Measuring wider framework conditions for successful innovation. A system's review of UK and international data

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NESTA Making Innovation Flourish

Measuring Wider Framework Conditions for successful innovation

A system's review of UK and international innovation data

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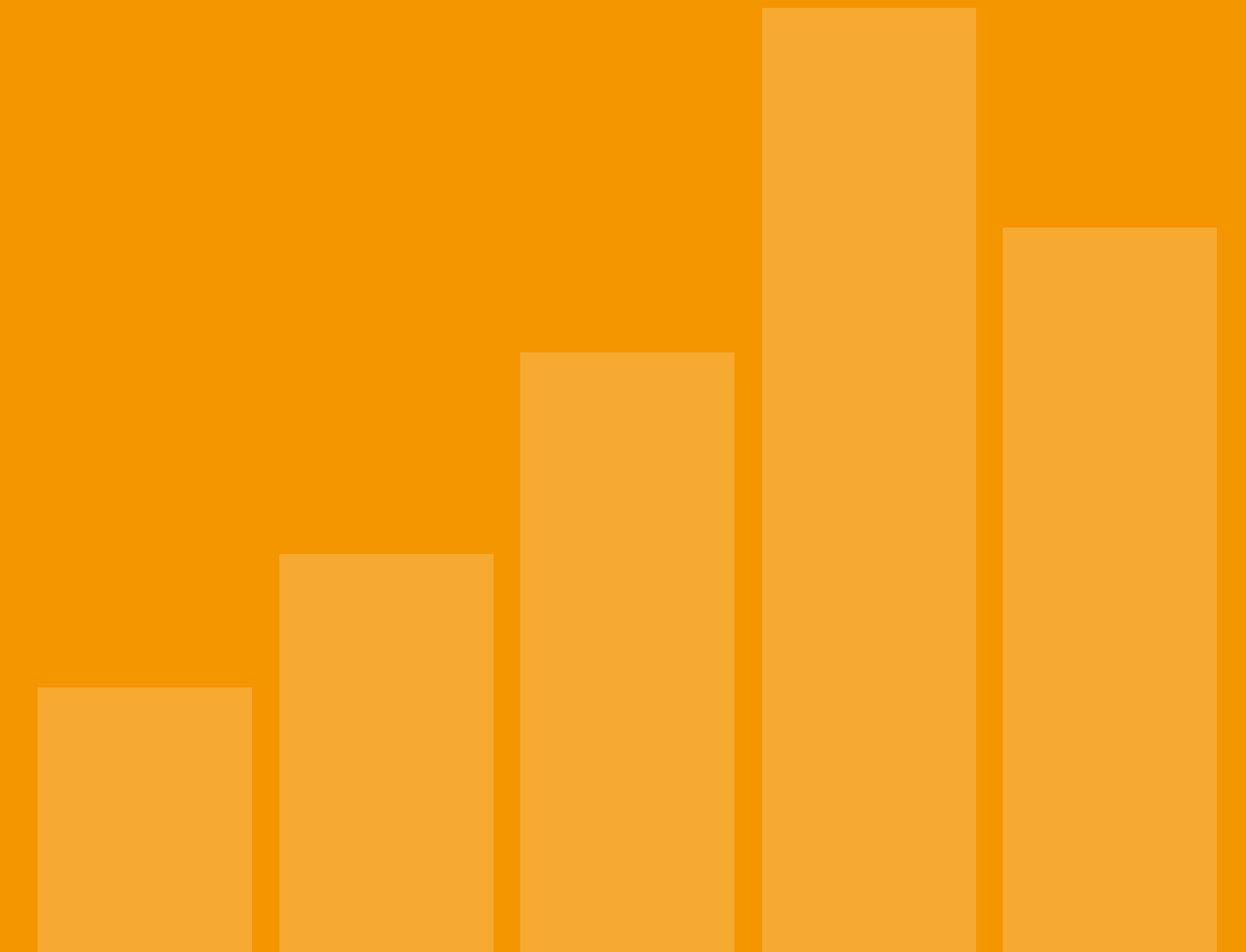

Measuring Wider Framework Conditions for successful innovation

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Foreword

Innovation policy needs to be underpinned by accurate and relevant measures of the innovation activities of businesses, government and universities. This has been recognised in the UK with delivery of NESTA's Innovation Index and internationally through the importance placed on measurement in the OECD Innovation Strategy and the EC Innovation Union.

This report provides a review by academics at Manchester University of the effectiveness of existing international data for measuring the wider conditions for successful innovation. It builds on the report published in 2009. Using NESTA's functional model of the innovation system, the review considers the relative strengths and weaknesses of current data, highlighting where gaps in the measurement of the conditions exist. Each section concludes with proposals for new data to address the gaps identified.

The report recognises the interdependence of the wider conditions – the need to consider data within a systems framework. At a time of greater preparedness to share data, the report highlights the value in working together to facilitate the creation of new effective measures of the conditions for effective innovation.

As always we welcome your comments.

Stian Westlake
Executive Director of Policy and Research, NESTA

January, 2011

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Executive summary

This document is a new indicator report on Wider Framework Conditions (WFCs) carried out by MIoIR as part of NESTA's Innovation Index. WFCs shape the context in which firms innovate and influence their innovation performance and subsequent market success. The selection and definition of those WFCs reflect our current understanding of innovation systems and encompass all those components that are outside the boundaries of the firms as key innovators in the market place. They characterise the different and competing environments that countries offer to innovating firms. This report identifies six key categories of WFCs. Opportunities for innovation come from many sources but a central role is played by the **public research base** and its propensity to work with innovating firms. **Demand** conditions and the degree of **competition** in the market affect the incentive to innovate. Key resources for innovation include the availability of high quality **human resources** and of **finance**. The **infrastructure and services** in the economy also constitute a resource for innovation and facilitate key flows of knowledge and people. Capabilities of firms to innovate are reflected in the degree of **entrepreneurship** they exhibit and the wider **business environment**.

Highlights – standing of the UK

The UK's **public research base** is widely recognised as a strength, with this reflected in the previously reported output-based indicators, notably the UK's share of world citations which rose in 2008 to 11.8 per cent, representing high productivity in relation to the budget share. On a per capita basis it was noted that mid-sized countries deliver higher levels. In terms of inputs to the public research base, Gross R&D expenditure (GERD) remains below the EU average at 1.8 per cent and has been largely static over the past decade. This figure needs to be interpreted with some caution as it reflects the sectoral composition of the economy. Performance in the commercialisation of research through intellectual property creation and spin-offs was previously reported as strong. An indicator of the attractiveness of the public research base (and of framework conditions for R&D more generally) is the share of UK Business R&D (BERD) financed abroad. In 2008 this was the highest in Europe at 23.5 per cent though it has declined from a peak of 29.7 per cent in 2002. Of more concern is a persistent decline in the proportion of R&D in higher education financed by the private sector, falling from 7.1 per cent in 2000 to 4.6 per cent in 2008, a figure below the EU average (of 2007) and far behind leaders such as Germany (14.2 per cent in 2007) and South Korea (12 per cent in 2008).

By comparison with peer countries, the UK shows consumer demand conditions that are only moderately favourable to innovation. Hence, at the level of consumers, 31 per cent of UK citizens are in favour of pursuing 'risky' new technologies as compared with 42 per cent in the leading country surveyed, the Netherlands. Buyer sophistication, which reflects the ability of buyers to understand innovation and to use it, again produces a middle ranking position of 4.6 which has fallen from the leading position in 2005. This is borne out by actual purchasing behaviour of technology-intensive products where the share of communication technologies in household consumption is the lowest in an OECD comparator group at 2.12 per cent, less than half than that of the leader, South Korea.

Business demand conditions also illustrate at best a moderate position. Firm-level technology absorption is in the lower group, indexed at 5.7 for the UK compared with 6.4 in Sweden. Companies' strategic engagement in innovation with their customers is comparable with France and Germany at 35 per cent of firms surveyed, though well behind Nordic leaders. Partnership with suppliers is the lowest in the comparator group, at 31 per cent, over 10 per cent behind France and Germany. While public procurement is now recognised as a key driver of innovation, statistics in this area are limited. However, companies surveyed rated the UK lowest in terms of the degree to which government procurement decisions result in technological innovation.

The state of the UK's **business environment and competition** between firms is generally strong. Survey data on intensity of competition place the UK in the top ten and equal first with Japan among G8 countries. The UK has a substantially higher birth rate of firms than other larger European countries and is 32 per cent above the EU average. However indicators more focused on innovation place the UK in a less favourable position. For the percentage of firms with new-to-market product innovations in 2004-2006, the UK is ranked 19th for the SME performance and ranked 24th for large firm performance. UK performance on intellectual property per capita is stronger but still behind other major EU economies and lags the EU27 average and the USA, being 16th in the triadic patent families per capita. A higher ranking is achieved in cross border trademarks where the UK ranks 8th.

Entrepreneurship refers to the dynamic with which economies generate new businesses. Overall, the picture is moderate to positive, UK fares well compared to large European competitor countries, but has some gaps to the US or the fast-growing economies. In the UK the barriers to entrepreneurship are perceived as being low compared to peer countries. However, the share of companies indicating a fear of failure rate – as a measure of risk aversion – has a medium position in the UK. Thirty-two per cent of people surveyed who see a good opportunity for doing business fear to fail, which is far lower than in Germany, France or Japan (50 per cent), but significantly higher than in countries such as Sweden, Norway, South Korea or the US (27 per cent). This corresponds exactly with actual early-stage entrepreneurial activity, where the UK has a medium position, far better than Japan or Germany, for example, but far behind the US and the Netherlands, let alone Brazil and China. Interestingly, the crisis year 2009 has seen a drop in failure rate and a rise in entrepreneurial activity in the UK. Further, the share of start-ups that are actually opportunity-driven (rather than necessity driven) is higher in the UK than in the other large EU countries, but lower than in the US, Brazil and China. As regards administrative burden on entrepreneurship, the UK is in the most favourable position overall, and the burden on start-ups is lowest (except New Zealand). However, the level of regulatory and administrative opacity is high compared to almost all comparator countries.

The **access to finance for UK companies** is important for investment and thus investment-intensive innovation. Here, the UK has a moderate to poor standing. The market capitalisation of listed companies is actually highest out of all comparator countries. For venture capital, the UK has an interesting position, as the country is best placed when it comes to the financing of the expansion phase of companies, with 0.17 per cent of GDP venture capital spent on the expansion phase (compared to, for example, 0.08 per cent of GDP in the US), but has only a very moderate position for the financing of early-stage firms (with venture capital being 0.03 per cent of GDP compared to 0.05 per cent in the US). Overall, the ease with which UK firms can get loans and venture capital is rated as very low in a global CEO survey compared to almost all comparator countries, and the assessment has become worse in recent years.

In terms of **infrastructure and services**, the UK emerges as high in the supply of Knowledge Intensive Business Services (KIBS) with an overall share of 3.21 per cent of employment, but in a medium position in 'financial services' (and in education and knowledge creation services) and a rather low position in IT services. In terms of overall creative workforce, we see the UK at the top end of the distribution, with a higher proportion of such workers (and implicitly, such industries) than other large countries like Germany and France. In one dimension of physical infrastructure, the 3G cellular mobile subscribers as a percentage of total subscribers, the UK is just below the OECD average and at 17.2 per cent far behind the shares found in East Asia, at 100 per cent in Korea and 82 per cent in Japan. The UK is leading in expenditure through the internet (world leader in e-commerce) and is also a net exporter of e-commerce services, exporting £2.80 for every £1 imported. However, it is only in a medium

position as regards to the provision of the actual infrastructure.

Human capital refers to the stock of accumulated experience, skills and abilities that people bring to bear on the production of an output. Improving the size and quality of human capital requires investment and here the UK is outperforming most of the comparator countries in the rate of change of investment, with a growth factor in primary, secondary and post-secondary non-tertiary education of 150.5 since 2000 compared with an OECD average of 124.2. The UK maintains levels in attainment around the OECD averages but above the EU average of 24 per cent in the share of 25-64 year olds with tertiary education in 2007. In terms of skill levels, Human Resources in Science and Technology (HRST) workers account for 43.2 per cent of the economically active population, ahead of the EU average of 39.3 per cent and just behind Germany, but well behind Nordic countries which are around the 49 per cent mark. A similar position exists for employees with ICT skills, indexed at 7.7 compared with 8.1 for the USA and 9.1 for Sweden. Looking at training for innovators, the UK is in the middle of the reference group with 50-70 per cent of employers having provided innovation-related training to staff.

Future needs

For each framework condition there are gaps in data and sometimes also conceptual gaps, as we do not have sound operationalisation for certain dimensions of a specific framework condition. The biggest challenge to fill gaps in the future appears to be the request for international comparison, as any survey or monitoring tool would have to be coordinated internationally.

Regarding the **public research base and knowledge exchange**, while input data is abundant, there is a lack of systematic data on university-industry cooperation. Further, international comparative analysis of performance of the public research base and university patents and their relative 'value' on an inter-country (EPO, WIPO) would be desirable. For example, an analysis of the scientific and technical articles cited in patents can point to the strength and relevance of the research for technology as well as to the globalisation of R&D, while an analysis of the citation patterns of university patents can point to their value in a similar manner to research publications.

For **demand**, data in general is very poor, mainly relying on rather small-scale surveys. The current exploration of product launch databases is a very positive step. For the short term, some overview of existing procurement policy schemes is suggested; in the medium to longer term a major means would be a procurer survey to capture procurement behaviour and outcome as well as introducing a limited set of questions on triggering and responsive demand in firm data surveys within the UK and beyond. However, for those new instruments or modules, international comparability would be a challenge, and OECD and EU/EUROSTAT coordination would be important.

There is no obvious indicator that could be created relatively easily from existing data sources for **business environment and competition**. Two indicators could be developed with some resource that would facilitate useful comparison with other relevant comparator countries: the effects of the IPR system on business environment and competition; and the cost of access to IPR services. These two new possible indicators cover an area of the economic activity that has increasing significance as economies make more use of intangibles, including intellectual property of various kinds including trademarks, design rights and more particularly patents. In addition, the OECD proposal to measure the rate of increase in intangible assets should be supported and taken advantage of.

As for **entrepreneurship**, it would be important to gather more systematic data on high-growth early-stage entrepreneurship activity and early-stage viability (costs and burden of starting a business). Further, the global market penetration of SME and potential barriers to export and internationalisation would appear fruitful developments in understanding their international trading capabilities.

As for **infrastructure and services**, more data on developing data on business use of mobile communications and social networking would be needed, obtained through surveys and access data.

Overall, the use of **human capital** as a wider framework condition is inhibited by the generality and proxied nature of the indicators used to measure it. Current statistics do not cover, inter alia, informally developed skills and techniques as well as new organizational practices; and formal educational qualifications have different signalling value across different

countries. The Index should tap into the current developments of new concepts to improve the situation (e.g. at OECD level or in the next EU-CIS). More directly, work on regional breakdown of the main indicators proposed should be undertaken and data on workforce development indicators mobilised.

Finally, beyond compiling yet more data, some more **conceptual work** in parallel would be important to better understand how those conditions effect different types of innovations. While for each chosen indicator there is a short justification as to what the indicator marks in terms of influencing innovation behaviour and performance of firms, it should be noted that it is not always clear-cut as to how a certain Framework Condition or one of its variables effects the various forms of innovation. For example, regulation may pave the way for incremental innovation across the board of the economy, but hamper radial innovation and breaking out of technology pathways. Some conditions enhance in-house innovation, while others support more rapid adoption of external innovations. There is no a priori way to determine whether the former or the latter might have more economic benefits. Thus, while the discussions here are typically discussing framework conditions simply in terms of benefits to innovativeness overall, it would be helpful in future work – both conceptual and empirical – to explore different types of linkages that might operate between specific (sets of) framework conditions and specific (sets of) innovation.

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Part I: Introduction

This document is a new indicator report on Wider Framework Conditions carried out by MIoIR as part of NESTA's Innovation Index. Wider Framework Conditions (WFCs) shape the environmental context in which firms innovate. At a very basic level, WFCs can be defined as those factors that are external to a firm and that drive and shape the innovation activity of firms; and influence their innovation performance and subsequent market success. These factors are outside the reach or influence of a single firm or even a group of firms. The interplay of WFCs and their significance can be conceptualised within the frame of a knowledge ecology, in which innovation is understood as a process of turning any kind of knowledge into value. WFCs are thus understood as external factors that define and determine the flows of knowledge, people and resources, enable the necessary interactions and thus shape the conditions for businesses' knowledge generation, transformation and exploitation.

WFCs frame any business innovation system and variations in the strength or weakness of these conditions strongly affect innovation performance at firm level. Essentially the principle is spatial, but recognises that the state of any given WFC will be the result of global, regional, national and local influences. By the same token the relative significance of different conditions will change for different policymakers according to the range of policy responses they have available to address the state of WFCs.

This report suggests a set of Wider Framework Conditions and underpins them with indicators and data. It is a follow up, update and revision of the earlier report on Wider Framework Conditions supported by NESTA.[1] It builds on a simplifying framework of WFCs as introduced in that earlier report.

The report:

- Revises the existing definition and selection of WFCs.
- Revises and as needed amends the selection of indicators for those WFCs.
- Delivers data as far as possible for those indicators.
- Defines ways forward to collect data in the future on those indicators that are seen to be of high importance but for which no meaningful data exists.

The principles for data collection were that, ideally, new data was available on a regular basis, and the data would be comparable on the international level.[2] In principle, the international comparison took into account the major partners and (potential) competitors of the UK with comparable economic systems. Thus, whenever the data base allowed, the international comparison comprises the US, Japan, South Korea, Brazil, Germany, France, Sweden, Finland, India, China, Norway and the Netherlands.

The report shall provide the basis for annual updates. Its purpose is to inform policymakers and wider stakeholders in the UK economy with a reliable, cost-efficient and well-tailored instrument to understand the innovation environment of the country, its development over time and in comparison to other main countries.

1. Miles, N., Wilkinson, C., Edler, J., Bleda, M., Simmonds, P. and Clark, J. (2009) 'The wider conditions for innovation in the UK: How the UK compares to leading innovation nations.' NESTA Index Report. London: NESTA.
2. When data was available regional data is added.

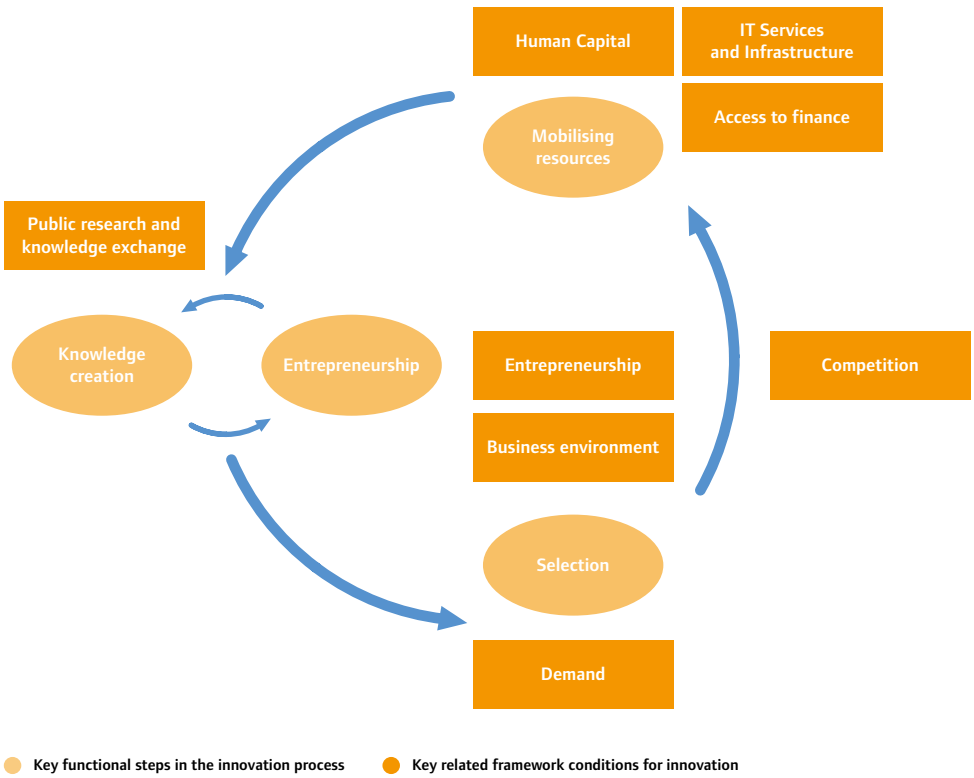
The report is structured as follows. Section 2 gives a very short introduction to the WFCs and their interplay. Section 3 delivers the individual WFC and the selected indicators within each WFC. Each WFC section follows the same logic: the WFC is introduced and its importance for innovation activities and performance discussed. Subsequently, the indicators within each WFC are presented and a rationale for the inclusion in the indices provided. In a further section within each WFC the report proposes new indicators that could be included in the future. Obviously, those suggestions for future indicators and data need to take into account that the more sophisticated indicators that necessitate new primary data gathering face a challenge when it comes to resources, as well as bringing together data provides across the innovation system.

Part 2: The meaning and interplay of WFC

The WFCs may be seen as providing the resources, incentives, capabilities and opportunities for firms to innovate. These in turn moderate the flows of people, finance, knowledge and services mentioned above. WFCs are both complementary and interactive but we have chosen the headings implicit from the above taxonomy to structure the presentation, presenting sets of indicators that have strong mutual relationship together. Figure 1 depicts those conditions and represents one way of interpreting the interplay of the indicators. It follows the model defined in the earlier WFC report, but adapts it according to the modifications in framework conditions in this report. The figure models the innovation process as a cycle of *knowledge generation* and *entrepreneurship*, *selection* (of knowledge, ideas, and innovations in the market) and the *mobilisation* of resources. The framework conditions shape this cycle and its performance in different ways.

3. Miles, N., Wilkinson, C., Edler, J., Bleda, M., Simmonds, P. and Clark, J. (2009) 'The wider conditions for innovation in the UK: How the UK compares to leading innovation nations.' NESTA Index Report. London: NESTA.

Figure 1: The Interplay of Wider Framework Conditions



Source: Miles *et al.* (2009), p.9, modified[3]

The opportunities for innovation come from many sources (including human resource and demand), but a central role is played by the **public research base** and by its propensity to work with innovating firms. The indicators of **demand** give some sense of the propensity of consumers and customers to demand and adopt innovations and give innovators a market incentive. Demand is a major determinant of the selection process, but equally a source of *knowledge*. **Competition** may also be seen as a driver of innovation, in this case both competition in the market and for the market as evidenced by firm entries and exits. Competition shapes and drives the selection process. The capabilities of firms to innovate are in part reflected by the degree of **entrepreneurship** they exhibit and also by aspects of the **business environment**. Key resources include the availability of **finance** for innovation, the **infrastructure and services** for innovation and the condition for their mobilisation and – last but not least – **human capital**.

Part 3: The Wider Framework Conditions

3.1 Public Research and Knowledge Exchange

The public research base[4] is widely regarded as an integral component of any country's innovation system for its contributions, both potential and real, to innovative performance, growth and economic prosperity.[5] World-class science and innovation is perceived in UK policy circles and elsewhere to be crucial for maintaining economic prosperity and responding to the challenges and opportunities of globalisation. Indeed the House of Commons Science and Technology Committee (2010, p.5) recently noted:

> *"Science enables us to address the global and domestic challenges of today and tomorrow, to raise the quality of life and, furthermore, is widely accepted to be an effective vehicle for economic growth."*

The main actors in the science base of the UK are the universities and public sector research enterprises (PSRE) with the main activities undertaken in higher education institutions.[6] There are 169 universities, including the separate colleges of the federal universities of London and Wales. The remainder of public research is conducted in PSREs which are owned and run by government directly or indirectly through the Research Councils. Research activities are essentially centralised with the Department for Business, Innovation and Skills (BIS) being the focal player.

3.1.1 The rationale for funding research

The most well known theoretic case for governments' support for the development of the science or public research base rests on the notion of market failure. Failure in financial and technology markets, indivisibility and economies of scale in R&D all lead to private sector under-investment in R&D. Thus, in order to achieve socially optimal R&D investment levels, governments should finance research activities at public research organisations.[7] In so doing the research base becomes larger and consequently more opportunities for the private sector to innovate are made available; opportunities for which they do not have to meet the initial costs of research.[8]

The aforementioned stream of thinking, while influential in the literature, and in policy, has been criticised by various scholars, including those of evolutionary economics/national innovation systems tradition who instead focus on both public and private dimensions of the innovation system.[9,10] One of their main contentions is that the market failure approach ignores subtle distinctions between information and knowledge. It misrepresents the nature of the innovation process, implying that scientific knowledge can be acquired 'off the shelf' and available at zero cost.[11] Moreover, it disregards the extent to which scientific or technical knowledge requires substantial user capability – both in research and in the application of knowledge;[12] neither does it fully appreciate the extent to which knowledge is embodied in specific researchers and the institutional networks within which they do research. Authors in this tradition[13] focus on the learning properties of individuals and organisations. Crucially important in this context are such issues as skills, networks of researchers and the development of new capabilities on the part of actors and institutions in the innovation system.[14]

Irrespective of which perspective is more intellectually appealing, the empirical evidence

4. The terms 'public research' and 'science base' are used interchangeably in the literature.
5. Boden, R., Cox, D., Georghiou, L. and Barker, K. (2001) Administrative Reform of United Kingdom Government Research Establishments: case studies of new organisational forms. In: Cox, D., Gummett, P. and Barker, K. (Eds) 'Government Laboratories: Transition and Transformation.' Washington, DC: IOS Press.
6. HM Treasury (2004) 'Science and Investment Framework 2004-2014, Annex A.' London: HM Treasury.
7. Arrow, K.J. (1962) Economic welfare and the allocation of resources for invention. In: Nelson, R. (Ed.) 'The Rate and Direction of Inventive Activity: Economic and Social Factors.' Princeton: Princeton University.
8. Beise, M. and Stahl, H. (1999) Public research and industrial innovations in Germany. 'Research Policy.' 28, pp.397-422.
9. Salter, A. and Martin, B. (2001) The Economic Benefits of Publicly Funded Research: A Critical Review. 'Research Policy.' 30, pp.509-532.
10. For the endogenous growth stream of thought, see: Romer, P.M. (1986) Increasing returns and long-run growth. 'Journal of Political Economy.' 94, pp.1002-1037; and Grossman, G. and Helpman, E. (1994) Endogenous Innovation in the Theory of Growth. 'Journal of Economic Perspectives.' 8(1), pp.23-44. And see Nelson, R.R (1998) The Agenda for Growth Theory: a Different Point of View. 'Cambridge Journal of Economics.' 22(4), pp.497-520, for a critique.
11. Rosenberg, N. (1990) Why Do Firms Do Basic Research (with Their Own Money)? 'Research Policy.' 19, pp.165-174.
12. Cohen, W. and Levinthal, D. (1989) Innovation and Learning: The Two Faces of R & D. 'The Economic Journal.' 99, pp.569-596.
13. See for example: Nelson, R.R. (1993) 'National Innovation Systems: A Comparative Analysis.' New York, Oxford University Press; and Metcalfe, J.S. (1998) 'Evolutionary Economics and Creative Destruction.' London: Routledge.
14. A more recent study criticises the NIS approach for being too static, descriptive and mechanical and focused disproportionately on science and technology as opposed to other loci of innovation. It argues that what is required is an approach that emphasises the dynamic, emergent

about the nature of the relationship between the science base and innovation, while appearing supportive, is far from settled. The House of Commons Science and Technology Committee (2010, p.18) report commented: "..the best literature on the subject concludes that reliable quantification of the economic impact of investment is deeply problematic at best..." Salter and Martin's (2001) wide-ranging literature survey points to many of the economic benefits of publicly funded research but identified various methodological flaws of studies approaching the issue from a variety of perspectives.

These range from measurement and such conceptual issues as the assumption of a linear production function model of the science system associated with econometric[15] estimations of the rate of return, to the realisation coming from various surveys and case studies that the notion of science as a public good, the traditional justification for public funding of research, does not necessarily represent the main kind of benefit. In addition to increasing the stock of knowledge, public funding of research results in: training skilled graduates; creating new scientific instrumentation and methodologies; forming networks and stimulating social interaction; increasing the capacity for scientific and technological problem-solving and creating new firms.[16]

Moreover, because of the non-linear nature of the innovation process, the relative impacts of the different forms of benefits vary by scientific field, technology and industrial sector. Systemic approaches to understanding innovation have provided new insights about the relationship between innovation and economic performance. A national innovation systems perspective directs attention to a complex web of interactions between and among the innovation actors and institutions.[17] A simple model that therefore characterises the innovation process as being a linear causal relationship running from science to innovation is unlikely to capture the dynamics and complexity of innovation. As Salter *et al.* (2000, p.5) so succinctly observe:

> *"The relationship between publicly funded research and innovation is interactive and non-linear. Short, simplistic models of cause and effect are deeply misleading. Science often follows technology and the market often leads technology and science."*

3.1.2 Indicators and data

Science base indicators have a history dating back to the efforts of the OECD and the US National Science Foundation in the 1960s and 1970s.[18] The OECD in particular has been working since to develop indicators that would service robust policy analysis of science, technology and innovation (STI). Most of its early efforts however related to simple input and output indicators with respect to research and development (R&D) expenditure. In general, input indicators provide tools for evaluating resources employed at various levels in a given country, typically including expenditure and manpower devoted to higher education, R&D and related areas of S&T activities. Output indicators on the other hand, tend to measure the extent of patenting and S&T publishing activity with which particular groups of S&T institutions and personnel are engaged.

Colecchia[19] (2007) notes that these early pioneers were perhaps too successful, as indicators constructed on R&D such as R&D intensity remain among the most popular and indeed have become enshrined as targets in specific STI policies in spite of the unidimensional measurement limitation associated with considering only one type of STI input within a complex system of innovation.

However as thinking about innovation developed, so too did thinking about the range of possible indicators. We now understand more fully that such input and output indicators are insufficient to describe the complex, multidimensional aspects of the innovation process, which depends on factors such as effective knowledge sharing and interactivity based on communication capacity and skills that are well beyond R&D and technology. These make it more challenging to measure innovation, but in recent years, particularly with the advent of Community Innovation Surveys, meeting such challenges has resulted in a wider range of indicators that better capture the more nuanced aspects of the innovation process. This however does not imply that more traditional input and output indicators are without merit.

In the Miles *et al.* (2009)[20] report on the Wider Condition for Innovation in the UK, coverage of the public research (the science base) was extensive and focused around the innovation outputs and processes of UK universities with indicators: (i) marking the absolute numbers,

and evolving nature of systems and the multiple and distributed sources of knowledge for innovation. See Dodgson, M., Hughes, A., Foster, J. and Metcalfe, J.S. (2010) 'Systems thinking, market failure, and the development of innovation policy: The case of Australia.' Working Paper 397. Cambridge: Centre for Business Research.

15. See also the recent studies: Guellec, D. and Van Pottelsberghe de la Potterie, B. (2004) From R&D to Productivity Growth. 'Oxford Bulletin of Economics and Statistics.' 66, pp.353-378; Haskel, J. and Wallis, G. (2010) 'Public Support for Innovation, Intangible Investment and Productivity Growth in the UK Market.' Sector Discussion Paper IZA. London: Imperial College Business School.
16. Salter, A. and Martin, B. (2001) The Economic Benefits of Publicly Funded Research: A Critical Review. 'Research Policy.' 30, pp.509-532.
17. OECD (1997) 'National Innovation Systems.' Paris: OECD.
18. Godin, B. (2001) 'The emergence of Science and Technology Indicators: Why did Governments Supplement Statistics With Indicators?' Project on the History and Sociology of Technology Indicators Paper No. 8. Montreal: OST.
19. Colecchia, A. (2007) Looking Ahead: What implications for STI development? In: OECD (Ed.) 'Science, Technology and Innovation in a Changing World: Responding to Policy Needs.' Paris: OECD.
20. Miles, N., Wilkinson, C., Edler, J., Bleda, M., Simmonds, P. and Clark, J. (2009) 'The wider conditions for innovation in the UK: How the UK compares to leading innovation nations.' NESTA Index Report. London: NESTA.

quality and impact of scientific publications and patents; (ii) measuring interactions between universities and firms to show the accessibility of the public research base by industry; and (iii) demonstrating commercial relevance of public research through spinout and disclosure activities.

For the present purposes, a range of indicators that strengthen and supplement the original list, and which can facilitate regular benchmarking of the UK public research base against international competitors such as the US, Germany, the Nordic hi-tech countries and emerging economies, are drawn from the OECD Main Science and Technology database and the Eurostat Science, Technology and Innovation database. They focus on a comparative understanding of the size and capacity of the public research base and also provide further evidence of collaborative or cooperative linkages between various actors acknowledged as vital to the innovation process. To further supplement the original output indicators produced in the publication, performance of the UK public research sector is also assessed relative to the higher education sector's investment in R&D using data drawn from the SCOPUS database.[21] In addition, indicators that reflect on the performance of UK universities drawn from the Higher Education Business and Community Interaction Surveys, for which there are no comparable data sets, are presented.

21. This data is available from www scimagojr.com
22. HM Treasury (2004) 'Science and Investment Framework 2004-2014.' London: HM Treasury.

Measures of Innovation Inputs

Gross Expenditure on R&D

This measures the Gross Expenditure on R&D expressed as a percentage of a country's Gross Domestic Product. The OECD publishes R&D-to-GDP ratios or R&D intensity in its Main Science and Technology Indicators as part of a 'scorecard' that is used to compare national innovation systems. However, this statistic is influenced by economic structure and propensity to perform R&D in particular sectors, which varies from country to country.

Table 1 shows annual data for the 2000-09 period. Although the UK is marginally below the EU average, with the exception of the Netherlands, there is evidence of an investment gap in the public research base compared to virtually all other countries. Moreover the UK has thus so far failed to achieve the 2.5 per cent target investment outlined in the Science and Investment Framework 2004-2014.[22] On the other hand when this is used in conjunction with publication data, it reinforces the evidence from the bibliometric data analysed in Miles *et*

Table 1: Gross Expenditure on Research and Development

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Finland	3.4	3.3	3.4	3.4	3.5	3.5	3.5	3.5	3.7	4.0
Sweden	_	4.2	_	3.9	3.6	3.6	3.7	3.6	3.8	_
Japan	3.0	3.1	3.2	3.2	3.2	3.3	3.4	3.4	3.4	_
Korea	2.3	2.5	2.4	2.5	2.7	2.8	3.0	3.2	3.4	_
US	1.8	2.7	2.6	2.6	2.5	2.6	2.6	2.7	2.8	_
Germany	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.6	_
France	2.2	2.2	2.2	2.2	2.2	2.1	2.1	2.0	2.0	_
EU (15)	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	2.0	_
UK	**1.8**	**1.8**	**1.8**	**1.8**	**1.7**	**1.7**	**1.8**	**1.8**	**1.8**	**_**
Netherlands	1.8	1.8	1.7	1.8	1.8	1.8	1.8	1.8	1.8	_
Norway	_	1.6	1.7	1.7	1.6	1.5	1.5	1.7	1.6	_
China	0.9	1.0	1.1	1.1	1.2	1.3	1.4	1.4	1.5	_

Source: OECD Main Science and Technology Indicators

Table 2: Share of GBAORD as per cent of total general government expenditure

	2000	2001	2002	2003	2004	2005	2006	2007	2008
United States	2.50	2.56	2.71	2.86	2.97	2.88	2.83	2.76	2.56
Finland	2.03	2.03	1.98	1.99	2.01	2.04	2.08	2.05	2.01
Norway	1.54	1.56	1.61	1.60	1.66	1.69	1.80	1.86	1.82
Germany	1.75	1.64	1.62	1.63	1.63	1.64	1.67	1.76	1.81
Sweden	1.26	1.48	_	1.62	1.58	1.57	1.58	1.54	1.53
Netherlands	1.75	1.66	1.60	1.57	1.59	1.54	1.56	1.52	1.52
UK	**1.73**	**1.65**	**1.83**	**1.76**	**1.61**	**1.52**	**1.51**	**1.49**	**1.34**
Korea	0.49	0.59	0.50	0.60	0.50	0.55	0.70	0.83	0.75
Japan	1.69	1.82	1.87	1.92	1.97	1.85	1.94	1.88	_
Switzerland	1.82	_	1.89	_	2.08	_	2.14	_	_
EU (15)	1.63	1.61	1.64	1.62	1.60	1.60	1.57	1.60	1.56

Source: Eurostat Science Technology and Innovation database

al. (2009)[23] that the UK research base has been and remains highly productive.

Government budget for R&D – GBAORD
The government budget appropriations or outlays for R&D measures the funds committed by central/federal government for R&D to be carried out in one of the four sectors of performance – business enterprise, government, higher education, private non-profit – at home or abroad (including by international organisations). The data are usually based on budgetary sources and reflect the views of the funding agencies. Table 2 shows data extracted from the Eurostat database.

Table 2 confirms the trends shown in GERD with respect to the level investment. However one of the advantages of using GBAORD is that although it relates to information on research inputs, there can be explicit connections between these inputs and the final social economic development intended by the investment. This has been an issue that has not been analysed systematically. Recently, new statistical indicators have been developed for GBAORD,[24] which classifies public budget figures according to socio-economic objectives, and these can be linked to other data sources to show the contribution of public funds to achieving national socio-economic objectives.

Higher Education Expenditure on R&D (HERD)
In many countries, as in the UK, higher education institutions and public sector research institutes are the key organisations involved in the creation and diffusion of scientific knowledge. Given that most basic research is performed in such organisations, public support for research is important for developing new scientific and technological knowledge and the human capital that can lead to innovation and improved competitiveness of the economy. As with the previously mentioned indicators, while HERD estimates can be used for the monitoring of policies of governments, they are unable by themselves to measure the impact or consequences of funding or engaging in research and development.

Table 3 shows the comparative data for the selected countries. The UK HERD investment has grown steadily since 2000, and until 2006 the UK outperformed EU(15). But the relative scale of UK higher education investment in R&D is small compared to Finland and Sweden among the Nordic countries.

Share of UK Business Expenditure on R&D (BERD) accounted for by foreign firms
Recent research has shown that firm performance requires many forms of investment complementary to traditional R&D.[25] However the latter is still considered important as it underlies technological progress

23. Miles, N., Wilkinson, C., Edler, J., Bleda, M., Simmonds, P. and Clark, J. (2009) 'The wider conditions for innovation in the UK: How the UK compares to leading innovation nations.' NESTA Index Report. London: NESTA.
24. OECD (2008) 'Science Technology and Industry Outlook 2008.' Paris: OECD.
25. Bulli, S. (2007) 'Business Innovation Investment in the UK.' London: Department for Innovation, Universities and Skills.

Table 3: Higher Education R&D as percentage of GDP

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Finland	0.60	0.60	0.65	0.66	0.68	0.66	0.65	0.65	0.64	0.72
Sweden	_	0.82	_	0.84	0.83	0.79	0.77	0.77	0.80	_
Netherlands	0.51	0.49	0.50	0.49	0.52	0.54	0.53	0.63	0.66	_
Norway	_	0.41	0.44	0.47	0.47	0.47	0.46	0.52	0.51	_
UK	**0.37**	**0.41**	**0.43**	**0.42**	**0.42**	**0.45**	**0.46**	**0.47**	**0.47**	**_**
Germany	0.40	0.40	0.42	0.43	0.41	0.41	0.41	0.41	0.43	_
Japan	0.44	0.45	0.44	0.44	0.43	0.45	0.43	0.43	0.40	_
Korea	0.26	0.26	0.25	0.25	0.27	0.28	0.30	0.34	0.38	_
United States	0.31	0.33	0.35	0.37	0.37	0.36	0.35	0.35	0.36	_
China	0.08	0.09	0.11	0.12	0.13	0.13	0.13	0.12	0.13	_
EU(15)	0.39	0.40	0.42	0.42	0.41	0.42	0.42	0.43	0.45	_

Source: OECD Main Science and Technology Indicators

which is the only sustainable way of achieving the long-term productivity growth essential for maintaining international competitiveness. One of the key features of the process of economic globalisation over the last two decades is that R&D in many countries has become more internationalised. Multi National Enterprises (MNEs) are key players in this process accounting for around half of global R&D expenditure and two-thirds of business R&D expenditures.[26] There are many reasons why firms and in particular research-performing firms relocate away from home countries. However one of them is that such decisions are partly driven by the desire to access foreign sources of knowledge.[27] Equally important of course is to acquire the knowledge to customise products and services to meet the needs of foreign markets.

26. Arthur D. Little (2005) 'Internationalisation of R&D in the UK: A Review of the Evidence.' Report to the Office of Science and Technology. Cambridge: Arthur D. Little Ltd.
27. Edler, J., Meyer-Krahmer, F. and Reger, G. (2002) Changes to the Strategic Management of Technology – Results of a Global benchmarking Study. 'R&D Management Journal.' 32, pp.149-164.

Table 4: Percentage of BERD financed by abroad

	2000	2001	2002	2003	2004	2005	2006	2007	2008
UK	**21.5**	**26.9**	**29.7**	**28.1**	**23.4**	**27.1**	**23.0**	**23.2**	**23.5**
Norway	_	8.3	_	8.9	_	10.4	8.8	11.7	11.5
Finland	1.0	0.7	1.0	0.8	1.0	5.3	6.3	5.5	6.0
Japan	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4
Korea	0.0	0.6	0.5	0.5	0.5	0.9	0.3	0.2	0.2
Germany	2.1	2.4	2.4	2.3	2.3	3.3	3.3	3.7	_
Netherlands	15.4	14.4	15.4	15.0	_	17.2	_	14.5	_
Sweden	_	2.9	_	8.1	_	9.1	_	10.5	_
US	_	_	_	_	_	_	_	_	_
EU(15)	8.7	9.6	11.0	10.6	10.0	10.9	10.2	10.8	_

Source: OECD Main Science and Technology Indicators

Table 5: Percentage of BERD financed by government

	2000	2001	2002	2003	2004	2005	2006	2007	2008
France	9.92	8.42	10.33	11.12	11.45	10.11	11.28	10.56	11.97
Norway	_	10.28	_	10.44	_	8.94	10.51	8.66	9.81
United States	8.56	8.37	8.46	8.87	9.73	9.69	9.81	9.87	8.92
UK	**8.81**	**7.84**	**7.07**	**9.63**	**10.18**	**8.34**	**7.56**	**6.81**	**6.58**
Korea	7.00	8.06	6.40	5.32	4.74	4.64	4.74	6.23	5.90
China	6.85	_	_	4.93	4.77	4.57	4.53	4.80	4.30
Finland	3.46	3.41	3.21	3.29	3.66	3.77	3.73	3.46	2.54
Japan	1.70	1.40	1.46	1.39	1.25	1.15	1.01	1.08	0.92
Germany	6.88	6.69	6.16	6.11	5.87	4.46	4.51	4.50	_
Netherlands	5.25	5.16	4.34	3.35	_	3.42	_	2.28	_
Sweden	_	5.80	_	5.87	_	4.53	_	4.31	_
EU(15)	7.74	7.54	7.34	8.02	8.09	6.95	6.96	_	_

Source: OECD Main Science and Technology Indicators

28. HM Treasury (2004) 'Science & innovation investment framework 2004-2014.' London: HM Treasury.
29. Miles, N., Wilkinson, C., Edler, J., Bleda, M., Simmonds, P. and Clark, J. (2009) 'The wider conditions for innovation in the UK: How the UK compares to leading innovation nations.' NESTA Index Report. London: NESTA.
30. OECD (2009) 'Information and Communications Technologies: OECD Communications Outlook.' Paris: OECD.

UK business R&D is heavily dependent on the research spending of foreign firms and the strength of the UK's public research base has been an attractor for foreign firms.[28] Although the data is patchy, Table 4 shows that in the UK the foreign contribution accounted for 29.7 per cent of business sector R&D in 2002 but this has declined subsequently and stood at 23.5 per cent in 2008. Comparator countries appear substantially less dependent on foreign investment in R&D by contrast. Among the Nordic countries, Norway averages around 10 per cent compared to around half that for Finland and Sweden. In Germany the figure stands at less than 4 per cent while in Japan and Korea it is under 1 per cent.

Input indicators to capture the underlying processes

Collaboration can be an important source of knowledge transfer for the innovation activities. Firms can gain important competitive advantages by innovating quickly and efficiently to compete in global market through reduced costs and managing risks by collaborating with suppliers, customers, universities or public sector research organisations. Collaboration enables businesses to tap into ideas and expertise available in national/global networks to resolve challenges, create new products and services. Miles *et al.* (2009)[29] examined two indicators of collaboration: co-authored publications and the intensity of research collaboration drawing upon data from the Global Competiveness Reports. However R&D input data can provide two additional proxies to capture different dimensions of public-private interactions: a government business dimension; and a business university dimension.

Government/Business

Public and private sector research are complementary inputs for innovation. Research in the business sector is closely linked to the creation of new products and production techniques. By contrast public research is important in funding and undertaking basic research where commercial returns may not be immediate. Analysing direct financial flows between government and the business enterprise sector for R&D is an additional way to track interactions between government and industry in the development of the public research base and innovation.[30] Table 5 shows the percentage of Business R&D (BERD) financed by government across selected countries.

While at the base of these figures are underlying institutional differences, there are nevertheless some interesting comparisons. Government financing of BERD in the UK was not too dissimilar to the US although a

Table 6: Percentage of HERD financed by the private sector

	2000	2001	2002	2003	2004	2005	2006	2007	2008
China	32.36	_	_	35.89	37.10	36.70	36.57	35.05	34.57
Korea	15.89	14.26	13.86	13.57	16.13	15.19	13.72	14.15	12.02
Finland	5.57	6.70	6.16	5.82	5.83	6.51	6.56	7.00	7.21
US	7.08	6.49	5.81	5.26	5.08	5.14	5.35	5.61	5.68
UK	**7.10**	**6.03**	**5.58**	**5.17**	**4.86**	**4.60**	**4.78**	**4.54**	**4.60**
Japan	2.50	2.34	2.81	2.88	2.77	2.82	2.94	3.03	2.99
France	2.70	3.07	2.86	2.66	1.76	1.64	1.74	1.63	1.63
Germany	11.63	12.19	11.83	12.60	13.18	14.15	14.20	14.24	_
Netherlands	7.03	7.05	6.66	6.83	_	_	_	7.46	_
Norway	_	5.82	_	4.98	_	4.74	_	4.03	_
Sweden	_	5.44	_	5.28	_	5.08	5.05	4.91	_
EU(15)	6.60	6.82	6.55	6.56	6.55	6.67	6.78	6.78	_

Source: OECD Main Science and Technology Indicators

gap opened up towards the end of the period as government support declined in the UK after 2004. Government support in China was roughly around half that of the US, especially after 2003, whereas in Japan government support was generally under 2 per cent and declining toward the end of the period, while in Korea it ranged from around 5 to 7 per cent over the period.

Business/University

Recently the analysis of university-industry links and their effect on innovation has been characterised by a 'relational' approach, incorporating a variety of bi-directional links and processes for knowledge sharing suggestive of wider benefits of public research for innovation.[31,32] However some element of knowledge sharing and cooperation between universities and businesses can also be inferred from input data. Indeed, in the OECD, business funded an average of 5.3 per cent of the R&D performed in the higher education and government sectors in 2006.[33] Over the last decade, the share of business-funded R&D in the higher education and government sectors increased significantly in a number of countries, but in general business funding only accounts for around 8 per cent of R&D performed in public institutions and universities in most large OECD economies.

Table 6 shows a persistent decline in university R&D financed by UK business so much so that by 2007 it was a full percentage point lower than the EU(15) average. However, compared to several other countries, business support of universities is relatively poor in the UK. In China for example, businesses financed well over 30 per cent of university R&D in all the years for which data is available. In Germany and Korea, business support was between two and three times that obtained in the UK.

Output indicators

The knowledge generated by the public research base has been considered critical to long-term national innovation performance. This knowledge should be seen as complementary to other sources of knowledge from companies or users and is a key driver for the creation of new ideas, some of which have the potential to deliver both innovation and significant economic and social benefits.

Publications

The UK public research base has traditionally been a strong performer in terms of the absolute number of publications and its publication productivity (measured by population or financial resources). BIS (2009),[34] based on an analysis provided by Evidence Ltd, noted that total publications in 2008 stood at 91,273, a 15 per cent increase over

31. Uyarra, E. (2008) 'The impact of universities on regional innovation: a critique and policy implications.' Manchester Business School Working Paper, Number 564. Manchester: Manchester Business School. Available at: http://www.mbs.ac.uk/research/workingpapers/
32. Universities have been re-conceptualised as multifaceted institutional actors in innovation systems with a great potential to contribute to innovation and value creation. See: Mowery, D.C. and Sampat, B.N. (2004) The Bayh-Dole Act of 1980 and University-Industry Technology Transfer: A Model for Other OECD Governments? 'The Journal of Technology Transfer.' 30(1), pp.115-127; Drucker, J. and Goldstein, H. (2007) Assessing the Regional Economic Development Impacts of Universities: A Review of Current Approaches. 'International Regional Science Review.' 30(1), pp.20-46; Varga, A. (2002) Knowledge Transfers from Universities and the Regional Economy: A Review of the Literature. In: Varga, A. and Szerb, L. (Eds) 'Innovation, Entrepreneurship and Regional Economic Development: International Experiences and Hungarian Challenges.' Pécs: University of Pécs Press. Recent research by NESTA has also shown the multifaceted contribution that universities make to the economy in the UK, both as sources of knowledge, and as key centres for economic clusters. See Kitson, M., Howells, J., Braham, R. and Westlake, S. (2009) 'The Connected University: Driving Recovery and Growth in the UK Economy.' London: NESTA.
33. OECD (2009) 'Science Technology and Industry Scoreboard 2009.' Paris: OECD.
34. Department for Business, Innovation and Skills (2009) 'International Comparative Performance of the UK Research Base.' London: BIS.

Table 7: Publication per 100,000 population

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Sweden	196.9	193.8	187.7	217.8	224.2	242.2	247.2	255.2	250.1
Finland	162.5	165.1	161.4	185.0	196.9	210.6	222.8	235.3	238.9
Norway	133.6	128.2	135.1	152.2	163.9	189.5	202.3	219.8	225.2
Netherlands	142.5	138.8	143.5	164.8	175.4	196.1	206.4	211.3	218.1
UK	**137.0**	**128.1**	**129.6**	**144.6**	**150.3**	**162.0**	**172.1**	**178.8**	**177.8**
Germany	97.6	97.0	96.0	109.0	112.4	121.8	124.2	124.5	128.5
US	111.6	109.0	109.3	115.8	108.7	116.0	121.9	124.9	123.3
Korea	35.6	39.6	41.4	52.3	60.8	70.7	80.5	88.7	92.8
Japan	71.5	69.6	69.4	75.3	76.7	82.9	84.1	81.0	79.4
China	3.4	4.5	4.4	5.4	7.9	11.7	13.7	15.2	17.5

Source: SCImago, 2007 – OECD Main Science and Technology Indicators; www.scimagojr.com

the 2003-07 average. However that analysis pointed out that in recent years the share of world publications has declined, falling from 9.3 per cent in 1999 to 7.9 per cent in 2008. Part of the reason for this, a phenomenon also experienced by other Western industrialised countries including the US, was the fourfold publication growth from China. For the following discussion, publication indicators data is based upon the Scopus database[35] rather than the Thomson Reuters database used by BIS/Evidence. Table 7 depicts the total number of publications per 100,000 population. Relative to its size, UK publication output is well placed against the comparator countries, just above the middle of the table, with the Nordic countries and the Netherlands occupying the top positions, although in absolute terms the US, the UK and China were the top producers in 2008.

35. The publication data used for this exercise has been drawn from the SCImago portal (http://www.scimagojr.com) which has developed various bibliometric indicators based on the Scopus® database (Elsevier B.V.) This data cannot strictly be compared with the BIS data mentioned above which has been sourced from Thomson Reuters. However, Archambault *et al.* (2008) has argued that the outputs (papers) and impacts (citations) of Scopus and Thomson Reuters are extremely correlated. See Archambault, É., Campbell, D., Gingras, Y. and Lariviere, V. (2008) 'WOS vs. Scopus: On the reliability of scientometrics.' Book of Abstracts of the 10th International Conference on Science and Technology Indicators, pp.94-97.

Table 8: Publications per million dollars (constant $, base 2000)

	2000	2001	2002	2003	2004	2005	2006	2007	2008
China	18.9	19.2	14.9	15.2	19.2	25.4	27.7	27.2	27.1
UK	**14.1**	**11.9**	**11.1**	**12.4**	**12.7**	**12.6**	**12.8**	**12.8**	**12.6**
Finland	10.6	10.5	9.4	10.3	10.3	11.0	11.4	11.6	11.8
Korea	8.0	8.7	8.8	10.7	_	12.2	12.2	11.3	10.5
Germany	9.5	9.2	8.7	9.8	10.3	11.1	11.1	10.8	10.5
Netherlands	9.6	9.6	9.8	11.3	11.2	11.8	12.3	10.2	10.0
Sweden	_	8.5	_	9.0	9.0	9.9	10.0	10.2	9.7
Norway	_	8.7	8.6	_	9.2	9.9	10.1	9.6	9.4
US	10.3	9.4	8.8	8.8	8.1	8.6	9.0	9.2	9.0
Japan	6.3	6.0	6.2	6.7	6.8	6.9	7.0	6.6	7.1

Source: SCImago, 2007 – OECD Main Science and Technology Indicators; www.scimagojr.com

Table 9: Average annual citation per HERD expenditure

	2000	2001	2002	2003	2004	2005	2006	2007	2008
UK	**36.0**	**31.6**	**31.8**	**37.6**	**38.3**	**37.8**	**36.3**	**35.8**	**32.9**
Netherlands	25.3	26.5	27.7	36.0	34.7	36.4	37.5	31.3	27.6
Finland	25.7	26.3	24.7	28.1	26.5	28.6	28.2	28.7	27.0
Sweden	_	23.2	_	27.2	26.3	29.4	28.3	28.5	25.2
Germany	19.7	19.7	20.0	24.2	26.2	28.8	28.6	29.3	24.6
US	28.1	27.1	26.3	27.7	26.2	26.9	27.1	26.5	22.8
China	13.6	13.1	13.5	16.9	19.7	22.7	25.6	25.9	22.3
Norway	_	20.5	20.7	24.2	25.3	26.6	26.0	23.4	20.3
Korea	10.7	11.9	13.4	17.5	18.0	19.1	17.9	15.9	13.6
Japan	10.0	10.1	10.7	12.5	12.9	12.3	12.5	11.8	11.3

Source: SCImago, 2007 – OECD Main Science and Technology Indicators; www.scimagojr.com

Another way of differentiating between countries' performances is to weigh publications by their cost of production – a simple measure of productivity. By assuming HERD as a proxy for publication cost, Table 8 shows the number of publications per million (constant $, 2000) dollars of HERD expenditure.

By this measure, UK productivity declined marginally from 14 to 13 publications per million dollars between 2000 and 2008. Another interesting feature of this table is that by 2008, apart from the UK and US, all comparator countries for which data exists in 2000 increased their productivities by 2008, with China going from 18.9 to 27.1 papers per million dollars. The UK nevertheless held second position in the table closely followed by Finland and Korea.

The citation profile of the UK publications offers another possible target from which to consider performance. The number of citations to scientific articles is a good proxy of the quality of a country's academic publications. The more citations a scientific publication achieves, the bigger is its impact and relevance. Miles *et al.* (2009), based on limited data from 2000-2002, showed the UK citation to population ratio to be below Scandinavian countries but above Germany and France. Table 9 presents instead the ratio of average annual citations[36] of publications to HERD expenditure.

Of the comparator countries, the UK has a consistently higher citation return from its HERD investment. The 2008 figure of 32.9 citations per million (constant 2000) dollars however is well below the 2004 value of 38.3 per million. In fact 2008 figures for all countries are lower than for 2007, a feature that might be attributable to the 2008 publications not having had time to accumulate citations beyond the publication year. If 2008 data is discounted, then China almost doubled its citation return. The Netherlands came close to matching UK performance in a few years (2003, 2005 and 2006) but seemed to have fallen subsequently, while the Nordic countries finished the period much stronger than they started.

Other Output indicators: Patents, Disclosures, Licences and Spin-offs

The previous section has focused on the research publication but other indicators of knowledge produced in the public research system include university patents and disclosures, university spin-offs and licensing agreements. Some partial data and country/region specific analysis can be found in relation to these issues in the recent academic literature, however systematic cross country analysis has been hindered by limited data availability.

36. Miles, N., Wilkinson, C., Edler, J., Bleda, M., Simmonds, P. and Clark, J. (2009) 'The wider conditions for innovation in the UK: How the UK compares to leading innovation nations.' NESTA Index Report. London: NESTA. Please note that the citation period is usually taken as the publication year plus a further two years window. The SCImago portal provides the citations accumulated up to the end point of 2008. Accumulated citations were divided by the number of years to the end point to give the annual average citation.

Table 10: Patents, Invention Disclosures and Licences

	Patent Applications	Patents Granted	Invention Disclosures	Licences	Spin offs
2000/01	725	188	1,912	238	187
2001/02	896	250	1,146	306	220
2002/03	967	199	1,166	415	199
2003/04	1,222	377	2,710	508	177
2004/05	1,308	463	3,029	4,800	133
2005/06	1,536	577	3,268	5,381	155
2006/07	1,913	647	3,746	2,312	172
2007/08	1,898	590	3,616	2,153	169
2008/09	2,097	653	3,822	2,612	157

Source: www.hefce.ac.uk/pubs/hefce/2010/10_14/10_14a.xls

Miles *et al.* (2009),[37] drawing on the Higher Education Business and Community Interaction (HE-BCI) survey data for the UK universities, identified a generally increasing trend over the 2000-2006 period in applications for and patents granted, in invention disclosures and in the number of licences. The picture for spin-off creations was less clear. The numbers declined after 2001, started to rise again after 2004 but subsequently fell (as did the other indicators) in 2007.

Table 10 presents summary data which has been updated for the 2008-09 period. The latest data shows a 10 per cent increase in patents applied for and granted relative to 2007-08. Invention disclosures increased by 6 per cent while IP licences enjoyed a 21 per cent increase. Spin-off activity however declined again, by around 5 per cent.

The data from the HE-BCI survey can be used to generate other indicators of performance. Table 11 shows the various sources of research income for UK universities and three further measures by which performance can be judged.

As Table 11 shows, the university sector earns over £2 billion annually from its business and community interactions. On average, income grew by 6 per cent per year but this was mainly due to the jump (13 per cent) in income between 2005-06 and 2006-07. After this, annual growth continued, but at a more moderate pace. Of special interest is the relationship between contract and consultancy research and research income. Both of these relationships are important because they reflect the interaction of universities with the private and non-commercial sectors who commission research or consultancy reports. Contract research accounts for as much as 30 per cent of research income and this ratio has increased marginally between 2003-04 and 2008-09. Consultancy contracts account for about one third the value of contract research and the consultancy to research income ratio too has shown a tendency to increase marginally over the period to reach 11.2 per cent by 2008-09.

3.1.3 Summary of UK position

Miles *et al.* (2009)[38] considered a wealth of output, quality and collaboration indicators related to the science base (public research). In this note several more traditional indicators that frame and characterise the public research base were proposed in order to complement those indicators previously considered. Many, but not all, of the indicators chosen were biased towards the input side of the innovation process and it is quite obvious that such indicators by themselves cannot tell the nuanced story of innovation or of all developments in the public research base.

While few scholars would disagree with the view that considerable scientific expenditures required for innovation are outside of R&D,[39] nevertheless R&D-derived indicators remain among the most useful and widely accepted measures of science and innovation at the

37. See Footnote above.
38. Miles, N., Wilkinson, C., Edler, J., Bleda, M., Simmonds, P. and Clark, J. (2009) 'The wider conditions for innovation in the UK: How the UK compares to leading innovation nations.' NESTA Index Report. London: NESTA.
39. Baldwin, J.R., Beckstead, D. and Gellatly, G. (2005) 'Canada's Investments in Science and Innovation: Is the Existing Concept of Research and Development Sufficient?' Economic Analysis (EA) Research Paper Series. Catalogue No. 11F0027MIE – No. 032. Ottawa: Statistics Canada.

Table 11: Sources of University Research Income

Sources of University Research Income	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
Collaborative research	614	587	645	703	713	732
Contract research	655	683	705	823	854	937.
Consultancy contracts	239	248	262	303	343	332
Facilities & equipment related services	91	84	97	98	106	110
CPD	248	306	310	369	393	383
CPD and CE	87	112	126	141	157	176
Regeneration & development programmes	245	230	246	279	244	172
IP income	43	63	63	61	68	124
Total Income	2,222	2,313	2,454	2,777	2,878	2,966
Possible Performance Measures						
Percentage Growth of Income (%)		4.1	6.1	13.2	3.6	3.1
Contract research/Research Income (%)	29.5	29.5	28.7	29.6	29.7	31.6
Consultancy contracts/ Research Income (%)	10.8	10.7	10.7	10.9	11.9	11.2

Source: www.hefce.ac.uk/econsoc/buscom/hebci/#prevsurveys

policy level. The indicators that have been covered do not lead to an overall positive assessment of the UK position. Benchmarked against a number of international countries, the UK does not appear to have devoted similar amounts of resources to R&D investment in all sectors of the economy as its competitors. Moreover there seems to be a declining level of public support for private sector R&D and private sector support of the higher education sector R&D. The extent to which this will affect the UK's future prosperity cannot be determined with any certainty but there may be cause for concern.

On the output side, the public research base has performed creditably. Although a mid-table performer against the comparator countries in terms of publication outputs, the UK was second only to China when its publication output was measured against HERD. Not only does the UK enjoy a higher level of output productivity than most comparator countries, it enjoys a higher citation return on its HERD expenditure, placing it at the top of comparator countries. While there is little data for systematic comparative analysis of other types of public research outputs (e.g. patents or spin-offs), UK evidence indicates that the public research base has been making steady progress in terms of patents, invention disclosures and spin-offs. Moreover, there has been marginal but positive improvement in the share of contract and consultancy research incomes relative to total research income.

3.1.4 Future indicator and data needs

Table 12 below identifies three indicators for the future that will enhance knowledge about not only the science base but how it interacts with the business community.

Recent studies have indicated that a considerable amount of interaction occurs between universities and businesses, and this can be as much formal as informal.[40] The Community Innovation Surveys collect data

40. Hughes, A. (2006) 'University-Industry Linkages and UK Science and Innovation Policy.' Research Working Paper No. 326. Cambridge: University Of Cambridge Centre for Business Research.

Table 12: Indicators for Science base to fill gaps and their characterisation

Indicator (label and short definition)	Gap filled	Explanation Why important, how linked to innovation	Suggested Data Source	Suggested process (who, when, how), requirements	Further comments
Indicators that would need investment in collection exercise in the future					
Share of firms with co-operation agreements with government or higher education	Extent of co-operation between HE or public sector and firms	If EU micro data is accessible comparative evidence can be extracted	European CIS data –Luxemburg		
Number of scientific and technical articles cited in patents	Relevance of public research	Can be used to evaluate the strength and relevance of research for technology	EPO Thomson ISI		
Citations to academic patents	Crude measure of the value		EPO, WIPO		

from firms about the types of cooperation partners they use, including universities, and where are they located. Access to individual country data would, at the very least, allow for a systematic comparative analysis of the patterns of such relationships across European countries.

There seems to be no shortage of reliable output indicators of the Science Base, particularly those that relate to the bibliometrics. In addition to those proposed by Miles *et al.* (2009),[41] the Department for Business, Innovation and Skills, for example, has commissioned annual reports over recent years on the relative international performance and productivity of the science base.[42] The latest of these studies report on around 30 indicators covering research publications, collaboration, post graduate training, the research workforce and output productivity using data primarily from the Thomson Reuters database.

On the other hand, less is known about the international comparative performance of Public Research Base patents and their relative 'value'. For a start there is very little systematic data collection outside of the US (Association of University Technology Managers) and the UK (Higher Education Community Interaction Surveys), the latter of which was reported in Miles *et al.* (2009). Moreover, while there are some academic studies about the university patents and their value, few tend to be inter-country. Two further measures suggested require substantive investment for cross-country comparison, although initial investments could be made into an examination of the UK data. This would involve interrogation of the patent databases such as the European Patent Office or the World Intellectual Property Office to extract patents in which universities are listed as assignees. An analysis of the scientific and technical articles cited in patents can point to the strength and relevance of the research for technology as well as to the globalisation of R&D. An analysis of the citation patterns of university patents can point to their value in a similar manner to research publications.

3.2 Demand

3.2.1 The meaning of demand for innovation

There is an abundance of conceptual and empirical literature stressing the importance of demand and of demand conditions for innovation activity and performance of companies and economies. This literature has stressed that clear signals from the demand side incentivise innovation and reduce uncertainty for innovators.[43] It has further demonstrated that customers provide important input to the innovation process,[44] contributing to the productivity and competitiveness of firms and markets. In

41. Miles, N., Wilkinson, C., Edler, J., Bleda, M., Simmonds, P. and Clark, J. (2009) 'The wider conditions for innovation in the UK: How the UK compares to leading innovation nations.' NESTA Index Report. London: NESTA.
42. See for example Department for Business, Innovation and Skills (2009) 'International Comparative Performance of the UK Research Base.' London: BIS.
43. Mowery, D. and Rosenberg, N. (1979) The influence of market demand upon innovation: a critical review of some recent empirical studies. 'Research Policy.' 8, pp.102-153; also Schmookler, J. (1962) Economic Sources of Inventive Activity. 'The Journal of Economic History.' 22, pp.1-20.
44. Prandelli, E., Sawhney, M. and Verona, G. (2008) 'Collaborating with customers to innovate: conceiving and marketing products in the networking age.' Northampton, MA: Edward Elgar Publishing. Von Hippel, E. (1986) Lead Users: A Source of Novel Product Concepts. 'Management Science.' 32, pp.791-805.

short, demanding consumers are important for stimulating and sustaining competitive and innovative firms.[45]

The link between innovation and demand has two facets:[46] *triggering* demand, whereby signals from the users induce a reaction by the supply side;[47] and *responsive* demand, determined by the willingness and ability to absorb innovations once they are produced. In this latter understanding, demand is not the origin of the innovation, but obviously crucial as an incentive for producers of innovations.[48] Consequently, the marketing literature has put great emphasis on the adoption and the speed of diffusion of innovation as an important positive characteristic of markets.[49] There is a further distinction between public and private demand, which is especially important when it comes to public policy to spur demand.

Empirically it has been shown that demand conditions are crucial for innovation. A survey across a range of sectors in the UK conducted in 2009 found that 83 per cent of respondents asked rated demand conditions as very or fairly important in relation to the innovation process, and thus demand is the third most important framework condition after 'talent' and 'competition'.[50] The potential of demand to trigger – or hamper – innovation has also been shown empirically. Major surveys of service innovation across Europe and the United States[51] and of firms across different sectors[52] showed that the most significant barrier to innovation was in fact lack of demand for innovation. Customers who were unwilling or unable to pay for new services and unresponsive to new service developments were identified as a key barrier to innovation for businesses. Equally, it has been shown that policy measures that improve demand conditions are rated as most conducive for innovation in firms.[53] There are numerous case studies which show how intelligent public procurement can actually trigger innovation and catalyse the diffusion of innovation.[54] Those cases confirm earlier findings that over longer time periods, public procurement triggered off greater innovation impulses in more areas than R&D subsidies.[55] The overall implication is that policies to improve demand conditions may actually be even rather more effective than traditional supply-based policy approaches.[56]

In sum, the more a location is characterised by attitudes, awareness and capabilities in private and public customers that are conducive to absorb novelties in the marketplace (responsive demand) and/or even to induce novelties (triggering demand) for which a greater demand exists, the more it is attractive not only as a sales market, but also as a location in which innovation diffuses quickly and innovation performance is likely to be located. What indicators need to measure as to demand as WFC is not the theoretically endless needs or wants of societies, but what potential buyers actually are *willing* and *able* to buy and how they signal this to the market.

3.2.2 Indicators and data

Attitudes towards technology

A first set of indicators characterises how responsive societies are vis-à-vis innovations. This starts with very general attitudes towards technology and science, which are directly linked to the reception of technology and science-based innovation: the more sceptical societies are vis-à-vis technological novelties, the less likely they are to have a positive attitude to the application of those novelties.

Table 13: Interest in new inventions and technologies – percentage

Percentage of respondents who are very or moderately interested in new scientific discoveries and technological developments	Netherlands	Sweden	Norway	France	**UK**	Finland	Germany
2005	88	88	87	86	**78**	83	84
2010	90	90	89	87	**87**	85	83

Source: EUROBAROMETER, Europeans Science and Technology, Special Eurobarometer 224 and Science and Technology Report, Special Eurobarometer 340, Question 224 – QA1.5; 340-QC1.5

45. Porter, M. (1990) The Competitive Advantage of Nations. 'Harvard Business Review.' 68: 2, pp.73-93; Edquist, C., Hommen, L. and Tsipouri, L. (2000) 'Public Technology Procurement and Innovation.' Boston, MA/Dordrecht/London, UK: Kluwer Academic Publishers; Anderson, R. (2007) Renewing the WTO Agreement on Government Procurement: Progress to Date and Ongoing Negotiations. 'Public Procurement Law Review.' 16:4, pp.255-73.
46. Edler, J. (2009) 'Demand Policies for Innovation in EU CEE Countries.' Manchester Business School Working Paper No 579. Manchester: Manchester Business School.
47. Triggering demand should not be confused with user innovations – the former relates to users sending signals to producers or co-producing innovations with them, the latter characterising innovations that are actually developed, used and often economically exploited by users themselves. This dimension is not included in this report, as NESTA commissioned a separate study published in April 2010 (Flowers, S., Von Hippel, E.V., Jong, J.D. and Sinozic, T. (2010) 'Measuring user innovation in the UK. The importance of product creation by users.' London: NESTA. Available at: http://www.nesta.org.uk/library/documents/MeasuringUserInnovation.pdf).
48. Kleinknecht, A. and Verspagen, B. (1990) Demand and innovation: Schmookler re-examined. 'Research Policy.' 19, pp.387-394.
49. Veryzer, R. (2003) Marketing and the development of innovative new products. In: Shavinina, L.V. (Ed.) 'International Handbook on Innovation.' New York: Pergamon: Elsevier Science Ltd; Tellis, G.J., Stremersch, S. and Yin, E. (2003) The International Takeoff of New Products: The Role of Economics, Culture, and Country Innovativeness. 'Marketing Science.' 22, pp.188-208.
50. Survey done in the context of Roper, S., Hales, C., Bryson, J. and Love, J. (2009): Measuring sectoral innovation capability in nine areas of the UK economy, whereby results on WFC were not included in that report, but cited in Miles *et al.* (2009).
51. Howells, J., Tether, B., Cox, D. and Rigby, J. (2004) Beyond industry-university links: Sourcing knowledge for innovation from consultants, private research organisations and the public science-base. 'Research Policy.' 37, pp.1653-1654.

Table 14: Attitudes to the development of technology despite its potential risks

Percentage of respondents who are in favour of continuing the development of a new technology even if it poses a risk that is not fully understood.*	Netherlands	Norway	Sweden	UK	Finland	Germany	France
2005	41	25	29	**29**	25	23	17
2010	42	40	35	**31**	31	27	14

Source: EUROBAROMETER, Europeans Science and Technology, Special Eurobarometer 224 and Science and Technology Report, Special Eurobarometer 340, Question 224 – QA.15b6; 340 QC7.7

* The exact statement was: if a new technology poses a risk that is not fully understood, the development of this technology should be stopped even if it offers clear benefits. The percentage indicates the share of respondents disagreeing with this original statement

The following table depicts the interest in new inventions and technologies and the attitude towards potentially risky technologies. In the last five years the general attitudes towards inventions and technologies have improved considerably, so that the UK now is on an average level in the peer group.

Table 14 indicates that the UK population shows a medium position when it comes to accepting risky technologies, with a few countries being much less risk averse, such as the Netherlands or Norway.

The *data* for those two variables above is based on the Eurobarometer, a population survey across EU 27 and candidate countries as well as EFTA countries. For our question of broad demand conditions with end consumption as a major dimension, the random sample approach of the Eurobarometer and its comparative nature are in principle suitable. However, the specific data on technology and science is only collected in the Special Survey on Science and Technology that was carried out in 2010 and 2005 only. While it is highly likely that such a survey will be done in the future again, it is not exactly sure when this will be and if the question will be included in exactly the same manner. Thus, for an annually updated report, this data source is not practical. This data, nevertheless, can be an important marker for the general background, included in the first version with an explanatory note and taken up at a later stage.

Consumer Confidence Index – attitude and buying intentions as to innovation

Levie[57] regularly surveys a sample of private consumers in 30 countries and asked three questions to which respondents could answer on a five point scale, ranging from strongly agree to strongly disagree, with 'neither agree or disagree' as neutral answer:

52. Business Decision Limited (2003) 'The Power of Customers to Drive Innovation.' Report to the European Commission. Brussels: European Commission.
53. European Commission (2009) 'Innobarometer.' Brussels: European Commission. Available at: www.proinno-europe.eu/admin/uploaded.../Innobarometer_2009.pdf
54. A detailed synopsis of those cases has been compiled by the project UNDERPIN and can be found at http://underpin.portals.mbs.ac.uk/
55. Rothwell, R. and Zegveld, W. (1981) 'Industrial innovation and public policy: Preparing for the 1980s and the 1990s.' Westport, CT: Greenwood Press.
56. Flowers, S., Von Hippel, E., De Jong, J. and Sinozic, T. (2010) 'Measuring user innovation in the UK. The importance of product creation by users.' London: NESTA.
57. Levie, J. (2010) 'The IIIP Innovation Confidence Index 2009.' Glasgow: University of Strathclyde.

Table 15: Consumer Confidence Index

	2007	2008	2009
Spain	76.0	66.0	64.0
Ireland	66.0	65.0	_
US	58.0	60.0	58.0
UK	**55.0**	**50.0**	**43.0**
Netherlands	38.0	_	38.0
South Korea	_	44.0	34.0
Finland	44.0	42.0	_

Source: Source: Levie, 2010[58]

Note: Data for other comparator countries is not available

1. In the next six months, are you likely to buy a new product or service?

2. In the next six months, are you likely to try products or services with new technology?

3. In the next six months, will new products or services improve your life?

The Confidence Index is the average percentage of people that agree or strongly agree to each of the three statements. The higher the index, the more likely people are buying and using innovations and perceive innovations as something that improves their lives. Table 15 below indicates the position of the UK. The table shows that the relative position of the UK vis-à-vis other comparator countries has not changed, but the index itself, as in other countries, has deteriorated – for 2009 it was considerably lower than for 2008. This, it seems, is a clear result of the change of attitude during recession.

The Levie survey is supposed to be institutionalised on an annual basis, and thus could deliver interesting data for the development over time. It reflects short term buying intentions and can give a good indication as to how general demand intentions for innovation interact with economic cycles. In the absence of a monitoring system on innovation launches and uptake and diffusion of innovations, this is one appropriate, if limited, proxy. Its downside obviously is the limited number of countries that we consider to be interesting comparators to the UK.

Buyer sophistication and firms ability to absorb technologies

A further indicator for the responsiveness of potential buyers is buyer sophistication. This is not so much the attitude to technologies but the ability to understand innovations and to use them. The more buyers are able to comprehend the added value of innovation and to learn how to use it, the more likely they can and will buy innovations. One indicator for this is contained in the Annual Report of the World Economic Forum, which is based on a survey of business leaders within the countries. This indicator is a general, economy-wide, perception-based indicator. It is not built up from sectoral perspectives nor does the information on which it is based include explicitly perceptions of the process and

Table 16: Buyer sophistication: ability of buyers to understand innovation and utilise it

	2005	2006	2007	2008	2009
Japan	_	_	_	5.3	5.2
Sweden	5.5	5.5	_	5.1	5.0
Canada	5.6	5.8	_	4.9	4.7
South Korea	5.5	5.6	_	5.0	4.6
Netherlands	5.5	5.6	_	4.9	4.6
UK	**5.9**	**5.8**	**_**	**4.7**	**4.6**
China	_	_	_	4.8	4.6
US	5.9	6.2	_	5.1	4.5
Norway	_	_	_	4.9	4.5
Finland	5.5	5.6	_	4.9	4.4
Germany	5.4	5.9	_	4.8	4.4
France	5.8	5.8	_	4.8	4.1
India	_	_	_	4.2	3.8
Brazil	_	_	_	3.6	3.6

Source: WEF, 2010 – Global Competitiveness Report. Geneva

Note: Averages, Question: Buyers in your country make purchasing decisions (1 = based solely on the lowest price, 7 = based on a sophisticated analysis of performance attributes)

Table 17: Firm-level technology absorption

	2005	2006	2007	2008	2009
Sweden	6.3	5.7	_	6.2	6.4
Japan	_	_	_	6.3	6.3
Norway	_	_	_	6.1	6.2
South Korea	6.6	5.8	_	5.8	6.1
US	6.3	6.3	_	6.3	6.0
Finland	5.9	6.1	_	6.1	6.0
Germany	5.8	5.6	_	6.0	6.0
UK	**5.3**	**5.3**	**_**	**5.6**	**5.7**
France	5.1	5.3	_	5.6	5.6
Canada	5.3	5.4	_	5.6	5.6
Netherlands	5.0	5.0	_	5.5	5.6
India	_	_	_	5.5	5.3
Brazil	_	_	_	5.3	5.2
China	_	_	_	5.1	4.9

Source: WEF, 2010 – Global Competitiveness Report. Geneva

Note: Ability of companies to absorb new technology (1 = not able to absorb new technology, 7 = aggressive in absorbing new technology)

product aspects of innovation respectively. Table 16 indicates a good medium position of the UK in relation to the available comparator groups of countries. Interestingly, during the economic crisis the assessment of the firm leaders in the UK has only very slightly deteriorated while respondents in most countries have lowered their assessment more strongly. Thus the relative position of the UK has slightly improved in 2009.

A further indicator, from the same data source WEF, is related to buyer sophistication, but focused on firms as buyers rather than general consumption.

The respondents indicated to what degree they thought firms are able to absorb new technology and are actually doing so (Table 17). Here, UK firms receive a weaker assessment as technology buyers than firms in seven out of 14 relevant comparator countries, and this position does not seem to have changed over the last five years of the survey.

The WEF *data* has a set of advantages: it is an annual survey and thus a regular source of data. It further asks concrete questions about demand behaviour in various forms, and thus gives a differentiated picture. It is also done in a broad range of countries with a close scrutiny of methods for all research institutes involved. However, the downside of the data source is that it is entirely based on a subjective assessment of suppliers (which, however, guides their decisions). Further, the overall number of the sample varies considerably for our country sample, ranging from, for example, Germany with 68 respondents to USA with 437 (in the 2009 survey, WEF 2010, p.60-61). Thus, while the samples are stratified for sectors in the countries, the potential sector sample bias is not reported. Potential cultural differences in response behaviour are not accounted for either. Nevertheless, judging from the time series of assessments across a range of countries, the data appears to be reliable over time.

Table 18: Final consumption expenditure of households: share of communication - percentage

	2005	2006	2007	2008	2009
US	2.24	_	2.29	_	2.31
Norway	3.23	3.16	2.91	_	_
Korea	5.09	4.81	4.65	4.52	4.39
Netherlands	4.64	4.66	4.53	4.29	4.19
Japan	3.07	3.12	3.18	3.28	_
Sweden	3.56	3.40	3.33	3.26	3.23
Germany	2.90	2.85	2.84	2.80	_
Australia	2.94	2.83	2.77	2.74	_
France	2.78	2.70	2.70	2.69	2.68
Finland	2.81	2.66	2.57	2.43	2.24
Canada	2.38	2.39	2.35	2.32	2.34
UK	**2.32**	**2.27**	**2.18**	**2.12**	_

Source: OECD, 2010 – National Accounts Database

58. Levie, J. (2010) 'The IIIP Innovation Confidence Index 2009.' Glasgow: University of Strathclyde.
59. The OECD also delivers data on share of private consumption in health technologies, another technology intensive area, as a marker for innovation-friendly demand. However, because of distortion stemming from different health systems, and thus different shares of private consumption of health altogether, this data is not presented here.
60. This is confirmed in recent work undertaken in the research project UNDERPIN, conducted by Edler, J., Georghiou, L., Uyarra, E. *et al.* Available at: http://underpin.portals.mbs.ac.uk

Consumption of technology intensive products

A further measure of innovation purchase behaviour is actual purchasing behaviour of goods that are more technology-intensive. This measure is an approximation only, it does not tell us at what point in the innovation and diffusion curve technology-intensive goods are purchased. A willingness to purchase technology-intensive goods does not equal a willingness to buy it early in the diffusion cycle, to absorb those products when they are new to the market. Nevertheless, a high share of those products in the overall consumption behaviour is a marker for the willingness and ability to buy products in a sector that is characterised by a high level of innovation. Table 18 indicates that UK households show the lowest share of communication technologies in all final consumption of households in key OECD countries. The data is robust, provided though national accounts and compiled by OECD on a regular basis, albeit with some time lag in some countries.[59]

Public procurement

As discussed above, public procurement can be an important catalyst for innovation. However, the data on the link between public procurement and innovation is scarce; current research on public procurement confirms that this is a genuine desiderata[60] (see below). The most relevant, albeit limited (see above) source is the World Economic Forum report, as its survey explicitly asks respondents to rate the degree to which government procurement results in technology innovation. It is not quite clear if this question is to be interpreted as responsive or triggering demand, and equally, the level of government is not differentiated. However, it gives a general indication as to public purchase behaviour and its effect on innovation in firms. The assessment of firm leaders in the UK of the UK government in this respect is poorest out of all comparator countries except for India (Table 19).

This assessment is the more problematic, as the potential for innovation through public procurement, at least in the pre-crisis environment, has been high in the UK, as here the value of public procurement (openly advertised and thus above the EU thresholds) as a percentage of GDP has consistently been highest in all available comparator countries (Table 20). To include this data in the annual reporting system would allow us to assess the consequences of public spending cuts on procurement behaviour more generally, and thus on the potential for public purchase of innovation.

Table 19: Government procurement of advanced technology products

	2005	2006	2007	2008	2009
US	4.7	4.8	_	4.9	4.7
Finland	4.8	4.8	_	4.7	4.7
Sweden	4.3	4.0	_	4.7	4.5
China	_	_	_	4.2	4.5
Canada	4.0	4.2	_	4.1	4.3
Netherlands	4.1	4.2	_	4.0	4.3
Germany	4.6	4.4	_	4.0	4.2
Norway	_	_	_	4.3	4.2
Korea	4.4	4.8	_	5.1	4.1
Japan	_	_	_	3.9	4.1
France	4.6	4.8	_	4.3	4.0
Brazil	_	_	_	3.4	3.9
UK	**4.2**	**4.0**	**_**	**4.0**	**3.8**
India	_	_	_	3.4	3.5

Source: WEF, 2010 – Global Competitiveness Report. Geneva

Note: Average, Company managers were asked to rate if in their country government procurement decisions result in technological innovation (1 = strongly disagree, 7 = strongly agree)

Triggering demand – cooperation with clients in support of innovation

The indicators for demand that triggers innovation by suppliers are extremely poor. There are no systematic surveys done on the share of innovations that are actually triggered by signals from, and co-production with, (potential) users.[61] One proxy for the importance of users is to look at the level of cooperation between firms and clients in the UK compared to other countries and in relation to the cooperation behaviour more generally. This indicator is a marker for involvement of users in the innovation process. The most

61. As stated above, the first systematic study on user produced innovation, whereby users themselves produce the innovation, was commissioned by NESTA. See Flowers, S., Von Hippel, E., Jong, J.D. and Sinozic, T. (2010) 'Measuring user innovation in the UK. The importance of product creation by users.' London: NESTA.

Table 20: Value of public procurement which is openly advertised as a percentage of GDP

	2001	2002	2003	2004	2005	2006	2007	2008
UK	**3.73**	**3.77**	**7.18**	**4.56**	**3.50**	**4.60**	**3.97**	**4.44**
Finland	2.30	2.22	2.52	2.90	3.29	3.06	3.56	3.95
France	2.71	3.12	3.71	2.76	2.98	3.44	3.38	3.69
Sweden	4.56	3.81	3.58	3.33	3.19	3.07	3.09	3.54
Netherlands	2.47	1.82	1.71	1.75	1.60	2.30	1.80	1.87
Germany	0.94	1.26	1.81	1.17	1.61	1.65	1.12	1.19

Source: EUROSTAT, http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tsier090

Note: Based on the calls for tenders published in the Official Journal of the European Communities, values calculated as the product of averages of prices in published calls and the number of those calls

Table 21: Cooperation with clients

Share of companies developing strategic partnerships in support of (their) innovation strategies with:	Finland	Sweden	Norway	France	UK	Germany	Netherlands
Specific customers or clients	58.0	53.0	42.0	37.0	**35.0**	34.0	32.0
Suppliers	51.0	46.0	47.0	45.0	**31.0**	42.0	44.0
Other companies	37.0	33.0	31.0	17.0	**29.0**	26.0	29.0
Research institutes	37.0	21.0	25.0	9.0	**20.0**	8.0	22.0

Source: European Commission (2009): Innobarometer, 2009 http://www.proinno-europe.eu/page/innobarometer, p.46-48

recent data we have is based on a firm survey at EU level (Innobarometer). This shows that the share of companies engaged in user cooperation for innovation strategy support is comparable to France and Germany, but far below Nordic countries, while the share of cooperation with suppliers (whereby the respondent firm is the client, the demander) is lowest in our comparison group. Thus, in sum, cooperation between clients and customers in the UK to support innovation strategies is comparatively low.

A caveat as relates this data source is that those surveys are done with varying research foci and a changing range of questions. Thus, time series of that data are not systematically available.[62] Further, the indicator does not only signal the quality of users to engage and demand innovation, but also the ability and willingness of firms to actually cooperate with them, and as such it is a demand and a supplier measure.

3.2.3 Summary of the UK position

Despite the shortcomings and gaps of the indicators and data discussed above, there still emerges an overall impression that, in relation to the comparator countries chosen, the UK shows a moderate picture as to demand as framework conditions. The attitudes towards science and technology are average in the peer group, and have improved in recent years. During the recession, the overall confidence index has further deteriorated, but the relative position to other countries has remained the same. Equally, buyer sophistication and firm technology absorption are average compared to other countries. Finally, the actual consumption of technology-intensive goods (an example being communication goods) is poor.

The picture, based on the limited data available, is also rather average when it comes to public procurement, where a high potential of public procurement is not materialised, as the firm survey shows the lowest assessment of innovation technology procurement in the peer group. Finally, the very limited data on the importance of users as an innovation source or partner indicates again a slightly below average position. Given the clearly demonstrated importance of favourable demand conditions the argument for more conscious policies to improve those conditions for private and public demand is convincing. To do so, however, better data and indicators would be helpful.

3.2.4 Future indicator and data needs

The search process for this report has shown that data on responsive and triggering demand is in general rather poor. This is clearly confirmed in the latest OECD report on Measuring Innovation[63] where the indicators presented mainly refer to consumption behaviour in specific product areas that are technology intensive. Equally, some of the valuable data we have on EU-level are based on one-off surveys or surveys that are done every four to five years and in doing so change variables rather considerably (Community Innovation Survey, Innobarometer, Eurobarometer). Ironically, those surveys that methodologically are not 100 per cent satisfying, such as the World Economic Forum report, or give a rather vague picture of

62. Equally, the Community Innovation Survey data on cooperation behaviour is available every four to five years only and questions therein tend to slightly change over time.
63. OECD (2010) 'Measuring Innovation: A New Perspective.' Paris: OECD.

Table 22: Indicators for demand conditions to fill gaps and their characterisation

Indicator (label and short definition)	Gap filled	Explanation: why important, how linked to innovation	Suggested Data Source	Suggested process (who, when, how) requirements	Further comments
Indicators that could be gathered in the short term					
Growth of specific schemes such as SBRI, other pre-commercial procurement, forward commitment etc. schemes (budgets spent)	Public demand, triggering	The proactive attempts to spur innovation activities with firms in areas for which public demand is clearly defined and subsequent adequate procurement more likely. Could also include analysis of successful subsequent procurement	Own analysis based on available data on web pages and ERA-WATCH/Trend-Chart sources, linking to on-going EU MIoIR study	Could be an annual update of this data, ideally connected with a telephone survey on key policy makers in national ministries	Once analysis is set up, annual updates would be routine work, but need to be done proactively each year.
Indicators that would need investment in collection exercises in the future					
Share of innovations bought in public procurement	Public demand, triggering	Public demand can be a catalyst for innovation; to know the actual purchasing behaviour of public administrations is key to understanding responsive public demand	Procurers' survey	Regular procurers survey through OGC or the like, every two years; maybe subcontract to a consultancy or university institute to advise on the process	Could be implemented in a cost-efficient way
Share of tender processes using innovation-friendly procedures (e.g. explicitly asking for variances, competitive dialogue, forward commitment etc.)	Public demand, triggering	As above, variants indicate that administrations are actively seeking new ways	Procurers' survey	Regular procurers survey through OGC or the like, every two years; maybe subcontract to a consultancy or university institute to advise on the process	Could be implemented in a cost-efficient way
Co-production of services between public bodies and suppliers	Public demand, triggering	The OECD (OECD 2010) works on indicators and data gathering to understand the extent to which public bodies are engaged in co-production of services (OECD 2010, p.90)	Developed by OECD	Developed by OECD, development in OECD needs to be monitored	
Various variables in potential UK company survey (if a company survey would be done or if module on demand in company survey would be possible, a more concrete list of variables could be developed that would fit into the existing questionnaire structure):					
For example, Survey: private and public buyers as source for innovation	Responsive and triggering demand	There is very little reliable data on the relative importance of consumers for triggering innovation, and the data we have is based on small scale survey of CEOs (WEF)	Any large-scale UK firm survey in future should include demand variables. Problem: not internationally comparable	Depends on the future structure of firm survey; this should be coordinated.	

confidence and intentions (Levie), are more regular, with the WEF even covering all sensible peer countries. Especially poor is the data on triggering demand and on public procurement of innovation. In addition, regional data on the level one would need for demand conditions is scarce and certainly not available in an internationally comparative way.

Table 22 below suggests indicators that could fill important gaps and also potential instruments to do so. One activity that is not mentioned because it has already started is the NESTA-commissioned study on global product launches, a very good indicator for attractiveness of markets for innovation and highly recommended to be part of a future index. For the indicators suggested in the table below the major challenge is the request for international comparison and regional comparison within the UK at least. There are signs of interest at OECD level and at EU level, and there might be a good window of opportunity for joined-up action. However, it will be a challenge to get those instruments up internationally. For the national level, all activities proposed in the table could easily be broken down to the regional level.

The suggestions in the table comprise – as a short-term activity even – policy action (such as S-BRI, forward commitment schemes). Most of the actions, however, would need investment in a survey or in thorough international data gathering. A major means would be a procurer survey to capture procurement behaviour and outcome through a procurer survey as well as introducing a limited set of questions on triggering and responsive demand in firm data surveys within the UK and beyond.

3.3 Business environment and competition

3.3.1 The Meaning of Business Environment and Competition for Innovation

It is generally agreed that the business environment and the extent of competition between firms both increases and reflects the level of innovation in the economy. However, within the area of economic theory that underpins this area of indicator development, there has been some controversy over the question as to what extent competition between firms truly supports competition, with some evidence showing that large firms that are dominant in certain industries achieve high levels of innovation, while in markets where there are many small firms operating and under significant competitive pressure, there is less innovation. Issues central to understanding competition and its relationship with innovation are industry structure, and what type of advantage firms are competing for. One key distinction that has been made to this debate is that between competition working at the level of new products, what has been called 'creative destruction', and competition working within the context of process innovation, termed 'creative accumulation'. Clearly, such competition is different and indicators to measure one form would differ from those to measure the other.

The indicators in this sub-section comprise measures that are created on the one hand from individual firm data right across the economy, and on the other, from samples of firms which those collecting the data have done their best to make representative of the whole economy. The data used to create indicators in this section are from a range of types of data. On the one hand there are indicators based on financial information based on financial returns from companies (after processing by HMRC – with comparator international data from other national tax authorities or other relevant bodies, for example, ministries of finance) and also from interview data of personal opinions and judgements. The ease and cost of collection of data has not been examined here although the issue of availability of data has been reviewed.

3.3.2 Indicator and data

Intensity of local competition

The first indicator suggested is intensity of local competition. The assumption here is that the industry structure affects innovation with more innovation resulting from competition. Research shows that structure does affect competitiveness, and innovation, but there are differences across sectors. This measure is a ranking of countries based on the answers to questions that ask respondents (in this case corporate CEOs) to indicate how strong the competition between firms within a country is on a scale of 1 to 7 with 1 being limited, to 7 being intense. This is a very soft indicator, but the collection process is extensive and includes between 80 and 100 CEOs of large companies in each country. The data is provided by the WEF's Global Competitiveness Report (Table 23).

Table 23: Intensity of local competition

	2010
Germany	6.1
Sweden	5.9
Japan	5.8
UK	**5.8**
Netherlands	5.8
Korea	5.7
US	5.6
France	5.6
China	5.6
Norway	5.5
India	5.4

Source: WEF 2010. Global Competitiveness Report, Geneva

64. ONS (2008) 'First Release: Business Demography, 2007.' Newport: ONS.

The UK scores well on this list, having a high rating. Its position is at number eight out of 193 countries and compares favourably with a number of the usual comparator countries, including the US, Korea and China. The EU countries that do better than the UK are Germany, which is second in the list, Belgium, Sweden and Austria.

Business Entry Rate

Business Entry Rate measures the rate at which new firms enter the economy. It is one measure of the dynamism of the economy. The World Bank provides this in its World Development indicators but other indicator providers also give this information. The indicator is relatively simple to construct and is expressed normally as a percentage where the rate of entry is the number of new registrations of firms divided by the total stock of firms. The data used in the UK has used new business registrations for VAT; to some degree, this indicator does not include all very small firms as some may not enter the VAT system at start-up as their turnover is below the VAT threshold. To this extent, the indicator may lag economic growth and the innovative performance of the economy. Eurostat data uses other classifications for a business, making comparisons between the UK and other countries difficult. In the following paragraph, other issues of classification are noted which are relevant to the business entry rate, business exit rate and measures derived from these indicators.

Business Churn Rate

Business Churn Rate uses the number of firms entering and leaving the economy to reflect the dynamism and change occurring. However, there are choices to be made about whether to use a rate of change in the number of firms entering and exiting, which is gross, i.e. adds the number of businesses that have entered (registered) to the number of firms which have delisted, or to subtract one number from the other to give net rate. The Office of National Statistics[64] First Release: Business Demography 2007 describes the current method of calculating the birth and death of firms. These measures require a large number of assumptions to be made about the status of firms. For example, some firms may not have been wound up but may not be trading. In the UK data, a major change has recently been made to constitute the new series of data on entry and exit from PAYE organisations, i.e. economic units some of which may have no VAT registration but which are in fact contributing to the economy (ONS, 2007). This step may increase the number of business units upon which the indicator is based, but it makes comparison with previous data series difficult.

OECD data, shown below in Table 25, does not use the UK as the UK method is not comparable. Broadly speaking, the indicators show the UK to be better at creating new businesses than other countries, including even the United States.

Table 24: Births, Deaths and Active Stock Indicator

	Active Stock	Births	Rate %	Deaths	Rate %	Churn as Net (Births-Deaths/ Total Stock) %
2000	2,041,280	242,485	11.9	203,275	10.0	1.9
2001	2,084,105	243,430	11.7	211,930	10.2	1.5
2002	2,115,915	242,540	11.5	213,345	10.1	1.4
2003	2,136,405	267,000	12.5	232,385	10.9	1.6
2004	2,158,555	280,080	13.0	243,765	11.3	1.7
2005	2,182,755	274,855	12.6	228,155	10.5	2.2
2006	2,207,290	255,530	11.6	209,050	9.5	2.1
2007	2,301,225	301,595	13.1	228,180	9.9	3.2

Source: Business demography 2007 (2008), Enterprise Births, Deaths and Survival http://www.statistics.gov.uk/pdfdir/bd1108.pdf

Table 25: OECD Comparative Data on Employer Enterprise Death Rate

	2004	2005	2006	2007	2008
Austria	_	8.9	9.5	_	_
Czech Republic	_	11.7	_	_	_
Denmark	10.8	12.0	12.3	_	_
Finland	_	10.6	_	_	_
Hungary	_	11.4	12.0	_	_
Italy	_	9.2	12.5	_	_
Luxembourg	_	11.6	12.9	_	_
Netherlands	_	10.3	_	_	_
New Zealand	13.4	13.4	12.5	12.1	11.9
Norway	_	7.2	7.8	_	_
Slovak Republic	_	14.2	_	_	_
Spain	_	12.3	11.8	_	_
Spain - Andalucía	_	9.2	9.2	5.4	5.7
Sweden	_	_	10.4	_	_
US	10.0	10.0	9.5	_	_
Brazil	12.2	12.4	11.2	_	_
Bulgaria	_	11.1	10.5	_	_
Estonia	_	12.9	15.0	_	_
Latvia	_	11.0	_	_	_
Lithuania	10.0	12.5	_	_	_
Romania	_	16.1	12.6	_	_

Source: OECD Business Demography database; Indicators are broken down by industry using the International Standard of Industrial Classification (ISIC Revision 3) and, for some of them, by employment size-class.

Table 26: EU and EU Countries Birth Rate of Firms

	2006
UK	**12.9**
Germany	10.0
Netherlands	9.8
France	9.4
Finland	8.3

Source: Business economy, Eurostat, SBS

Data on firm birth and death rates is limited in scope and subject to variations because of different national methods. Few country and year comparisons are available through either Eurostat or OECD (see Table 25 for the UK). The general UK position vis-à-vis other countries in Table 26 is strong and shows that the birth rate is relatively high compared with the EU average. The UK is fifth overall. The OCED's SBS data shown above provides for limited comparisons between countries and over time.

As Eurostat notes, differences in national rates are likely to reflect sectoral differences in a national economy because rates are normally low in industrial activities while in business activities, financial services and construction, there are many small business start-ups by single individuals. These birth and date rate indicators and their derivatives can therefore be significantly sectorally biased.

Trade to GDP Ratio

While the two earlier measures consider competition within an economy defined as a national system, other measures of competition consider an economy in a broader context. The Trade to GDP ratio measure gives an indication of the extent to which the UK economy is open to foreign competition. Using the sum of imports and exports divided by twice the GDP,

Table 27: Trade to GDP Ratio, Current Prices, current Exchange Rates

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Netherlands	122	135	129	122	120	125	131	138	141	145	131
Korea	68	74	69	65	68	78	76	78	82	107	96
Sweden	80	87	86	82	80	84	89	94	96	100	90
Germany	58	66	68	67	67	72	77	85	87	89	77
Finland	69	78	74	72	71	73	79	86	87	90	72
Norway	71	76	75	69	68	71	73	75	76	77	69
UK	**54**	**57**	**57**	**55**	**53**	**53**	**56**	**60**	**56**	**61**	**58**
France	50	56	55	53	50	51	53	55	55	56	48
Japan	19	21	20	21	22	25	27	31	34	35	_
US	24	26	24	23	23	25	26	28	29	30	_

Source: OECD Dataset: Macro Trade Indicators. The series of data is then subject to averaging. This shows the UK to be in a relatively low position in the list in terms of the openness of its economy.

Table 28: Net FDI Inflows Relative to GDP (percentage)

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Finland	12.97	5.81	3.80	0.72	7.41	1.04	15.47	-0.27	4.03
Brazil	1.15	1.11	0.72	0.80	0.91	2.14	2.04	3.39	2.64
US	5.81	4.71	1.05	3.03	2.70	6.73	5.88	6.99	2.64
France	3.76	3.40	2.39	1.59	3.96	3.17	3.79	2.26	2.26
Germany	1.23	0.34	1.58	0.98	1.72	1.97	0.98	-0.34	1.80
Netherlands	4.06	3.29	1.84	2.74	1.71	1.72	2.53	2.75	1.65
India	3.34	3.39	2.87	2.84	3.51	2.87	3.95	3.26	1.57
Japan	3.66	1.58	1.48	2.60	7.78	6.32	7.22	3.51	1.14
Sweden	2.99	6.12	2.11	1.52	2.46	3.72	5.13	-1.14	1.08
Norway	1.38	2.66	1.27	-0.36	1.67	1.94	2.33	0.68	1.07
Korea	1.66	0.81	0.58	1.24	0.90	1.82	1.94	2.28	0.94
China	0.15	0.23	0.15	0.17	0.07	-0.16	0.51	0.50	0.23
UK	**0.70**	**0.42**	**0.55**	**1.28**	**0.75**	**0.38**	**0.17**	**0.36**	**0.18**

Source: World Bank Development Indicators Database

the measure is one of the World Bank's World Development Indicators (Table 27).

Net FDI Inflows Relative to GDP
Net FDI Inflows Relative to GDP is a further indicator that shows the extent to which the UK economy is open to competition from outside. This measure assumes that foreign investment within a country generally reflects the commercial opportunities and attractiveness of that country. The indicator is produced by the World Bank, World Development Indicators and is constructed from the investment inflows minus outflows divided by GPD and expressed as a percentage (Table 28).

The UK ranks consistently towards the bottom of this list of 13 countries with only China below in most years while the US is toward the top and has the highest average over all of the years shown. Finland and Sweden are normally towards the top, but have large variations in some years.

New-to-market Product Innovations (an indicator of innovation broader than R&D)
New-to-market Product Innovations are important measures of the innovation performance of the firms in an economy. The measure can be calculated as the proportion of firms in an economy introducing such innovations or as a share of the turnover of the economy attributable to new-to-market product innovations. Either measure shows how innovative are the firms in an economy. The information is currently held within the Eurostat CIS-4 data (Table 29).

On this indicator, the UK is 19th ranked for the SME performance and 24th ranked for large firm performance. Generally the performance of SMEs and large firms is related. Most of the EU comparator countries surprisingly fare better than the UK, particularly given the UK's relatively good performance in the business demography statistics: Germany, Finland, France and even Greece manage top ten or near top finishes in this list. A combined ranking would show the UK next but last to Hungary.

Patents and Trademarks per Capita
Patents and Trademarks Per Capita is a further indicator showing the extent to which an economy is successful in invention and innovation. Trademarks and patents are the forms of intellectual property that can most

Table 29: Firms with new-to-market product innovations by size. Percentage of all firms, 2004-06

	SMEs	SME Rank	Large firms	Large Firm Rank
UK	**12.0**	**19.0**	**21.0**	**24.0**
Norway	14.0	16.0	24.0	20.0
Netherlands	16.0	13.0	39.0	11.0
Germany	18.0	10.0	42.0	9.0
Sweden	22.0	3.0	43.0	8.0
Finland	22.0	4.0	48.0	6.0
France	25.0	2.0	51.0	5.0

Source: Eurostat, CIS-2006, May 2009. For New Zealand: SMEs: 10-99 employees. France: manufacturing only.

easily be associated with innovation and economic growth. This indicator is related to the indicator shown above, investment in intangible assets as a share of GDP, and while it is easier to obtain and has been collected for longer, it may be in the long term a less useful form of indicator (Table 30).

The UK performance on this indicator is stronger but still behind other major EU economies, and indeed lags the EU27 average. It is 16th in the Triadic patent families per capita, while in the cross border trademarks, the UK ranks as 8th in the list.

3.3.3 Summary of the UK position

The indicators presented here show the UK to be in a relatively strong position compared with competitor countries in a number of areas but not all. In terms of the rate of new business formation and business climate the UK is generally strong; but in the areas of IPR generation and international openness (which measures the trade to GDP ratio) the UK is average or below average.

3.3.4 Future Indicators and Data Needs

There is one indicator that could be created relatively easily from existing data sources subject to agreement about methods between the various groups engaged in preparing it. There are however a number of indicators that could be developed given some resource that would facilitate useful comparison with other relevant comparator countries. These two areas are a) the effects of the IPR system on business environment and competition; and b) cost of access to IPR services. These two new possible indicators cover an area of the economic activity which has increasing significance as economies make more use of intangibles, including intellectual property of various kinds including trademarks, design rights and more particularly patents.

The two new indicators proposed here would provide insight into two important aspects of the business environment that influence innovation. The first of these indicators would attempt to reflect the quality and character of the national IPR system, i.e. the wider framework conditions, upon inventive behaviour, and therefore upon innovation activities. A drawback of such an indicator is that, as we move towards the creation of common IPR systems across the EU – there is already an EU patent system and Community Design Right and Trademark – national differences may decline. Thus, if there was some convergence in terms of regulatory and legal frameworks, other factors would then become important influences on IPR generation activity. However, the indicator is meant to constitute a measure of the stimulus provided by the national IPR system to invent, and, as this depends upon other factors, it could show up national differences even where there is a supra-national IPR framework. Such an indicator could therefore be important from a policy perspective. OECD is beginning to

Table 30: Patents and trademarks per capita, 2005-07

	Triadic patent families per capita	Overall Rank	Cross-border trademarks per capita	Overall Rank
Norway	27.1	17	44.4	14
UK	**27.9**	**16**	**64.4**	**8**
France	40.0	13	43.9	15
Korea	48.6	9	19.4	24
US	53.5	8	61.7	9
Finland	62.0	6	42.3	16
Netherlands	63.6	5	68.8	7
Germany	76.0	4	58.0	10
Sweden	87.8	3	73.7	6
Japan	112.7	2	24.2	22
Brazil	0.3	35	2.1	35
China	0.4	34	1.2	38
India	0.2	38	0.2	41

Source: OECD, Patent Database, January 2010; USPTO Trademark BIB ACE Database (Cassis), June 2008 ; OHIM and JPO annual reports 1997-2008 ; World Intellectual Property Organization (WIPO) Trademark Statistics, January 2010.

Note: ranked after triadic patent family per capita

explore this measure and preparatory work has now been undertaken and published.[65]

The second indicator proposed here would measure the cost of access to IPR services. Access to IPR services requires consideration of a wide range of activities, including general advice, prosecution, and potential litigation costs. A UK Intellectual Property Office Research Paper 'Challenges Affecting the Use and Enforcement of Intellectual Property Rights' by Dietmar Harhoff indicates the aspects which could be covered. The cost of access to IPR services (some of which are dependent upon government, some of which on private service providers such as patent agents/attorneys and trademark agents) is an important influence upon inventive activity and upon innovation behaviour. Lower costs for access to the IPR system may indicate a superior service for inventors and innovators, although service quality issues are also vital for innovators.

Investment in Intangible Assets as a Share of GDP

The OECD, following work by Corrado, Hulten and Sichel (2006),[66] proposes the creation of a new class of intangible capital assets that should be included in the System of National Accounts (OECD 2010).[67] Some of these – software, artistic originals and, from 2013, R&D – are already covered in the System of National Accounts, but the wider framework would also include design, business process and organisation, workplace skills and branding.

NESTA has adopted the Corrado, Hulten and Sichel framework (Haskel *et al.* 2009, 2010)[68] and has made significant advances in developing more accurate measurements of these investments in intangibles including implementing a survey of UK firms to gain a more accurate measure of where such investment was taking place (Awano *et al.* 2010).[69] The work includes other important

65. OECD (2009) 'Innovation in Firms: A Microeconomic Perspective.' Paris: OECD.
66. 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.
67. OECD (2010) 'Handbook on Deriving Capital Measures of Intellectual Property Products. Paris: OECD.
68. NESTA Innovation Index reports. See Haskel *et al.* (2009) 'Innovation, knowledge spending and productivity growth in the UK' London; NESTA; Haskel *et al.* (2011) 'Driving Economic Growth: Innovation, Knowledge Spending and Productivity Growth in the UK.' London: NESTA.
69. See Awano *et al.* (2010) 'Investing in Innovation: Findings from the UK Investment in Intangible Asset Survey.' London: NESTA; also Awano *et al.* (2010) Measuring investment in intangible assets in the UK: results from a new survey. 'Economic & Labour Market Review.' Vol. 4, No.7, pp.66-71. The latter measures expenditure on, and the life lengths of, a broad range of intangible assets.

aspects of investment such as the average lifetime of the investment.

A study led by the Chief Economist of the UK IPO has also begun to explore this area with a report due in the first quarter of 2011 on 'IPRs in the Economy' to identify the proportion of intangible investment covered by intellectual property rights. This raises an important distinction between intangible investment, which covers a broad measure of intellectual property used to generate future returns, and IP which is owned and can be traded by its owners. Work so far has suggested that in the area of copyright some investment which should already be covered by the System of National Accounts may need upward revision, reflecting the difficulties faced by statistics offices in gathering data from new assets in emerging industries.

An indicator of knowledge investment should be developed as the technical issues are settled. The rate of increase in intangible assets provides a means of assessing the extent to which an economy is innovative and could be a forward indicator of both product and process development. At present, data collection is from a range of sources, and comparisons are difficult as a common methodology has not been used. In the future though, such a measure could be used. The value of such an indicator is much more than a count of patents of various types; it reflects the value of the IP creation activities within an economy.

3.4 Entrepreneurship and Finance

3.4.1 Entrepreneurship

Attitude towards the risk of business failure
A dynamic economy is based upon its ability to generate new sources of economic activity and value, where entrepreneurs are a key ingredient for stimulating new economic activity as they exploit technological or commercial opportunities that existing firms have failed to spot or act upon. Consequently there are

Table 31: List of business environment and competition indicators to fill gaps

Indicator (label and short definition)	Gap filled	Explanation: why important, how linked to innovation	Suggested Data Source	Suggested process (who, when, how) requirements	Further comments
Indicators that could be gathered in the short term					
None considered appropriate at present					
Indicators that would need investment in a collection exercise in the future					
Cost of access to IPR services	Business Environment and Competition	Cost of access to IPR services requires consideration of a wide range of activities, including general advice, prosecution, and potential litigation costs	UK Intellectual Property Office Research Paper, 'Challenges Affecting the Use and Enforcement of Intellectual Property Rights' by Dietmar Harhoff indicates aspects which could be covered		
Effects of IPR system on inventiveness	Business Environment and Competition	Research is being conducted by the OECD to develop indicators that measure various effects of IPR regulation on the inventive behaviour of firms at sector and country level	'Innovation in Firms: A Microeconomic Perspective.' Pages: 150 ISBN 978-92-64-05620-6 Published: Nov. 2009	If OECD is involved, country coverage should be broad	

Table 32: Fear of failure rate

Expressed as percentage of individuals who see good opportunities to start a business	2006	2008	2009
Korea	_	32.0	23.0
Norway	_	_	25.0
Finland	_	32.0	26.0
US	21.0	28.0	27.0
Netherlands	_	33.0	29.0
Brazil	_	_	31.0
United Kingdom	36.0	38.0	32.0
China	_	_	32.0
Germany	47.0	49.0	37.0
France	50.0	53.0	47.0
Japan	_	_	50.0
Sweden	_	_	_

Source: GEM, 2006, 2008, and 2009

a number of indicators that could be chosen to highlight the viability of an economy to encourage, foster, and support entrepreneurial activity in developing new business entities. Primarily though, the most useful indicators capture entrepreneurial 'perceptions' as these appear to correlate most closely to start-up rate data over significant time series.

Culturally the UK has still some way to go. The emotional perception of unfavourable outcomes and its manifestation as fear in establishing a business is relatively high in the UK, given its relative position in terms of regulatory and administrative barriers, and further examination of indicators around 'perception' appear warranted.

The perception of fear appears to correlate more closely to firm formation than other time series indicators, and examination of the literature supports this assertion.[70] The UK's international standing in this area is above the average for similar EU economies (innovation-driven economies as determined by GEM), but it has some way to go in closing the gap in terms of the leaders (Table 32).

What may appear interesting in the time series data is that the relationship between fear of failure and start-up is non linear, and that there may be threshold levels which, when fear of failure drops below around 30 per cent, deliver significant step improvements in start-up rates.[71]

Over the last decade, fear of failure in terms of business formation has been rising steadily, and at the same time the trend for early-stage entrepreneurial activity has been declining in the context of broadly static regulatory and administrative barriers to firm formation within the UK. However, last year (2009) bucked that trend and saw a marked drop in the fear of failure which in turn drove a slight increase in early-stage entrepreneurial activity (Table 33).

Examination of the data shows that there are consistencies between GEM and Eurostat and the European Entrepreneurship Surveys and therefore there should be confidence in the representation of these indicators.

Barriers to entrepreneurship

Culture is a difficult phenomenon to influence in itself, and therefore from a policy dimension influencers need to be deconstructed across observable domains. The OECD examined barriers to entrepreneurship across a number of areas, from regulation through to administrative burden and barriers to competition. The UK is in the most favourable position overall, and the burden on start-ups is lowest (except New Zealand). However, the

70. Arenius, P. and Minniti, M. (2005) Perceptual Variables and Nascent Entrepreneurship. 'Small Business Economics.' 24, pp.233-247.

71. See US and UK data from the Global Entrepreneurship Monitor Data from 2001. Data series available at: http://www.gemconsortium.org/about.aspx?page=pub_gem_global_reports

Table 33: Fear of failure rate in the UK

2001	2002	2003	2004	2005	2006	2007	2008	2009
30.0	34.0	34.0	33.0	34.0	36.0	38.0	38.0	32.0

Source: GEM survey
Note: Expressed as percentage of individuals who see good opportunities to start a business

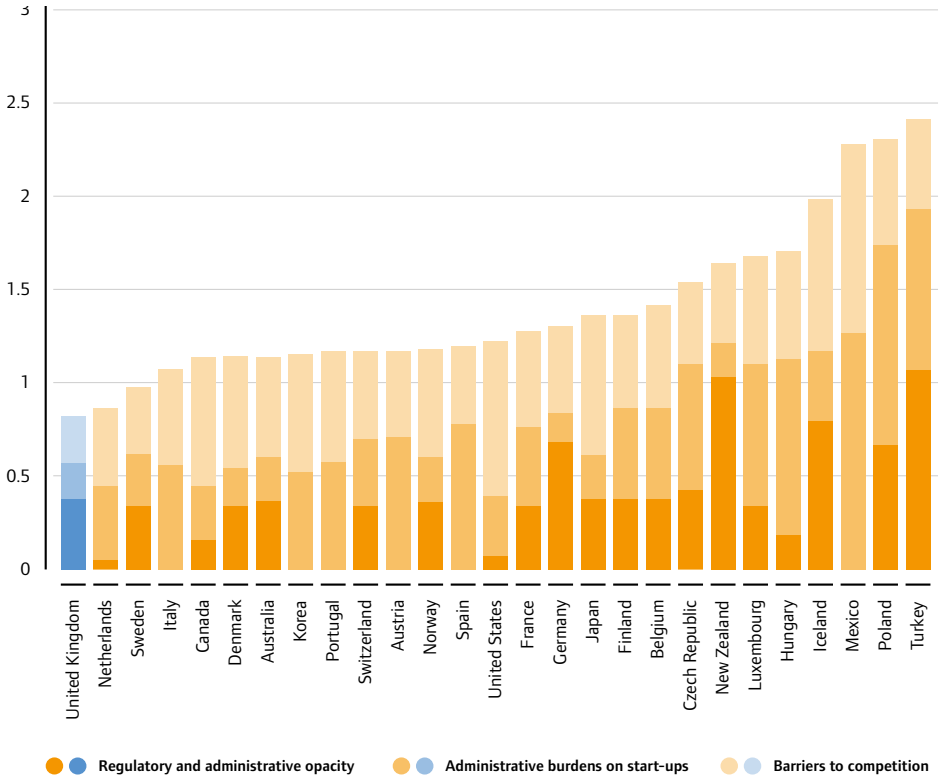
level of regulatory and administrative opacity is high compared to almost all comparator countries (Figure 2).

Time series data on these indicators would also be interesting in the context of start-up rates in the UK.

Early-stage entrepreneurial activity
Early stage entrepreneurial activity is the feeder for future enterprise-related output. Early-stage entrepreneurial activity for those of working age (18-64) appears to be fragile, and closely related to attitude of risk and fear of failure. Therefore, creating a culture that embraces both the opportunities and risks of start-up is critical for sustained economic growth.

A risk-taking culture and favourable conditions for early-stage entrepreneurial activity are essential. The UK's position has been one of decline since 2006, however since the economic crisis commenced in 2009 there

Figure 2: Barriers to entrepreneurship, 2008



Source: OECD, December 2009 – Product Market Regulation Database, http://www.oecd.org/dataoecd/29/13/45188052.pdf Scale 0 to 6, with 6 being maximum barrier

Table 34: Early-stage entrepreneurial activity in the UK

2001	2002	2003	2004	2005	2006	2007	2008	2009
7.7	**5.4**	**6.4**	**5.8**	**6.0**	**5.8**	**5.5**	**5.5**	**5.7**

Source: GEM survey

Note: GEM Adult Population Survey (APS): percentage of people accepting the existence of opportunity for early-stage activity

has been a slight increase in early-stage entrepreneurial activity – correlated to the decline in fear of failure (Table 34).

However using the GEM Measure, Total Entrepreneurial Activity (TEA) overall the UK's position is significantly behind the US, leading EU economies, and the efficiency-driven economies of China and Brazil (Table 35).

This situation is not consistent across the UK, with certain regions like the East of England achieving 7.2 per cent, with Yorkshire and Humberside at 4.2 per cent.[72] What is interesting about regional differences is that entrepreneurial attitudes towards starting a business, and the perceived possession of appropriate knowledge and skills, are less pronounced than actual early-stage formation rates, highlighting a cultural consistency towards business formation in the UK but difficulty in translating that conversion geographically.

Given the importance of early-stage start-up rates, a further consideration is the push and pull effects of economic necessity, given the shifting economic picture in the UK. The UK has been consistent in necessity to opportunity-driven entrepreneurship start-ups, with around 16 per cent of start-up activity based on necessity (GEM average 17 per cent), as opposed to 43 per cent as a result of opportunity (GEM average 56).[73] Given the

72. Global Entrepreneurship Monitor (2008) 'Monitoring Report: United Kingdom.' London: GEM.
73. Global Entrepreneurship Monitor (2009) 'Global Entrepreneurship Monitor: 2009 Global Report.' London: GEM.

Table 35: Early-stage entrepreneurial activity – percentage

	2008	2009
China	_	18.8
Brazil	_	15.3
Norway	_	8.5
United States	10.8	8.0
Netherlands	5.2	7.2
South Korea	10.0	7.0
United Kingdom	**5.5**	**5.7**
Finland	7.3	5.2
France	5.6	4.3
Germany	3.8	4.1
Japan	_	3.3
Sweden	_	_

Source: GEM, 2008 and 2009

Note: GEM Adult Population Survey (APS): percentage of people accepting the existence of opportunity for early-stage activity

Table 36: Necessity and opportunity entrepreneurship

	Opportunity TEA	Necessity TEA
Brazil	9.4	5.9
China	9.4	9.0
US	5.5	1.9
UK	**4.3**	**1.0**
France	3.4	0.6
Germany	2.5	1.3
Japan	2.2	1.0

Source: GEM 2009 APS

Note: Number of Adults [18-64 years old] per 100 involved in a nascent firm or young firm or both (if doing both, still counted as one active person) reporting a NECESSITY motive; ordered by Opportunity

UK's situation of public spending cuts, this picture may shift over the next few years and may require differing policy interventions.

Within the GEM survey, of the 5.7 per cent early-stage entrepreneurial activity, the bias is towards entrepreneurs seeking out opportunities, however, interestingly Germany and the US have a significant proportion of necessity entrepreneurs. Further analysis of sectoral and age differences between opportunity and necessity entrepreneurship may help further inform policy interventions.[74]

3.4.2 Access to finance

Stock market capitalisation

Stock markets are essential in allowing companies to raise capital in exchange for selling equity to investors. The availability of funding and the efficient functioning of markets are essential if companies are to raise risky or significant investment; from early-stage capital through to supporting corporates in financing technological developments through to large-scale commercial acquisitions.

The UK's stock market plays a central role in sourcing both UK and international companies with sources of capital. The composition of the capitalisation of the UK market illustrates its international reach. In 2010 the UK's market capitalisation was £3,780 billion, with UK-based companies taking £1,867 billion.[75] Within the top ten firms, the market capitalisation was £980 billion, of which four UK based firms were valued at £394 billion. This may go some way in addressing the issue of the UK's high ratio of financial assets (relative to GDP) and problems in organisations accessing capital within the UK, especially relative to other EU markets (see Table 37).

The size, as a proportion of market capitalisation and liquidity as indicated by total value traded relative to GDP, shows the UK to have a shifting and mixed position. In terms of market capitalisation the UK is in an excellent position.

Whilst the shifting GDP levels have propelled the UK to the fore in terms of market capitalisation, the situation for liquidity however, in terms of total value of stocks traded relative to GDP, has seen a significant fall, with the UK well behind the US.

Availability of venture capital

Venture capital is seen as crucial in knowledge-driven innovation economies as it provides significant funding for commercially risky early-stage opportunities which may eventually redefine industries and sectors. Venture capital also brings with it networks and support frameworks which guide emerging commercial opportunities.

At an aggregate level the UK appears to be particularly well placed with venture capital investments reaching 0.2 per cent of GDP relative to other countries – although this is a fall back to levels witnessed in the UK around 2003. However, broken down by expansion phase and early-stage, the UK's position in the latter is behind the leaders (Table 39, Table 40, Table 41).

74. Global Entrepreneurship Monitor (2002) Entrepreneurship and Unemployment: Relationships between unemployment and entrepreneurship in 37 nations participating in the Global Entrepreneurship Monitor.' London: GEM.
75. London Stock Exchange data for September 2010. See http://www.londonstockexchange.com/statistics/historic/main-market/main-market.htm for data source and other historical data.

Table 37: Market Capitalisation of listed companies (percentage of GDP)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
UK	**174.4**	**147.2**	**115.6**	**132.2**	**127.9**	**134.1**	**155.5**	**137.9**	**69.6**	**128.6**
Sweden	133.7	105.0	72.1	93.2	104.1	109.0	143.6	132.4	51.8	106.5
US	154.7	137.5	106.5	130.8	138.2	134.9	145.7	142.4	81.7	105.8
Korea	32.2	43.6	43.3	51.2	59.4	85.0	87.8	107.1	53.1	100.5
China	48.5	39.5	31.9	41.5	33.1	34.6	89.3	177.6	61.6	100.5
India	32.2	23.1	25.8	46.6	53.8	66.1	86.3	147.6	53.2	90.0
France	108.9	87.7	66.4	75.3	75.6	81.9	107.2	106.8	52.3	74.4
Brazil	35.1	33.6	24.6	42.5	49.8	53.8	65.3	100.3	36.0	74.3
Netherlands	166.3	114.4	91.7	90.8	88.3	92.9	115.0	122.9	44.4	68.5
Japan	67.6	55.0	54.3	71.9	79.9	104.0	108.3	101.7	65.9	66.7
Norway	38.6	40.4	35.1	42.1	54.7	63.2	83.5	92.2	27.9	59.5
Germany	66.8	56.7	34.3	44.2	43.5	43.8	56.2	63.4	30.3	38.8
Finland	241.1	152.3	102.6	103.5	97.3	107.1	127.8	150.2	57.2	38.3

Source: World Development Indicators – World Bank

When Venture Capital is broken down into more detail by regions in the UK, there are significant shifts across the regions, all except for the London area where the trend has remained pretty consistent. Areas like the North West and East of England have seen a sharp decline in the amount of VC funding relative to firm populations. Examination of the Venture Capital value chain reveals a number of trends for the UK, particularly around seed and

Table 38: Total value of stock traded ratio

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
US	326.3	288.2	243.5	142.5	163.9	171.0	249.5	304.1	253.8	327.8
Korea	200.2	139.5	137.5	106.0	88.5	142.4	140.8	188.1	157.4	190.0
China	60.2	33.9	22.9	29.1	38.7	26.0	60.2	222.3	120.7	179.7
UK	**124.2**	**126.5**	**118.5**	**118.8**	**168.3**	**182.8**	**173.9**	**368.9**	**243.6**	**156.5**
Sweden	158.8	133.9	87.9	84.8	113.9	125.2	169.7	209.5	131.6	96.1
India	110.8	52.2	38.9	47.5	52.6	51.8	67.3	89.8	86.5	83.1
Japan	57.7	44.6	40.2	53.7	74.5	109.8	143.3	148.4	120.3	82.7
Netherlands	175.9	257.9	105.6	98.4	122.6	130.9	161.7	231.7	131.0	76.3
Norway	35.7	30.6	25.5	31.1	52.4	64.5	104.2	121.8	81.7	64.9
France	81.6	80.4	64.1	61.3	68.7	71.1	110.5	131.8	114.4	51.6
Brazil	15.7	11.8	9.6	10.9	14.1	17.5	23.4	42.8	44.4	41.3
Germany	56.3	75.1	61.1	47.0	51.2	63.2	85.3	101.2	84.9	38.5
Finland	169.7	143.1	130.4	99.3	116.5	139.8	171.7	221.1	144.7	38.4

Source: World Development Indicators – World Bank

Table 39: Venture capital investment as a percentage of UK GDP, 1996-2007

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Early-stage	0.06	0.04	0.04	0.05	0.05	0.22	0.02	0.04	0.03
Expansion	0.13	0.13	0.21	0.18	0.31	0.40	0.26	0.29	0.17

Source: Eurostat

Table 40: Venture capital investments as percentage of GDP – expansion phase

	2001	2002	2003	2004	2005	2006	2007	2008	2009
UK	**0.13**	**0.13**	**0.21**	**0.18**	**0.31**	**0.40**	**0.26**	**0.29**	**0.17**
Sweden	0.30	0.16	0.09	0.15	0.24	0.24	0.16	0.21	0.16
Finland	0.05	0.14	0.14	0.05	0.05	0.09	0.08	0.09	0.14
France	0.05	0.06	0.09	0.08	0.07	0.08	0.07	0.10	0.09
US	0.29	0.16	0.14	0.15	0.14	0.16	0.16	0.15	0.08
Netherlands	0.19	0.16	0.09	0.08	0.15	0.09	0.08	0.09	0.08
Norway	0.11	0.06	0.10	0.08	0.11	0.08	0.13	0.09	0.05
Germany	0.08	0.04	0.02	0.03	0.04	0.03	0.03	0.05	0.03

Source: Eurostat

Table 41: Venture capital investments as percentage of GDP – early-stage

	2001	2002	2003	2004	2005	2006	2007	2008	2009
US	0.09	0.04	0.03	0.04	0.04	0.04	0.05	0.05	0.05
Sweden	0.09	0.09	0.06	0.08	0.05	0.06	0.07	0.05	0.04
Finland	0.10	0.07	0.06	0.03	0.04	0.03	0.04	0.03	0.03
Norway	0.03	0.04	0.03	0.02	0.03	0.01	0.07	0.04	0.03
UK	**0.06**	**0.04**	**0.04**	**0.05**	**0.05**	**0.22**	**0.02**	**0.04**	**0.03**
France	0.04	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02
Netherlands	0.04	0.04	0.01	0.01	0.00	0.01	0.02	0.04	0.02
Germany	0.06	0.03	0.01	0.02	0.01	0.01	0.02	0.02	0.02

Source: Eurostat

start-up funding, with that gap being filled by Secondary and Management Buy Out activity.

Further information on the economic rates of return and funding windows (time to realise exit) across venture funding may explain these changes in funding investment choices over the last three years. Indeed, research has highlighted that within the UK, shorter-term investments of around 3-4 years witnessed

Table 42: Average and total amount invested by stage (UK)

Financing Stage	Average amount invested (£000s)			Total Amount Invested (£m)		
	2007	2008	2009	2007	2008	2009
Seed	265	160	135	16	12	5
Start-up	1,042	1,277	182	174	160	10
Other early stage	430	516	672	244	187	137
Late stage venture	_	_	1,565	_	_	144
Total early stage	**865**	**636**	**763**	**434**	**359**	**296**
Expansion	117	2,482	3,389	947	2,050	1,064
Bridge financing	5,593	464	476	190	17	10
Total expansion	**1,290**	**2,396**	**3,206**	**1,137**	**2,067**	**1,074**
Replacement capital	24,512	3,601	833	2,549	141	5
Secondary buy-out		13,937	4,167		767	25
PIPE	4,187	2,050	2,667	91	4	8
Refinancing bank debt	2,019	5,841	14,400	29	199	216
Total replacement capital	**17,111**	**8,536**	**8,467**	**2,669**	**1,111**	**254**
MBO	11,476	6,431	16,683	7,173	3,048	1,051
MBI	7,722	4,499	2,000	347	86	16
Total MBO/MBI	**11,224**	**6,357**	**15,028**	**7,520**	**3,134**	**1,067**
Public to private	1,591	10,720	7,000	212	1,886	21
Rescue/turnaround			636			14
Other			4,529			231
Other late stage	**1,591**	**10,720**	**3,500**	**212**	**1,886**	**266**
Grand total	**9,002**	**3,844**	**3,546**	**11,972**	**8,557**	**2,957**

Source: BVCA, 2009- Private Equity and Venture Capital Report on Investment Activity 2009

around 2002 is no longer the norm, with investment windows now averaging six years. As a consequence of risks involved over the extended funding window, the paucity of early-stage investment, and exit timelines in the UK, further indicators would be particularly interesting at informing more appropriate policy strategies to encourage early-stage capital flows (Table 42).

Access to finance

Access to finance is one of the most constraining elements of doing business in the UK, according to the latest WEF 2010 Global Competitiveness Report, and therefore merits particular attention. The ability for enterprises to access finance is critical. Finance provides the means by which firms can invest funds strategically beyond the boundaries of their own means (working capital). Access requires finance to be available efficiently and at levels which met the commercial requirements of the investment. In the UK the position appears to have worsened; whilst this is consistent with other countries, the UK's position is slightly more marked – dropping from 3.5 in 2008.

Table 43: Ease of access to loans

	Finland	Norway	Sweden	China	N'lands	US	France	India	Japan	Brazil	Germany	UK	Korea
2010	4.5	4.4	4.2	3.7	3.7	3.4	3.4	3.3	3.1	2.8	2.8	**2.7**	2.1

Source: WEF, Global Competitiveness Report

Note: Averages; the indicator measures how easy it is to obtain a bank loan in your country with only a good business plan and no collateral? [1 = very difficult; 7 = very easy]

Table 44: Venture capital availability

	Norway	Finland	Sweden	China	US	N'lands	Germany	France	India	UK	Japan	Brazil	Korea
2010	4.3	4.2	4.0	3.9	3.8	3.7	3.7	3.2	3.2	**3.0**	2.8	2.6	2.2

Source: WEF, Global Competitiveness Report. Geneva

Note: Averages; the indicator measures how easy it is for entrepreneurs with innovative but risky projects to find venture capital? [1 = very difficult; 7 = very easy]

Table 45: Ease of access to local equity markets

	France	India	Norway	Sweden	China	Japan	US	UK	Finland	Germany	Brazil	Korea	N'lands
2010	4.8	4.7	4.6	4.4	4.4	4.4	4.1	**4.1**	3.9	3.9	3.9	3.8	3.7

Source: WEF, Global Competitiveness Report, Geneva

Note: Averages; the indicator measures how easy it is to raise money by issuing shares on the stock market in your country? [1 = very difficult; 7 = very easy]

This is linked to a 22 per cent spike in company liquidations in the UK, rising from 15,535 to 19,077 in 2009.[76] Further statistical information on insolvency rates, and the perception of insolvency protection of other countries, would place into context the sensitivities of the UK's market relative to other leading economies (Table 43).

This position for venture capital availability is similar, in that the UK's absolute and relative position has slipped, and is now behind that of Germany (Table 44).

In terms of ease of access to local equity markets, the UK has managed to hold some ground, with the picture not changing that much since the last survey (Table 45).

It does appear that the UK needs to improve its access to finance position. Whilst it is acknowledged that the problem is global, the situation in the UK appears to have slipped in its relative position in the last year. Further information on the default rates of UK companies in terms of loans, relative to other countries, would merit further attention. If default rates are increasing, it may go some way to explain the increasing difficulty in accessing finance, justified potentially against easier insolvency regulations in the UK.

3.4.3 Summary of the UK position

Overall the picture is moderate to positive. The UK fares well compared to large European competitor countries, but has some gaps to the US or the fast-growing economies. In the UK the barriers to entrepreneurship are perceived as being low compared to peer countries. However, the share of companies indicating a fear of failure rate – as a measure of risk

76. Data taken from the Insolvency database series at: http://www.insolvency.gov.uk/otherinformation/statistics/historicdata/HDmenu.htm)

aversion – has a medium position in the UK, and is lower than in Germany, France or Japan, but significantly higher than in countries such as Sweden, Norway, South Korea or the US. This corresponds markedly with the actual early-stage entrepreneurial activity, where the UK has a medium position, far better than Japan or Germany, for example, but far behind US, Netherlands, let alone Brazil and China. Interestingly, the crisis year 2009 has seen a *drop* in failure rate and a rise in entrepreneurial activity in the UK. Further, the share of start-ups that are actually opportunity driven (rather than necessity driven) is higher in the UK than in the other large EU countries, but lower than in the US, Brazil and China. As regards administrative burden on entrepreneurship, the UK is in the most favourable position overall, and the burden on start-ups is lowest (except New Zealand). However, the level of regulatory and administrative opacity is high compared to almost all comparator countries.

As for access to finance for UK companies, the UK has a moderate to poor standing. The market capitalisation of listed companies is actually highest out of all comparator countries. For venture capital, the UK has an interesting position, as the country is best placed when it comes to the financing of the expansion phase of companies, but has only a very moderate position for the financing of early-stage firms. Overall, the ease with which UK firms can get loans and venture capital is rated very low in a global CEO survey compared to almost all comparator countries, and the assessment has become worse in recent years. This appears to have a particularly compounding effect for early-stage businesses that may be more capital-intensive and require financing.

3.4.4 Future indicator and data needs

As for entrepreneurship, there are two indicators that are currently published by the OECD but not available for the UK which would appear to be important. The first is the share of new firms in manufacturing and services. Recently the OECD has been collecting data on one and two year old enterprises in manufacturing and services. Replicating this indicator with the inclusion of UK data would illustrate the ecology of early-stage enterprise activity and the ability of an economy to support new entrants which are more or less capital-intensive.

The second set of indicators concern high-growth 'gazelle' entrepreneurial activity. The importance of high-growth and gazelle enterprises is growing in importance, with recent literature highlighting that high-growth businesses support a disproportionate number of new jobs and that they are more robust through recessionary periods.[77] This supports the findings of NESTA that found 6 per cent of UK businesses with the highest growth rates generated half of the new jobs created by existing businesses between 2002 and 2008.[78] Also, NESTA's work on the growth dynamics of firms across the EU and US explores the UK in terms of its ability to foster and support high-growth enterprises which have been seen to make a significant contribution to the US in terms of new jobs and robust sales growth.[79]

Furthermore, one important gap to fill would be around early-stage economic viability. In terms of fear of failure, regulatory and administrative burdens, and access of finance, the UK has mixed performance positions relative to leading countries in these areas. None of the indicators presented to date cover the economic fundamentals of start-up costs, regardless of trading activity. Early-stage economic viability would consider the expense of business start-up and regulatory costs in the UK, and help reveal if there are any particular areas of concern. The problem with this is that the indicator would have to cover a significant number of cost variables per country, such as: company incorporation costs; typical costs of submission of audited accounts; business rates; tax liabilities; typical office/space charges per square meter; minimum wage rates and salary rates for recent graduates – with these fluctuating significantly across the country as a whole. These rates could be normalised against a given commodity in the country to take account of cost of living differences, however comparisons still may be difficult and the development of a robust compound measure problematic. The mainstay of indicators around early-stage entrepreneurial activity are perception-related. Here an economic viability indicator could be related to, or explore, perceptions of expenses in early-stage start-up activity.

A further important indicator would be global market penetration by SMEs. The ability of SMEs to access international markets is a significant contributor to securing diversity in customers, thus contributing to the long-term economic success of a business. Within the EU, barriers to international trade have been reducing for a number of years, and within a global context, the ability to trade more internationally through ICT enablers have

77. Henrekson, M. and Johansson, D. (2010) Gazelles as job creators: a survey and interpretation of the evidence. 'Small Business Economics.' 35, pp.227-244.
78. NESTA (2009) 'The Vital 6 per cent: How high-growth innovative businesses create jobs and prosperity.' London: NESTA. Available at: http://www.nesta.org.uk/publications/reports/assets/features/the_vital_6_per_cent
79. NESTA (2010) 'Growth Dynamics: Exploring business growth and contraction in Europe and the US.' London: NESTA. Available at: http://www.nesta.org.uk/library/documents/Report-62-GrowthDynamicswebv2.pdf

80. See Office of National Statistics, at: http://www.statistics.gov.uk/cci/nugget.asp?id=198).

81. See Anyadike-Danes, M. *et al.* (2009) 'Measuring Business Growth.' London: NESTA; also Mason, G. *et al.* (2009) 'Business Growth and Innovation.' London: NESTA. These reports are summarised in NESTA (2009) 'The vital 6 per cent.' London: NESTA.

also reduced barriers. Also, recent Sterling devaluations relative to the Dollar and Euro have made UK exports more favourable. Consequently, in 2010 there was a 4.2 per cent rise in manufacturing output, with machine and equipment manufacturing reaching a 16 per cent growth in output.[80] However, there is still someway to go before manufacturing output levels return to those of 2007/8.

Further investigation of these figures, and the contribution SMEs are making, does warrant investigation as the propensity for businesses to export goods illustrates internationally competitive products and services.

Eurostat currently collects data on trade statistics on intra-EU trade amongst SMEs (dispatches and arrivals). In 2007 data showed

Table 46: List of WFC Entrepreneurship and Finance indicators to fill gaps

Indicator (label and short definition)	Gap filled	Explanation: why important, how linked to innovation	Suggested Data Source	Suggested process (who, when, how) requirements	Further comments
Indicators that could be gathered in the short term					
High-growth early-stage entrepreneurial activity	Entrepreneurship	Gazelles, or high growth businesses support a disproportionate amount of new job creation[81] – they are also robust through recessions – newness appears a more significant variable than size or sector.	Data has been collected by the OECD and ONS, split between growth of jobs or finance. Data collection on-going.	Further review of literature to examine the stability/ contribution of these companies. Work already undertaken by NESTA in this area.	See forthcoming Eurostat data. OECD data for 2005. Regional data for gazelles.
Indicators that would need investment in collection exercise in the future					
Early-stage economic viability	Entrepreneurship	There are intrinsic costs related to establishing businesses. The higher and lengthier the costs, the greater barrier to firm formation. This relates to risk perception and accessing finance. Due to problems in commensurability, survey may consider entrepreneurs' perception of costs.	Costs of creating a business: fees of incorporation; taxes; audit costs; fees to dissolve entity; minimum wage and graduate costs etc. Data could be formed from some existing metrics – to develop a compound measure.	Data review of OECD, Eurostat and Treasury Reports.	Data collection on-going, with a review of existing metrics and reports.
Global market penetration by SMEs	Entrepreneurship	The ability of SMEs to access global markets. Through ICT SMEs now have reduced barriers to sell products and services globally. However, regulatory, cultural and administrative barriers still remain.	Internationalisation of European SMEs – 2010. Barriers and drivers to international trade – OECD Report 2009.	Eurobarometer. EU coverage with data 2006-2008.	Actual database range to be agreed.

that small and medium sized enterprises (SMEs) accounted for a considerable share of total intra-EU trade. Indeed, SMEs (1-249 employees) stood for 55 per cent of trade value for arrivals (imports from another EU Member State) and 43 per cent of trade value in dispatches (exports to another EU Member State). However, this data series did not include the UK.

In supporting this aggregate level indicator, further information on what prevents or enables SMEs to export would also be welcomed and help explain the UK's standing. In research conducted by the OECD (2009),[82] the most significant barriers to SME trade were identified as:

1. Shortage of working capital to finance exports and identify foreign business opportunities.
2. Limited information of foreign markets.
3. Inability to contact overseas customers/ reliable representation.
4. Lack of managerial time/capabilities to deal with internationalisation.
5. Competitor pricing.
6. Government assistance.
7. Transportation costs.

Within the literature 1, 3, 4 were cited as being the most significant. Therefore, examination of the exporting trends of SMEs, and potential barriers, would appear fruitful developments in understanding the UK's international trading capabilities.

3.5 Infrastructure and Services

The coverage of this group of indicators has been particularly difficult, as this is the newest area where indicators have been developed. There are many efforts to develop new data and analyses but much that is non-standardised, experimental, or owned by consultancies and therefore it is difficult to determine its quality. While our review of this field has been extensive there may be lines of development that have not been fully covered.

3.5.1 Indicator and data

Services – knowledge intensive business services

There is a considerable body of literature arguing that knowledge-intensive business services form crucial inputs to production, alongside more conventional labour, equipment and raw materials. Several innovation researchers argue for KIBS as agents of innovation – as well as providing an additional means for knowledge transfer in an economy (an alternative to labour mobility, in fact). Various statistical enquiries have found positive relationships between the use of KIBS by different industrial sectors and these sectors' growth rates; and between the share of KIBS in regional economies and the performance of these regions.

To take a recent example of this literature, The European Cluster Observatory's 2009 Priority Sector Report on *Knowledge Intensive Business Services*[83] reports analyses concluding that: "Regions with strong KIBS sectors exhibit the highest prosperity levels in Europe". and that: "the presence of a strong KIBS sector positively affects regional innovation performance (patenting)." (p.1). The data that this report provides (p.2) to support these claims demonstrates striking trends. Economic geographers have long argued for the importance of access to local business services in supporting industries, and there have been some efforts to build measures of regional (dis) advantage using indicators of such access.

The European Cluster Observatory dataset[84] provides statistics on KIBS employment (disaggregated into the groups IT services, education and knowledge creation, financial services, and business services). These data can be weighted in the figures by national or regional employment totals, as appropriate. For regional analysis, in particular, the ECO presents data in terms of Specialisation: how far a particular cluster category (KIBS is one such) is more intensive in a region as compared to Europe in general. The argument is that high specialisation means that the economic effects of the regional cluster are strong enough to attract related economic activity from other regions to this location, with the implication of stronger spill-overs and linkages. (This is certainly more plausible for KIBS than for sectors based on geologically-dependent natural resources, for example). However, in Table 47 we just present national aggregate information for 2009: for regional maps and

82. OECD (2009b) 'Top Barriers and Drivers to SME Internationalisation.' Report by the OECD Working Party on SMEs and Entrepreneurship. Paris: OECD.
83. Europe INNOVA (2009) 'Knowledge Intensive Business Services.' Brussels: Europe INNOVA.
84. See http://www.clusterobservatory.eu

Table 47: Share of employment in KIBS, 2009

	Business Services	IT services	Education and Knowledge Creation	Financial Services	Total
UK	**5.73**	**0.93**	**2.97**	**3.58**	**13.21**
Germany	4.33	1.45	1.75	4.53	12.06
France	4.09	0.82	1.10	5.01	11.02
Netherlands	3.98	1.00	2.36	3.61	10.95
Finland	4.79	1.93	0.58	3.16	10.46
Norway	3.09	1.00	2.80	2.27	9.16

Source: European Cluster Observatory database, at http://www.clusterobservatory.eu Ordered by share of IT services

time series, data can be accessed through the European Clusters Observatory website.

The UK emerges as high in the supply of KIBS Business Services (and in education and knowledge creation services), but in a medium position in 'financial services' and a rather low position in IT services. It will be necessary to inspect data for individual services subsectors in more detail to make more sense of this.

It should be possible to extend these analyses to the USA and Canada (whose NAICS industrial code is comparable to the European NACE code used for this study).

Creative industries and milieux

There is a large literature – much with a regional or city-level focus – arguing that innovation is supported by creative environments. The most famous author here is Richard Florida, but other researchers have focused on creative industries. Part of the argument from Florida and those in his wake is that some environments are more attractive to innovative people and their organisations, and that one of the key elements of this is the availability of cultural facilities and creative workforces. The ECO website (see above) has used a standard definition of creative industries to process data on employment, again making

Table 48: Employment in Creative Sectors, Share of Employment in 'Standard Sectors'

	Advertising	Artistic creation and literary creation	Museums and preservation of historical sites and buildings	Printing and publishing	Radio and television	Retail and distribution	Software	Total creatives
Sweden	0.94	0.81	0.05	1.51	0.49	0.23	1.95	5.98
Finland	0.55	0.66	0.01	1.71	0.55	0.22	1.72	5.40
Netherlands	0.55	1.15	0.35	1.59	0.22	0.36	0.87	5.09
UK	**0.30**	**0.90**	**0.33**	**1.13**	**0.42**	**0.36**	**0.78**	**4.21**
Norway	0.27	0.58	0.68	1.10	0.38	0.21	0.91	4.13
Germany	0.40	0.55	0.10	1.08	0.27	0.20	0.81	3.41
France	0.55	0.60	0.11	0.81	0.40	0.20	0.50	3.17

Source: European Cluster Observatory database, at http://www.clusterobservatory.eu
Note: Ordered by the 'total' column.

this material available by country and region in the EU.

The ECO data covers a set of creative industries: Advertising; Artistic creation and literary creation; Museums and preservation of historical sites and buildings; Printing and publishing; Radio and television; Retail and distribution (related to the creative industries); and Software (Table 48). Software is, we would argue, more relevant as a KIBS than as a creative industry (with the exception of videogames production), and indeed it features among the IT services. It is included in the table below, and the aggregation of data to provide a 'creative total', for the sake of completeness, but we would suggest it be handled as a KIBS only in future work.

In terms of overall creative workforce, we see the UK at the top end of the distribution, with a higher proportion of such workers (and implicitly, such industries) than other large countries like Germany and France. This disguises considerable variation across subsectors. The UK is relatively low compared to the other large countries in terms of employment in advertising. In terms of software, the UK lies just behind Germany, and well ahead of France. In contrast the UK is high in terms of artistic creation, museums, printing and publishing, radio and TV, and related retail and distribution. Some smaller countries appear as high performers in terms of the share of creatives across several or many sectors, but in most respects the UK emerges as a particularly attractive milieu – if the presence of such workers is indeed a good indicator.

Comparable data could be produced for North America, but we should note that the ECO data can also be examined in terms of regions. The arguments about creative milieux generally deal with geographical scales considerably below that of the nation state – the city region being a familiar example – and this raises a number of issues. In many countries the capital city is overwhelmingly the location of creatives, so it might be appropriate to compare capital cities. However, in the UK, creative work seems rather more dispersed over several cities than most EU countries.[85] The availability of cultural facilities on a wide basis could itself be seen as a WFC.

Communication networks

Framework conditions are conceptually distinct from the performance they should be facilitating. (Just as we routinely distinguish between opportunities and outcomes, in discussions of equality, for instance.) Indicators can be differentiated accordingly, in principle. In practice, as so often, matters may be not so simple.

One example of this is so familiar that it has been granted the status of a law, 'Metcalfe's Law'.[86] The essence of this is that the value of a network is a function of the number of others engaged in the network, other things being equal. To be the only possessor of a telephone or member of a social networking community is not of any great benefit. To be able to link with thousands of other relevant people may be of considerable value (especially if there are directories or more sophisticated tools for locating exactly the right set of people with whom to establish contact). The implication is that access to networks is only a partial indicator; the level of use of the network may also be a framework condition, as well as evidence of the exploitation of this condition. Regional innovation capabilities, for instance, may be greater if more innovation actors in the region are already online – because this renders more innovation contacts accessible to a would-be innovator.

Data on access to Broadband networks has been covered in the earlier study of Framework Conditions. In Miles *et al.* 2009,[87] the 'openness' indicators include Broadband penetration, Broadband speed, Broadband price, and Business satisfaction with ICT infrastructure. Information on these dimensions continues to be developed and updated by various authorities, though problems of international comparability should not be minimised.

One important development in the last years has been the growth of the mobile internet, with Wi-Fi and 3G networks becoming ever more intensively used for business communication purposes. (Note: we have so far been unable to locate anything like adequate data concerning Wi-Fi use, though there are many compilations of intelligence on 'hotspots' and areas of free access – it should be possible with some effort to create statistics from these.) It is rare to take a train journey or plane flight without observing the use of Blackberries, iPads, and similar devices for email exchange and web browsing. How far this supports or hinders innovation is a matter of speculation. One line of argument is that 'black holes' in which we are temporarily spared incessant chatter actually allows us to reflect and engage in free creative thought. The opposing view is that being deprived of instant communication removes external sources of

85. See Clifton, N. (2008) The 'Creative Class' in the UK: An Initial Analysis. 'Geographical Annals.' B 90 (1), pp.63-82; Clifton, N. And Cooke P. (2007) The 'Creative Class' in the UK: An Initial Analysis. Centre for Advanced Studies: Regional Industrial Studies Research Report 43. Cardiff: Centre for Advanced Studies. More recently a major NESTA study of these issues is Chapain, C., Cooke, P., De Propris, L., MacNeill, S. and Mateos-Garcia, J. (2010) 'Creative clusters and innovation.' London, NESTA; with background material at De Propris, L., Chapain, C., Cooke, P., MacNeill, S. and Mateos-Garcia, J. (2009) 'The Geography of Creativity.' London: NESTA.

86. Reed, D. (2001) The Law of the Pack. 'Harvard Business Review.' February 2001, pp.23-24.

87. Miles, N., Wilkinson, C., Edler, J., Bleda, M., Simmonds, P. and Clark, J. (2009) 'The wider conditions for innovation in the UK: How the UK compares to leading innovation nations.' NESTA Index Report. London: NESTA.

Table 49: 3G cellular mobile adoption – percentage

	2007
Korea	100.00
Japan	82.07
Sweden	22.00
Australia	21.45
Finland	17.11
UK	**17.02**
Germany	8.96
United States	0.22

Source: OECD, 2009 – Communications outlook

stimulus and validation of ideas. Since each view has its merits, we conclude that the situation is not clearcut; but that if access to broadband is taken seriously as a framework condition, then so should access to wireless communications.

Relevant data are provided in OECD Communications Outlook 2009[88] 3G cellular mobile adoption rates, though these are not specifically business users (and we would anticipate business/consumer use ratios to vary across countries). It would be possible to infer business use on the basis of any evidence on the proportion of businesses/business users using mobile telephony in general, though there are clear risks attached to this. Data is provided by the OECD for 21 countries, for 2007 (Table 49). The rapid pace of change in mobile communications means that we should be cautious in assuming that these are stable rankings. The low ranking of the US in Table 49

88. OECD (2009a) 'Information and Communications Technologies: OECD Communications Outlook.' Paris: OECD. Chapter 4, Figure 4.8.

Table 50: e-Intensity Index

	Score
Korea	139
Japan	138
Sweden	134
Netherlands	129
United Kingdom	**128**
Norway	125
Finland	124
Germany	120
United States	109
France	105

Source: Akamai; Eurostat; Information Technology & Innovation Foundation; OECD; United Nations; MagnaGlobl; BCG analysis

Note: The index is scaled so that the geometric mean equals 100 for the sample countries in the study

is also belied by the high level of use of some business communication tools in the US.

The UK here emerges as well below the OECD average, but this is pushed up by Asian countries in particular. The UK is ahead of Germany and the anomalously low USA. Lack of standardisation has long been an issue impeding US adoption of mobile telephony, but these figures are startlingly low given the evident use of business-friendly devices like Blackberries in the USA, so we would caution against treating them at face value. Intra-EU comparisons are probably more reliable, though even here the pace of change is such that small differences in roll-out dates may result in large, but transitory, variations in uptake.

Internet intensity

A report published by the Boston Consulting Group[89] has constructed a composite indicator for internet-intensity. This index combines enablement (how well built and how accessible is the internet infrastructure?, 50 per cent weighing), *expenditure* (online spending of consumers and businesses, 25 per cent weighing) and *engagement* (level of embracing internet by consumers and firms, 25 per cent weighing).[90]

The internet intensity index (Table 50) shows a strong standing of the UK, with five countries out of 27 comparator countries having higher scores (Denmark, South Korea, Japan, Sweden, United States). The UK is leading in expenditure through the internet (world leader in e-commerce) and is also a net exporter of e-commerce services, exporting £2.80 for every £1 imported. However, it is only in a medium position in engagement and in enablement (the actual infrastructure).

On the regional level, there is clear discrepancy between the lead London followed by the South East and the East of England, with Wales, Scotland, and Northern Ireland on the lower end of the spectrum, scoring poorly.

3.5.2 Summary of the UK position

The UK emerges as high in the supply of Knowledge Intensive Business Services (KIBS) with an overall share of 3.21 per cent of employment, but in a medium position in 'financial services' (and in education and knowledge creation services) and a rather low position in IT services. In terms of overall creative workforce, we see the UK at the top end of the distribution, with a higher proportion of such workers (and implicitly, such industries) than other large countries like Germany and France. In one dimension of physical infrastructure, the 3G cellular mobile subscribers as a percentage of total subscribers, the UK is just below the OECD average and at 17.2 per cent far behind the shares found in East Asia, at 100 per cent in Korea and 82 per cent in Japan.

3.5.3 Future indicator needs

Table 51 below summarises the need for further data. We would argue strongly for more effort into developing data on the business use of mobile communications. Surveys of various sorts could be envisaged, or integrating questions within existing employee surveys such as the Labour Force Survey and European Working Conditions Survey) or firm-level surveys (such as CIS, where questions could be tailored to uses in innovation activities). Access data can also be generated from data on coverage of 3G and higher networks, for example (OECD presents some information on this and availability of WiFi networks at various rates – notably, free WiFi is the norm in some cities round the world).

3.6 Human Capital

3.6.1 The meaning of human capital and innovation

Human capital refers to the stock of accumulated experience, skills and abilities that people bring to bear on the production of an output.[91,92] Human capital is perceived as an endogenous key factor in growth[93] because it arises through the transformation of the population into qualified labour through educational and professional training. Education duration and credentials achieved are seen as the main resources for human capital and in knowledge-based economies, knowledge, embedded in the training and skills of the human capital of the innovative firm, is viewed as a primary resource for innovative firms.[94]

Although empirical studies are sparse, there is some evidence of how different education variables can be used as indicators of the innovation capabilities of the enterprise by combining data on highest achieved educational attainment with data on R&D.[95] The quality of output of national education structures and the time people spend in them have long been considered a major

89. Boston Consulting Group (2010) 'The Connected Kingdom: How the Internet is transforming the UK economy. Boston: BCG. Available at: http://www.connectedkingdom.co.uk/downloads/bcg-the-connected-kingdom-oct-10.pdf
90. For more details on the methodology, see Boston Consulting Group, op. cit.
91. Becker, G.S. (1964) 'Human Capital: A theoretical and empirical analysis with special reference to education.' Chicago: University of Chicago Press.
92. Schultz, T. (1961) Investment in Human Capital. 'American Economic Review.' March. pp.1-17; Schultz, T. (1971) 'Investment in Human Capital: the role of education and of research.' New York: New York Free Press; Schultz, T. (1972) 'Human Resources (Human Capital: Policy Issues and Research Opportunities). New York: National Bureau of Economic Research.
93. OECD (2001) 'OECD Growth Project.' Paris: OECD.
94. For further reading: UK Department of Trade and Industry (2006) 'Innovation in the UK: Indicators and Insights.' DTI Occasional Paper No. 6. London: DTI. It is argued that skills and capabilities of staff and managers are a vital ingredient in successful innovation. See also: Nickell, S. and Nicolitsas, D. (1997) 'Human Capital and Innovation: What are the Connections?' LSE Centre for Economic Performance Working Paper CEPDP 370. London: LSE; De Clercq, D. and Dakhli, M. (2003) 'Human Capital, Social Capital, and Innovation: A Multi-country Study.' Vlerick Leuven Working Paper Series 2003/18. Leuven: Vlerick Leuven Gent Management School. The authors find strong support for a positive relationship between human capital and innovation. Baldwin, J.R. and Johnson, J. (1995) 'Human Capital Development and Innovation: The Case of Training in Small and Medium-Sized Firms.' Statistics Canada Working Paper 74. Ottawa: Statistics Canada.
95. Sandven, T. (2002) 'The educational attainment of employees as an indicator of the innovation capacities of enterprises.' STEP report No R-07. Oslo: STEP.

Table 51: Indicators for infrastructure and services to fill gaps and their characterisation

Indicator (label and short definition)	Gap filled	Explanation: why important, how linked to innovation	Suggested Data Source	Suggested process (who, when, how) requirements	Further comments
Indicators that could be gathered in the short term					
3G (and above) coverage indicators, and other indicators of cost and quality of service.	Access to high-speed data services.	Extends analysis of broadband access.	OECD already aggregates data from several countries, but the data sources use different definitions.	OECD should press for consistent data.	
Indicators that would need investment in collection exercise in the future					
Business use of mobile internet.	Lack of knowledge of relative use of online services while mobile.	Evidence on access to information sources and communication services in what have been 'black holes' in the past. If new survey data used, or questions added to CIS, then could make the data very innovation-specific.	Surveys – e.g. special questions in labour force surveys, ECWS, or CIS. Use of secondary data routinely collected by network service operators (some already present relevant data on e.g. use of mobile internet in airports).	Eurostat or OECD would need to cooperate in terms of data gathering.	Needs to be future proofed – better to ask about specific functions (access to web-style data services and email while away from home or office) rather than trying to specify technologies and tools. Need to take into account Wi-Fi and other alternatives to 3G etc. Might also consider data on usage of internet by hotel guests?
Business Use of Social Networking (proportion of firms actively using social network sites such as LinkedIn to make business contacts, etc.).	Use of new technology to support networking.	Some evidence that businesses use social networks for more than just marketing, but also to work with communities of interest. If new survey data used, or questions added to CIS, then could make the data very innovation-specific.	Surveys and/or analysis of use of services such as LinkedIn and similar facilities in other regions.	Building on studies such as the proprietary one by REGUS, which reports some data for various countries, and proposes an 'activity index'.	Survey results are sparsely reported in REGUS (2010) study, 'Social Success: A global survey of business social networking A global report from REGUS.' July 2010 http://www.regus.com/ This takes account of the different network sites that are prevalent in different countries (which make it difficult to use secondary data on membership of these sites from their operators).

underpinning for economic growth and international competitiveness. Longitudinal data from 146 countries analysed by the US National Bureau of Economic Research, collected between 1950 and 2010, for example, found that each year of additional average schooling attained by a population translated into at least a 2 per cent increase in economic output: a 2007 World Bank policy research working paper reported similar results.[96]

At the level of the individual, education is perceived as a primary asset providing the foundation for future skill building, educational attainment and credentials aimed at facilitating labour market entry and socio-cultural participation. At the macro level, in post-industrial knowledge societies, knowledge has become a 'strategic force' in growth.[97] Education systems and their outputs are thus viewed as playing a broad role in supporting growth and innovation because knowledge-based societies rely on a highly qualified and flexible labour force in all sectors of the economy and society. Educational attainment is considered an important construct because it is taken as indicating both the actual and potential in the population of factors of human capital and cultural capital.[98] It functions as a signalling device for cognitive ability, discipline, trainability and motivation and may indicate capacity and flexibility to learn throughout adult working life. Innovation, in its most general sense, implies the capacity to continually learn and upgrade skills with all the implications for demand of high-skilled workers capable of taking advantage of the knowledge society. This demand for higher levels of skill (most often associated with stocks of HRST[99]) has had an impact on governmental and supra governmental policy as countries seek pathways to enhance the development, supply and utilisation of skills conducive to an innovative society.[100] Determining skills levels is most commonly done by using levels of educational attainment as a proxy, which means the highest level of education[101] an individual has achieved is correlated as higher skill.

The stock of human capital and its quality may be related to other wider framework conditions. Demand for innovations depends critically on the ability and desire of potential users to adopt them, which in turn is strongly influenced by the level of training and general education of the population. This applies both in the workplace, where adoption of new technologies depends on skills and flexibilities within the workforce, and in the sphere of consumer behaviour, where uptake and usage of new goods and services demands a level of awareness and sophistication. The ubiquity and pervasiveness of ICT and the availability of high-grade internet services and efficient means of communication are prerequisites for the realisation of the innovative potential of individuals in many areas. A general environment in which creativity is encouraged is likely to lead to an innovative culture, to the extent that the human capital embodied in the population is sufficient to enable new ideas to be developed and come to fruition. Similarly, a skilled and educated population might be expected to be better able to assess and reduce the level of risk associated with innovative activities. Shane (1992)[102] has found that individualistic societies are more innovative than others, perhaps because they are more willing to accept uncertainty in a climate where 'innovation championing' roles in business are regarded as more legitimate, roles which in turn presuppose requisite skills.[103]

3.6.2 Indicator and data

Investment in education

As noted above, general educational levels impact on innovation in many ways. With respect to the workplace, econometric evidence indicates clearly that there are positive returns in terms of wages to qualifications at all levels. The returns are greater at higher levels of qualification, but core basic skills such as literacy and numeracy yield a significant positive return.[104] The literature on absorptive capacity, "the ability of a firm to recognise the value of new, external information, assimilate it, and apply it to commercial ends",[105] stresses that an educated, and hence relatively flexible and adaptable workforce is an important component in a firms' ability to incorporate innovative ideas. General education is also important in promoting an aware and sophisticated consumer population, as considered in the 'demand' section of this report.

Total expenditure on education as a proportion of GDP in the UK fluctuates around the average of our comparator countries. The UK ratio has increased rapidly since the turn of the century, its rate of growth outstripping that of most of the comparator countries.

Educational attainment

Proficiency in reading, scientific and mathematical literacy are considered essential attributes as outcomes of compulsory schooling as these lay the basis for the development of

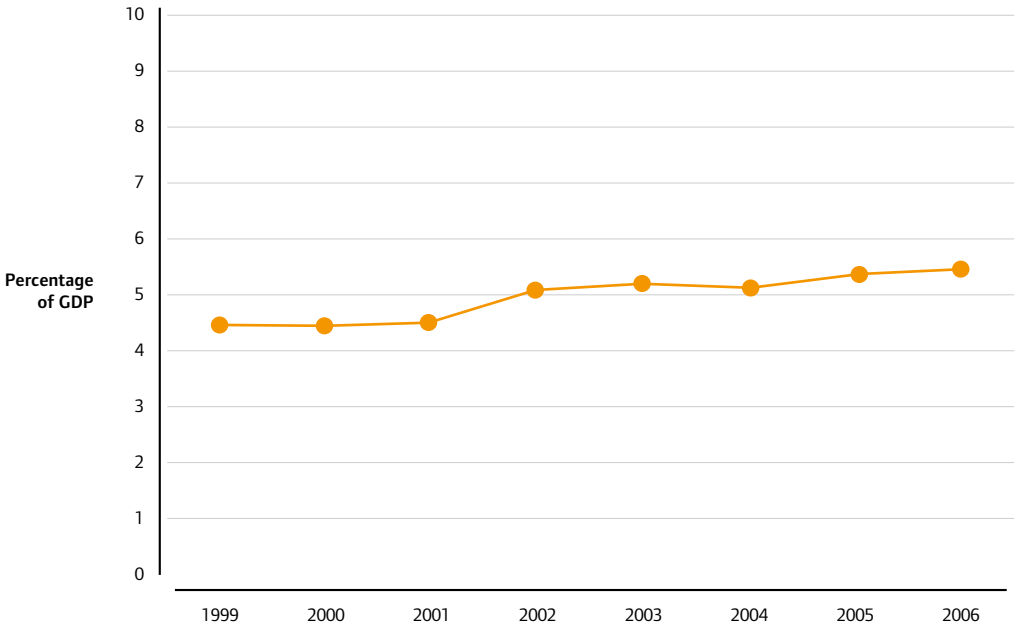
96. Whitehurst, G.J. (2010) 'Spurring innovation through education.' Washington DC: The Brookings Institution.
97. Bell, D. (1973) 'The Coming of Post-Industrial Society: A Venture in Social Forecasting.' New York: Basic Books.
98. Bourdieu, P. (1977) 'Outline of a Theory of Practice.' Cambridge: Cambridge University Press.
99. Human Resources in science and technology: those who have successfully completed education at the third level in an S&T field of study at ISCED-97 5/6 and those not formally qualified at 5/6 but employed in an S&T occupation where the above qualifications are normally required
100. Lisbonstrategyadopted in 2000 whereby Europe is to become "the most competitive and dynamic knowledge-based economy in the world". See http://europa.eu/ scadplus/ glossary/lisbon_strategy_en.htm, OECD 2008.
101. Internationally accepted levels of educational attainment based on ISCED-97 (OECD):
ISCED level 0 Pre-primary education (early childhood education).
ISCED level 1 Primary education (usually the first six years of formal schooling).
ISCED level 2 Lower secondary education (usually coincides with the end of full-time compulsory schooling after around nine years of schooling).
ISCED level 3 Upper secondary education (where university entrance certificates and vocational qualifications which require completion of level 2 are awarded).
ISCED level 4 Post-secondary non-tertiary education (programmes that straddle the boundary between level 3 and 5, e.g. university entrance certificates for adults or non-tertiary vocational education after general upper secondary).
ISCED level 5 First stage of tertiary education (all university and vocational college education exclusive of PhD/doctorate and equivalent).
ISCED level 6 Second stage of tertiary education (leading to an advanced research qualification, i.e. PhD/doctorate and equivalent).
102. Shane, S.A. (1992) Why do Some Societies Invent More than Others? 'Journal of Business Venturing.' 7.

Table 52: Education Expenditure – 2006

	Expenditure on educational institutions				Annual expenditure per student			Index of change in annual expenditure per student	
	Public and private	Public		Private	USD using PPPs			Prim., second., post-second, non-tertiary education	Tertiary education
	% of GDP	% of GDP	2000 = 100	% of GDP	Primary education	Secondary education	Tertiary education	2000 = 100	2000 = 100
Finland	5.8	5.7	122.3	0.1	5,898.6	7,533.1	12,844.9	118.9	112.1
France	5.9	5.5	103.0	0.4	5,482.3	9,303.3	11,568.1	103.0	104.6
Germany	4.8	4.1	103.5	0.7	5,361.7	7,547.7	13,015.9	103.8	98.5
Japan	5.0	3.3	100.6	1.7	6,989.4	8,305.4	13,418.0	111.7	111.7
Korea	7.3	4.5	150.6	2.9	4,935.4	7,260.9	8,563.9	158.9	134.4
Netherlands	5.6	4.8	120.2	0.8	6,425.0	9,516.0	15,195.6	116.4	97.6
Norway	_	5.4	120.3	_	9,485.6	11,435.0	16,235.2	103.3	96.8
Sweden	6.3	6.2	118.0	0.2	7,698.8	8,496.4	16,990.8	113.7	99.9
UK	**5.9**	**5.2**	**117.1**	**0.7**	**7,732.1**	**8,762.9**	**15,447.1**	**150.5**	**138.8**
US	7.4	5.0	120.1	2.4	9,708.5	10,821.2	25,108.8	113.7	102.9
OECD	5.8	4.9	120.7	0.8	6,437.0	8,006.4	12,336.4	124.2	111.5
Brazil	_	4.9	157.4	_	1,566.2	1,538.3	10,293.9	165.2	84.5

Source: OECD indicators, Paris, 2009 – Education at a Glance. www.oecd.org/edu/eag2009
Note: Financial and human resources invested in education

Figure 3: Expenditure of education share of GDP % UK, 1999-2006



Source: Eurostat

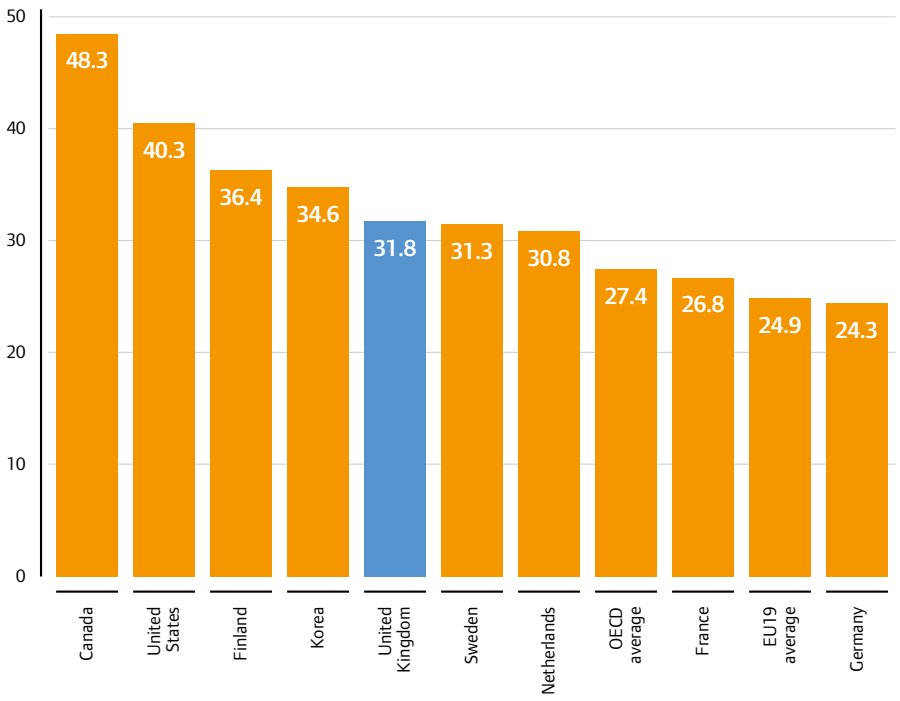
103. De Clercq, D. and Dakhli, M. (2003) 'Human Capital, Social Capital, and Innovation: A Multi-country Study.' Vlerick Leuven Working Paper Series 2003/18. Leuven: Vlerick Leuven Gent Management School.
104. Sianesi, B. and Van Reenan, J. (2003) The Returns to Education: Macroeconomics. 'Journal of Economic Surveys.' Vol. 17 (2), pp.157-200; Dearden, L., McIntosh, S., Myck, M. and Vignoles, A. (2000) 'The Returns to Academic and Vocational Qualifications in Britain.' CEE Discussion Paper 0004. London: Centre for the Economics of Education, LSE; Dearden, L., Reed, H. and Van Reenen, J. (2000) 'Who Gains When Workers Train? Training and Corporate Productivity in a Panel of British Industries.' Discussion Papers 2486. London: CEPR.
105. Cohen, W.M. and Levinthal, D.A. (1990) Absorptive Capacity: A New Perspective on Learning and Innovation. 'Administrative Science Quarterly.' 35, pp.128-152.

Table 53: Education performance, 2007. Share of 25-64 year olds with tertiary education, 2007

	Student performance on the reading, scientific and mathematical literacy scales, mean score, 2006 (1)			Percentage of educational attainment of adult population and current graduation rates			
	Reading	Maths	Science	Upper secondary or higher, 25-64 year olds(2)	Current upper secondary graduation rate	All tertiary attainment, 25-64-year olds	First-time tertiary – type A graduation rate
Finland	546.9	548.4	563.3	80.5	96.8	36.4	48.5
France	487.7	495.5	495.2	68.7	_	26.8	_
Germany	494.9	503.8	515.6	84.4	99.5	24.3	23.4
Japan	498.0	523.1	531.4	_	93.0	41.0	38.8
Korea	556.0	547.5	522.1	77.9	91.3	34.6	_
Netherlands	506.7	530.7	524.9	73.2	_	30.8	42.8
Norway	484.3	489.8	486.5	78.9	91.9	34.2	43.4
Sweden	507.3	502.4	503.3	84.6	74.1	31.3	39.9
UK	**495.1**	**495.4**	**514.8**	**68.3**	**88.7**	**31.8**	**38.7**
US	_	474.4	488.9	87.9	77.5	40.3	36.5
OECD	491.8	497.7	500.0	70.1	82.1	27.5	38.7
Brazil	392.9	369.5	390.3	36.8	_	9.6	15.1

Source: OECD, Paris, 2009 – Education at a Glance, OECD indicators, www.oecd.org/edu/eag2009; PISA 2006: Science Competencies for Tomorrow's World, OECD, Paris. www.pisa.oecd.org. (1) At age 15 and therefore approaching the end of compulsory schooling. (2) Excluding ISCE 3C short programmes

Figure 4: Tertiary attainments, 25-64 year olds



Source: OECD, Paris, 2009 – Education at a Glance, OECD indicators, www.oecd.org/edu/eag2009

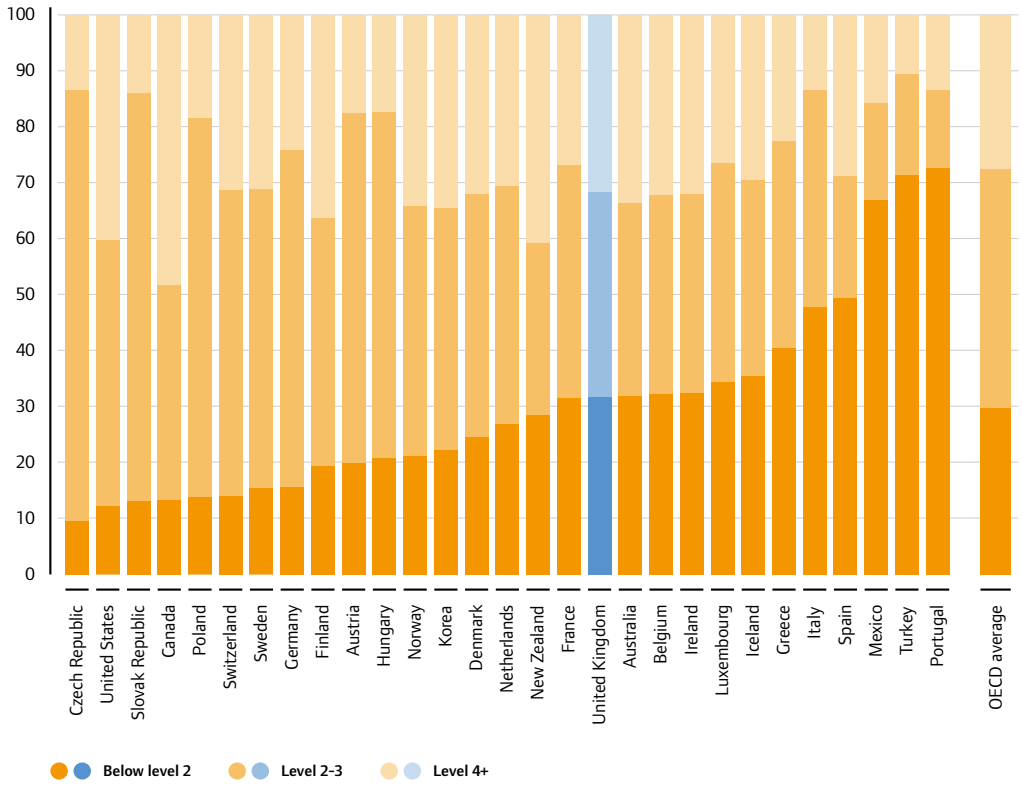
higher order literacies. All countries are seeking to increase the proportion of the population that has completed higher or tertiary education as it provides an indication of the breadth of the availability of higher order skills and confidence needed by innovative, knowledge-based societies. There is a presumption that a population with a greater proportion of people with higher-level knowledge and skills will be more productive than a population with a lower share of people with those skills. This difference is evident in the wages and life-time earnings of people with higher level qualifications, and it is evident in the recruitment behaviour of knowledge-based businesses. However, there is less evidence as to the impact of such population-wide changes on the innovativeness of sectors or entire economies.

The UK maintains levels in attainment that hover at or below the OECD averages but above the EU average of 24 per cent in tertiary education. The UK lags significantly behind Canada with a figure of 48 per cent. It should be noted that Germany is the clear anomaly in these data, however this is a reflection of the structure of its education system and the very significant proportion of people that obtain higher-level vocational qualifications that are equivalent – in complexity – to degrees, but are not counted in these data.

Levels of skill

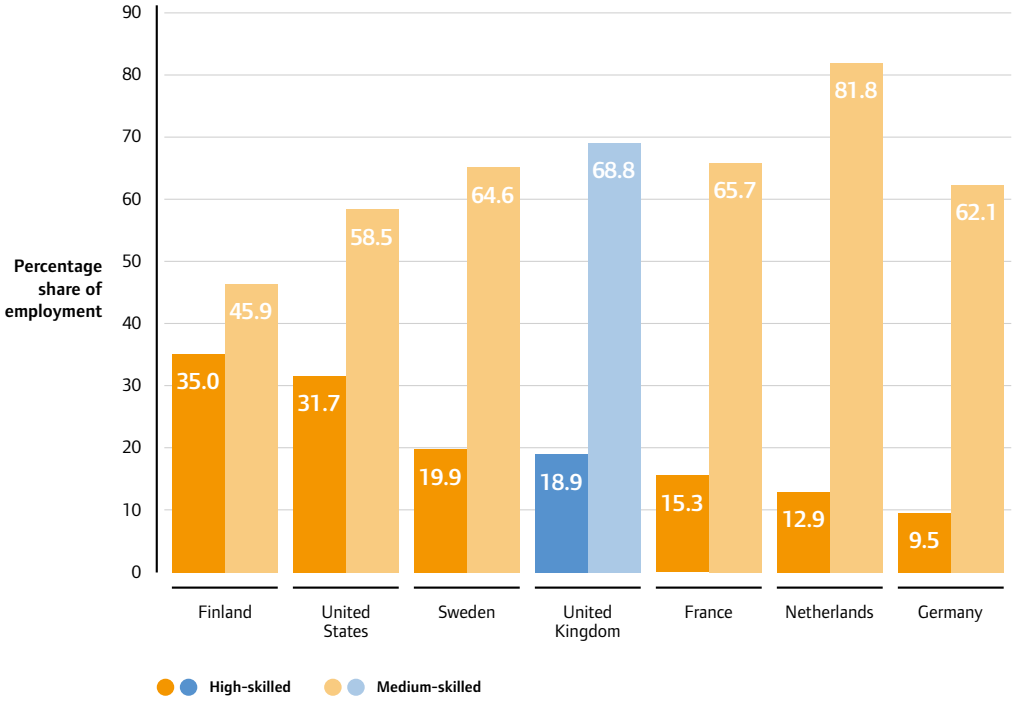
The level of skill availability of labour greatly impacts innovative activity of UK firms. Firms draw on high-skilled labour to generate ideas, but also to develop new products and commercialise them. The availability of skilled labour is an important factor impacting on innovation success. Skilled occupations are those designated by the UN 'International Standard Classification of Occupations' (ISCO-88) as ISCO1 (legislators, senior officials and

Figure 5: International comparisons of workforce qualifications



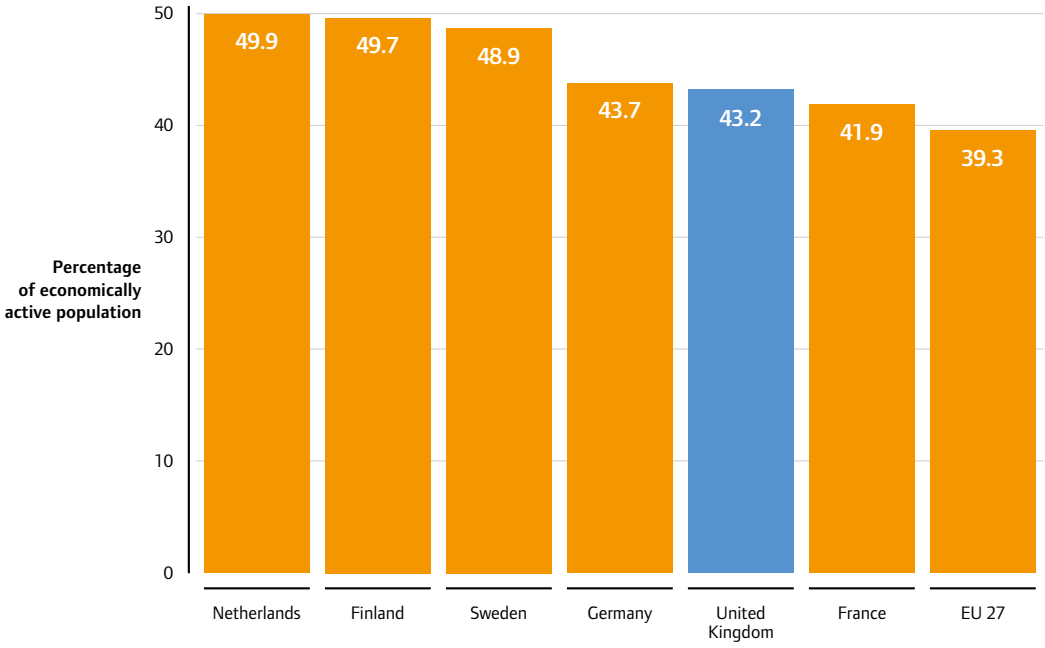
Source: OECD Education at a glance 2008 Tables A1. 2a and A1.3a 2007: Percentage of Population aged 25-64 that has attained the equivalent of below Level 2, Level 2-3 and Level 4 respectively

Figure 6: Percentage of high-skilled and medium-skilled workers, 2005



Source: EUKLEMS, data for 2005 (UK and US figures are share of total employment, remaining figures are share of total hours worked)

Figure 7: HRST as a percentage of economically active population, 2007



Source: Eurostat, stored for 2007

Table 54: Human resources in science and technology as a share of labour force (%)

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Norway	48.0	48.0	46.6	48.0	48.0	48.8 (b)	49.4	50.1	51.3
Netherlands	45.4	45.8	48.2 (b)	49.4	49.3	48.1 (b)	49.8	50.5	50.9
Finland	48.6	45.5 (b)	45.5	47.3	48.0	48.7 (b)	49.6	50.1	50.7
Sweden	44.1 (b)	44.7	45.6	46.3	47.3 (b)	48.0 (b)	48.7	49.3	49.6
Germany	41.6	41.5	42.2	42.7	43.1	43.2 (b)	43.6	44.0	44.8
UK	**37.3**	**38.0**	**39.2**	**40.7**	**41.2**	**42.5 (b)**	**43.3**	**42.7**	**44.4**
EU (27 countries)	34.5	35.0	35.9	37.0	37.8	38.6	39.2	39.6	40.1

Source: Eurostat

Note: b=Break in series

managers), ISCO2 (professionals) and ISCO3 (technicians and associate professionals).

These tables indicate that the UK performs ahead of some comparator countries but trails others. However the deficit in high-skill labour indicated here may be in the process of remediation when the index of change (see above) in expenditure on tertiary education is considered. HRST workers comprise a skilled group accounting overall for about 31 per cent of total employed persons in the EU. They fall within one of two broad classes of the International Standard classification of Occupations – 'professionals' and 'technicians and associate professionals'. In the UK, around 20 per cent of HRST's are scientists and engineers, 32 per cent are other professionals, and 48 per cent technicians and associate professionals. The indicator thus captures those with R&D skills and those with skills which are less directly R&D related but which are nevertheless very important for the generation, adaption and absorption of innovations.

Table 54 indicates that the UK ranks below four of our reference EU countries: but ranking above the EU 27 average. There is evidence, however, of 'catching up' as the UK has increased its proportion of HRST workers in the

Table 55: Individuals' level of computer skills. Individuals who have carried out five or six of the computer-related activities. Percentage of the total number of individuals aged 16 to 74

	2005	2006	2007	2008
Netherlands	33.0	33.0	32.0	40.0
Finland	13.0	29.0	29.0	33.0
Denmark	39.0	38.0	36.0	31.0
France	_	21.0	27.0	30.0
United Kingdom	**31.0**	**26.0**	**26.0**	**29.0**
Germany	22.0	27.0	28.0	28.0
Sweden	32.0	30.0	27.0	21.0
EU (15 countries)	24.0	24.0	26.0	27.0
EU (25 countries)	22.0	22.0	24.0	26.0

Source: Eurostat

Table 56: Individuals' level of internet skills. Individuals who have carried out five or six of the internet-related activities.Percentage of the total number of individuals aged 16 to 74

	2005	2006	2007
Norway	9.0	14.0	14.0
Denmark	7.0	13.0	12.0
France	_	_	12.0
Netherlands	6.0	9.0	12.0
Finland	8.0	10.0	11.0
Sweden	1.0	8.0	8.0
UK	**7.0**	**5.0**	**8.0**
EU (25 countries)	5.0	6.0	8.0
EU (15 countries)	5.0	6.0	8.0

Source: Eurostat

workforce by more than any of the comparator countries since 2001.

Levels of computer and internet skills

The ubiquity and pervasiveness of information and communication skills and the rapid progress of implementation of Web 2.0 and cloud computing technologies and the implications presented for incremental innovation, indicate that e-skills literacy is a key requirement for people to work effectively and efficiently. The level of e-skills/confidence in the general population of working age is an important metric for general innovation skills.[106]

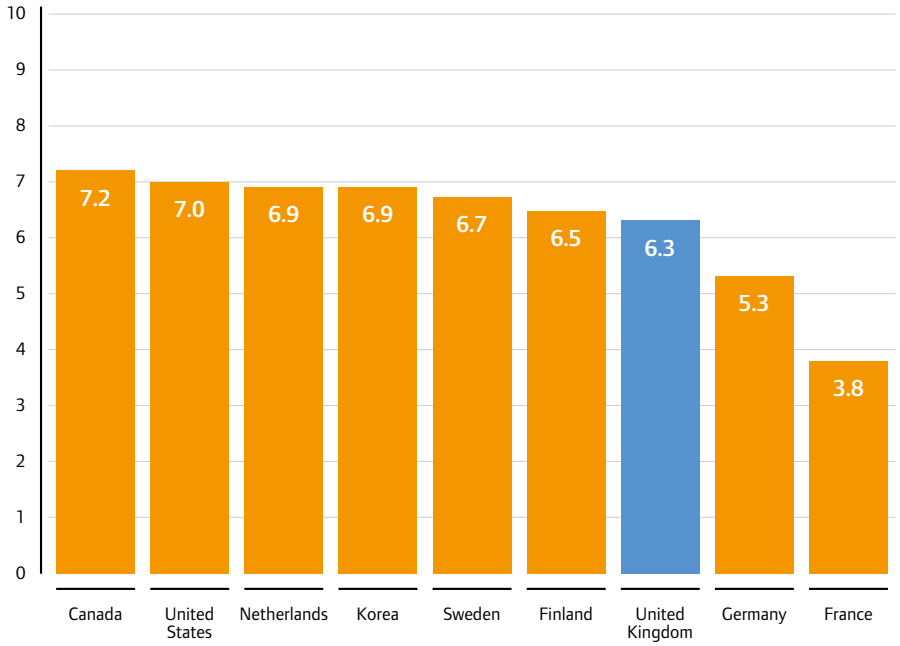
In Table 55 the level of basic computer skills are measured using a self-assessment approach, where the respondent indicates whether he/she has carried out specific tasks related to computer use, without these skills being assessed, tested or actually observed. Six computer-related items were used to group the respondents into levels of computer skills in 2006, 2007 and 2009: copy or move a file or folder; use copy and paste tools to duplicate or move information within a document; use basic arithmetic operations (addition, substraction, multiplication, division) in a spreadsheet; compress files; connect and install new devices, e.g. a printer or a modem; write a computer program using a specialised programming language. Instead of the item on having connected and installed new devices, the 2005 items included the use of a mouse to launch programs such as an Internet browser or word processor. In the case of low level of basic computer skills, this means individuals who have carried out one or two of the six computer-related items. Medium level of basic computer skills relates to individuals who have carried out three or four of the six computer-related items. High level of basic computer skills: Individuals who have carried out five or six of the six computer-related items.

In Table 56 the level of internet skills are measured using a self-assessment approach, where the respondent indicates whether he/she has carried out specific tasks related to internet use, without these skills being assessed, tested or actually observed. Six internet-related items were used to group the respondents into levels of internet skills in 2005, 2006 and 2007: use a search engine to find information; send an e-mail with attached files; post messages to chatrooms, newsgroups or any online discussion forum; use the internet to make telephone calls; use peer-to-peer file sharing for exchanging movies, music etc.; create a web page. Low level of basic internet skills: Individuals who have carried out one or two of the six internet-related items. Medium level of basic internet skills: Individuals who have carried out three or four of the six internet-related items. High level of basic internet skills: Individuals who have carried out five or six of the six internet-related items.

The tables show that the UK is above only Korea among our comparator countries on this

106. There is an important rider here regarding IT skills, since the development of more intuitive interfaces will rapidly make much of the already 'traditional' methods and skills of using and interrogating databases obsolete. Mergers between 'high-tech' or 'dotcom' firms have been successful where the merger is really extension along the value chain. Mergers driven by apparent convergence of core technologies have not been so successful because it was not sufficiently clear that the products, markets, and business models of the partners were not themselves converging. This means that on a micro-level, the real day-to-day content and purpose of skills in these different sectors is also not converging but contains a significant element of sector-specific expertise. See Levy, F. and Murmane, R.J. (2004) 'The new division of labour.' Princeton: Princeton University Press; also Autor, D.H, Katz, L.F. and Kearney, M.S. (2006) The Polarization of the U.S. Labor Market. 'American Economic Review.' 96(2), pp.189-194.

Figure 8: Adaptability of the workforce, 2009



Source: IMD WCY Executive Opinion Survey based on an index from 0-10. Flexibility and adaptability of people are high when faced with challenges.

measure, although the majority are clustered closely, some way below the US and Sweden. The International Institute for Management Development (IMD) data places the UK above Portugal, Italy and the Antipodean countries. Eurostat data on proportion of population with a high level of basic computer skills show that the UK is somewhat behind its peers, although above the EU 27 average. Overall however the UK trend is towards improvement or maintenance of its position.

Workforce adaptability

The concept of workforce adaptability and flexibility is an important one, and is a quality that national education and training systems to a large degree determine. Cognitive ability, discipline, trainability and motivation derive from education and educational attainment levels and indicate capacity and flexibility to learn throughout adult working life. The measurement of adaptability even at its most general is problematic. The data supplied by the IMD for its 'World Competitiveness Yearbook' on adaptability of the labour force is impressionistic. In a survey of enterprises, respondents were asked to rate their economies on a scale of 1-10 on the 'flexibility and adaptability of people when faced with new challenges'.

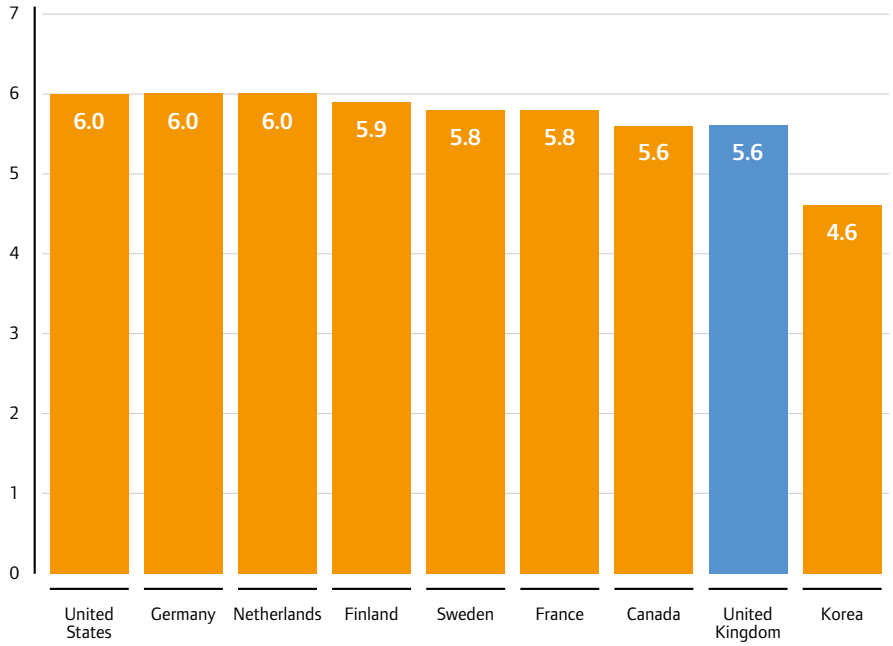
The UK features among the bottom three on this measure. Many of the comparator countries have a more highly trained workforce than the UK in specific areas; but the data implies that the UK workforce may be more rigid in its outlook and expectations, and possibly less adaptable and less minded to innovate.

Workforce training

Training is a primary means by which to update/refresh the knowledge and skills of the workforce, and to introduce/train the working population to ideas and techniques that were not mainstream when they were in school or college. Good quality on-the-job training has important implications for the ability and willingness of managers and other staff to innovate and to adapt to innovation. Given the length of time people are in work, 40-50 years, and the rate at which technology, markets and regulations change, the quality and volume of training provided to the working population must be as important an innovation framework condition as the level of educational attainment of the general population.

Data from the World Economic Forum (WEF) survey of business executives, relating

Figure 9: Local availability of specialised research and training services, 2009

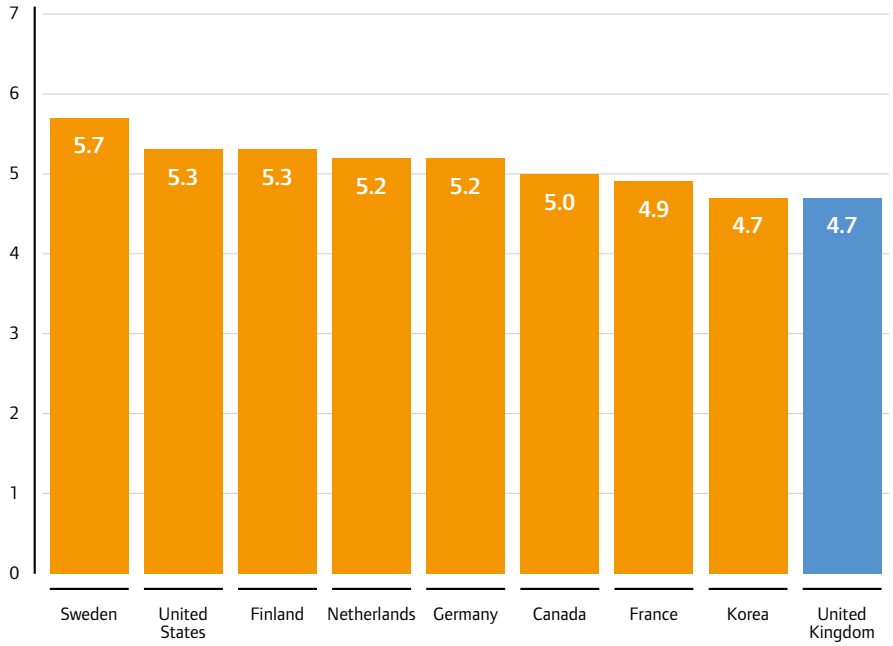


Source: WEF, 2009 – Global Competitiveness Report. Geneva

107. World Economic Forum (2010) 'Global Competitiveness Report.' Geneva: WEF.

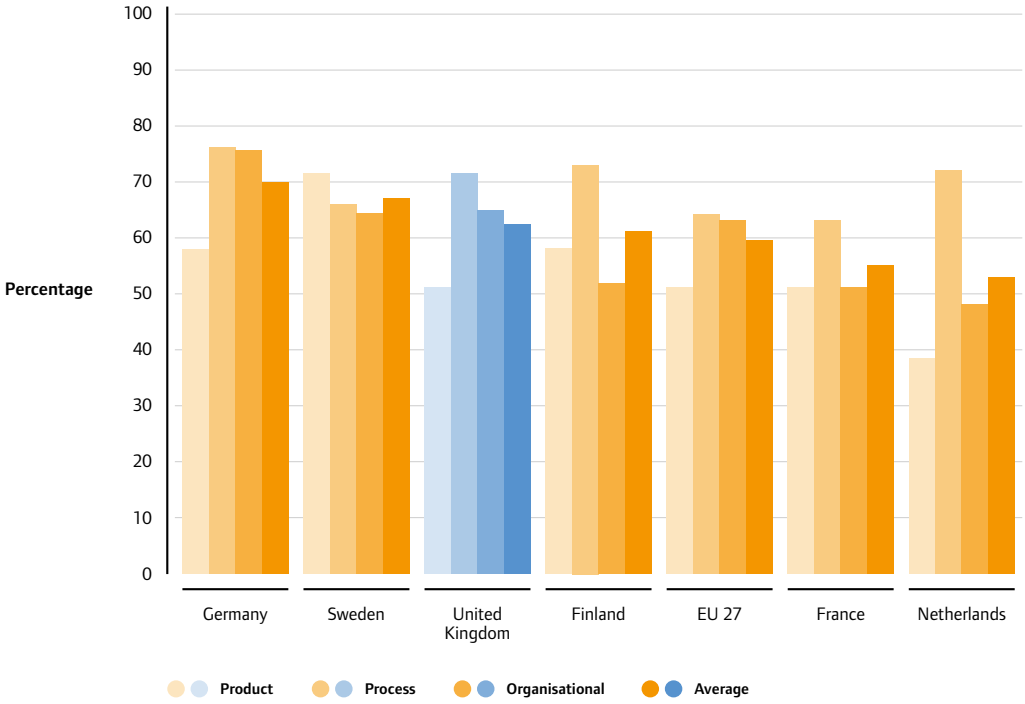
respectively to perceptions of the availability of training services and investment in such services (both on 1-7 scales).[107] For the former, executives were asked to rate the availability of specialised research and training services in their country (1=not available, 7=available from world-class local institutions). For the latter, the issue was the general approach of companies in the respondent's country to human resources (1=to invest little in training/ employee development, 7=to invest heavily to attract, train and retain employees).

Figure 10: Extent of staff training, 2009



Source: WEF, 2009 – Global Competitiveness Report

Figure 11: Training needs for innovation, 2007



Source: Innobarometer Analytic Report – 2007

Regarding perceptions of availability, the UK ranks among the bottom three although differences among the group of comparator countries are not significant – the only exception being Korea. Regarding investment in training, however, differences are more pronounced, with UK employers judged to show significantly less enthusiasm for training than all others (Figure 10). The implication is that the UK workforce will be less well equipped than many others to deal with new techniques and innovations.

Training needs for innovators

This indicator looks at the proportion of employers that provide staff with training following the implementation of a new process or new product. It is an indicator of the degree to which employers believe staff need specific training in order to be 'kept up to speed' with company changes in order for innovations to be as successful as they might be. It should complement the more general 'in-work' training metrics, showing differences across countries (and no doubt sectors, were data available) in employers' aggregate views of the need to update staff skills in light of company innovation.

Data for the Innobarometer survey (2007)[108] was collected on the need to upgrade employee skills and knowledge in the light of company innovations. Survey respondents were asked whether, in the previous two years, their company needed to provide training or skills upgrading for employees respectively for product, process or organisational innovations. For EU 27, process and organisational innovation (with 64 per cent and 63 per cent of 'yes' responses) were more likely to require staff training, understandably, than were product innovations (51 per cent). This difference is even more marked for the UK, which is above the EU 27 average for process and organisational innovations (71 per cent and 65 per cent) but below the average for product innovations (51 per cent). Overall, it was found that the high-tech segment was the only sector where training related to product innovation (64 per cent) was more extensive than that related to process innovation (58 per cent). The UK falls somewhere in the middle of our reference countries, with 50-70 per cent of employers having provided innovation-related training to staff (Figure 11).

Lifelong learning

The proportion of the population between 25 and 64 that participates in 'lifelong learning'

108. European Commission (2007) 'Innobarometer 2007 Analytical Report.' Flash EB Series 215. Brussels: EC. Available at: http://ec.europa.eu/public_opinion/flash/fl_215_en.pdf

Table 57: Lifelong learning as a percentage

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Sweden	17.5 (b)	18.4	_ (u)	_ (u)	17.4 (p)	18.4	18.6	22.2 (b)	22.2 (p)
Finland	17.2	17.3	22.4 (b)	22.8	22.5	23.1	23.4	23.1	22.1
UK	20.9	21.3	27.2 (b)	29.0	27.6 (b)	26.7	20.0	19.9	20.1
Norway	14.2	13.3	17.1 (b)	17.4	17.8	18.7	18.0	19.3	18.1
Netherlands	15.9	15.8	16.4 (b)	16.4	15.9	15.6	16.6	17.0	17.0
Germany	5.2	5.8	6.0 (i)	7.4 (i)	7.7	7.5	7.8	7.9	7.8
France	2.7	2.7	7.1 (b)	7.1	7.1	7.7	7.5	6.0	6.0
EU (27 countries)	7.1 (e)	7.2	8.5 (b)	9.3	9.8	9.7	9.5	9.4	9.3 (p)

Source: Eurostat, Note: refers to persons aged 25 to 64 who stated that they received education or training in the four weeks preceding the survey. Not available e=Estimated value b=Break in series p=Provisional value i=See explanatory text u=Unreliable or uncertain data

is believed to be a good indication of people's openness to new ideas and attitudes towards the need for and value that might be derived from ongoing involvement in learning activities, outside employment, to acquire new skills and knowledge. It may be closely linked to adaptability. It is measured as the number of people who reported undertaking some form of education or training course, formal or informal. It is viewed as an indication of a country's ability to animate and reskill large sections of a population confronted with major industrial or technological change. The tables refer to persons aged 25 to 64 who stated that they received education or training in the four weeks preceding the survey (numerator). The denominator consists of the total population of the same age group, excluding those who did not answer to the question 'participation to education and training'. Both the numerator and the denominator come from the EU Labour Force Survey. The information collected relates to all education or training whether or not relevant to the respondent's current or possible future job.

The data suggest: that the UK is performing well against other comparison EU countries, with Sweden highest.

Social capital, openness and work organisation

There is much discussion of organisational conditions for workforce that foster innovation, and several survey instruments have been developed here: we are not aware of substantial systematic data collected with such instruments that could be used for comparative analysis. However, workforce surveys that address issues such as problem-solving and freedom to use own ideas at work provide a partial insight into these issues. Thus, the European Working Conditions Survey, conducted every few years for the European Foundation, asks many questions concerning circumstances encountered at work. Several of these questions deal with topics such as autonomy at work, the extent to which work is monotonous and repetitive, the extent to which it allows for problem solving and choice, and the ability to learn and use one's own ideas. (The survey can also be mined for information on teleworking, use of computers and internet, and dealing with nonemployees.)

Data is available, in some cases for several years, for EU countries (the number expanding in line with that of the EU itself). Table 58 displays results from the fourth EWCS (conducted in 2005) for the UK and a small number of the other countries. The UK appears to be relatively low on these indicators, in terms of likely contribution to framework conditions. For instance, there is a high level of monotonous work – which is unlikely to be conducive to innovation. Compared to Germany, fewer workers consider their jobs to involve complex tasks, though more report learning new things and ability to use their own ideas at work – the reverse is true for

Table 58: Choice, Discretion and Creativity at Work – ECWS 2005 data

	Dealing directly with people who are not employees (e.g. customers)	Working with computers	Solving unforeseen problems	Monotonous tasks	Complex tasks
Finland	73.9	62	81.7	48	74.5
Germany	60.8	53.5	77.4	28.5	71.6
Netherlands	66.1	71.6	93.9	22.7	65
Norway	77.9	55.9	94.3	25.4	64.3
France	70	53.3	86	40.8	57.2
UK	**69.8**	**50.7**	**78.5**	**55**	**56.1**

Source: From derived data presented in Fourth European Working Conditions Survey Parent – Thirion *et al.* (2007[110]) available at: http://www.eurofound.europa.eu/pubdocs/2006/98/en/2/ef0698en.pdf. Ordered for 'share complex tasks'

Note: Percentages refer to proportion of respondents answering postively with don't knows/refusals omitted from calculations

comparisons with France. The differences are not large though, with the outliers mainly being smaller countries.

Some researchers have sought to use such data to compute more global scores of worker autonomy, and, in one case (Arundel *et al.*) to estimate the prevalence of different patterns of work organisation (Taylorist, lean etc.) across countries and sectors. This looks to be a very promising direction for further work.[109]

Interpretation of the simple percentages in this table, furthermore, needs to be done cautiously. The nature of working life is highly correlated with the occupational group one holds, and the occupational structure of countries is influenced by their overall industrial structure and the extent to which this has been 'modernised' through new technology and organisational practices. From the raw ECWS data it would be possible to perform multivariate analyses, exploring what the UK performance looks like once we control for differential occupational structures across countries; and, probably most interesting of all, how far the work experience of people in specific occupational categories (or economic sectors, or both) varies across countries. For example, do professionals in the UK report lower levels of autonomy than those in some comparator countries?

3.6.3 Summary of the UK position

On the basis of the indicators used above the UK presents a not unfavourable position in regard to its comparators. In regard to rates of change in investment in education at all levels, the UK is outperforming most of the comparator countries. Investment in education is important as education duration and credentials achieved are seen as the main resources for improving the size and quality of human capital. However, the indicators currently used are problematic as they too are broad based and lack granularity. This is discussed below.

3.6.4 Future indicator and data needs

The use of human capital as a wider framework condition is inhibited by the generality and proxied nature of the indicators used to measure it. In many areas a lack of rigorous metrics is substituted by useful but impressionistic survey outcomes. Levels of education are uni-dimensional and currently do not differentiate between types of education, especially general and vocational education (TVET). They only categorise formal qualification levels, for example, which may not be relevant to employers and do not indicate technical and practical skills which may have been acquired informally in the workplace.

109. Arundel, A., Lorenz, E., Lundvall, B.-A. and Valevre, A. (2007) How Europe's economies learn: a comparison of work organization and innovation mode for the EU-15. 'Industrial and Corporate Change.' Vol. 16 (6), pp.1175-1210.

110. Parent-Thirion, A., Fernández Macías, E., Hurley, J. and Vermeylen, G. (2007) 'Fourth European Working Conditions Survey.' Dublin: European Foundation for the Improvement of Living and Working Conditions.

These latter skills, often dynamically being reconfigured, are important as they emerge from a process of diffusion of tacit knowledge seen as crucial in innovation processes. There is ongoing evidence that general and vocational education on the one hand, and vocational education and training on the other, are becoming increasingly inseparable, and it is impossible to draw the line between them in a consistent way cross-nationally.[111]

Current statistical methods are not capturing this development. The signalling value of educational qualifications differs substantially across countries, particularly in terms of the provision of specific occupational skills in vocational education and training and in terms of the degree of standardisation. The measurement of educational attainment in cross-national surveys is affected by a number of weaknesses which adversely affect the validity of claims based on analyses of these data. Primarily, countries and surveys are inconsistent in the way they measure educational attainment and apply ISCED 97 to national data. Further, the actual years of education and the one-digit version of ISCED 97 distort measures of association to differing degrees in different countries. Both make cross-national comparisons using these measures highly problematic.[112] For example, British Bachelor's degrees, the French Licence and the German Diplom and Magister are all first degrees, but the German degrees take longer and accordingly cover a higher level of educational content than the first degrees in France and the United Kingdom.

There is also evidence that some countries select ISCED levels in their counting to enhance the notion of an education system producing larger supplies of skills than is actual.[113] This skews effective international comparison.[114] HRST are currently measured on two dimensions: occupations (ISCO2 and ISCO3) and level of educational attainment (ISCED5 and ISCED6) but have not contained an industry level skill. The OECD has developed a new database, ANSKIL, which adds that dimension to the STAN Database for Structural Analysis and which covers European countries, Australia, Canada, Japan and the United States. The major comparability issue relates to the industry breakdown. The need to focus on more specific sub-populations is also being developed through the OECD/UNESCO Institute for Statistics/Eurostat project on Careers of Doctorate Holders (CDH). This project aims at better understanding this population's labour market, career paths and mobility through better measurement of specific aspects of the career patterns of doctorate holders. For instance, improved definitions and means of measuring two new important phenomena, postdoctoral positions and types of mobility (e.g. inter-sectoral and international mobility), will illuminate the role of HRST in innovation. The outcomes will be available by end-2010 in the CDH data collection. The near availability of this data, and that emerging from capturing[115] the convergence of general and vocational education and vocational educational and training, will enhance the capability of developing indicators for human capital in the wider framework conditions for innovation.

A further obstacle to the coherence of human capital as a wider framework condition for innovation concerns capturing the interaction between work organisation, skills and technology and the reconfiguration of skills that often takes place. Concepts such as job rotation, incentives to participate actively in innovation, and measures to monitor, evaluate, capture and diffuse improvements across work teams, are often used to describe new organisational practices and have been tested in a number of surveys.[116] Studies that have looked at the relation between new organisational practices and innovation have usually found it to be positive (Greenan and Lorenz, 2009). To improve understanding of these relations it is now recognised that it is necessary to harmonise definitions and collect comparable data of organisational changes, innovative workplaces and actual workplace skills. Matching such data will enable effective analyses of the relation between skills, innovation and performance. Currently conceptual frameworks are being developed[117] to better guide and prioritise the measurement of skills for innovation. This entails defining the relations among concepts of creativity, entrepreneurship and innovation and linking measurement to clearly defined policy objectives.

Data is currently emerging from OECD PIAAC as to types of work organisations (see Appendix) demanding particular employee skills, which shows that workers who participated in quality-improvement circles appeared to need higher reading and numeracy skills and stronger communication skills, while team-working was associated with greater internal communication skills. The full PIAAC[118] survey, to be carried out in 2011, will cover Canada, Chile, Japan, Korea, the Russian Federation and United States, in addition to

111. König, W., Lüttinger, P. and Müller, W. (1988) 'A Comparative Analysis of the Development and Structure of Educational Systems. Methodological Foundations and the Construction of a Comparative Educational Scale.' CAS-MIN Working Paper No. 12. Mannheim: Universität Mannheim.
112. Schneider, S.L. (2010) Nominal comparability is not enough. (In-) Equivalence of construct validity of cross-national measures of educational attainment in the European Social Survey. 'Research in Social Stratification and Mobility.' 28(3), pp.343-357.
113. Steedman, H. (1999) Measuring the Quality of Educational Outputs: Some Unresolved Problems. In Alexander, R., Broadfoot, P. and Phillips, D. (Eds) 'Learning from Comparing: New Directions in Comparative Education Research.' Wallingford, Oxon: Triangle Books; also Steedman, H. (2000) 'Looking into the Qualifications 'Black Box': What Can International Surveys Tell Us about Basic Competence?' Working paper. Centre for Economic Performance. London: LSE.
114. The Bologna process seeks to address this.
115. Ongoing work in CASMIN, CEDEFOP.
116. The European Working Conditions Survey, EWCS.
117. By OECD and Eurostat.
118. Programme for the International Assessment for Adult Competencies Survey. See www.oecd.org/els/employment/piaac/

Table 59: List of WFC indicators to fill gaps and their characterisation WFC SKILLS

Indicator (label and short definition)	Gap filled (indicate dimension of WFC that would be supported)	Explanation: why important, how linked to innovation (key data source if needed)	Suggested Data Source	Suggested process (who, when, how) requirements, (frequency of collection, coverage international, regional, sectoral)	Further comments
Indicators that could be gathered in the short term					
Regional	Using all current indicators across the four nations and the region level.	Would add depth to metrics as to the stock quantity and quality of human capital stock.	ONS, LFS	Annually.	BIS and other sources show clearly that higher skill stocks are concentrated in the Greater South East area of England. See the approach of the West Midlands Regional Observatory.[119]
Workforce Development Indicators (incorporating training) and Entrepreneurship Training.	Capture data at firm-employee level as to/whether innovative firms improve their human capital.		LFS, Eurostat, WERS		

EU countries. It will allow for investigating the links between key cognitive skills and a range of variables, with a particular focus on skills of individuals and their actual use in the workplace. This will complement the extensive data already available for reading, science and mathematical literacy levels acquired at the end of compulsory schooling. A 'PIAAC-type' component or module to in-link skills in the workplace to innovation outcomes has been added to the next Eurostat Community Innovation Survey (CIS-2010) This will contain a short ad hoc module (about four questions) on 'Creativity and Skills for Innovation'.

These current, ongoing and significant revaluation approaches to human capital data and measurement by international organisations would suggest further scope for development of human capital indicators in the context of wider framework conditions for innovation.

119. See http://www.wmro.org/standardTemplate.aspx/Home/OurResearch/Skills/Skillsperformanceindicatorframework

Part 4: Conclusion

This report had two purposes. First, it further developed the methodology for defining and measuring Wider Framework Conditions (WFCs) that had been begun by Miles *et al*. 2009.[120] Second, on the basis of these methodological improvements, it compiled available data for the UK and comparator countries to assess the relative position of the UK as regards the innovation context the country provides. This informs the current reporting on innovation and WFC in the UK.

As for the methodological development, the study operationalised and identified six WFCs, defined as those conditions that shape the context in which firms innovate and thus influence their innovation performance and, with it, the attractiveness of a location for innovation. Further, it identified a set of components that represent each WFC and that can be characterised and measured through appropriate indicators. The WFCs that were defined and the components and indicators that were selected to represent those WFCs were conceptualised within an innovation system approach. WFCs interact with each other, and it is this interplay that defines the context for innovation of firms and third sector actors in a given country. Only those WFCs and individual components were selected for which conceptual literature and empirical evidence clearly suggests a link to innovation behaviour and performance. This report thus contributed to a better understanding and operationalisation of WFCs and laid the ground for measurement and monitoring of those conditions in the future.

However, while the state of the art as established in this report is a step forward, further conceptual and empirical work to understand and measure WFCs is needed. This regards mainly the overall interpretation of the concrete meaning of WFCs and their development over time. The link of WFC components to different kinds of innovation, in different sectors and for different kinds of actors (e.g. small and large firms, third sector) would be desirable. On the basis of current knowledge, it is not always clear whether a certain development of a WFC component is positive or problematic for the economy as a whole. For example, while a certain WFC development might be positive for incremental innovation for established actors, it might be detrimental for radical innovation and new actors to enter markets. More work on the relationship of WFC components with specific actors and kinds of innovation is thus needed.

A further caveat is the availability of data. For many components that clearly influence the innovation behaviour of firms, we lack data or are dependent on limited business leader surveys. Within the UK, the regional data is poor for most of the WFC. For each WFC the report has made concrete suggestions as to which data gaps would need to be filled in the future to come to a more complete picture. Of course, gathering such data comes with a cost and not everything that is desirable will be feasible. Further, international data will not be easily available in all cases and international organisations would have to be mobilised to cooperate. Nevertheless, the authors of this study strongly recommend the filling of some of those key gaps in the future, ideally based on a discourse as to which areas are seen to be of highest political and economic importance.

As for the second purpose of the study, a concrete assessment of the WFC the UK provides for its firms and third sector actors, the report updated and considerably enlarged

120. Miles, N., Wilkinson, C., Edler, J., Bleda, M., Simmonds, P. and Clark, J. (2009) 'The wider conditions for innovation in the UK: How the UK compares to leading innovation nations.' NESTA Index Report. London: NESTA.

the indicators previously established. It shows a mixed picture, as for some WFC the UK appears to be strong, while in others the position relative to comparator countries is moderate to poor. The report re-confirmed the relative strengths and attractiveness of the public research base, but noted the worrying trend of reduced private spending for public R&D. For demand conditions, the assessment of the UK is only moderate, with private and public buyers being less prone and able to demand and adopt innovations than in some comparator countries. The UK's overall business environment and degree of competition between firms can be generally regarded as strong. However, this is limited by the fact that concrete innovation indicators such as patent rankings or new-to-market innovation rankings again show only an average performance in the UK, i.e. the concrete innovation environment and performance need improvement. In relation to European comparator countries, the UK shows a strong position in terms of entrepreneurship but lags behind the US and some fast-growing economies. Interestingly, while the finance sector has been strong in the UK, the relative position of the country as regards access to finance is only moderate, mainly in respect to the financing of early-stage firms which is poor – in contrast to finance for subsequent expansion. As regards infrastructure and services, the picture is slightly brighter. The UK has a high supply of Knowledge Intensive Business Services (but is poor in IT services) and a high share of creative workforce, and it has a strong position in terms of expenditure through the internet and trade with e-commerce services. The country is weaker, however, as regards the provision of physical infrastructure. Finally, the UK is about average in terms of tertiary education enrolment and in terms of skill levels, but has a far above average growth in education investment in the last decade.

The authors of this report hope that the conceptual development and the current data compiled and interpreted in this report will support an evidence policy to improve the conditions under which innovation in the UK is generated and introduced into the marketplace. They also hope that it is a further step towards a better informed annual reporting system that also allows further methodological and data improvements in the future.

Appendix

Classifying skills

It might be noted that there are broadly three main philosophies underlying skills classification and skill development approaches in the EU: competence-based (which aims to unpick occupations in relation to broad types and levels of competencies); standardisation (where benchmarks are effectively set through qualifications like national apprenticeship standards); and transparency-based, where the aim is to translate qualifications and certificates into easily-understood 'reflectors' of aptitude, experience and adaptability. Against this background, definitions and constructs of skills and competences are highly variable and highly contextualised.

There is no consistent consensus on what constitutes 'competences' across organisations, cross-nationally, or even within the same organisation. A key distinction (and confusion) is between 'behavioural' competences, associated with 'personality' factors such as team working, and 'skill' competences related to job function. Similarly, definitions of 'skill' are rooted in organisational and cultural patrimonies. In some countries 'skill' is applied only to lower levels of employee (for example non-managerial or 'shop floor' workers). In manufacturing sectors, skills systems are closely aligned with specific processes and products. In this sense, companies tend to think of 'competences' as 'skills ladders' – which means a scale of usefulness of workers in a particular production process.

Similarly, in the IT sector, competences are closely related to experience and expertise in a particular software system. Generally, across all sectors – particularly service industries, and at the managerial level generally - competence systems are becoming more and more to mean expertise and immersion in a particular 'business model'. Additionally, highly innovative firms have teams that produce work patterns that are not easily formalised or reproducible under different circumstances (however highly specifiable the technical components of the system may be).

These innovative firms have to cope with knowledge spillover as a necessary consequence of the need to develop many aspects of an innovative new system simultaneously. Any benchmark procedure, for example, for forecasting and evaluating qualifications and skills thus has to be flexible enough to cover such cases. Further, an increasing number of persons are employed in activities where skills are developed in and through innovative project work, within which the division of labour is never finalised before work processes are altered again, and this presents a major challenge for determining future curriculum and training development. This can often also lead to problems of 'cognitive dissonance' between employees and managers in relation to the definition of skills and training needed in such environments.

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