engineers, beyond the creation of new ideas and designs by other workers, and beyond the turning of those inventions and ideas into new products and services. Inventions, ideas, new products, and new services are worthless without a downstream process that turns them into something that convinces people and firms to become customers.”²⁵

The seven types of investment in innovation described above can all be seen at work in practical business innovations. Consider, for example, the development by Bird’s Eye in the early part of the decade of a range of innovative frozen ready meals, the ‘Steam Fresh’ range, which could be steamed from frozen and which commanded a price premium in the otherwise commoditised frozen food market. Bird’s Eye’s investments to develop this product included, but went far beyond,

activities we would recognise as R&D.

In addition to food-science R&D, their investment included design (the product relied on innovative packaging to work properly) and a significant outlay on branding and marketing (both to demonstrate the need for the product in the first place and to make the case to retailers and consumers that it justified a price premium).

Service industries often rely heavily on investments in training and organisational improvement when they innovate. Retail banking innovation, such as the deployment of online banking, for example, typically involves a combination of software investments to process the new service, organisational improvement to support it, and training investments to ensure that staff are able to deliver it.

Copyright is a particularly important investment for creative businesses, while investment in mineral exploration typically distinguishes more innovative oil and gas firms from less innovative competitors.²⁶

25. Corrado, C. (2007) ‘Comment submitted to the Advisory Committee on Measuring Innovation in the 21st Century Economy.’ Available at: <http://www.innovationmetrics.gov/comments/051107FederalReserveBoard.pdf>
26. NESTA (2007) ‘Hidden Innovation: how innovation happens in six ‘low innovation’ sectors.’ London: NESTA.
27. This research was conducted by Professor Stephen Roper of Warwick Business School and Professor Jim Love of Aston Business School, and is published separately as ‘Measuring sectoral innovation capability in nine areas of the UK economy.’
28. See Barnett, D. (2009) ‘UK Intangible Investment: Evidence from the Innovation Index Survey.’ London: CeRIBA.
29. The Blue Book is the annual publication of ONS National Accounts.
30. R&D expenditure data were derived from the BERD survey. To avoid double counting of R&D and software investment, the R&D expenditure in the computer and related activities sector was subtracted from R&D in the financial sector.

house design activities, from new engineering designs to the development of new financial instruments. Second, we collected new primary data²⁷ that were used to test the robustness of the estimates for the different types of investment in innovation, with the result that the measures produced are more reliable.²⁸ And last, but not least, we updated all the measures up to 2007, the latest year for which national accounts data are available.²⁹

The quality of data will be further improved in time for the revised Index report in 2010 through the use of a detailed survey on investment into innovative assets by UK firms.

A growth accounting approach was used to understand the effect of these on productivity growth

The impact of these investments on productivity growth was then determined using the same growth accounting approach used to generate the national accounts. This provides a clear indication of the potential contribution of

innovation investments to labour productivity growth.

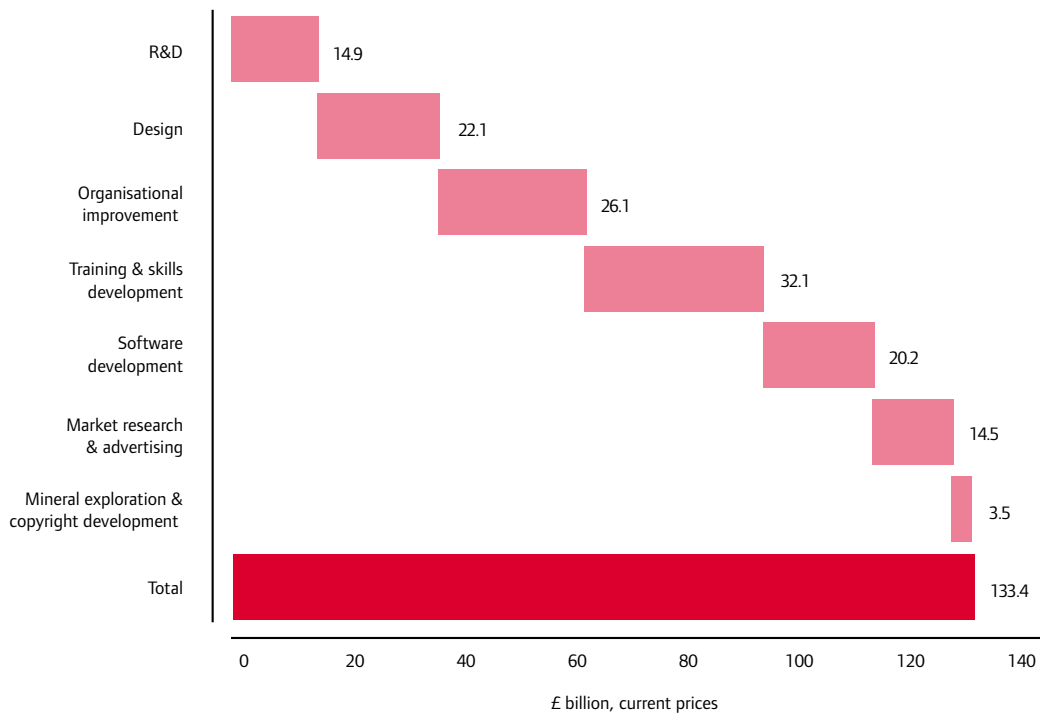
B. Findings

The UK private sector invested approximately 14 per cent of private sector GVA in innovation in 2007

Figure 1 shows investment in innovation by the UK private sector in 2007, the most recent year for which the Index generated results. It is notable that investment in R&D is significantly lower than other types of investment in innovation.

The breakdown of investment in innovation shows that that R&D is only the fifth largest category of innovation investment, at 11 per cent of the total.³⁰ UK firms invest most of their knowledge capital in training the workforce: training makes up a quarter of all innovation investment as currently defined.

Figure 1: Investment in innovation, (£ billion), 2007



Organisational improvements represent the second largest share of innovative investment in the UK. Together with investment in training, this investment in ‘economic competencies’ makes up almost half of the total investment in innovation. Investment in design, ranging from architectural and engineering to the design of new financial instruments, is the third largest share of innovation investment, reflecting the importance design plays in product and service development.

After losing importance after the end of the dot.com boom, investment in software has been accelerating since and is a key factor for the innovativeness of UK firms. UK firms invest as much in market research and advertising as they do on R&D. This is significant because this is the ‘strategic’ element of innovation – to determine the need for new products and services and exploit them commercially. Neither mineral exploration nor measured copyright investments play a quantitatively significant role for the knowledge investments of the majority UK firms, but it is worth noting that the measurement of copyright investments is particularly poor in existing sources, and one aim of the next version of the Index will be to improve this.

These data are available for the time period 1990–2007, showing the changes in the different types of innovation investment over time. Since 1990, there have been considerable shifts in the importance of different types of investment in innovation. The largest share, investment in training, has grown steadily since the mid 1990s, although its pace has slowed more recently. Perhaps partly as a result of the Government’s R&D tax credits, investment in R&D has seen a marked increase since 2004, after declining through much of the 1990s. While the end of the 1990s saw a significant acceleration of investments in software, its share of market GVA has since been declining and only recently shown growth. Following growth throughout the 1990s, investments in organisational capacity, brand equity and design have all stalled and declined as a share of market GVA in the last five years.

In total, investment in innovation has outpaced investment in physical capital and in 2007 stood at 14.1 per cent of market GVA. The end of the dot.com boom saw investment in physical assets declining, while total investment in intangible assets continued to grow (albeit at a slower pace). From 2006 to 2007, the share of intangible assets has decreased

Figure 2: Investment by type of intangible asset as a share of Market Sector Gross Value Added

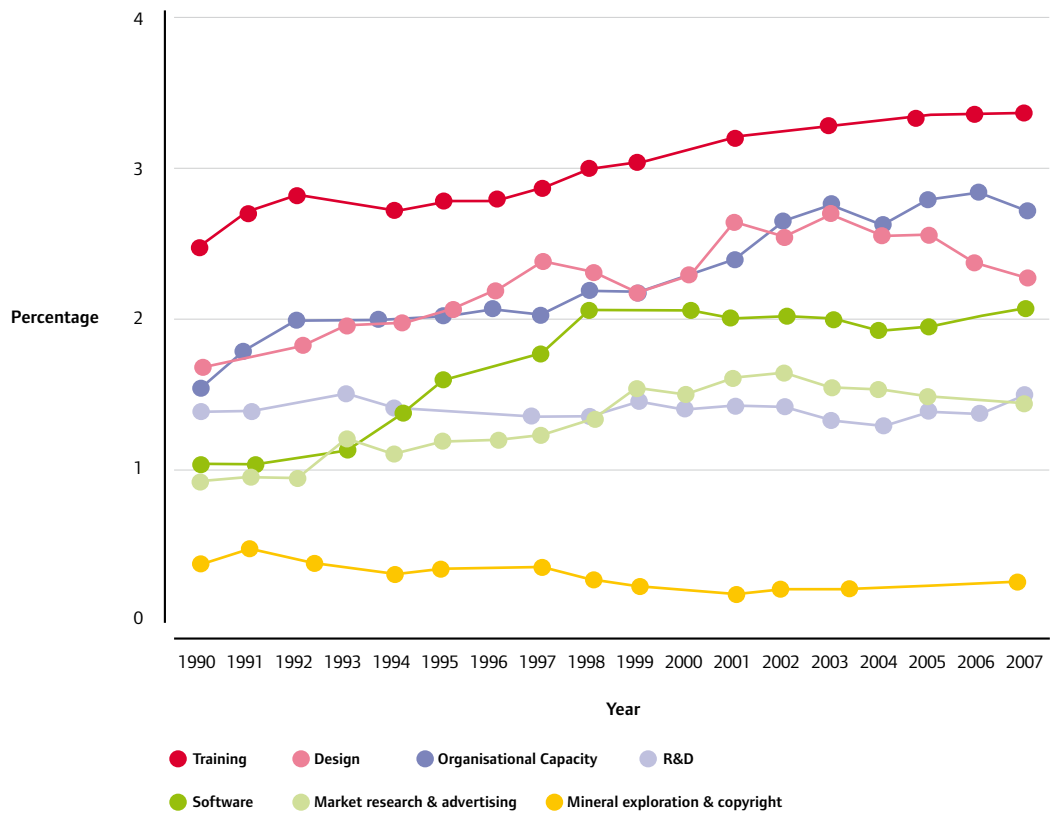
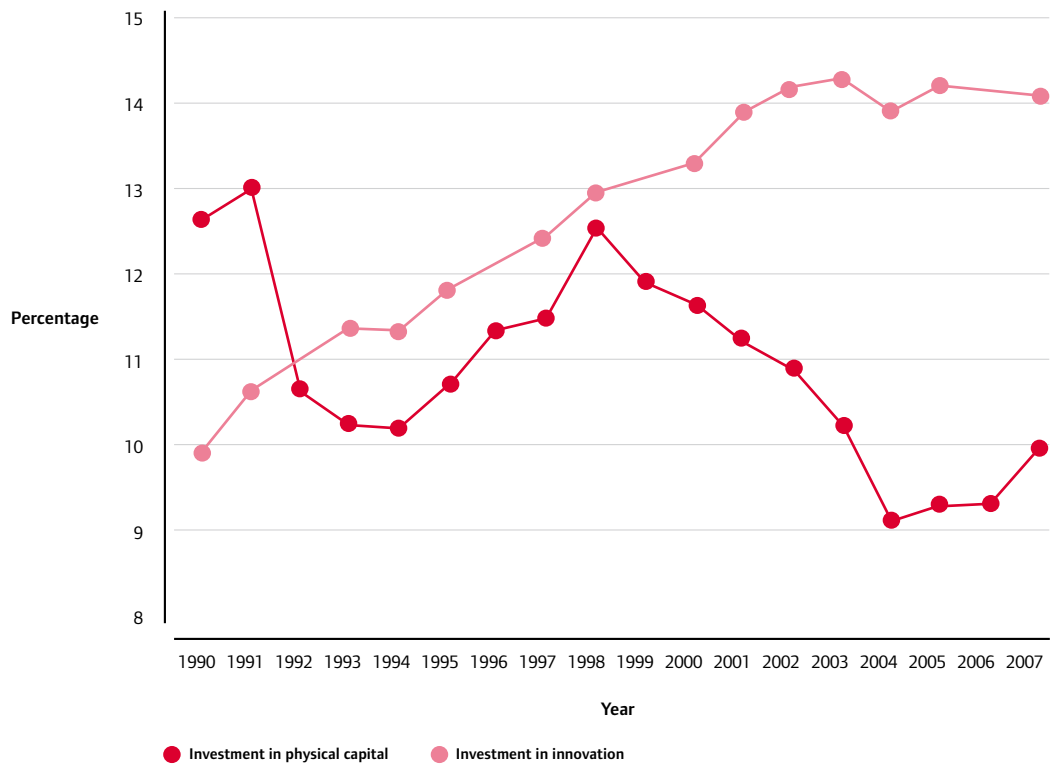


Figure 3: Investment in innovation compared to investment in capital as a share of Market Sector Gross Value Added 1990-2007



slightly, while the share of physical assets grew significantly.

Internationally, as is well known, the UK appears to under-invest in R&D, although this may in part be a product of the UK's industrial structure.³¹ However, if the full range of investment in innovation is taken into account, international studies surveyed by Barnes and McClure suggest that the UK compares more favourably. It is important to note that the figures reported by Barnes and McClure should be interpreted with great care, since they have not been gathered on a consistent basis and were not based on the same analysis as the UK figures presented in this report. It is possible that this relatively strong investment in innovation could be a cause of the higher

rates of labour productivity growth enjoyed by the UK over the past five years, and may be an endorsement of a policy focus on innovation.

This investment was responsible for two-thirds of productivity growth

The Index also identifies the contribution that innovation made to productivity growth in the period. The contribution of innovation was taken to be the sum of two elements.

- The first of these is the direct contribution of the investments in innovation described above. This represents the value created by innovation investments that is captured by the businesses that make the investments, or the so-called 'private' benefits of innovation investment.

Figure 4a: International comparison of R&D as a share of GDP 2007

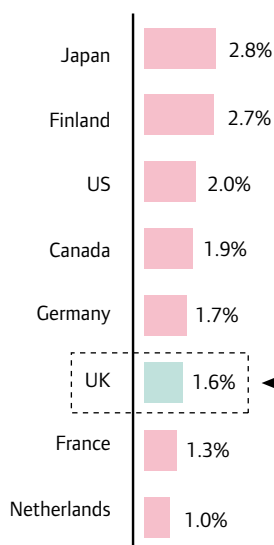
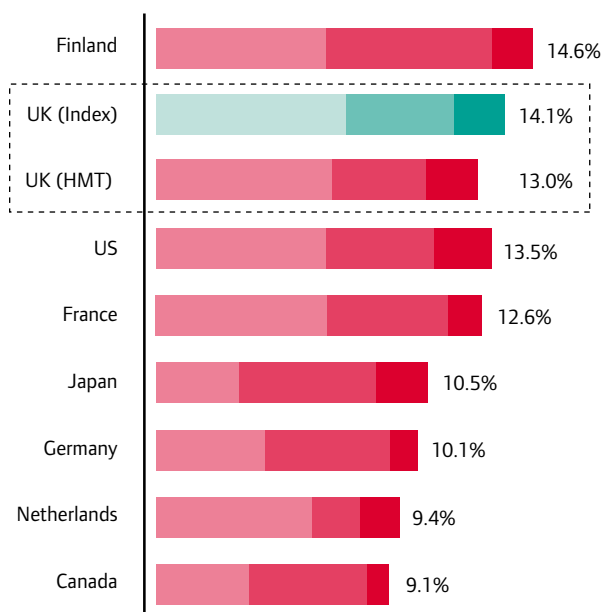


Figure 4b: International comparison of investment in innovation as a share of Market Sector Gross Value Added



- Software development
- Traditional innovation – includes R&D, design, mineral exploration and copyright development
- Hidden innovation – includes training & skills development, organisational improvement, market research and advertising

Note: Comparisons between countries in figure 4b should be interpreted with caution. The chart shows investment in innovation as a share of the adjusted output (including investment in intangibles) of the sectors for which intangibles are measured. These differ for different countries. In the case of the UK, France and Germany this is the market sector; for the US the data cover the non-farm business sector; for Finland it covers the non-financial business sector economy while for Japan, the Netherlands and Canada output relates to the whole economy. UK output data are for 2007³² and 2004,³³ US 1998-2000, Japan 2000-2005, Netherlands, Canada and Finland 2005, France and Germany 2004.³⁴

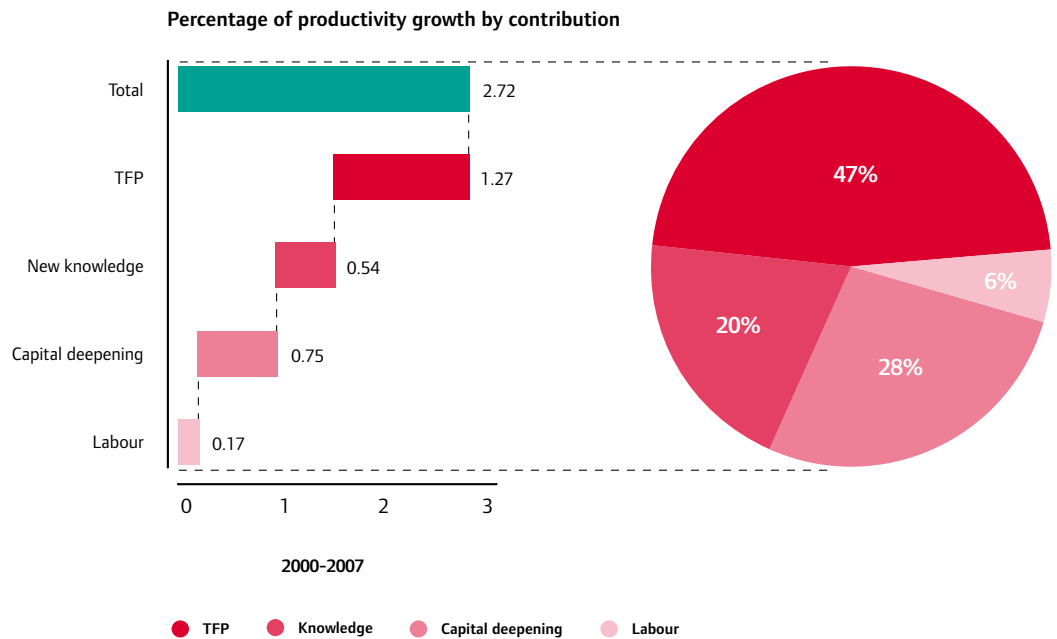
31. DTI (2005) 'R&D Intensive Businesses in the UK.' DTI Economics Paper No. 11. London: DTI. Available at: <http://www.berr.gov.uk/files/file9656.pdf>

32. NESTA (2009) 'Innovation, knowledge spending and productivity growth: interim report for NESTA Innovation Index project.' London: NESTA.

33. Notably Giorgio Marrano, M., Haskel, J. and Wallis, G. (2007) 'Intangible investment and Britain's productivity.' Treasury Economic Working Paper No.1. London: HM Treasury.

34. Barnes, P. and McClure, A. (2009) 'Investments in intangible assets and Australia's productivity growth.' Staff working paper. Melbourne: Australian Government Productivity Division.

Figure 5: Productivity growth by contribution (%) 2000-2007



35. Ishaq Nadiri, M. (1993) 'Innovations and Technological Spillovers.' NBER Working Paper 4423. Cambridge, MA: National Bureau of Economic Research; see also Jones, C.I., Williams, J.C. (1998) 'Measuring the Social Return to R&D.' *Quarterly Journal of Economics*, November 1998, Vol. 113, No. 4, pp.1119-1135; and Griliches, Z. (1992) 'The Search for R&D Spillovers.' *The Scandinavian Journal of Economics*, Vol. 94, Supplement. Proceedings of a Symposium on Productivity Concepts and Measurement Problems: Welfare, Quality and Productivity in the Service Industries, pp.529-547.

- The second component is what macroeconomists describe as Total Factor Productivity (TFP). This is the measure of productivity growth that is not accounted for by the growth in factor inputs, such as physical capital or labour quality, and is generally attributed to better ways of doing things, including the broader benefits of technological advances and improved processes. In the approach used in the Innovation Index, in which the private benefits of investments such as R&D are captured separately, TFP includes the spillover benefits of innovation investment.

This methodology shows that between 2000 and 2007, labour productivity grew at an annual average of 2.7 per cent per year. Innovation contributed 1.8 per cent, or approximately two-thirds of the growth experienced.

Figure 7 shows the impact of different types of innovation investment on productivity.

Decomposing the contribution of individual components of innovation investment reaffirms the importance of investment in economic competencies of training and organisational improvement, which between them contributed 0.26 percentage points to labour productivity growth between 2000 and

2007. While the contribution of R&D has been steady over the entire period since 1990, the contribution of software development peaked at a high level in the late 90s, and has since declined significantly. It is important to note the overwhelming importance of TFP, which includes the spillovers from other innovation investments, for example R&D. Even though the direct contribution of R&D to productivity growth appears to be modest in the 17 years analysed, this overlooks the potentially significant benefits of R&D spillovers (which some research has suggested is more than double the private benefit of R&D).³⁵

C. Next steps

The next phase of the Index will involve a survey of UK firms, administered by ONS, to understand in more detail their investment in innovation. This new intangible investments business survey will allow the estimates of investment in innovation to be considerably refined and will be of considerable interest not just nationally but internationally.

In addition, the definition of innovation will be refined; the questions of whether to include investments in innovative physical capital (and if so, how) and whether to exclude some types

Figure 6: Average labour productivity increase per year, percentage

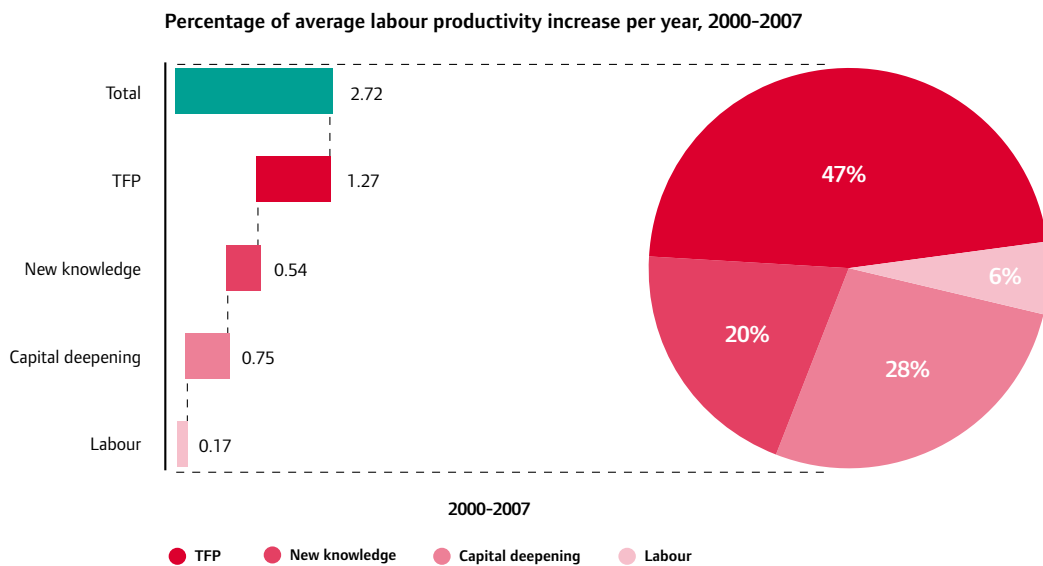
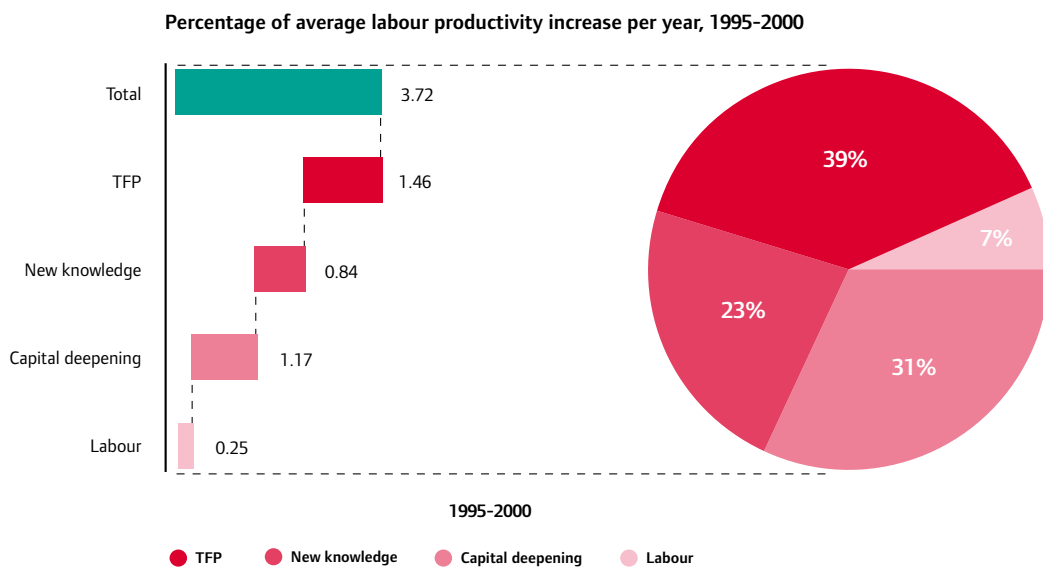
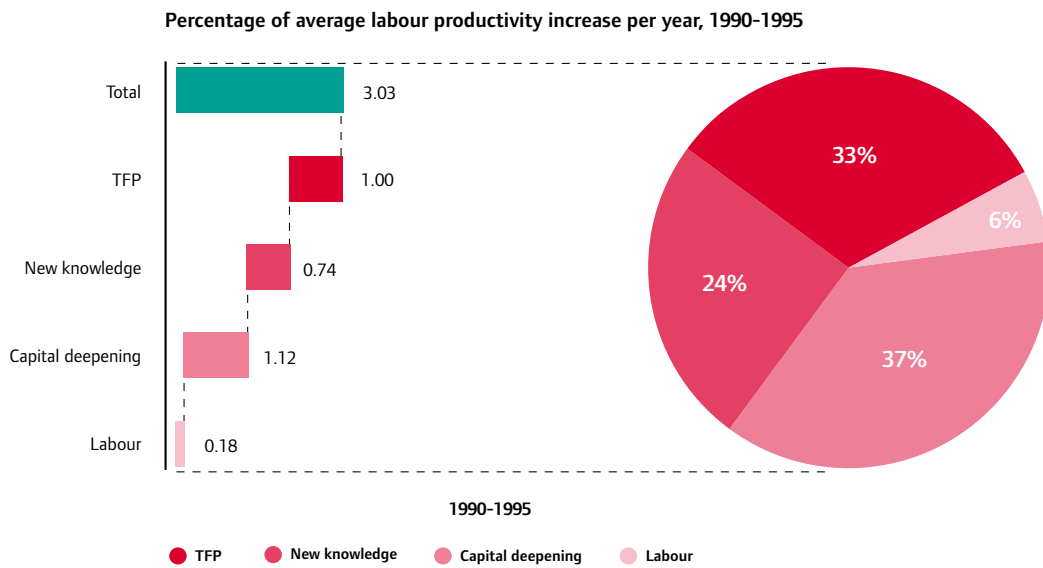
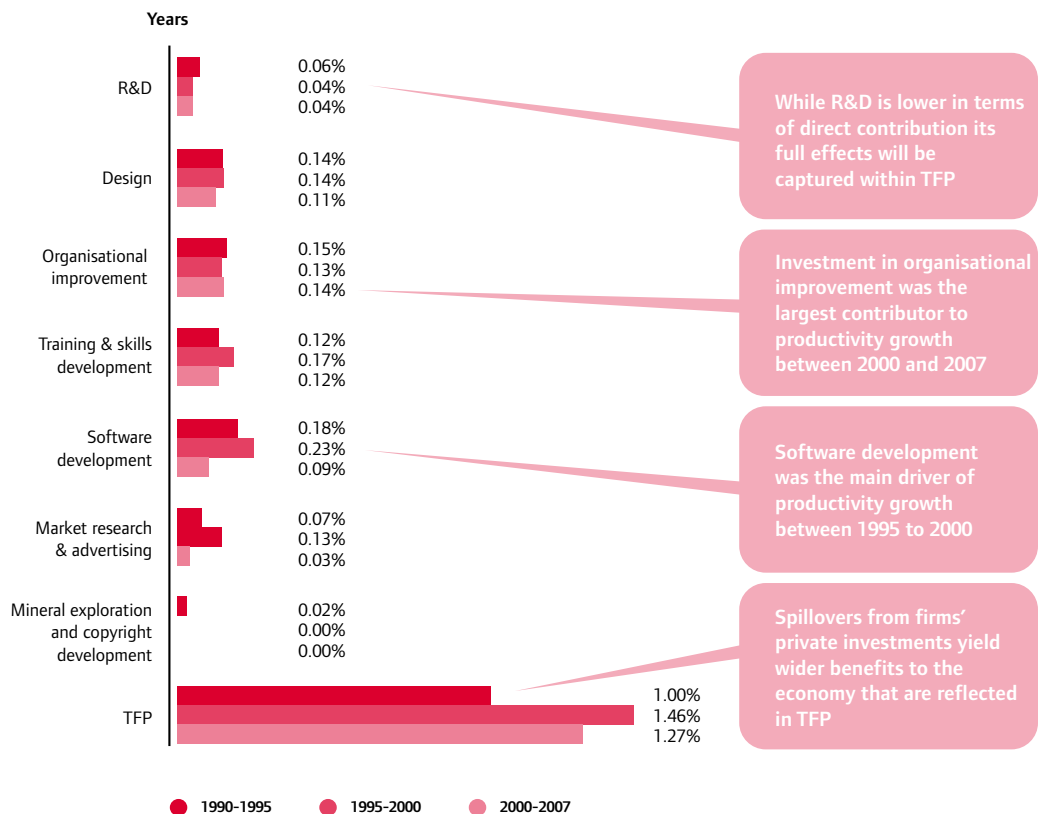


Figure 7: Contribution to labour productivity growth (percentage points per annum)



36. This research was conducted by Professor Stephen Roper of Warwick Business School and Professor Jim Love of Aston Business School, and is published separately as 'Measuring sectoral innovation capability in nine areas of the UK economy.'

37. Hansen, M. and Birkinshaw, J. (2007) The Innovation Value Chain. 'Harvard Business Review.' Vol. 85, No.6, pp.121-30.

of branding and training (and if so, which) will be considered; and the role of public sector intangibles factored in, along with any feedback received on this pilot.

In the future, it is NESTA's intention to design a parsimonious way of gathering annual data to indicate how levels of investment in innovation are changing. This may involve a survey or a panel, but ought to be smaller in scale and less resource-intensive than the Innovation Investment survey that will be conducted in 2010. This will allow an updated Innovation Index to be published on an annual basis.

Component 2: A measure of innovation at firm level

The second aim of the pilot Index is to develop a firm-level innovation survey that reflects elements of 'hidden' innovation and is tailored to the innovation needs of specific sectors.³⁶

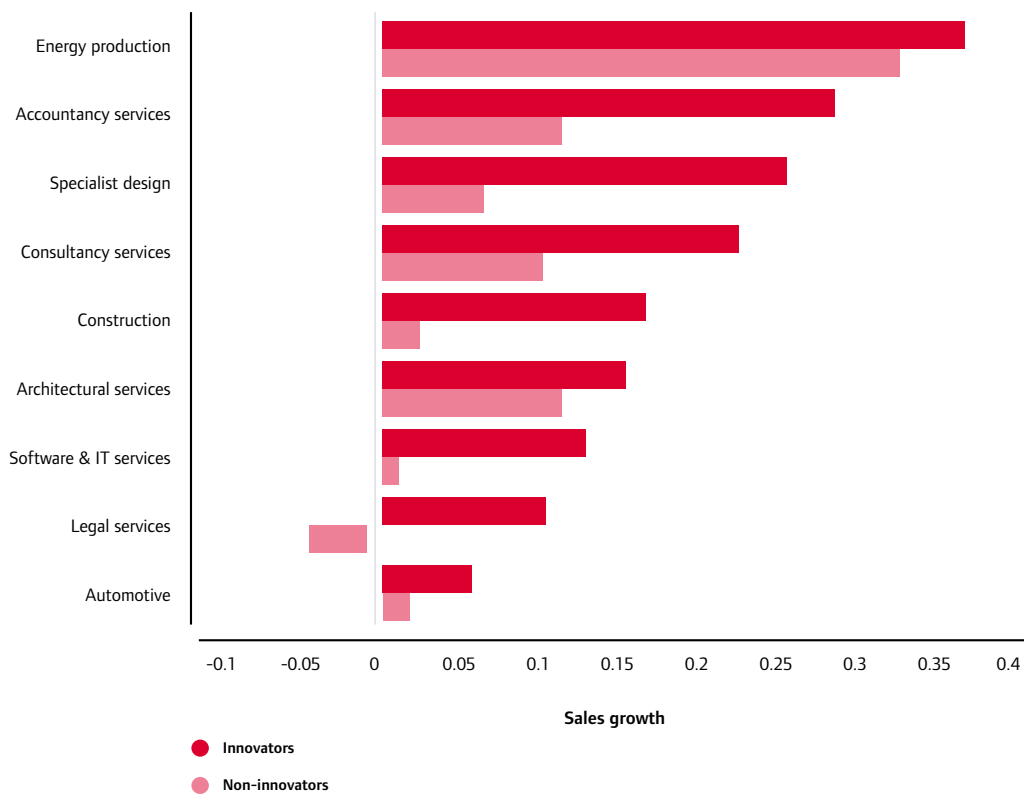
A. What was done

The researchers developed and tested a questionnaire based on a widely used model of how businesses innovate, which is based on academic research and has subsequently been used as a consulting tool in a range of businesses.³⁷ This framework looks separately at firms' ability to access innovation (develop ideas or obtain them from elsewhere), build innovation (turn ideas into products) and commercialise innovation (use innovative goods or services to make money).

The questionnaire tested a number of areas not included in the Community Innovation Survey (CIS), and differed from other surveys in the sector-specificity of how the questions were designed and asked.

An example of the extended scope of the survey is its coverage of the process by which companies acquire knowledge, a key theme in the literature on open innovation. Thus while the CIS simply asks all firms to rate the

Figure 8: Comparison of sales growth between innovative and non-innovative firms by sector (2006-2009)



38. NESTA (2009) 'Business Growth and Innovation: The wider impact of rapidly-growing firms in the UK city-regions.' London: NESTA.

Source: Innovation Index Survey, responses weighted to give representative results.

importance they place on different broadly defined external sources of information, the Index survey goes into more detail, investigating the extent to which firms relied on a wide range of particular external knowledge sources that had been identified by prior research as relevant to their particular industry.

At the same time, the structure of the questionnaire allowed comparability across sectors, so that it is possible to compare the relative innovation intensity of firms in different sectors.

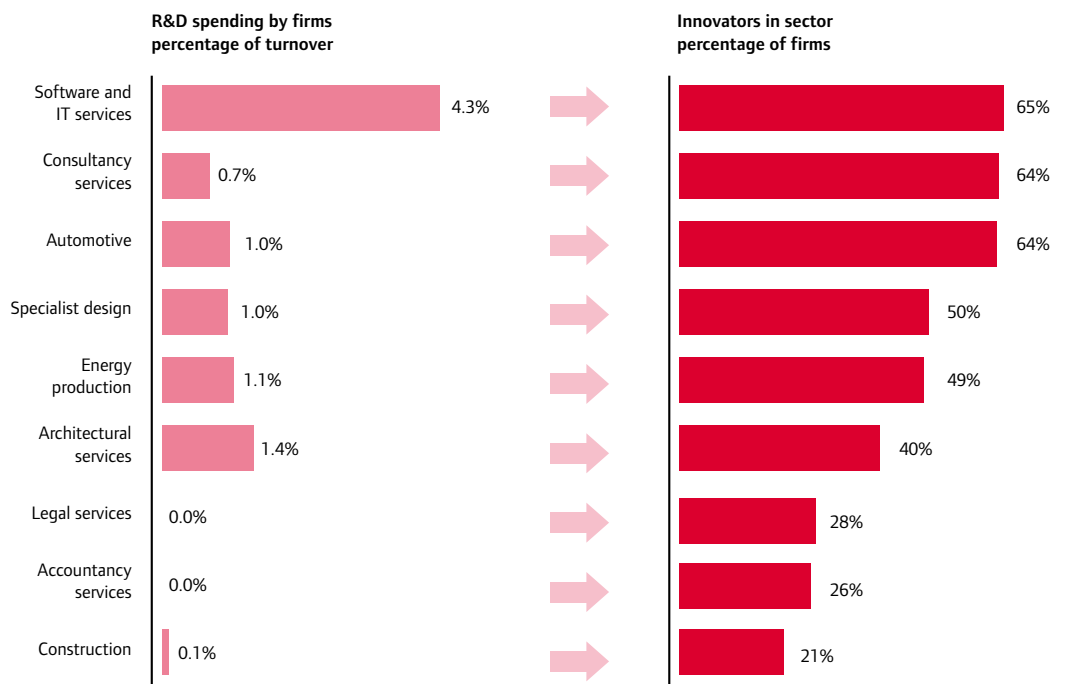
The questionnaire was administered by telephone to 1,500 businesses across ten industries selected to provide a mixture of traditionally innovative sectors (such as the automotive industry) and sectors that were not usually associated with innovation (such as legal services). Each sector received a tailored version of the questionnaire, adapted to reflect dominant modes of innovation in the sector, as determined by interviews carried out by the

researchers. For instance, survey questions regarding the sources of external knowledge used by firms were different for each sector to reflect variations across sectors. In automotive, for example, firms were asked about reverse engineering and recruitment from rival firms while in specialist design firms were asked about sources such as museums and observing people.

B. Findings

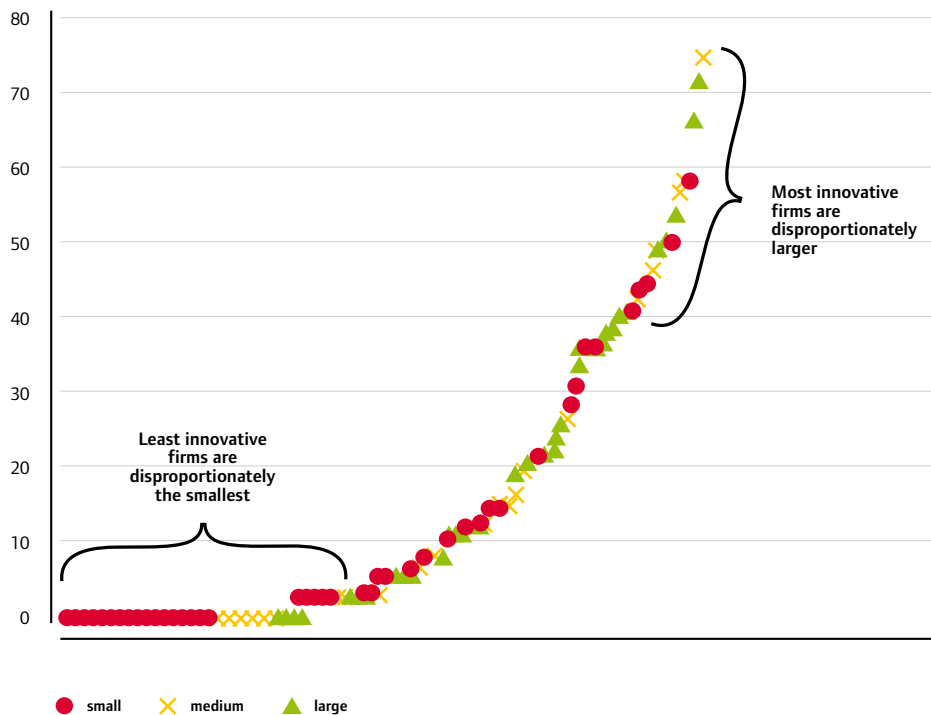
Innovative firms show higher sales growth than non-innovators. This holds true for every sector included in the pilot, although the effect was small in the energy production sector. Innovative accountancy firms grow twice as fast as non-innovative ones, and for law firms, innovation makes the difference between sales growth and decline. These findings have been tested in more depth in *Business Growth and Innovation*,³⁸ demonstrating the relationship between innovation and growth through econometric analysis.

Figure 9: Comparison between levels of R&D intensity and proportion of firms innovating within sectors



Note: An innovative firm is one that introduced a new or significantly improved product/service in the last three years.

Figure 10: Distribution of legal services firms by capacity for building innovation



Note: The vertical axis represents a firm's score for the building innovation phase of the Innovative Value Chain. The score ranges from 0 to 100 where 100 is the most innovative; individual firms are ranked lowest score to highest score (left to right) on the horizontal axis.

Figure 11: Comparison of inter- and intra-sectoral variations of innovation

	Accountancy	Architectural services	Automotive	Construction	Consultancy services	Energy production	Legal services	Software & IT services	Specialist design
Accessing knowledge	● L	● L	● M	● M	● M	● H	● L	● H	● M
Building innovation	● L	● M	● M	● M	● M	● M	● M	● H	● H
Commercialising innovation	● L	● L	● M	● L	● M	● H	● L	● M	● M

Note: The chart shows the differences in the levels of innovation between sectors and the degree to which firms in the same sector are different. The coloured circle denotes the relative levels of innovation activity for the sector when compared to the leading sectors. A red denotes lower relative levels of innovation while green denotes higher relative levels. The adjoining letter denotes the degree of variation between firms within a sector. An L (Low) is applied if firms within a sector are very similar, while H (High) is applied if there is a higher level of variation between firms within the same sector.

The firm-level survey also demonstrates that measuring R&D investment does not capture investments in innovation in most sectors of the UK economy. The sectors chosen in the Index sample are mostly 'low R&D' sectors. In spite of this, the nine sectors we examined for the pilot Innovation Index exhibited significant levels of innovation. Much of this investment occurred in the form of organisational, design or marketing innovation, rather than R&D.

The importance of innovation varies for each sector. In some sectors, such as software and IT, innovation is widespread (a greater percentage of firms are innovators) and simply a condition for survival (the minority of non-innovative firms experience much slower growth). In others, such as legal services, firms are slower to innovate (there are fewer innovative firms), but innovative firms gain an enormous advantage over those that do not (sales growth is still higher among innovative firms).

A number of industries surveyed show significant differences in the reported responses of small and large firms. The chart below shows the situation for legal services, where small firms are typically less innovative than medium and large ones. In other industries, such as consulting, the reverse is suggested by the survey.

The survey also makes it possible to compare levels of innovation across sectors, either at an aggregate level, or in relation to specific innovation activities. Figure 11, prepared as

part of the underlying research based on the survey, provides an overview of the relative levels of innovation in the nine sectors surveyed.

It is also possible to view sectoral performance at a detailed level, as shown in Table 2 in Appendix A, which shows how firms from each sector answered each category of question.

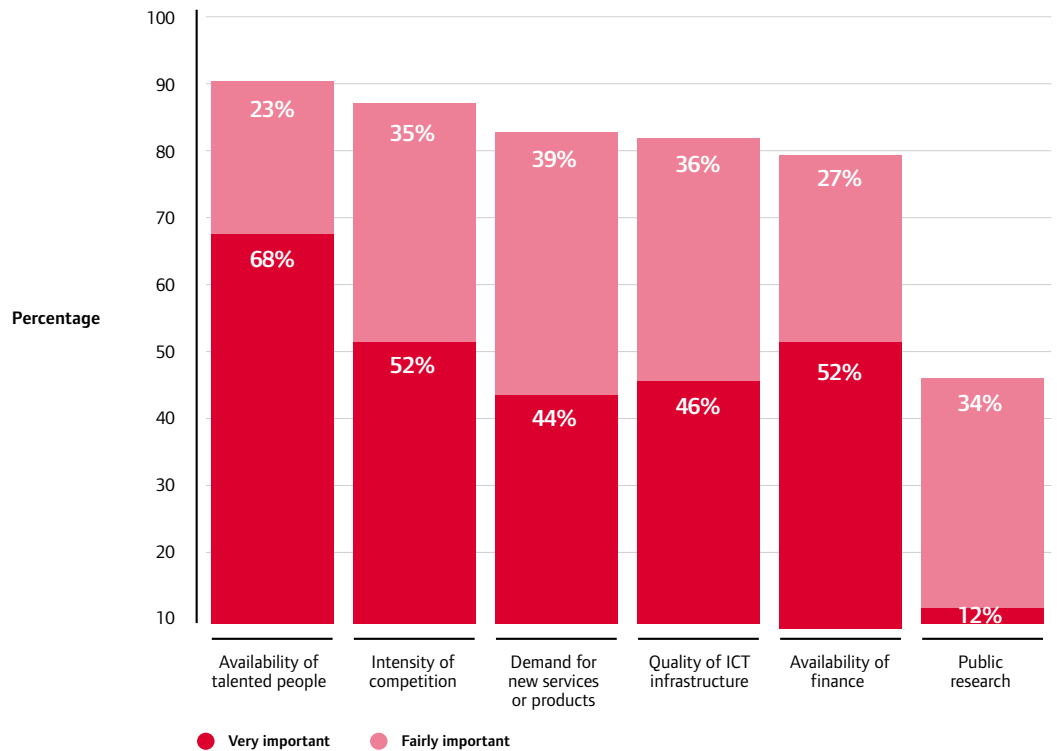
C. Next steps

The detailed answers to the 20 questions in the survey can be compared to firm-level performance information, such as revenue growth, to determine using econometrics which factors are most important for each sector.

NESTA has been approached by a number of sector bodies that have expressed an interest in conducting a survey of firms in their sector using this tool; it is proposed that this demand-led approach be used to extend the survey to new firms, rather than commissioning a very large follow-up survey of other sectors. The exception may be in one or more of the growth sectors of particular interest to the Department for Business, Innovation and Skills, where a more proactive approach will be considered.

Finally, reflecting the international nature of many of the industries considered here, NESTA will consider ways of expanding the survey to obtain comparisons with leading firms in other countries.

Figure 12: Importance of wider conditions for innovation to UK firms



39. This research was conducted by GHK, Technopolis and the University of Manchester; the functional model of innovation was set out in previous work by NESTA; see NESTA (2007) 'An exploration of innovation systems.' London: NESTA. (Unpublished report to DIUS). The research and detailed lists of indicators are being published separately as 'The Wider Conditions for Innovation in the UK: How the UK compares to leading innovation nations.'

Component 3: An assessment of the wider conditions for innovation in the UK

Although a number of measures of the framework conditions for innovation exist, notably the EIS, many are not based on a functional model of how innovation works, and NESTA believes there is room to improve on them. The assessment of the wider conditions for innovation was intended to be an exploratory tool that improved on existing measures without gathering new primary data. It is intended to capture neglected framework conditions (such as demand), to be rooted in factors that have been demonstrably linked to innovation and in a clear model of how innovation occurs, and to provide a time series of data and comparability across leading countries.³⁹

A. What was done

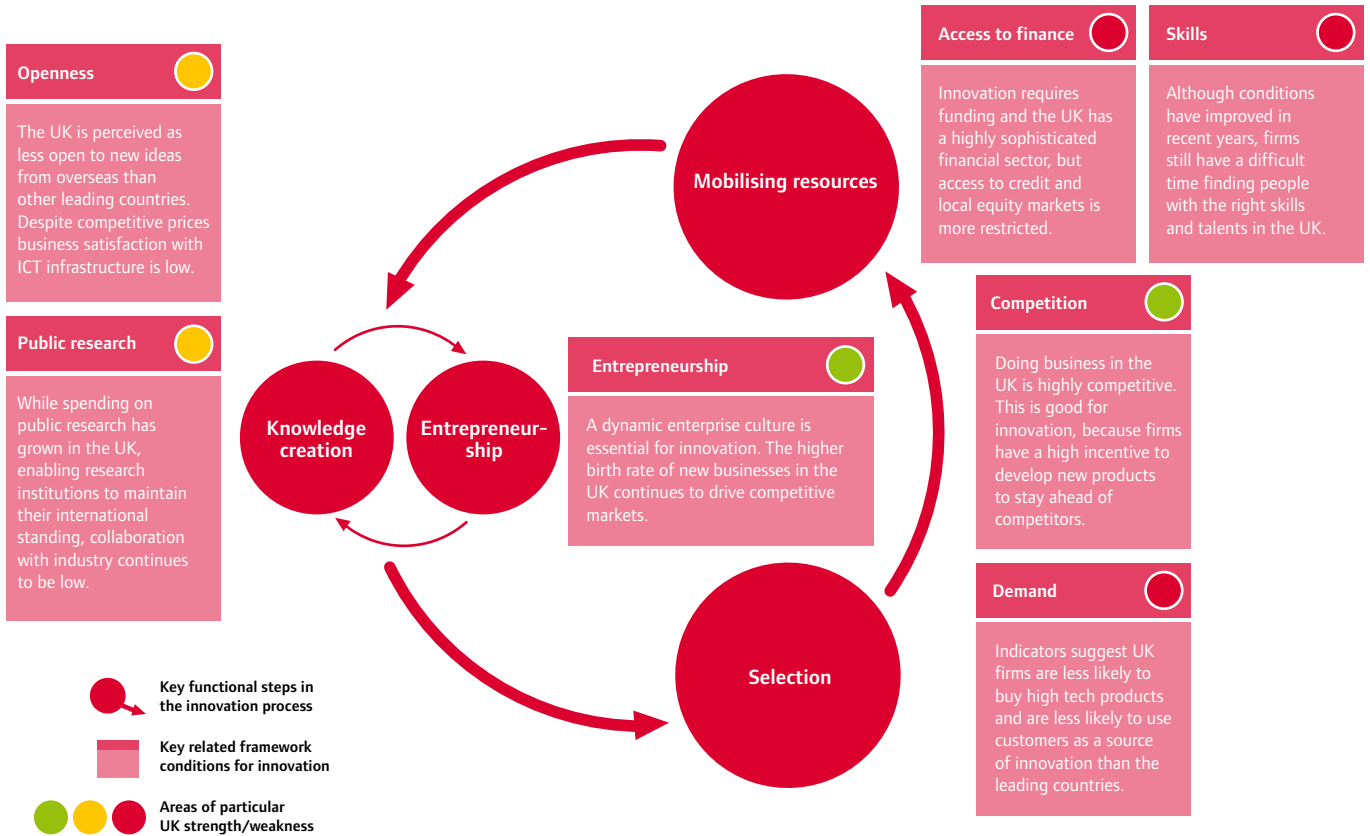
A literature review was undertaken to identify a wide range of factors influencing innovation, and existing indicators that described them. These were aligned to a four-part model of innovation designed by NESTA, and grouped

into 'conditions'. A question was included in the firm innovation survey asking businesses to rate the importance of the conditions for their own ability to innovate (Figure 12). This validated the chosen conditions.

Detailed data on each indicator were then gathered (no new primary data collection was undertaken for this component of the Index, but a thorough examination of existing metrics was undertaken); the data were then presented and the UK's performance assessed compared to a range of leading comparator countries. For some of these indicators, there are relatively well established international metrics used widely in performance evaluation; in other areas, such as public procurement or customer demand, available indicators are less complete. It is worth noting that these countries were deliberately chosen to be leading innovators, not a representative sample of all the world's economies.

An aggregate 'traffic light' score was calculated for each of the seven conditions identified, based on a combination of the UK's current performance compared to leading economies, and based on the overall trajectory of this performance over time.

Figure 13: Assessment of UK wider conditions for innovation



B. Findings

The report found that the UK performed relatively well, typically being in the middle of the group of comparator countries. This echoes the findings of the EIS which typically ranks the UK in the top group, but not at the very top of the table. A few areas of particular concern were raised: the UK underperformed against competitor countries in its access to finance for growth companies, the use of demand to spur innovation (especially government procurement), and the availability of skilled workers (including level 3 and 4 skills, and to a lesser extent management skills).

Figure 13 shows performance against these criteria mapped onto the functional model of innovation that links the seven conditions.

An example of the analysis of one condition, access to finance, is provided below.

The share of early-stage venture capital of GDP in the UK has fallen since 2004 while for the

other comparator countries, with the exception of France, it has risen in 2008 compared to 2004.

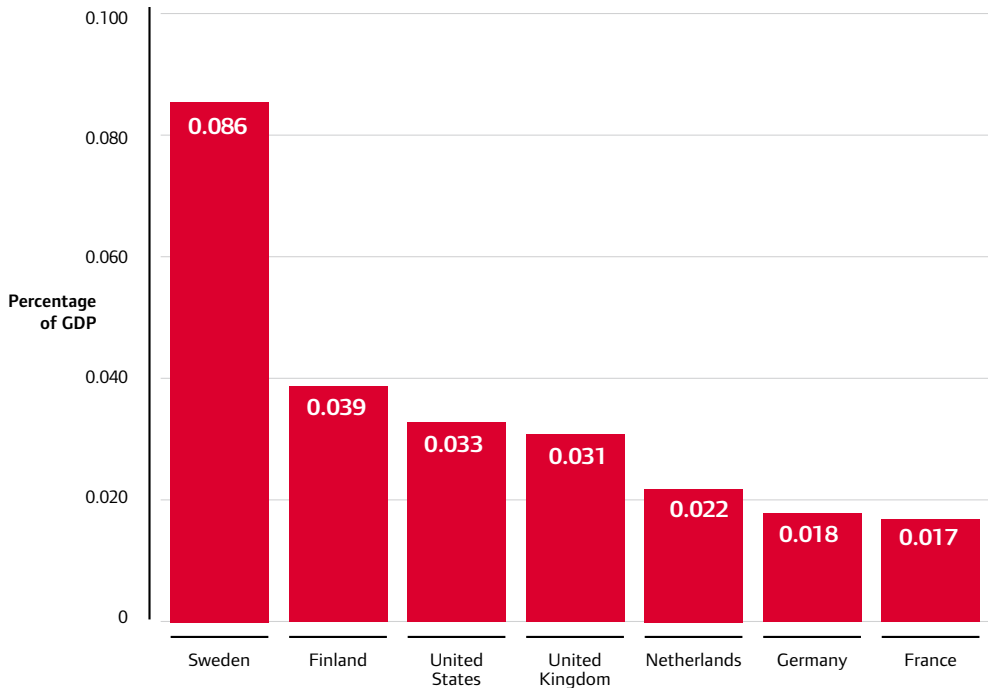
The UK’s relative position is also weak on indicators measuring perceived access to finance. This implies that even though the UK has a very high ratio of financial assets to GDP, this has not necessarily translated into enhanced access for end-users of capital within the country. The question as to why the UK is unable to translate relatively strong performance in areas such as venture capital or banking into ease of access to capital as assessed by businesses is an important line of inquiry that NESTA continues to examine in other work.

C. Next steps

NESTA will look into the possibility of gathering relevant primary data to cast more light on the seven conditions (in particular

Example indicators for one condition: access to finance

Figure 14: Early-stage venture capital investments – percentage of GDP



Measure

Venture capital investments by investment stage – percentage of GDP

Definition

The indicator measures early-stage venture capital investments per year as share of GDP

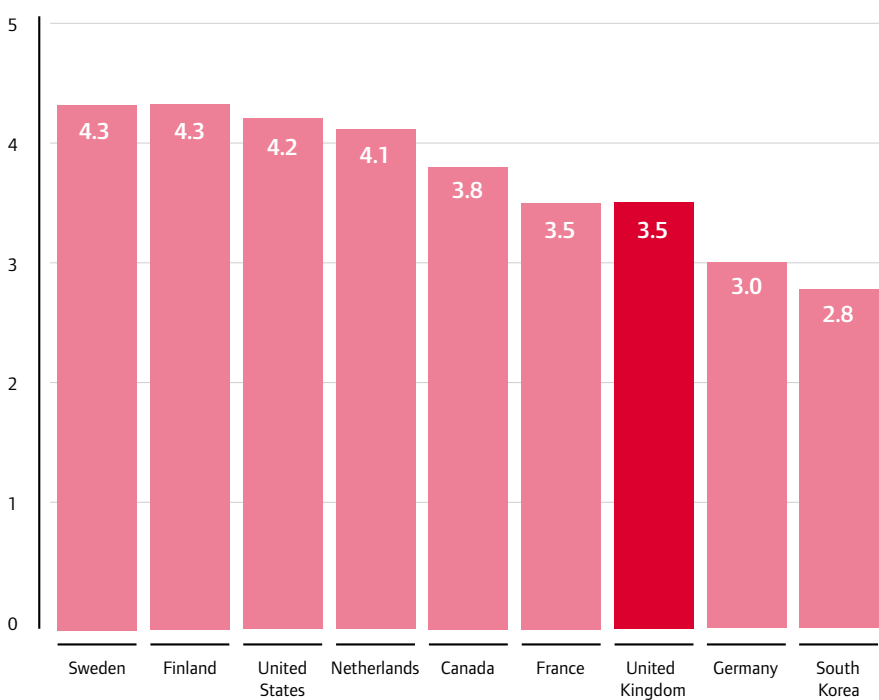
Trend

Early-stage venture capital has been declining as a share of GDP

Current

The UK is placed mid-range compared to our international competitors

Figure 15: Access to venture capital, 2009



Measure

Ease of access to venture capital

Definition

The indicators are a business survey measure of respondents' views on the ease with which entrepreneurs with innovative but risky projects can find venture capital in a country (1 = impossible, 7 = very easy)

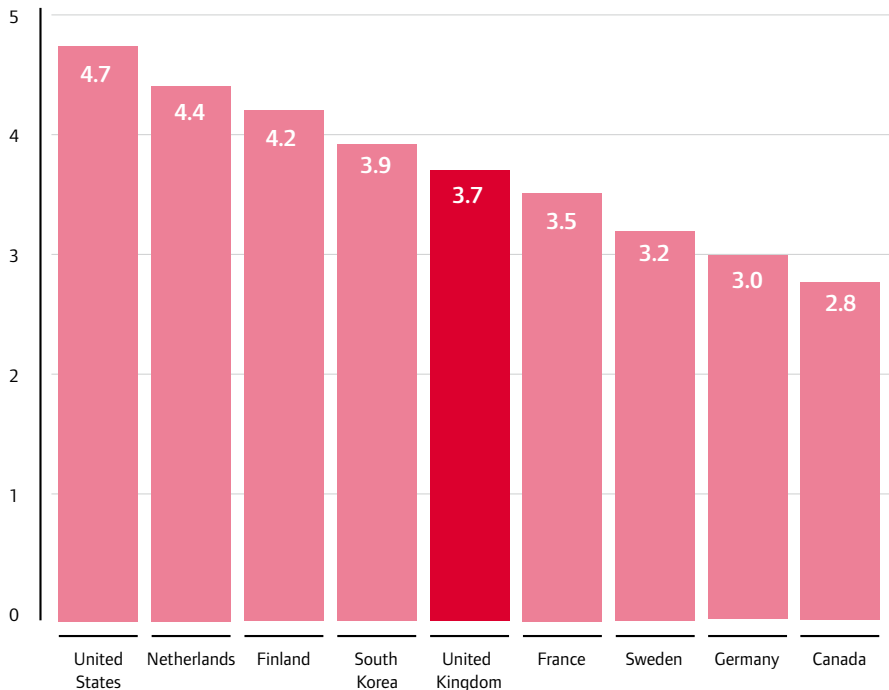
Trend

The UK has declined in terms of access to venture capital, falling from 5th to 7th since 2008

Current

However, the perception is that venture capital is difficult to access

Figure 16: Access to loans, 2009



Measure

Ease of access to loans

Definition

The indicators are a business survey measure of respondents' views on:

Figure 16

a) how easy is it to obtain a bank loan in a country with only a good business plan and no collateral (1 = impossible, 7 = easy)

Figure 17

b) the percentage of firms (from the Eurobarometer survey) reporting access to loan finance as their most pressing problem

Trend

The UK has declined in terms of access to loans, falling from 4th to 5th since 2008

Current

The tightening credit conditions are impacting on riskier new businesses

Figure 17: Companies identifying access to finance as the most pressing problem

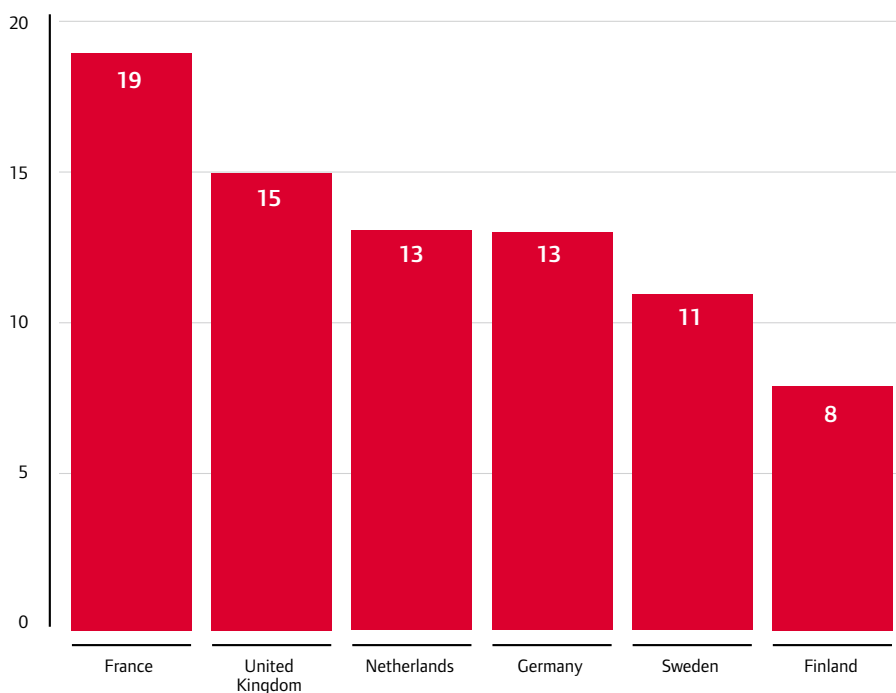
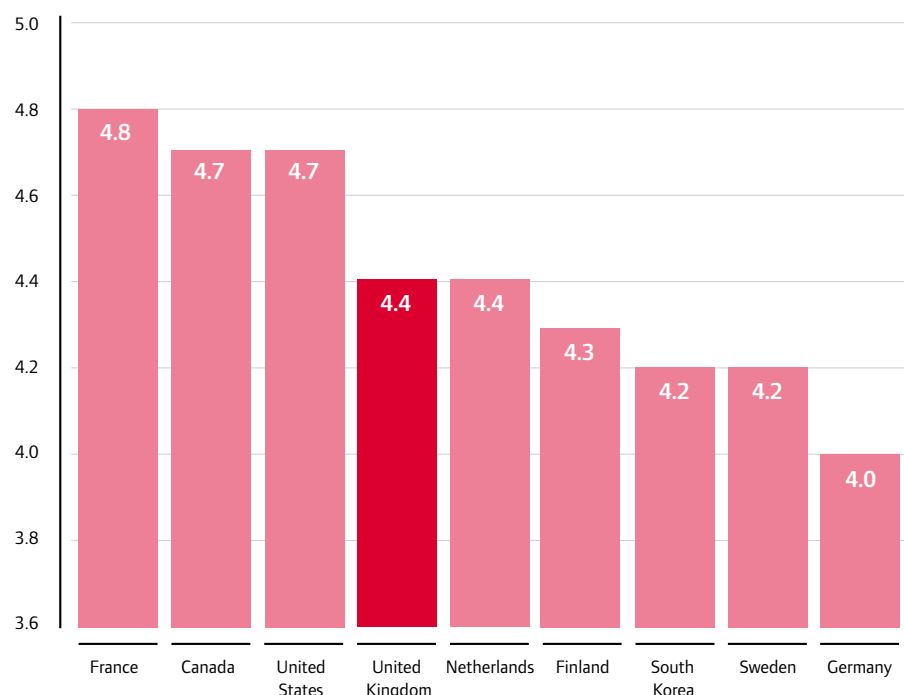


Figure 18: Access to local equity markets, 2009



Measure

Ease of access to local equity markets

Definition

The indicators are a business survey measure of respondents' views on how easy it is to raise money by issuing shares on the stock market in a country is (1 = impossible, 7 = very easy)

Trend

Access to local equity markets has become harder since 2008, a continuation of the trend that has seen the UK fall from 1st to 4th

Current

Sourcing funds from equity markets in the UK is more difficult than for major competitors

the areas that seem to be problematic in the UK and where the available indicators are less comprehensive), and will incorporate feedback from the pilot.

Implications – from measurement to improvement

The pilot Index provides a powerful framework that will act as a basis for better policy.

First of all, it provides a more up-to-date and comprehensive measure of UK innovation investment that reflects how businesses of all types develop ideas, take them to market, and profit from them. Secondly, it links this investment directly to productivity growth, one of government's most important economic priorities. Finally, it provides new data on innovation at the level of businesses and industries, and on the wider conditions for innovation in the UK, which complements that available from other sources.

There are a number of important implications of this work:

1. Policymakers should track the success of innovation policy using these new and more representative measures. It is now possible to measure a wider definition of innovation than just R&D, patents, citations and the proportion of firms who are actively engaged in innovation. Rather than setting an 'innovation' target of spending 3 per cent of GDP on R&D, government should consider the level of investment in innovation as more broadly defined to include design, organisational innovation and business investment in human capital. The fluctuation in this wider measure of innovation investment provides a much better indicator of the success of innovation policy.
2. Tracking broader measures of innovation will encourage policymakers to appreciate better the different patterns of innovation seen across the economy, including those that do not rely heavily on R&D to innovate, such as many parts of the service

sector. Rising levels of R&D investment over the past few years suggest that government policies to encourage R&D (such as tax credits) have had an effect. But these policies have had limited effect on sectors such as retail or oil and gas production. NESTA believes that focusing on a wider definition of innovation will encourage the development of new policies that will stimulate innovation across the whole economy.

3. Innovation policy should focus on areas where the UK lags behind other countries, and where improvement is within the grasp of government. Key conditions include access to finance, procurement, and skills; these are all important gaps, and in each area, government has a role to play. The Index will help policymakers understand potential barriers and help identify appropriate tracking measures.
4. These measures should be developed further and incorporated into headline economic indicators. In particular, the Office for National Statistics should consider how the measurement of innovation investments can be incorporated into national accounts, for example by creating satellite accounts for important categories of innovation investment.

Appendix A: Detailed sectoral-level innovation performance

Table 2: Detailed sectoral-level innovation performance

	Accountancy services	Architectural services	Automotive	Construction	Consultancy services	Energy production	Legal services	Software & IT services	Specialist design	Total
A1 The proportion of externally sourced ideas (%)	4.9	10.7	16.0	6.6	13.4	13.8	4.5	20.1	11.7	9.1
A2 R&D intensity (%)	0.0	1.4	1.0	0.1	0.7	1.1	0.0	4.3	1.0	0.7
A3 Design intensity (%)	0.4	1.1	0.7	0.2	2.4	0.7	0.1	5.2	1.0	1.0
A4 Multi-functionality in accessing knowledge (%)	13.2	21.8	35.6	15.2	42.1	34.6	21.0	41.7	34.6	23.2
A5 xExternal knowledge sources for accessing knowledge (%)	11.8	21.3	30.2	12.2	26.0	26.7	12.8	29.5	20.3	16.9
B1 Process innovation intensity (expenditure per sales) (%)	0.6	1.6	2.1	0.3	1.1	0.2	0.3	1.9	0.9	0.7
B2 Percentage of sales of innovative products (%)	4.4	12.4	19.5	4.8	22.1	12.0	5.7	24.4	17.4	10.2
B3 Diversity of innovation activity (%)	17.6	28.2	38.4	19.8	44.7	37.0	21.7	42.4	37.3	26.9
B4 Multi-functionality in building innovation (%)	12.9	21.6	33.6	13.6	37.4	31.3	21.0	42.3	35.6	22.2
B5 Embeddedness of team-working in building innovation (%)	7.8	16.9	25.3	10.0	29.6	22.9	11.9	36.6	21.6	16.1
B6 External knowledge sources for building innovation (%)	6.7	13.1	14.2	6.8	14.3	17.6	7.5	14.6	12.3	9.6
C1 Range of customer relation modes (%)	50.6	50.2	56.9	37.8	66.0	56.2	54.3	69.1	70.1	51.3
C2 Branding, marketing intensity (expenditure per sales)	0.6	0.4	0.3	1.3	2.1	0.5	0.5	0.8	1.0	1.0
C3 Multi-functionality in commercialising innovation (%)	11.4	18.3	26.3	9.0	30.8	25.9	14.4	28.6	29.4	16.6
C4 External knowledge sources for commercialisation (%)	4.1	4.6	4.4	3.8	10.7	11.2	4.6	11.1	9.2	5.8
C5 Use of IP protection (%)	12.3	26.7	39.1	10.8	36.1	36.9	14.6	43.9	37.3	21.2

Acknowledgements

The pilot Index is based on an extensive work programme, including three detailed research papers published by NESTA in November 2009: *Innovation, knowledge spending and productivity growth in the UK: Interim report for NESTA Innovation Index project* by Haskel *et al.*; *Measuring sectoral innovation capability in nine areas of the UK economy* by Roper *et al.*; *The wider conditions for innovation in the UK: How the UK compares to leading innovation nations* by GHK Consulting, Manchester Institute of Innovation Research, and Technopolis. The Index also builds on an extensive consultation and co-design process and a variety of exploratory projects undertaken over the course of 2008 and 2009. This summary was written by Stian Westlake, Brian MacAulay, Peter Gratzke, Albert Bravo-Biosca and Hasan Bakhshi.

A number of people deserve special thanks for their formative role in the Index. The impetus for the development of the Index sprang from a conversation with John Kingman. Richard Halkett provided the thought leadership required to make the project a reality and set it in motion. Philippe Schneider devised the innovation model used in the assessment of the wider conditions for innovation in the UK.

Thanks also to Lord David Currie who has acted as an insightful and prescient chairman of the Index project, providing invaluable guidance and a powerful sense of what would work. Our Advisory Board, consisting of Sir Michael Barber, Karen Dunnell, Simon Edmonds, David Evans, Helen Fleming, David Godber, Dr Iain Gray, Susanne Huttner, Christine Hewitt, Richard Lambert, Charles Manby, Jil Matheson, Polly Payne, Vicky Pryce, Ceri Smith, Sir Richard Sykes, Professor Nigel Thrift and Andrew Wyckoff, have also given generously of their (very scarce) time and (very abundant) expertise, and have continually challenged us to make the project rigorous and relevant. We are also grateful to the Inner Policy Group and Expert Group, who have provided detailed feedback, support and critique on the technical and policy dimensions of the Index.

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Published: November 2009
TII/42

