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NESTA Making Innovation Flourish

The wider conditions for innovation in the UK

How the UK compares to leading innovation nations

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Foreword

Measuring innovation is a challenging but important task. This report provides a framework for measuring how favourable a climate the UK offers for innovation, compared to leading international competitors. This forms an important strand of NESTA's Innovation Index.

The report draws together a wide range of indicators, organised around a functional model of how innovation occurs, and provides a means to track the most important drivers of innovation over time.

The Index is an ongoing project, and the scope exists both to analyse these data further and to build on the methodology.

As always, we welcome your comments.

Stian Westlake
Executive Director of Policy and Research, NESTA

November, 2009

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

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

Executive summary

Innovative firms drive the economic growth and prosperity of the UK. While internal factors such as good management and strong leadership may affect a company's capacity to innovate, the economic and social conditions in which companies operate can also spur or stifle innovation efforts. In order to expand the number of home-grown innovative firms, and to attract the most innovative international firms to the UK, policymakers have understood that it is critical to get the UK's wider conditions for innovation right. Yet understanding what the optimum conditions for innovation are, and how to influence them, remains a challenge.

This report brings together a variety of indicators of how favourable the UK is as a place for firms to innovate, and compares them to a number of other innovative countries. The 35 indicators are grouped together into seven overarching 'wider conditions' for innovation. These conditions cover not only the generation of new ideas, but their development into products, the markets in which they compete, and the availability of resources to invest in innovation and diffusion.

The seven wider conditions for innovation are as follows: They were confirmed as the most important for companies through a NESTA commissioned survey of 1,500 UK businesses.

- **Public research**. Both the amount spent on public research, and the strengths of business-industry links.
- **Openness**. How quickly and effectively good ideas can diffuse and be absorbed. This includes both the physical infrastructure for openness (such as broadband internet) and its social underpinnings (such as how hierarchical workplaces are).
- **Entrepreneurship**. How effectively new businesses spring up to take advantage of innovative opportunities, and how willing people are to take the risks necessary to innovate.
- **Demand**. Whether customers are willing to buy innovative products. An important part of this is government's willingness to procure innovative products.
- **Competition**. The overall level of competition in the economy.
- **Access to finance**. Whether risky, innovative businesses can attract funding, in particular venture capital, but also other forms of finance such as business credit.
- **Skills**. Whether skilled workers are available to work in an innovative venture, and whether workforces have the necessary skills to innovate themselves.

The report finds that the quality of these framework conditions for innovation vary in the UK. While the UK performs well compared to other leading innovative countries in entrepreneurship and competition, there is room for improvement in public research and openness. The UK appears to lag behind other leading countries in the areas of access to finance, demand for innovation and skills.

The UK performs well in:

- **Competition**: The UK performs well on competition conditions as measured by new start-up rates and business churn. UK trade with international competitors is strong and the economy benefits from relatively high net flows of foreign inward investment. Further work on issues, such as market power, could provide deeper insight into the competitive framework of countries.
- **Entrepreneurship**: UK companies and individuals are willing entrepreneurs. The

analysis demonstrates that they continue to perform well compared to other countries. A note of caution needs to be struck as there are initial signs that the prospects for early-stage enterprise are weakening with individuals expressing a slightly greater reluctance to take on risk than in previous years.

There is room for improvement in:

- **Public research:** Public research forms the basis for fostering a wider culture of research and contributes also directly to economic benefits when commercialised. The UK excels in research in universities and research bodies as highlighted by the volume and quality of scientific publications. Though the UK has significantly improved its performance in fostering collaboration between companies and universities, it still lags behind some other leading economies.

- **Openness**: Indicators measuring openness seek to a) identify whether collaboration is fostered through physical infrastructure measures, and b) capture social attitudes towards collaboration. In terms of physical infrastructure, the key variable is ICT networks where some competitors continue to outperform the UK. Business surveys indicate a perception that the UK is less open to ideas from other nations compared to its competitors.

The UK lags behind leading countries in:

- **Access to Finance**: The UK has a sophisticated financial services industry characterised by surging equity and debt markets in the past few years. Despite this surfeit of funding, innovative UK companies have struggled to access finance in recent years. With sharp contractions in both debt and equity markets, UK companies appear to have experienced further difficulties in accessing finance. Initial analysis suggests the situation in the UK appears to have deteriorated compared to other countries.[1]

- **Demand**: Existing indicators suggest that UK consumers are comparatively reluctant purchasers of innovative products, and UK businesses are slower to adopt new technologies than their foreign counterparts. Similarly the UK Government's track record on purchasing advanced technology products and services seems to be poor compared to other countries. This is despite the UK openly advertising more contracts than most other countries.[2]

- **Skills**: This report confirms that there is a chronic skills shortage in the UK, particularly in the levels of tertiary education amongst the working population. The report also highlights that UK companies employ fewer research and development staff than those in other leading countries.

Overall while the UK performs well for some conditions it rarely ranks at the top of the table, and there is some room for improvement compared to the world leaders. This report provides the basis to measure this performance in the future on the UK's comparative performance and provides insight into how policy could be improved in some critical areas, such as access to finance, demand for innovation and skills levels.

1. It should be noted that this research does not include the effects of recent government schemes to address the access to finance issue, such as the Innovation Investment Fund and the National Investment Corporation.
2. This is an area where there is a strong case for developing better primary data sets.

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1. Wider conditions for innovation impact how firms innovate in the UK

Innovation is an interdependent activity. Firms draw on external resources and their performance is affected by their environment. External factors can enable or hinder innovation. Competitive market conditions or incentives to invest in innovative technologies can spur innovation in firms. At the same time, a shortage of skilled workers or access to finance can be barriers to innovation.

This study seeks to assess the 'wider conditions' affecting firms' capacity to innovate in the UK. While the other reports that accompany the Innovation Index detail the innovative activity of UK firms and the benefits of innovation to the economy, this report focuses on the environment in which firms operate. This is critical since it is the variable of the innovation equation that the Government can influence. Through identifying the strengths and weaknesses of the UK innovation system, this report highlights the priority areas that policymakers need to address in order to support innovation in the UK.

1.1 The operating environment for firms emerges through a dynamic interplay of different conditions

The conditions for innovation are influenced by social and economic processes that can be shaped by public policy. The degree to which the Government can have a positive impact on the conditions for innovation varies according to the available policy levers.

1.2 Evidence on the performance of the UK's innovation system is needed for effective policy interventions

Accurate measurements of innovation help shape more targeted and effective policy responses. Policymakers require a broad set of accurate indicators they can use to judge the progress of efforts to improve the innovation system. These metrics needs to be grounded in a clear model of how innovation works.

To categorise and structure the conditions that matter most to innovative firms, NESTA has in the past used a functional model of innovation systems. The systems model links together the complex network of factors that lie outside the control of individual firms, but affect their innovation capability and performance.

1.3 The UK needs to benchmark its performance against leading innovation economies

This report provides a view of the UK's standing amongst innovation-driven economies by selecting those metrics judged to be most important to the UK and ranking the UK against only those nations. Some of UK's most important competitors when it comes to innovation are the US, Germany and France, which have higher productivity rates than the UK, Finland, Korea, Sweden, the Netherlands and Canada, all of which score highly on the existing frameworks of innovation measures. It is this group of leading innovation countries the UK should compare itself to. Fast-growing economies, such as China and India are important economies on which to compare the UK. However, the range of comparable data is limited so for the purposes of this study they have been excluded.

1.4 Several existing approaches already measure the conditions for innovation and permit international comparisons

The European Innovation Scoreboard compares 82 countries across 19 indicators, reflecting innovation performance, enablers, and environment. The Nordic Innovation Index (FORA) measures the innovation capacity in OECD countries and rates the Nordic countries' innovation capacity against other countries, by drawing comparisons on 135 indicators across 42 policy areas. INSEAD's Global Innovation Index ranks and scores 130 countries on their overall innovativeness, based on 92 indicators. These approaches provide a wide range of data to compare conditions for innovation in the UK to other countries.

1.5 Yet existing measures do not always provide the granular information needed to inform UK policy

The current suite of innovation indices take a broad approach and include metrics on the innovative performance of firms, as well as input and output indicators in the innovation process. In contrast, this report focuses exclusively on the conditions for innovation from a UK perspective. It provides a systematic framework to understand what drives innovation in firms, how wider conditions for innovation affect those drivers, and what policy can do to improve conditions in the UK.[3] To do so, it draws on research evidence to link each selected metric to innovation activity of firms, and considers in depth some areas that traditionally have received the least attention, such as the role of demand conditions.

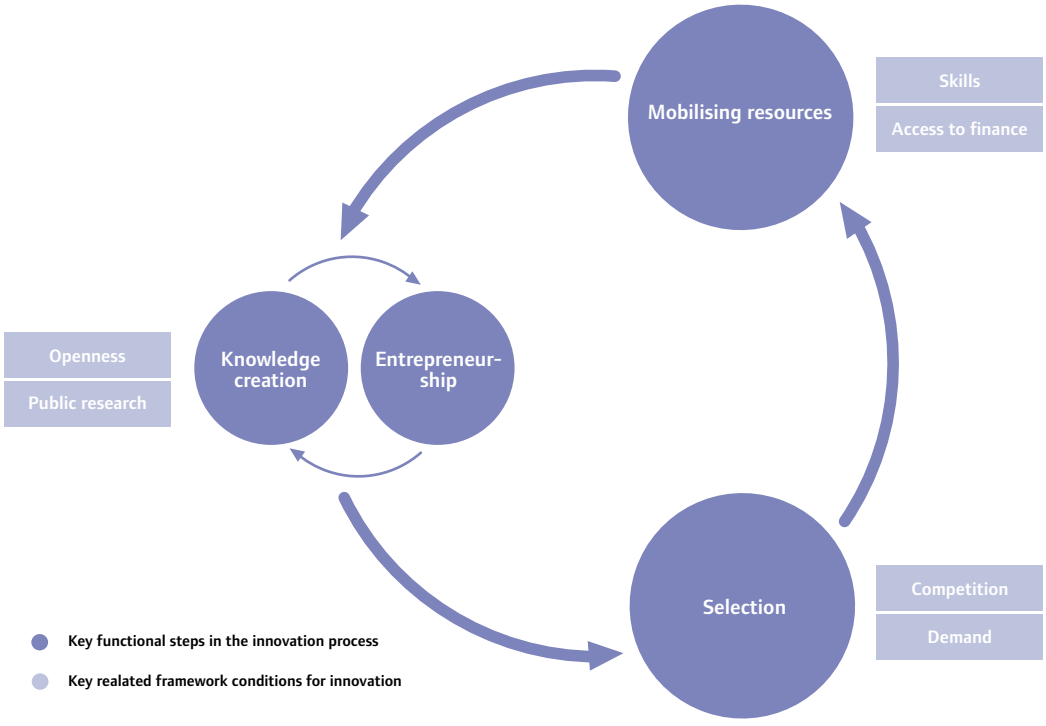
It is important to note that because it has consciously focused on collating existing metrics rather than gathering new primary data, it has identified some areas where further work would be beneficial. The areas of innovation demand and access to finance in particular would be fruitful topics for new research to create new measures.

2. Exploring the wider conditions for innovation using a functional model of innovation systems

Different conditions influence innovation in different ways. Models of innovation systems have provided useful frameworks for considering how innovation works and enables policymakers to develop a robust understanding of what impacts innovation across all sectors of the economy. A functional model of the innovation system provides an intuitive framework to identify and structure

3. Systematic efforts are done with CIS data, however the dependent variable is a mix of different innovation dimensions on country levels. The Nordic Innovation Index correlates, on country level, quality of framework conditions with innovation performance, but does not give a clear empirical basis for individual linkages.

Figure 1: Innovation systems



the wider conditions that determine the environment in which firms innovate.

2.1 A functional model of innovation systems has several advantages to an institutional model

The key insight of the functional model is identifying those elements of the innovation system without which innovative activity would stall entirely. It is more insightful than institutional models, in that it can be universally applied within and across institutional levels. It is also comprehensive, and provides a strong rationale to select measures for the conditions for innovation. The perspective of the functional system shows how conditions for innovation impact on the ability of firms to innovate, and thereby provides a view of bottlenecks and insufficiencies for each element of the system.

2.2 The functional model of innovation has four main elements[4]

The stages of knowledge creation and entrepreneurship are most commonly understood to be at the core of the innovative process, but the model shows how other factors impact firms' ability to innovate, most notably how resources are mobilised and allocated and how specific innovations are selected and taken forward.

The system points to the seven wider conditions that matter for innovation, and highlights what their specific role is. By linking those functions to the conditions, it is possible to understand how wider conditions have an impact on innovation in firms. For example, the selection process that discriminates between good and bad ideas works better when there is a competitive market and a responsive demand, with open-minded customers willing to try new products or services. Figure 1 summarises the different elements of the model.

i. **Firms innovate by creating and adopting new knowledge.**

   This is the core element of innovation. Firms generate ideas, develop new products, write new software, experiment with new business models, or draw up new designs. Those new products can range from new manufactured goods, high-tech devices, and financial products to new forms of services such as online film rentals, or GPS functions on mobile phones.

   But in the process of knowledge creation leading to innovation, firms rarely operate in isolation. Rather they draw on multiple sources of knowledge and information. To be able to do this, two wider conditions are critical. First, the '**openness**' of the environment in which they innovate. Second, the quality of the **public research** base, often acts as a catalyst for large scale disruptive innovations and fosters greater innovation across all sectors of the economy.

   Therefore, a knowledge creation component that generates a large pool of ideas characterised by breadth, depth and variety is crucial in a well functioning innovation system. But it is only a part of it. For instance, ideas that have been generated need to be screened for viability and demand by consumers and their development needs to be appropriately resourced. Not least, knowledge creation itself is intimately linked to the commercial exploitation of innovative ideas.

ii. **Entrepreneurship is critical to commercially exploit innovations.**

   Because the value of innovations to firms is realised through the revenue generated in the market, their commercial exploitation is closely linked to knowledge creation. By bringing entrepreneurship into the equation, the perspective of the innovation systems shows that knowledge creation in firms is closely linked to the commercial drive of firms.

   Without commercial motivation and entrepreneurship, many ideas would not be exploited, or in many cases never even have surfaced. The process by which firms convert ideas into marketed products often includes 'putting ideas to work' in an experimental fashion. But encouraging entrepreneurial exploration can be difficult because, by definition, there is frequently weak or absent demand for something that has not been invented yet.

   Because innovation is inherently uncertain and contains high levels of risk, a high degree of exploration is necessary to spread bets. While much of this exploration will fail, some will succeed. As part of an innovation system, a well functioning entrepreneurial component will encourage experimentation and not punish failure. It will test many ideas of wide variety.

4. Schneider, P. (2007) 'An exploration of innovation systems.' London: NESTA. (Unpublished report to DIUS).

iii. **Selecting the best innovations is critical to an innovation system.**

This process is key to developing only the most effective and efficient projects, thereby ensuring that what works is kept and what doesn't is discarded. The selection process can come at the front end of the process, when firms screen markets for demand and direct innovation activity towards meeting that demand, or after ideas have been generated and options have to be evaluated. Without selection, the innovation process becomes chaotic as all projects continue with equal priority. Selection can in some cases be accomplished by a centralised authority (for instance, a research selection board, government procurement or regulation) or – more commonly – through the market.

Selection is successful if the best innovations are chosen out of the large variety created by knowledge creators and entrepreneurs. This is more likely to happen if customers (individuals, firms or governments) are open to try out innovative solutions. So a responsive **demand** for innovation is an important wider condition. But it is not sufficient if firms don't have the incentives or the opportunity to put forward new products and services. A **competitive market** that facilitates entry, rewards successful innovators and selects out poor performing firms is therefore another key condition that drives selection.

iv. **It takes resources to generate ideas and take existing ideas forward.**

The ability of a company to exploit an idea is critically dependent on the availability and quality of human resources (numbers of people, skills, etc.) and capital resources (including finance and infrastructure).

The interaction between each functional area and the factors which influence is also beginning to be better understood by researchers.

There is no 'first step' in the innovation system
The process is continuous and each functional stage affects the others. Often firms identify a gap in the market, then allocate resources to create a product to address the gap, and then generate ideas to take forward. In other cases, resources will be provided to R&D divisions, which generate several options for management to take forward or not. In the last case, ideas will be generated from day to day work. In this case, it is necessary to have strong organisational processes to identify and select the best ideas to fund and roll out.

Striking the right balance between the components of the innovation system is critical for success
Effective knowledge creation and exploration results in an enormous number of new ideas; selection is required to choose between them. By contrast, over-zealous selection will undermine the conditions necessary for knowledge creation and exploration (notably reward for experimentation). Similarly, resource allocation intimately linked to selection. Too weak a link will mean that resources are not quickly reallocated to efficient innovation activities. Too strong a link will result in the system too often following well worn paths and therefore failing to be sufficiently creative.

The ability of firms to act effectively at each functional stage of the innovation system is determined by the wider conditions
Each element of the innovation system is affected by external factors. These factors represent the wider conditions for innovation. Good conditions for innovation will enable each functional element to play its part in the innovation system. Poor conditions may mean that functional components of the system do not perform, and thereby stifle innovation in the whole system. While the seven conditions affect different functional elements of the innovation system, it is important to note that the influence is not just direct; rather the conditions are inter-related, with each impacting on each other to varying degrees.

Within the innovation system, well functioning resource mobilisation will respond to feedback in selection by rapidly and precisely generating and allocating resources to those innovation activities that demonstrate the highest success rate. But the ability of firms to do this is constrained if the last two conditions are missing, namely **access to finance** is limited or the **skill level** of the population does not match the needs of innovative firms.

2.3 Firms agree that these conditions for innovation are important

The conditions developed from analysis of the functional innovation model were validated with survey data. The sectoral survey of UK firms undertaken in one of the work streams of the Index work[5] asked UK firms to rank the seven framework conditions by importance. Figure 2 presents the results of the survey.

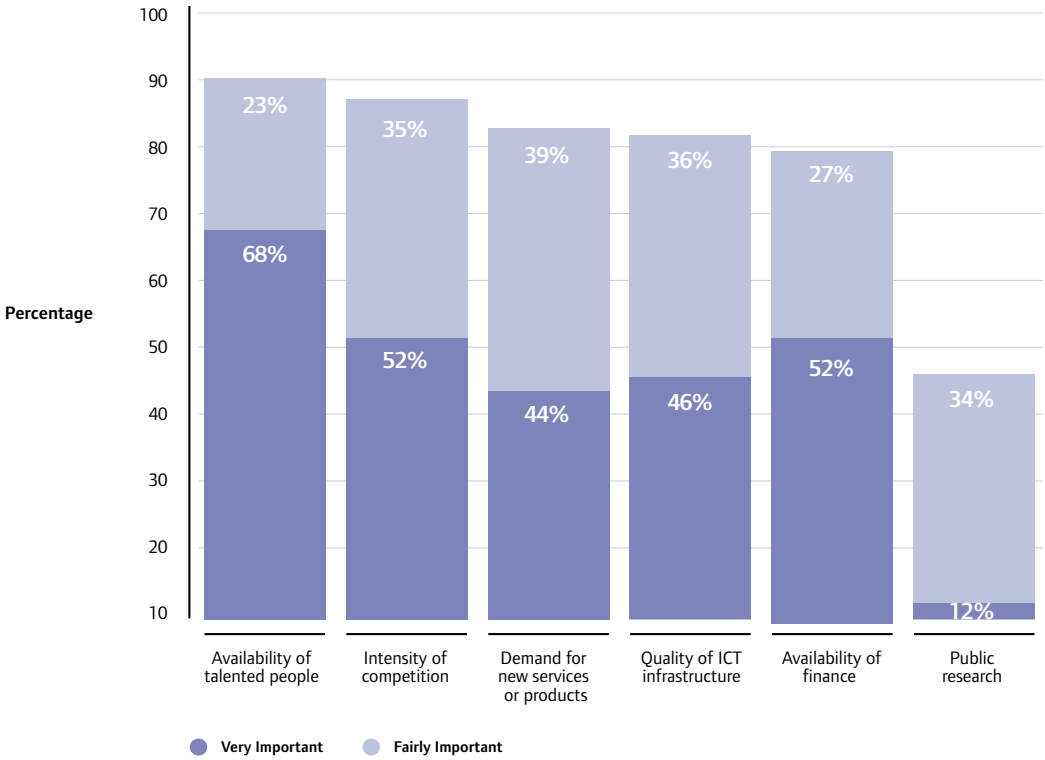
Firms rate the availability of human resources, the intensity of competition, and demand for new products and services as the most important of the wider conditions for innovation. This result shows firms are most concerned with the elements of selection and resources in the innovation system. Firms consider a supply of talented individuals to be the most critical factor in being innovative. Likewise, the intensity of competition and the demand for new services or products is considered essential for firms to have an incentive to innovate. Public research, on the other hand, is not thought to be as important by firms, and potentially reflects the relatively parlous state of collaboration between UK universities and companies.

3. An assessment of the conditions for innovation in the UK

The functional model of innovation systems provides the framework through which the interrelationship between the conditions can be seen. Having identified the wider conditions that affect each functional element of the innovation system, it is possible to select measures that allow robust inferences of how good the conditions for innovation are in the UK. The project has screened existing metrics for the data that most effectively capture each condition.

5. Roper *et al.* (2009) 'Measuring sectoral innovation capability in nine areas of the UK economy.' Report for NESTA Innovation Index project. London: NESTA.

Figure 2: Importance of wider conditions for innovation to UK firms



3.1 To assess how the UK performs on each condition, the project has assembled 35 indicators that provide a comprehensive perspective

Each indicator provides information on an aspect of the particular condition for innovation in the UK and is supported by evidence linking it to the innovative activity of firms. The resulting set of measures represents a broad assessment of the conditions for innovation in the UK.

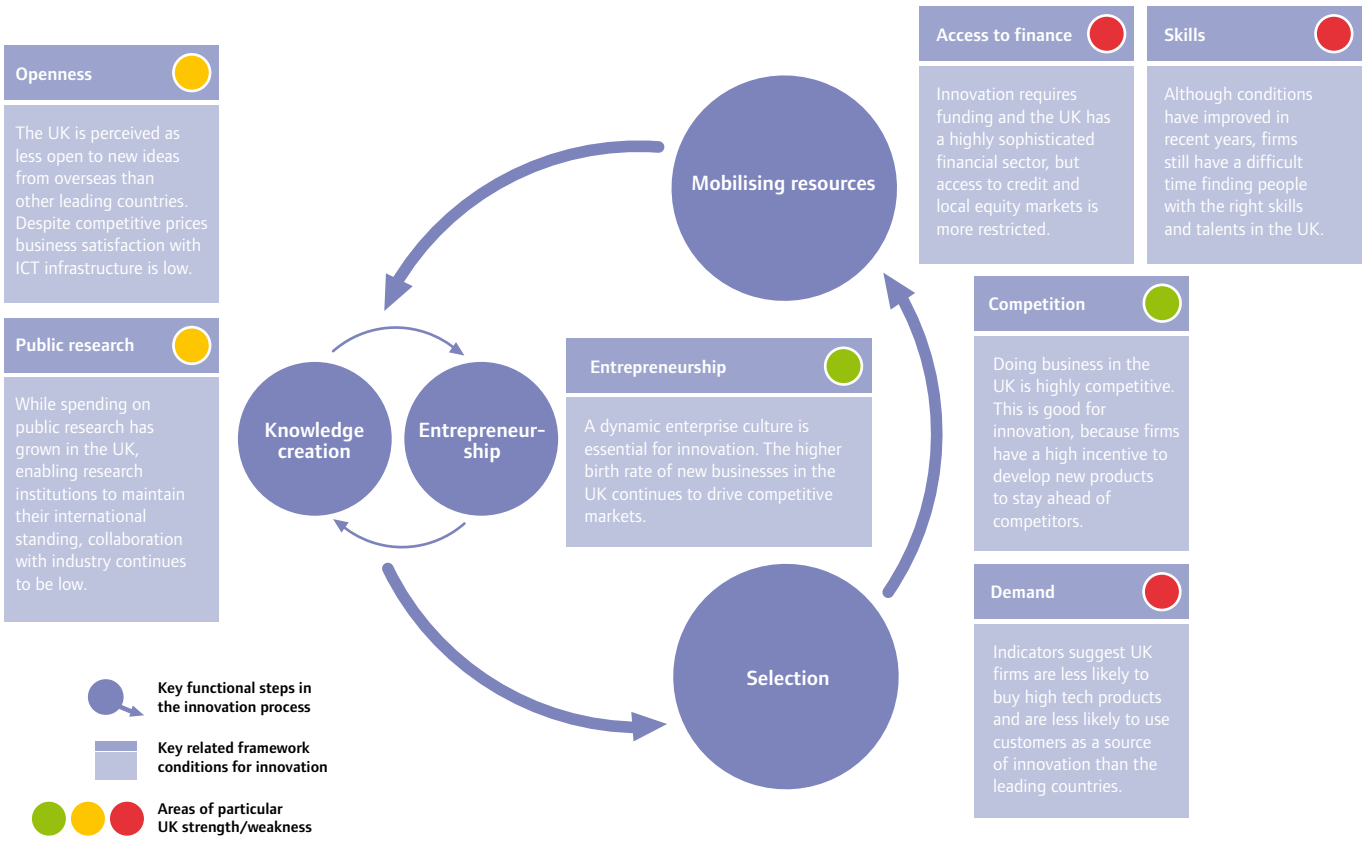
The discussion begins with an overall assessment of the UK environment for innovation, before discussing each of the seven conditions in turn. The next section provides a review of the issues emerging from the data. The full set of indicators, along with further discussion on their significance and impact on the UK innovation system are given in the appendix of indicators.

3.2 The conditions for innovation in the UK are best assessed in comparison to other leading innovation nations

The UK's main competitors are the United States, Germany, and France, which have higher productivity rates than the UK, as well as Finland, Korea, Sweden, the Netherlands, and Canada, all of which score highly on the existing frameworks of innovation measures.

The study has rated the UK's relative performance over time and how the country ranks compared to the other leading economies. A rating of green indicates that the UK has performed better over time on most indicators and is in the upper band in terms of the most recent ranking, a rating of amber indicates that the region has a similar trend performance and means the UK is amongst the three middle countries, and red means the UK is amongst the three trailing countries.

Figure 3: Assessment of UK wider conditions for innovation



3.3 The UK compares well with the leading innovation nations, although it does not rank at the top of the table frequently
Analysis in this report reveals that companies find a relatively good environment to innovate in the UK, with high levels of competition and good public research. However the UK performs poorly on insufficient access to finance, lack of skills, and low demand for innovation. This targeted approach to assessing the UK's performance on wider conditions for innovation is broadly in line with the findings of the EIS.

4. Openness

Innovations often have more than one source. In many cases, ideas and products are the result of collaborations and the interplay of many factors. In others, firms draw on and re-arrange ideas from outside of the firm to develop new products. To be able to do this, the 'openness' of the environment in which they innovate is critical for innovation to flourish.

There are two dimensions to openness: the attitude of the individuals involved and the physical enablers it takes to collaborate.

- High levels of openness are generated by individuals who actively seek and share knowledge from diverse sources. Openness broadens and diversifies the range of resources and information available to firms, providing an opportunity to generate new knowledge through the combination of previously disjointed areas.[6]

- To access external knowledge, the infrastructure must be in place to enable the effective exchange of knowledge. A good communications infrastructure is increasingly the essential link for knowledge exchange. Consequently the physical conditions for openness play an important role to the innovative activity of firms.

A lack of openness to external knowledge limits the opportunities for collaboration, hinders the exchange of ideas, and can impose on the innovative activity of firms. It is therefore easier for firms to innovate, if they can access other knowledge sources openly.

4.1 The UK performance
Openness and a tolerance to diverse opinions are recognised as positive contributors to inward investment and growth.[7] Increasing adoption of 'open innovation' is being driven by a global knowledge economy. Indicators suggest the UK is viewed as less open than the other leading economies. The perception of businesses is that the UK is less open to foreign ideas than is the case in the Netherlands, Canada, Sweden and Finland, but is more open than Germany and France.

While an openness to external sources of knowledge is important, so too is the culture of trust that exists within a society. Trust and a lower perception of corruption have been demonstrated to be positively related to higher levels of innovation.[8] Surveys suggest that the UK ranks below Sweden, Finland and Germany on how confident people are in trusting others, while international comparisons of the perception of corruption ranks the UK below these same countries and the Netherlands.

A further determinant of successful adoption of external ideas is the capacity of firms to source and integrate these into their processes. This is increasingly the role played by ICT infrastructures. The UK is ranked in the bottom 3rd in terms of broadband speed, above Germany and the US, but significantly below Sweden, Finland and France. This may be a legacy of existing infrastructure, with the UK slower to install new faster networks and instead upgrading the existing infrastructure.[9]

Demand for access is also influenced by price. Competition among suppliers drives prices down towards a competitive market price, and the data suggest this is occurring within the comparator economies. While domestic customers are not able to substitute between different countries' networks, price could be a factor in attracting foreign inward investment. Recent data shows that prices in the UK are the 3rd most competitive below South Korea and France.

While prices are competitive, the level of business satisfaction with the ICT infrastructure, despite improving over the last five years is still lower than all the other competitor countries.

In a global knowledge economy it is essential that UK firms be able to access efficient and competitively priced ICT networks. Survey evidence indicates the UK is below its competitors in providing effective networks. The UK government has committed to improve access. ICT is one element of openness and other

6. Laursen, K. and Salter, A. (2006) Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms. 'Strategic Management Journal.' 27(2), pp.131-150.
7. See Florida, R. and Gates, G. (2001) 'Technology and tolerance: The importance of diversity to high-tech growth.' Washington, DC: Brookings Institution, Center for Urban and Metropolitan Policy.
8. Arundel, A. and Hollanders, H. (2007) 'Differences in socio-economic conditions and regulatory environment: explaining variations in national innovation performance and policy implications.' INNO-Metrics Thematic Paper. Brussels: European Commission, DG Enterprise.
9. This finding may be affected by planned and current government policies to improve broadband speed.

softer indicators suggest that the UK is more open to new ideas than some of the other countries but lags key competitors. Openness is given a rating of amber.

5. Public research

Public research is an important source of external knowledge, and acts as a catalyst for wider innovation in the economy and occasionally stimulates large-scale disruptive innovations. Public research has been one of the key drivers of technological innovation in the past: the internet, GPS, and the MRI scanner, for instance, were all initially developed through public funded projects.

Public research often provides the basic research to promote innovations in fields where commercial exploitation is still unclear and the costs for firms to invest is too great. Economic benefits through private sector collaboration and university spin-offs can build up early-stage concepts into commercial products.

A flourishing system of public research can therefore be a critical source of innovation for firms to exploit, and, equally, a poorly developed or poorly integrated system of public research can mean that areas of potential future economic value will go unexplored, because of the commercial uncertainty involved.

5.1 The UK performance

The UK published over 90,000 papers[10] in 2008, which represents a 7.9 per cent share of world publications, down from 9.3 per cent in 1999. This pattern was reflected across the other leading economies. Much of the change was due to increased output volumes from China, Brazil and South Korea. Despite this drop in publications the UK share of world citations rose in 2008 to 11.8 per cent with no discernible impact on quality indices.[11]

Data on public research is principally grounded in the science, engineering and technology (SET) framework. The UK output of scientific publications is 2nd only to the US. When adjusted for population size, indicators of scientific publications based on population-weighted measures for the time period considered (2000-2008) indicate the UK is a mid-table performer. The most innovative countries (Sweden and Finland) deliver a higher number of scientific publications over the period. By this measure, the USA also performs relatively poorly.

As a measure of the degree of research interaction and connectivity between the public and private sectors, the number of public-private co-publications is highest in the most innovative countries (Sweden and Finland), with the UK performance below average over the time period considered. Data on public-private research collaboration indicates that firms in countries with a high innovation performance also tend to collaborate with universities more intensively than firms in other countries.

The UK is showing an improvement in research collaboration with industry. The UK has moved from being in the lower third in 2001 to being in the higher ranks in 2009. The number of patents has increased and latest data show they are 2.5 times higher than in 2001.

Public research is a significant source of knowledge for UK firms. The picture is mixed. Leading universities continue to influence wider research through the volume and quality of publications. Comparisons of the levels of commercial collaboration ranks the UK in the lower order and this will undermine innovative capabilities. Public research is given a rating of amber.

6. Entrepreneurship

Innovation is a speculative activity. Risk of failure is inherent to every stage of the innovation process. Ideas that are taken forward might never be developed into products, and products taken to market might commercially fail. Therefore attitudes towards risk are an important driving force for innovative activity and risk-averseness can stifle entrepreneurship.[12]

Entrepreneurial exploration is largely influenced by societal attitudes towards entrepreneurship.[13] Social attitudes are distinct between countries and include varying degrees of individualism, uncertainty avoidance, and trust, which describes how hierarchical societies are.[14] There is a negative relationship between power distance and uncertainty avoidance, and innovation, and a clear positive relationship between individualism and both economic creativity and innovation.[15] In societies that lack those attributes, entrepreneurship is

10. Thomson Reuters.
11. DIUS (2009) 'International Comparative Performance of the Research Base.' London: DIUS.
12. Beugelsdijk, S. (2007) Entrepreneurial culture, regional innovativeness and economic growth. 'Journal of Evolutionary Economics.' 17(1), p.187-210; see also Technopolis (2008) 'Socio-cultural determinants of innovation.' Europe Innova Working Paper No 10. Brighton: Technopolis.
13. Williams, L. and McGuire, S. (2005) 'Effects of National Culture on Economic Creativity and Innovation Implementation.' (Unpublished paper). Available at: www.isnie.org/ISNIE05/Papers05/Williams_McGuire.pdf
14. Hofstede, G. (2005) 'Cultures and Organizations: Software of the Mind.' London: McGraw-Hill.
15. Williams, L. and McGuire, S. (2005) Indicators of Innovation were the percentage change in the total value of exports with high R&D intensity, and an innovation implementation index, calculated as the sum of six subjective measures of innovation implementation taken from the Global Competitiveness Report.

reduced, and as a result of this, so is innovative activity.

Therefore the entrepreneurial culture in which innovative activity is embedded plays an essential role in the initiation, investment, and exploitation of innovation and determines the degree to which innovative ideas are explored and commercialised.

6.1 The UK performance

Since 1995 the UK business stock has been increasing as the number of firms exiting the market remains pretty stable, while new entry has been rising.[16] The business stock at the start of 2008 was 26 per cent higher than at the beginning of 1995. Compared with the other economies the UK business entry rates are broadly higher than the other economies.

As regards the culture of entrepreneurship the evidence is mixed. Since 2001 the trend in early-stage entrepreneurship is downwards. The proportion of nascent and new owner businesses fell from 7.7 per cent in 2001 to 5.5 per cent in 2008. The UK ranks significantly below the US and South Korea, but is comparable with France and the Netherlands and above Germany.

The decline in early-stage entrepreneurship may reflect an increasing fear of failure among potential entrepreneurs. Over the same period the fear of failure increased, from 30 per cent in 2001 to 38 per cent in 2008. Fear of failure among potential entrepreneurs is lowest in economies where early-stage entrepreneurship is highest – US, South Korea and Finland – and highest in the least entrepreneurial countries such as Germany and France.

The UK is regarded as a relatively good place to be an entrepreneur. Although the recession is likely to increase the risk of entreprenurship, the condition still warrants a rating of green.

7. Competition

In non-competitive markets the incentive to innovate may be weakened as profits can be maintained by servicing familiar needs in familiar ways. In a highly competitive marketplace, innovation becomes a key driver of competitive advantage, and all other things being equal, firms will invest more in innovation.

Competitive markets operate in an evolutionary way – weaker, less adaptive firms find it more difficult to access customers and eventually exit the market. Joseph Schumpeter termed this process 'creative destruction' and it is recognised as major driver of productivity growth – it also serves as an overwhelming incentive for firms to innovate.[17]

Most empirical studies have found the relationship between competitive intensity and innovation to be positive. A defining feature of competitive markets is freedom for participants to enter and exit. This literature indicates that the entry and exit, and the growth and decline of individual firms (firm dynamics), play an important role in enabling innovation and productivity growth by allowing resources to be reallocated from less productive to more productive businesses.

7.1 The UK performance

While local competition is high across the comparison countries, the assessment of the relative UK position indicates that competition in local markets is lower than that of Germany and the US. Clearly there are a significant number of influencing factors, such as sectoral mix, traditional industries, infrastructure and so forth which we would need to consider before making too strong an assertion about intensity of competition.

Market dynamics are clearly a driver of competition. New entrants both provide greater choice to customers, pushing prices down, but they also impact indirectly by forcing incumbents to be more efficient. A further beneficial impact is that new firms may be a catalyst in driving out inefficient firms, increasing productivity. A measure of the intensity of market dynamics is business churn, which is higher in the UK than other countries. The higher relative levels of new firm formation rates have been highlighted in the discussion on entrepreneurship.

Competition is now international. The UK trade ratio to GDP has risen in three out of the last four years between 2005 and 2008; this followed four years of consecutive decline. In 2008 the foreign trade ratio to GDP was around 30, significantly below Germany, which has a high export sector, but above France and almost twice the figure for the US.

The UK is increasingly seen as a good place for foreign investors. Since 2005 net inflows of Foreign Direct Investment (FDI) have increased as a share of GDP; in 2008 the UK

16. UK data on business stock available at http://stats.berr.gov.uk/ed/vat/
17. Schumpeter, J.A. (1943) 'Capitalism, Socialism and Democracy.' London: Allen and Unwin. (Originally published in the USA in 1942; reprinted by Routledge, London in 1994); see also Metcalfe, J.S (1998) 'Evolutionary economics and creative destruction.' The Graz Schumpeter Lectures. London: Routledge.
18. For example, Schmookler, J. (1962) Economic Sources of inventive activity. 'Journal of Economic History.' 22, pp.1-20; also Mowery, D. and Rosenberg, N. (1979) The influence of market demand upon innovation. A critical review of some recent empirical studies. 'Research Policy.' 8(2), pp.102-153; also Guerzoni, M. (2007) 'The impact of market size and sophistication on innovation: The patterns of demand.' Presentation to the conference Appropriability, proximity, routines and innovation, Copenhagen, June 18 2007; also Anderson, E.S. (2007) Innovation and Demand. In Hanusch, H. and Pyka, A. (Eds) 'Elgar Companion to Neo-Schumpeterian Economics.' Cheltenham: Edward Elgar.

ranked second among the comparator group, falling behind Sweden which had seen net FDI increase significantly in 2008 compared to 2007.

Conditions for competition in the UK are strong, making the economy a dynamic place to do business. This means firms in the UK have to innovate continuously to stay competitive. Global markets are also dynamic so careful monitoring of the conditions is essential to ensure they are not weakened. Competition is given the rating of green.

8. Demand

Firms innovate because of the economic benefits and the competitive advantages they gain through it. But the extent to which innovation delivers those pay-offs is greatly affected by the market conditions firms face in the form of the demand for innovation and the intensity of competition. Ultimately it is the market that decides.

Firms need to understand their customers if they are to maintain success. In established markets product changes often involve incremental variations in product or service characteristics. In terms of new innovative products the situation is more uncertain.

Firms are likely to invest more in innovation when there is a high demand for innovative products, and there is empirical evidence showing that clear signals from customers incentivise innovation and reduce the degree of uncertainty for innovators.[18]

Demand for innovations has two dimensions:

- How widely and quickly firms, consumers and public users adopt innovations is measured by the 'responsiveness' of demand. The rate of adoption and the speed with which innovation is spread is determined by market size,[19] as well as softer factors such as the sophistication of consumers.

- Consumers can also 'trigger demand' by signalling the need for innovation in a specific market. Consumers often provide important input to the innovation process,[20] a further demonstration of the importance of openness in innovation, and contribute to the productivity and competitiveness of firms and markets.[21] The clearer the signals given by consumers and the broader the potential market represented by those signals the more likely there will be successful innovative adaptations or new innovations.

8.1 The UK performance

There is a paucity of sophisticated international comparable measures of demand. The data rests primarily with consumers surveys of attitudes. Caution should be taken therefore in drawing too strong a conclusion on the available data.

UK consumers seem to present a less welcoming demand environment to innovative firms seeking to launch products than other countries. Survey data, which asked consumers of their likelihood to purchase innovative products in the next six months, show UK consumers indicating less propensity than in the US and Spain while slightly ahead of the Netherlands or Finland. In addition the UK's position has fallen slightly between 2007 and 2008. The UK also rates low on characteristics such as the certainty of demand for innovation or absorption of new technology by businesses, but relatively higher in the rankings for buyer sophistication although the trend here is that it is decreasing.[22]

The importance of public procurement as a factor is broadly accepted.[23] The indicator of public demand (procurement) shows that the UK still has a comparatively large share of public procurement in open tenders, expressed as a share of GDP. While a significant level for innovation, evidence suggest that the benefits to firms from government procurement is poor. Research suggest that SMEs find it hard to access government contracts.[24]

Government procurement can also act as a catalyst for the introduction of new innovative technologies. However, evidence suggests that across the comparator countries governments do not procure significant levels of new innovative technologies. The UK continues to be in the bottom 3rd of the countries, with little change in the indicator over the period.

It is difficult to assess the influence of sophisticated consumers given the limitations of the data. Broadly the UK ranks in the lower orders in terms of consumer and firm adoption of new technology, implying poor demand conditions. Government purchasing power could have a significant impact on innovation, but the perception is that it is not benefiting smaller innovative companies

19. For example, Schmookler, J. (1962) Economic Sources of inventive activity. 'Journal of Economic History.' 22, pp.1-20; Dekimpe, M., Parker, P. and Sarvary, M. (2000) Global Diffusion of Technological Innovations: A Coupled-Hazard Approach. 'Journal of Marketing Research.' 37 (February), pp.47-59; Tellis, G.J., Stremersch, S. and Yin, E. (2003) The International Takeoff of New Products. 'Marketing Science.' 22, S.188–208; Trott, P. (2003) Innovation and Market Research. In Shavinina, L. (Ed.) 'International Handbook on Innovation.' Oxford: Elsevier Science. pp.835-844; Veryzer, R.W. (2003) Marketing and the Development of Innovative New Products. In Shavinina, L. (Ed.) 'International Handbook on Innovation.' Oxford: Elsevier Science. pp.845-855.
20. For example, von Hippel, E. (1986) Lead Users: A source of novel product concepts. 'Management Science.' 32(7), pp.791-805; Guerzoni, M. (2007) 'The impact of market size and sophistication on innovation: The patterns of demand.' Presentation to the conference Appropriability, proximity, routines and innovation, Copenhagen, June 18 2007; Prandelli, E., Sawhney, M. and Verona, G. (2008) 'Collaborating with Customers to Innovate: Conceiving and Marketing Products in the Networking Age.' Cheltenham: Edward Elgar.
21. These authors are illustrative only and represent quite different perspectives on the meaning of demand for market development. More generally see Porter, M. (1990) 'The Competitive Advantage of Nations.' New York: The Free Press.
22. Further research could be undertaken to validate these data with the views of firms with experience of launching new products in a variety of national markets.
23. NESTA (2007) 'Driving innovation through public procurement.' London: NESTA.
24. SBS (2006) 'Annual Small Business Survey 2005.' London: SBS.

as much as it could. For these reasons demand has been given a rating of red.

9. Skills

Three categories of human capital impact on innovation:

- *Specialised knowledge* is crucial to cutting edge research which keeps businesses competitive. The availability of talented individuals – be they 'front-line' R&D staff in the pharmaceutical sector or trained software developers in the banking industry – is an essential factor in developing innovative products or processes, and realising the UK's potential to compete globally.

- *Vocational skills* of the work force are important in identifying and addressing procedural or organisational barriers to innovation. This is a crucial enabler of a firm's capacity to absorb and spread new technologies, processes and business practices internally. This applies as much to a firm's own innovations as it does to those that are adopted externally.

- *The general level of education* is becoming an important factor with the production of increasingly sophisticated goods and services. The ability of the workforce to keep up with technological advances and apply them is essential for firms to translate innovations into competitive advantage.

Without the individuals necessary to innovate – whether in high-tech R&D, IT, or architecture – firms will not be able to leverage their full innovative potential.

9.1 The UK performance

The share of professionals and technicians employed within the UK has increased since 2000, up from 37 per cent to 43 per cent in 2007. Nearly 50 per cent of these are employed as technicians or associated professions. While the rate of increase over the period is higher than in the other economies, the UK continues to rank in the bottom third, above France.

The UK has a lower level of intensity of the population who are engaged in research than other leading economies. In 2007 the UK ranked bottom among the sample of comparator economies. The UK proportion of researchers is 1/3rd that in Finland and 2/3rd the level of Germany. Since 2000 the UK share of researchers has remained stable, while they have increased across the other economies, with the Netherlands moving above the UK in 2006.

To more effectively utilise the wider knowledge, firms need to have an adaptive workforce. Research findings from within the EU highlight that businesses in the UK were more likely to have to invest in training staff when undertaking wider innovation such as process or organisational change.

The UK ranks in the lower third in measures of adaptability, significantly below the lead countries Canada and the US, but above Germany and France. Although improving since 2000, business continues to see ICT skills of the workforce in the UK as being poorer than those of workers in the comparator countries.

The share of high and medium skilled workers is also an issue that impacts on the capacity of UK firms to innovate. Although the share of employment from skilled workers has increased at a faster rate than other countries other than the Netherlands and Sweden, the UK continues to rank mid-table among the group of comparator countries.

The UK skills performance, based on the measures used within the study, show the UK ranked in the lower order of comparative countries. The share of researchers and technology employment is lower and key ICT skills are considered weak. The share of employment by higher skilled workers is still within the middle order. The assessment of these indicators leads us to give skills a rating of red.

10. Access to finance

Access to finance is a key driver in firms being able to develop and commercialise innovations, particularly for riskier, disruptive innovation. Research has highlighted this as a barrier.[25]

Specifically, early-stage firms exploring new business opportunities tend to be high-risk investment opportunities with intangible assets and uncertain cash flows. These features make it very difficult for innovative start-ups to secure a loan from banks.[26] Such firms rely on early-stage equity finance, venture capital and angel investments to meet their financing needs.[27] Larger firms rely mostly on institutional investors and banks as their

25. Hall, B.H. and Lerner, J. (2009) 'The Financing of R&D and Innovation.' NBER Working Paper 15325. Cambridge, MA: National Bureau of Economic Research.
26. Rivaud-Danset, D. (2002) 'Innovation and New Technologies: Corporate Finance and Financial Constraints.' Paper presented to the international conference Financial systems, corporate investment in innovation and venture capital. EU-DG research and the Institute for New Technologies of the United Nations University, Brussels, 7 and 8 November 2002.
27. NESTA (2009) 'Reshaping the UK economy.' London: NESTA.

primary source of finance.[28] While stock markets provide access to equity, banks serve as the source of external finance for private firms and small firms from established sectors.[29]

Innovative firms can draw finance from internally generated funds (personal savings, retained profit and sales of assets), or external funding (debt, equity and 'soft capital'). Especially small, early-stage firms often cannot finance investment in innovation from internal sources, and are particularly reliant on external sources of finance.[30]

10.1 The UK performance

The contraction of credit markets has disrupted access to finance for many UK firms. According to the latest Global Competitiveness Report, accessing finance is now the most problematic factor for doing business, with 1 in 5 companies ranking it the most serious problem they faced in 2009.

The level of private credit as a percentage of GDP in the UK grew significantly over the last decade. In 2008 it reached 213 per cent, two-thirds higher than at the beginning of the decade. But not all this increase went to provide credit to UK businesses. Household debt also rose over the period, from around 80 per cent of GDP in 2000 to 100 per cent of GDP in 2008.[31]

The UK had the highest level of private credit relative to GDP among all the comparator countries. This was likely the result of a combination of factors, such as the highly developed nature of the UK financial system and the magnitude of the credit bubble that the UK experienced.

UK stock markets are also highly developed. While market capitalisation of listed companies halved as a percentage of GDP in 2008, it was still consistently ranked among the top countries over the decade.

While on initial examination this suggests that there should be adequate supply of funds for business, other indicators provide a more nuanced view. In the years prior to the recession, it was easier to access loans in the UK than in most of the other comparator countries. But the financial crisis hit the UK harder than other countries. The UK now ranks among the worst three countries in terms of the ability to access loans.

The picture for venture capital is also mixed. Early-stage venture capital as a share of GDP is volatile over the period, reflecting the scale and value of key investments. The UK ranks around the middle of the table of comparator countries, although lags Sweden which leads the table, having risen above the US in 2001.

The discussion above suggests that the finance conditions for innovation in the UK have deteriorated over time. The UK is currently ranked low among the comparator countries indicating a poorer environment for finance compared to other countries. To reflect this assessment, access to finance is given a rating of red.

28. OECD (2004) 'Financing innovative SMEs in a global economy.' Paris: OECD.
29. Levine, R. and Zervos, S. (1998) Capital Control Liberalization and Stock Market Development. 'World Development.' 26(7), pp.1169–83.
30. Canepa, A. and Stoneman, P. (2003) 'Financial constraints on innovation: a European cross country study.' EIFC Technology and Finance Working Papers, Number 11. United Nations University, Institute for New Technologies.
31. See Daffi, C., Levy, S. and Walton, A. (2009) Improving measurement of household savings and wealth. 'Economic and Labour Market Review.' Vol.3 No.7 July 2009.

Data Appendix: The conditions for innovation in the UK

Table 1: List of indicators

Openness	
1	Openness to foreign ideas
2	Social capital
3	Broadband penetration
4	Broadband speed
5	Broadband price
6	Business satisfaction with ICT infrastructure
Public research	
7	Quality of public research – scientific publications
8	Accessibility of public research – collaboration
9	Relevance of public research – commercial exploitation
10	Quality of public research – citations
11	Relevance of public research – patents
12	Relevance of public research – invention disclosures
Entrepreneurship	
13	Attitude towards risk of business failure
14	Early-stage entrepreneurial activity
Competition	
15	Intensity of local competition
16	Intensity of foreign competition

Demand	
17	Consumer confidence index
18	Demand as innovation source
19	Firm-level technology absorption
20	Size and inclination to buy innovation
21	Uncertainty of demand as an obstacle to innovation
Skills	
22	Expenditure on education as a percentage of GDP
23	Share of population with tertiary education
24	Percentage of high-skilled labour in the workforce
25	Human Resources in Science And Technology (HRST)
26	Intensity of researchers in industry
27	Adaptability of the workforce
28	Employees' ICT skills
29	Training – availability and usage
30	Training needs for innovators
31	Participation in life-long learning
Access to finance	
32	Availability of credit
33	Stock market capitalisation
34	Availability of venture capital
35	Access to finance

Openness

1. Openness to foreign ideas

Why is it significant?

This indicator, sourced from the IMD World Competitiveness Yearbook, measures executive opinion as regards the extent to which their national culture is open to foreign ideas.

This indicator is important because, among cultural factors, tolerance, openness and inclusion are also considered vital to economic growth and innovation. It is often argued that talent is attracted to an open, tolerant and inclusive society. As long ago as 1869 John Stuart Mill recognised that tolerance is essential for objective thinking. The toleration of diverse opinions allows an intellectual freedom that is just not available when the individual rights of the person are not given their fullest expression. More recent work by Florida (1999, 2002a, 2002b, 2002c, 2005; Florida and Gates 2001)[32] demonstrates that talent is attracted to regions that offer low barriers to entry and higher levels of openness and tolerance. Florida and Gates (2001) found a significant relationship between the level of immigration and regional growth for small and medium-size regions and between the level of the gay population and growth in large regions.

Moreover, openness has been shown to be beneficial for firm innovativeness and performance.[33] It increases the amount of resources and information available to the firm and the opportunities to recombine previously disconnected ideas.

What is its relative importance?

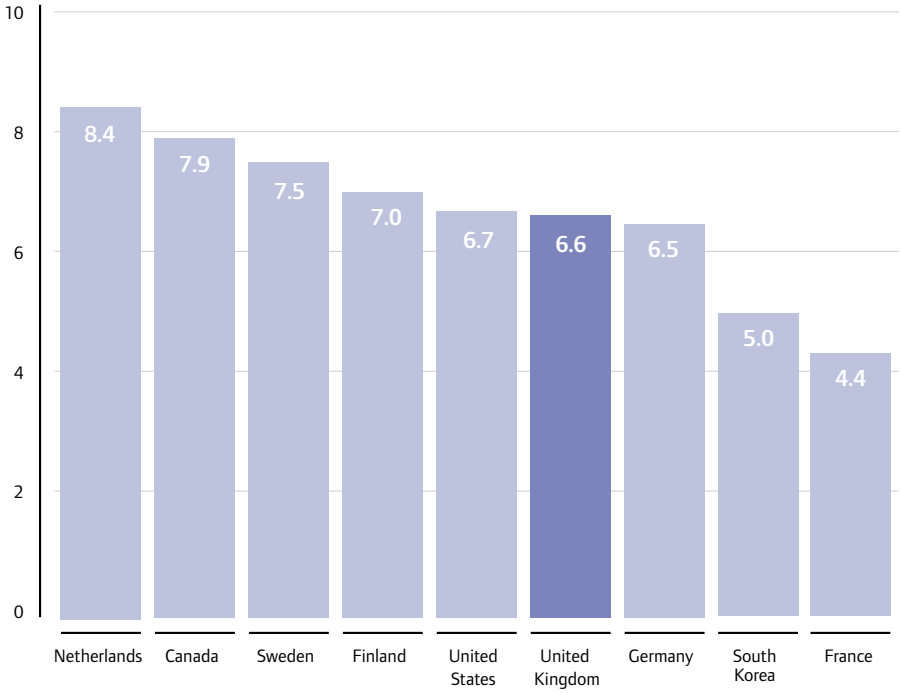
Companies' innovation activities are increasingly international – in a globalising knowledge-based economy, a firm's innovation performance depends not only on its internal interactions but also on its ability to identify and access external knowledge sources located far away (Scott 1998, Bresnahan *et al.* 2001, Bathelt 2003).[34] Moreover, businesses are embracing 'open innovation'. Global pipelines and open innovation can only flourish in a culture of trust and openness to external ideas.

Standing of the UK

Figure 4 shows survey evidence which indicates a lower rating in businesses assessment of UK openness to foreign ideas compared to many of its competitors and over time. Not only is the UK society becoming less open (Figure 5); but some of the other countries such as the Netherlands, Canada and Sweden are perceived as more open.

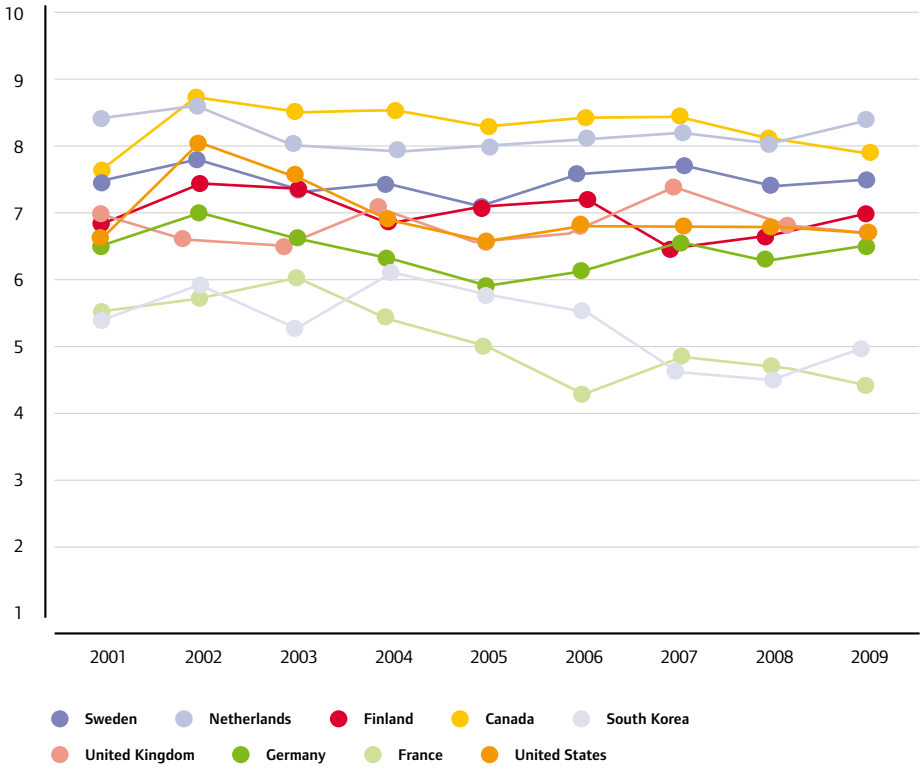
32. Florida, R. (1999) 'Competing in the age of talent.' Report to the R.K. Mellon Foundation, Pittsburgh, PA. Available at: http://www.heinz.cmu.edu/~florida; Florida, R. (2002) Bohemia and economic geography. 'Journal of Economic Geography.' 2, pp.55-71; Florida, R. (2002) 'The rise of the creative class: And how it's transforming work, leisure, and everyday life.' New York: Basic Books; Florida, R. (2002) The Economic Geography of Talent. 'Annals of the Association of American Geographers.' 92(4), pp.743-755; Florida, R. and Gates, G. (2001) 'Technology and tolerance: The importance of diversity to high-tech growth.' Washington, DC: Brookings Institution, Center for Urban and Metropolitan Policy.
33. Laursen, K. and Salter, A. (2006) Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms. 'Strategic Management Journal.' 27(2), pp.131-150.
34. Bathelt, H. (2003) Success in the local environment – local buzz, global pipelines and the importance of clusters. In Altana, A. (Ed.) 'Think on.' Issue 2. Cologne: Peipers. pp.28-33. Available at: http://www.altana.com/root/index.php?lang=en&page_id=893 [Accessed March 10, 2004]; Bresnahan, T., Gambardella, A. and Saxenian, A. (2001) 'Old economy' inputs for 'new economy' outcomes: cluster formation in the new Silicon Valleys. 'Industrial and Corporate Change.' 10, pp.835-860; Scott, A.J. (1998) 'Regions and the World Economy: The Coming Shape of Global Production, Competition, and Political Order.' Oxford and New York: Oxford University Press.

Figure 4: Openness to foreign ideas, 2009



Source: IMD WCY Executive Opinion Survey based on an index from 0 to 10; the extent to which national culture is open to foreign ideas.

Figure 5: Openness to foreign ideas, UK, 2001-2009



Source: IMD WCY Executive Opinion Survey based on an index from 0 to 10; the extent to which national culture is open to foreign ideas.

Openness

2. Social capital

Why is it significant?

The literature demonstrates that high levels of social capital – as measured by trust and the perception of corruption – contributes to innovation by reducing transaction costs as well as information and enforcement costs. Social capital in turn influences the innovation process because the financing of risky innovative projects requires that researchers and capital providers trust each other.[35] According to a recent study by OECD,[36] successful open innovation depends on trust and an open business model.

What is its relative importance?

According to the literature,[37] variations in social capital have a high explanatory power in explaining differences in innovation performance. Societies characterised by high levels of trust and low levels of perception of corruption demonstrated higher levels of innovation performance.

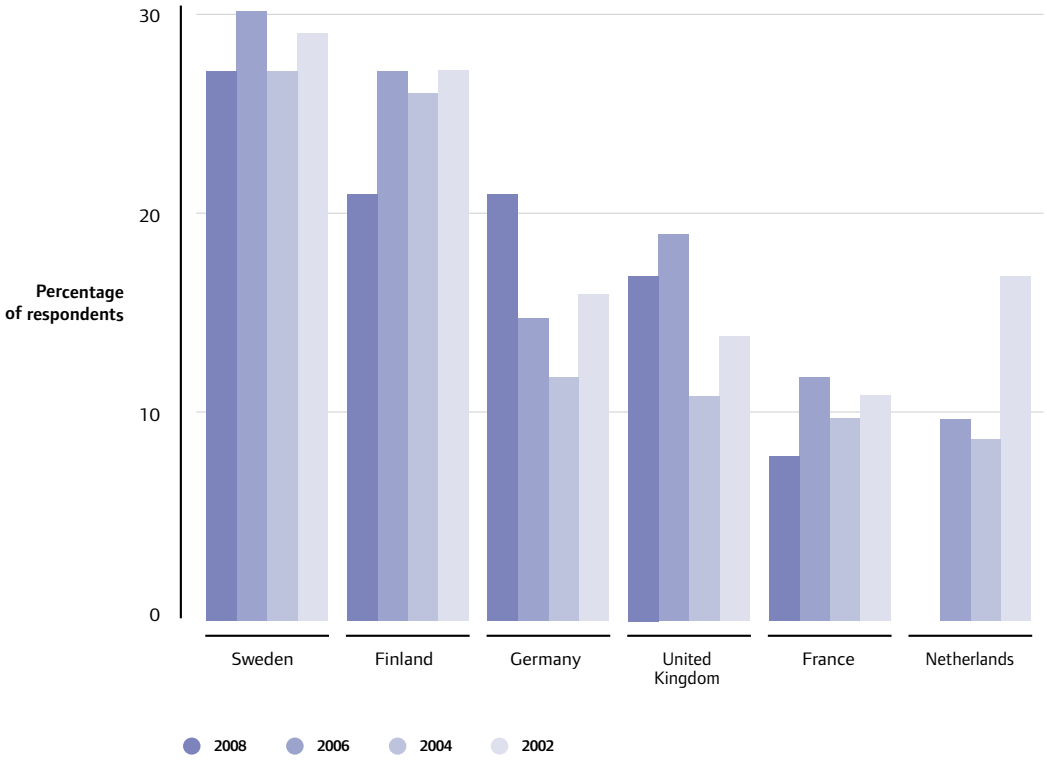
Standing of the UK

Figure 6 shows that the UK society is characterised by relatively low levels of trust as compared to the other leading innovation economies of Europe; and that people are becoming less trust-worthy of each other over time.

Corruption Perceptions Index ranks 180 countries by their perceived levels of corruption, as determined by expert assessments and opinion surveys. Table 2 shows the score of the nine benchmarking candidates over a four-year period. Again, the UK is a middle ranking country among the comparators and there is a noticeable fall in the score over time.

35. Akçomak, I. and ter Weel, B. (2008) Social Capital, Innovation and Growth: Evidence from Europe. 'European Economic Review.' 53:5, pp.544-567.
36. OECD (2008) 'Open Innovation in Global Networks.' Paris: OECD.
37. Arundel, A. and Hollanders, H. (2007) 'Differences in socio-economic conditions and regulatory environment: explaining variations in national innovation performance and policy implications.' INNO-Metrics Thematic Paper. Brussels: European Commission, DG Enterprise; Akçomak, I. and ter Weel, B. (2008) Social Capital, Innovation and Growth: Evidence from Europe. 'European Economic Review.' 53:5, pp.544-567.

Figure 6: Level of trust in the society – percentage of respondents stating "Most people can be trusted", 2008



Source: European Social Survey; Q. Generally speaking, would you say that most people can be trusted, or that you can't be too careful in dealing with people? Please tick the box that is closest to your opinion, where 0 means you can't be too careful and 5 means that most people can be trusted. Data not available for the Netherlands for 2008.

Table 2: Corruption perceptions index, 2001-2008

	2001	2002	2003	2004	2005	2006	2007	2008
Korea	4.2	4.5	4.3	4.5	5.0	5.1	5.1	5.6
Canada	8.9	9.0	8.7	8.5	8.4	8.5	8.7	8.7
France	6.7	6.3	6.9	7.1	7.5	7.4	7.3	6.9
United States	7.6	7.7	7.5	7.5	7.6	7.3	7.2	7.3
United Kingdom	8.3	8.7	8.7	8.6	8.6	8.6	8.4	7.7
Germany	7.4	7.3	7.7	8.2	8.2	8.0	7.8	7.9
Netherlands	8.8	9.0	8.9	8.7	8.6	8.7	9.0	8.9
Finland	9.9	9.7	9.7	9.7	9.6	9.6	9.4	9.0
Sweden	9.0	9.3	9.3	9.2	9.2	9.2	9.3	9.3

Source: transparency.org. A ranking of countries with scores ranging from 0 (highly corrupt) to 10 (highly clean).

Openness

3. Broadband penetration

Why is it significant?

ICT infrastructure has produced a massive increase in the connectedness of a typical business, both in terms of the scope of its connections (diversity, geography) and the speed at which potential links can be appraised and connections made and unmade.

The increasing capacity and almost costless quality of this information superhighway is providing a platform for developments both in the way businesses innovate, and driving innovations themselves, just as earlier generations of 'new' infrastructure would have done.

With infrastructural (and other) improvements, the boundaries between a firm and its environment have become more permeable; ideas and innovations can more easily transfer inward and outward.

The innovation literature suggests that the extent to which some or all of a country's business community has ready access to high-speed communications infrastructure, will have a bearing, all things being equal, on national innovativeness. The overall rate of innovation should improve the closer one gets to universal coverage of this enabling technology.

What is its relative importance?

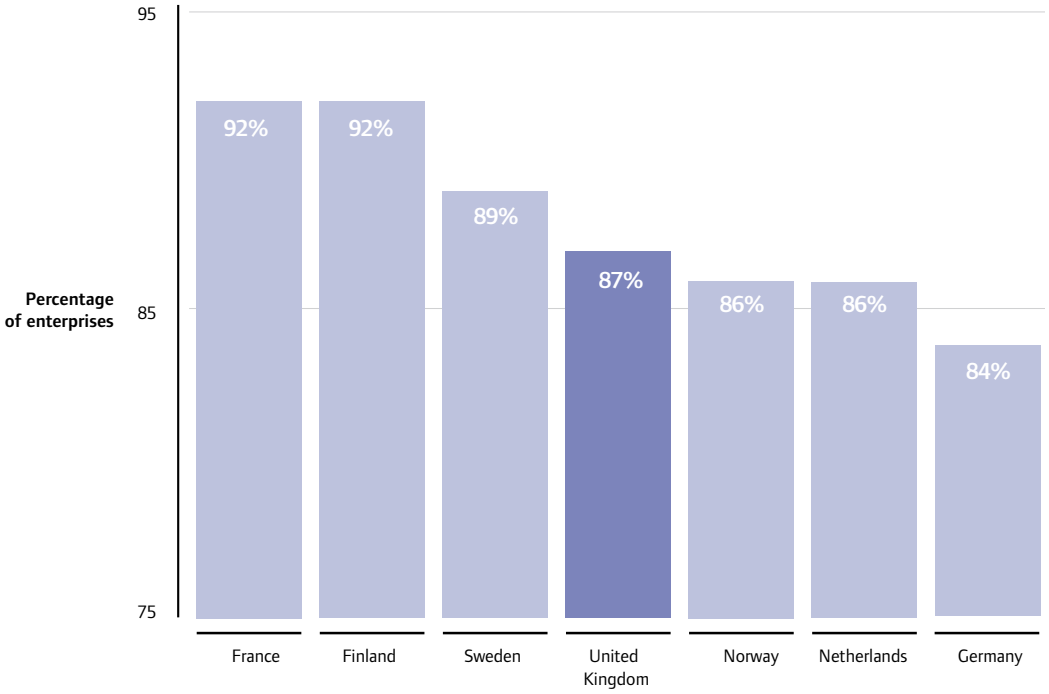
From the perspective of innovation, it is of critical importance to understand the extent to which cutting-edge ICT infrastructure is available to some or all of the business population. Universality is one of the two fundamental characteristics of any type of national infrastructure or public utility. The second relates to the quality of that infrastructure, which is tackled next. This view is echoed in the ICT indicator choices of Eurostat and the OECD, which both include business broadband penetration as one of their key indicators. It is an obvious and natural complement to a measure of the quality and price of that infrastructure.

Notwithstanding this fact, the favoured indicator – firm-level broadband penetration – is fast becoming redundant as we approach universal coverage across a majority of OECD countries. The challenge will be to find a new measure with a finer granularity, which does not require undue additional data collection by the business community.

Standing of the UK

The UK is in the middle ground on broadband penetration amongst the benchmark countries, with 87 per cent of all resident businesses (employing more than ten people) estimated to have a broad connection (Figure 7). Finland and France are ahead, however diffusion continues apace and the UK has been one of the fastest improvers from its lower position (27 per cent) in 2003.

Figure 7: Broadband penetration among businesses (percentage), 2008



Source: Eurostat Note: Proportion of all enterprises with a broadband connection, by selected EU member state (percentage).

Openness

4. Broadband speed

Why is it significant?

Broadband speed signals the capacity of a country's ICT infrastructure to transmit large volumes of digital data in a given time period, improvements in which provide businesses with the platform to either strengthen their innovation processes or even launch innovative new businesses.

Faster broadband has facilitated the emergence of a range of bandwidth-hungry developments in the innovation process, which for example permit businesses to carry out much more complex simulations and what-if analyses, working in collaboration with other businesses across supply chains. Improvements in the quality (and extent) of ICT infrastructure have been an important driver in the emergence of a new mode of innovation dubbed 'open innovation': a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology.

In terms of innovations, higher speed broadband has facilitated the emergence of an intermediate, 'soft' ICT infrastructure. Huge, low-cost bandwidth increasingly means that workers and citizens are 'permanently' connected and a steadily expanding proportion of all business and private life is conducted in cyberspace. This is providing opportunities for new products, services and businesses. For example, there is a growing number of (often free) online applications, which offer businesses access to an array of small, novel, productivity-enhancing tools. These range from trivial applications to permit someone to automatically check the weather through a 3G facility on their mobile phone or the more substantive development of online provision of high-quality administrative tools (to support accounts, sales, personnel) with big company functionality and systems development for small company prices (e.g. Google accounts) as well as the dozens of social network sites consuming more of our personal (and work) time, which facilitate user-led innovation.

Which is to say, all things being equal, the higher the broadband speed, the more opportunities that ought to arise within a country or region whereby businesses can change the way they innovate and or launch wholly new developments in the marketplace, which would not otherwise have been possible.

What is its relative importance?

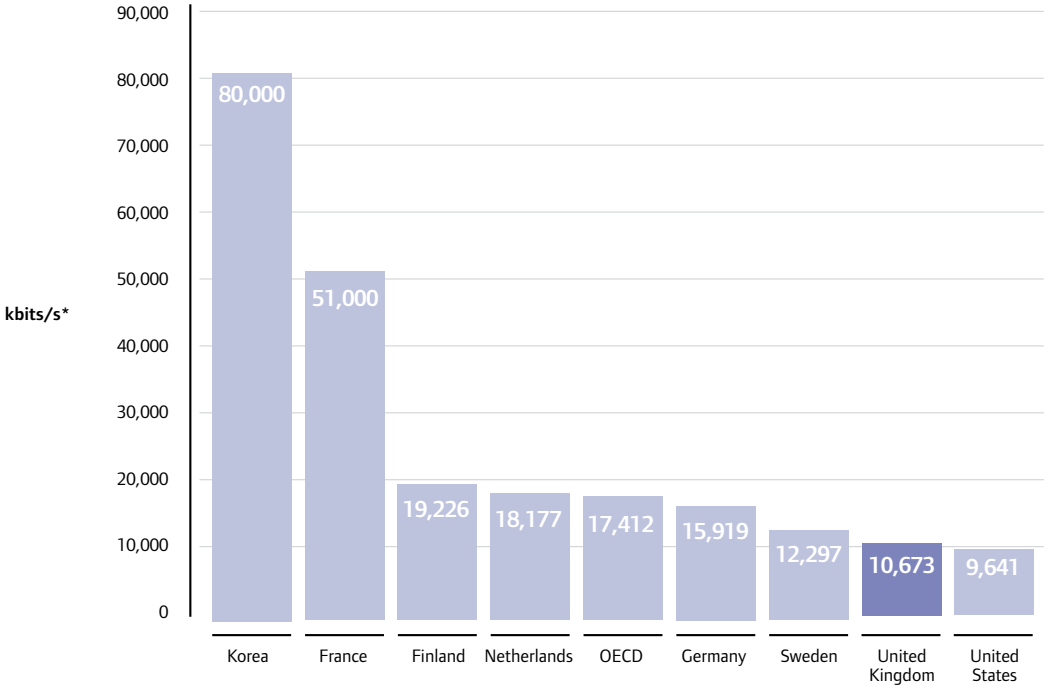
The 'quality' of the leading-edge, technological infrastructure available to resident businesses is the second of two fundamental characteristics for any type of national infrastructure or public utility. The other basic characteristic is extent. The two attributes seem equally important to innovation, and there is technological progress on both fronts, which interact and mean that businesses have the opportunity to buy levels of connectedness that was science fiction 20 years ago. The interplay between developments in ICT infrastructure and ICT technology/ devices is also said to be important.

Standing of the UK

The UK is the second worst performer amongst the eight comparators, as measured by average advertised download speed as at September 2008 (Figure 8). The figure for Korea was around 80Mbits/s. In Europe, France sets the benchmark, at more than 50Mbits/s, while the UK is around 10Mbits/s, or around 50 per cent of the OECD average.

The OECD maintains a time series for data on broadband speed, which is based on the contracted download speed of a representative broadband subscription (a BT DSL connection in the cases of the UK). Using this different data, the UK ranked 11th out of 30 countries on its speed in 2008. There was a substantial improvement from 2005 to 2006, with no improvement since. The Netherlands by contrast has seen multiple improvements in the period, and from a higher base than the UK. The other six comparator countries registered little or no growth in the period, although their speeds tended to be higher to begin with.

Figure 8: Average advertised broadband download speed, kbits per second*, 2008



Note (*): Advertised speeds are typically the theoretical maximum for the employed technologies. Users commonly have lower speeds. Also, often only parts of a country have been upgraded to allow for faster speeds.

Source: OECD Broadband Portal

Table 3: Speed of a typical broadband subscription, by country (2005-2008), kbits per second

	2005	2006	2007	2008	Rank (speed)	Increase	Rank (change)
Finland	24,000	24,000	24,576	24,576	2.0	0.0	3.0
France	18,000	18,000	18,432	18,432	5.0	0.0	3.0
Germany	6,016	6,016	6,144	6,144	7.0	0.0	5.0
Korea	102,400	102,400	102,400	102,400	1.0	0.0	6.0
Netherlands	8,000	6,144	6,144	20,000	4.0	1.5	2.0
Sweden	24,576	24,576	24,576	24,576	2.0	0.0	6.0
United Kingdom	2,200	8,192	8,192	8,192	6.0	2.7	1.0
United States	3,072	3,072	3,072	3,072	8.0	0.0	6.0

Source: OECD Broadband Portal

Openness

5. Broadband price

Why is it significant?

ICT 'access' price affects the rate and extent of take-up of new generation infrastructure, with bandwidth-hungry users being early adopters and small businesses and households being later adopters. In a competitive market place, prices tend to be fairly equal across providers and technological innovation in ICT infrastructure and related services also means that this generation/last generation technology becomes affordable to the majority within a relatively short period. In the early period of implementation, it is the business case rather than affordability in any absolute sense that will determine take-up for the great majority of UK businesses, outside maybe sole traders and micro-firms.

While national prices will tend to be broadly similar in what is a competitive marketplace, international price differences are substantial and might very well amount to a significant national advantage or disadvantage.

What is its relative importance?

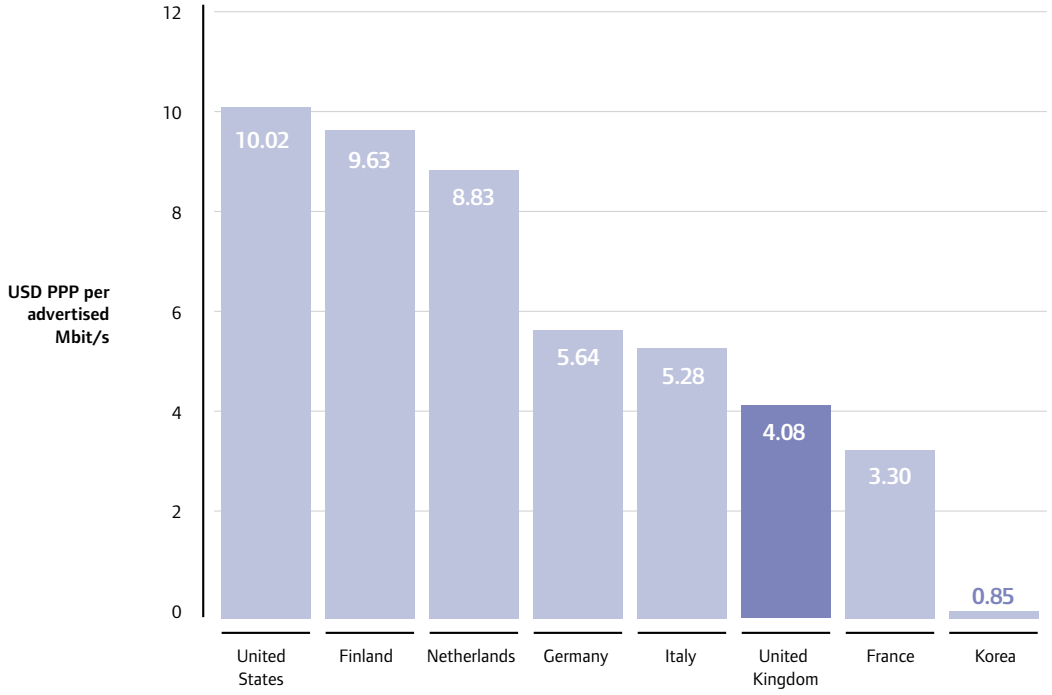
Price is linked with the rate of business uptake or diffusion of successive generations of ICT infrastructure, and in that regard has a bearing on the rate at which the great majority of a national business community is in a position to benefit from the improved conditions for innovation.

While price affects the rate of take-up, the ultimate penetration of ICT infrastructure is determined to a greater extent by location-specific supply-side issues (e.g. the technical and financial constraints of providing high-quality, high speed infrastructure in remote, challenging and sparsely populated territories). In locations where it is not cost-effective for commercial suppliers to provide a general service, businesses are left with scant few options: leased lines for example would be prohibitively expensive and an unwarranted cost for many enterprises. Technological breakthroughs – satellite services – might overcome these difficulties as can government policies to ensure a universal service. Speed is arguably a better indicator of the quality of ICT infrastructure.

Standing of the UK

The OECD broadband portal reports UK broadband prices as being the third most competitive amongst the eight comparator countries and it retains that rank when the population is increased to the full selection of 30 countries from around the world (Figure 9). At around $4 for a Mbit/s a month (adjusted for purchasing power), UK prices are around 70 per cent lower than the average price charged across the 30 OECD countries. France ranks second at $3, while Korea is out on its own with a figure of $0.85.

Figure 9: Average broadband monthly price per advertised Mbit/s, USD, PPP, 2008



Source: OECD Broadband Portal

Openness

6. Business satisfaction with ICT infrastructure

Why is it significant?

Business satisfaction with ICT infrastructure provision is a good subjective measure of the perceived quality (speed, available services, consistency of service, price-performance) of the national ICT infrastructure.

What is its relative importance?

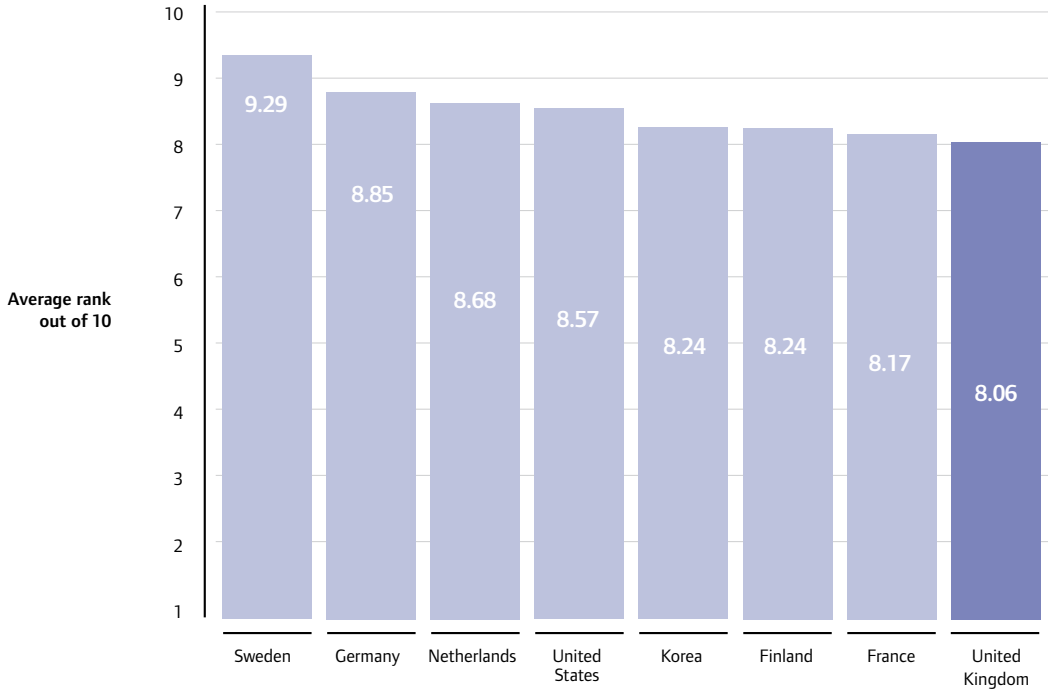
The satisfaction indicator is a good complement to the more objective data on broadband penetration, pricing and download speeds. In essence, it provides a synthetic judgement, from a user perspective, 180 degrees rotation from the supplier data, on the performance of the national infrastructure. It is less good as an international data set because of potential selection bias and real differences in the psychological profile across countries (the national character). The International Institute of Management Development (IMD) publishes data on this particular indicator for the UK and all of our other comparator countries and for 126 additional countries. However, the survey is carried out only intermittently, and given the rate of change in ICT infrastructure is likely to be rather out of date within a relatively short period.

Standing of the UK

This indicator (from IMD) shows business perceptions of the extent to which available communications technology meets their needs. Ratings on a 0-10 scale were requested in the surveys, which were conducted in 2003 and 2008.

Perhaps reflecting in part the average penetration and low broadband speed, the UK performs less well on 'business satisfaction' levels, where the IMD survey places the UK last amongst our comparator countries (Figure 10). Sweden recorded the highest levels of satisfaction, with the US, Germany and the Netherlands amongst the followers. Business perceptions have been improving steadily each year since the 2003, with the UK moving up the ranking over time (in 2008, it placed 18th in the longer list of 134 countries globally). While UK businesses were on average the least content of business communities across our benchmark countries, it should be noted that the overall score (at 8.06 out of 10) is quite high, and places the UK in the top 20 countries in the IMD survey. The UK also showed a significant improvement in perceptions from 7.42 in the 2003 survey, with several other countries recording a fall between the two. Sweden recorded the greatest satisfaction among all countries surveyed, and at substantially higher levels than say Korea or France, which have more and faster broadband according to other indicators.

Figure 10: Business satisfaction with communications technologies, 2008



Source: IMD Survey

7. Quality of public research – scientific publications

Why is it significant?

The knowledge generated by the science base has been considered critical to long-term national innovation performance for more than a century.[38] Alongside other sources of knowledge like companies, and users, the science base in the UK (mainly formed by universities) is widely recognised as an important component of the innovation system, and as 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.[39]

There exists substantial empirical evidence on the positive influence of high quality university research on innovation.[40] Universities, as producers of public scientific research, are considered to constitute key repositories of knowledge. In this particular role, it is high quality research-intensive universities (measured by the number of their scientific publications) which are considered to have a positive influence on the innovation activities of firms.[41] Subjective measures of quality of research are important and complementary lines of inquiry.

What is its relative importance?

The key role of universities as providers of high quality research underpinning innovation is significant. However, to consider quality of research and this uni-dimensional role in isolation runs the risk of universities becoming what Gernot Grabher has called (in a German context) 'cathedrals in the desert', and of their research (even if of high quality) being of no use for firms due to a lack of absorptive capacity. In addition, it assumes a unidirectional linear transfer of knowledge from universities to firms, and does thus not take into account the nonlinear and reciprocal nature of knowledge flows between science and industry.[42]

Standing of the UK

The US clearly stands out as the largest in terms of scientific publications with the UK second (Figure 11). A comparative measure, accounting for differences in population size, is publications per 100,000 of the population.

The UK ranks behind Sweden, Finland and the Netherlands in relation to the number of scientific publications per 100,000 of the population. Figure 12 shows a relatively stable level of activity in this indicator in the UK during 2000-2004 with a moderate increase in 2005, maintaining this level in 2006. A similar trend is observed in all the countries considered.

The perception of quality of the UK's scientific institutes is high with businesses ranking it 2nd to the US in 2009 (Figure 13).

38. 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. 'Government Laboratories: Transition and Transformation.' Washington, DC: IOS Press.
39. D'Este, P. and Patel, P. (2007) University-industry linkages in the UK: What are the factors underlying the variety of interactions with industry? 'Research Policy.' 36(9), pp.1295-1313; DIUS (2008) Department for Innovation, Universities and Skills, www.dius.gov.uk; Etzkowitz, H. (2002) 'MIT and the Rise of Entrepreneurial Science.' London: Routledge Press.
40. FORA (2009) 'Nordic Innovation Monitor 2009.' Copenhagen: Nordic Council of Ministers; O'Shea, R.P, Chugh, H. and Allen, T.J. (2008) Determinants and consequences of university spin-off activity: A conceptual framework. 'Journal of Technology Transfer.' Forthcoming; Wright, M., Clarysse, B., Lockett, A. and Binks, M. (2006) University spin-out companies and venture capital. 'Research Policy.' 35(4), pp.481-501.
41. Youtie, J. and Shapira, P. (2008) Building an Innovation Hub: A Case Study of the Transformation of University Roles in Regional Technological and Economic Development. 'Research Policy.' Vol. 37, pp.1188-1204.
42. Cockburn, I. and Henderson, R. (1996) Public-private interaction in pharmaceutical research. 'PNAS.' 93(23), pp.12725-12730; Meyer, M. (2003) Academic entrepreneurs or entrepreneurial academics? Research-based ventures and public support mechanism. 'R&D Management.' 33, pp.107-115; Meyer-Krahmer, F. and Schmoch, U. (1998) Science-based Technologies: University-Industry Interactions in Four Fields. 'Research Policy.' 27, pp.835-838.

Figure 11: Number of scientific publications, 2004-2006

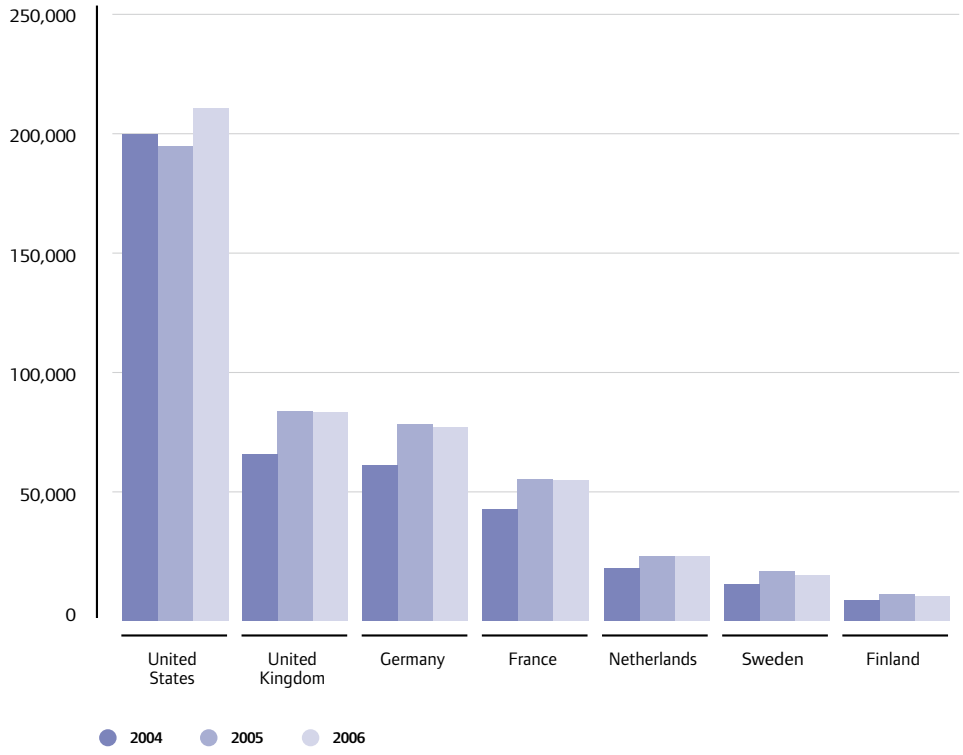


Figure 12: Number of scientific publications per 100,000 people, 2000-2006

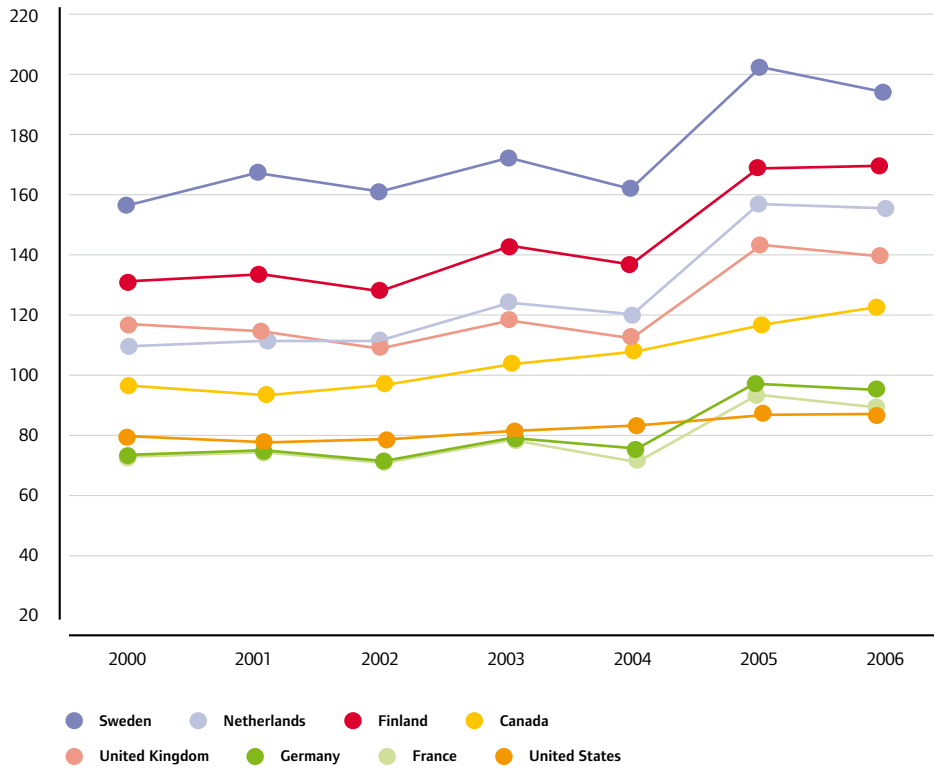
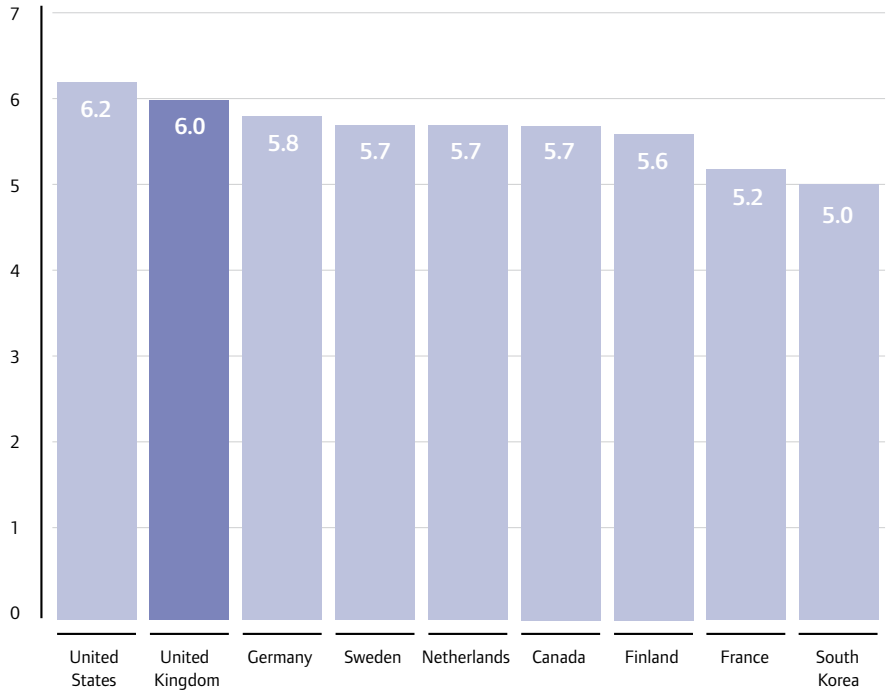


Figure 13: Quality of scientific research institutions, 2009



Source: WEF, Global Competitiveness Reports; Question: Scientific research institutions in your country (e.g. University laboratories, government laboratories) are 1 = non-existent, 7 = best in their fields?

Public research

8. Accessibility of public research – collaboration

Why is it significant?

In recent years the prevalent idea has been that the highest benefits of public research for innovation arise from a co-operating relationship between firms and universities rather than from their use by firms as a mere source of high quality scientific knowledge.[43] In this perspective, the measurement of the effect that university research has on innovation takes a 'relational' approach, incorporating a variety of bi-directional links and processes for knowledge sharing between firms and universities and suggesting wider more significant benefits of public research for innovation.[44] This implies a focus on the accessibility that companies have of universities' research. The existence of research collaboration and knowledge transfer between universities and industry are both indications that the knowledge provided by public research is accessible by firms for its use and application in delivering innovation. The number of public private co-authored publications in a country reflects the existence of interactions between universities and companies and also gives an indication of how accessible public research is by industry. These can be considered as the tangible outcomes of a process in which researchers belonging to both communities are likely to have interacted and shared or interchanged knowledge and skills. They also signal a more purposeful orientation or higher propensity of universities towards engaging in cooperative research with the private sector. The intensity of research collaboration is an explicit measure of the extent to which universities and industry interact in the production of knowledge.

What is its relative importance?

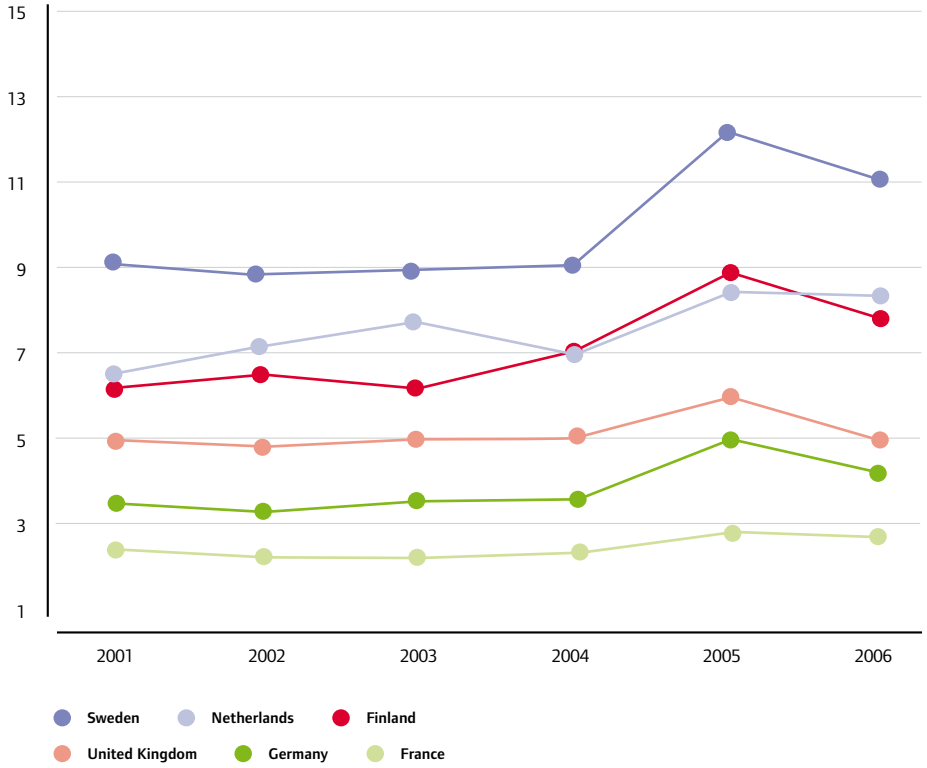
It is significant since the rapid expansion of the Higher Education sector, and a change of paradigm from 'Mode 1' to 'Mode 2' in the production of knowledge, require us to take into account not only the mere capitalising of knowledge assets but also the building of interactive dynamic ties between universities and industry.

Standing of the UK

The UK ranks behind Sweden, Finland and the Netherlands in relation to the number of scientific co-publications (Figure 14). The UK is a mid-table performer in respect to this indicator. Time series data for the period 2001-2006 show a relatively flat growth during 2001-2004, a moderate increase in 2005, and a fall in 2006. A similar trend is observed in all the countries considered with the exception of the Netherlands. The UK ranks behind the US, Sweden and Finland in relation to intensity of research collaboration (Figure 15).

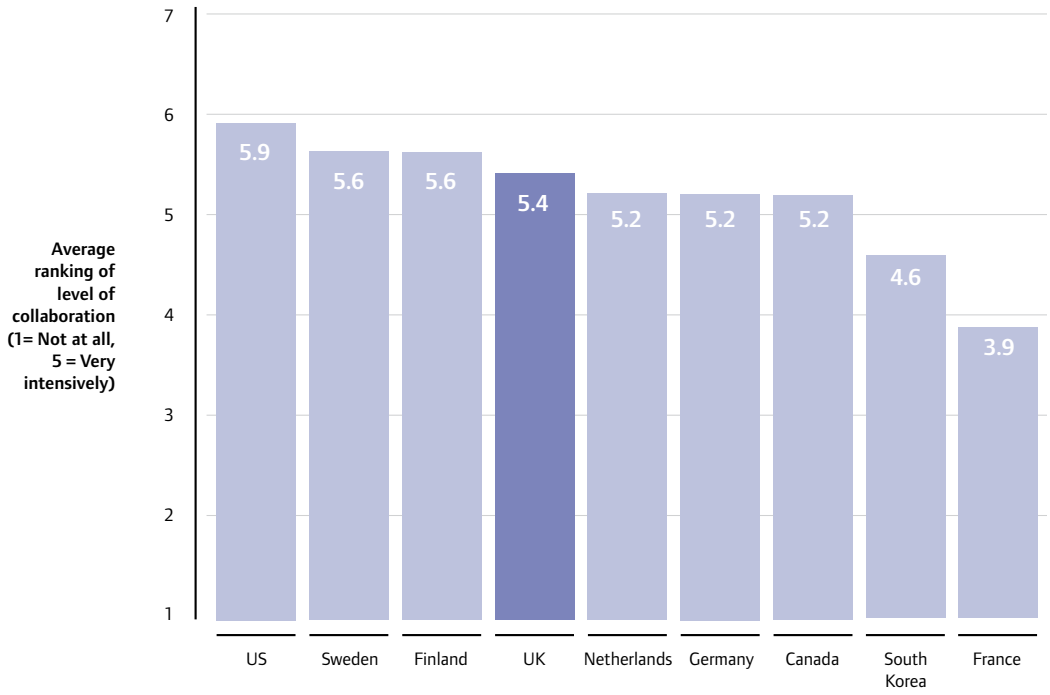
43. OECD (2002) 'Benchmarking Industry-Science Relationships.' Paris: OECD; OECD (2005) 'Innovation Policy and Performance: A cross-country comparison.' Innovation Policy and Performance in the United Kingdom. Chapter 7. pp.203-231; Swann, P. (2002) Innovative Businesses and the Science and Technology Base.' Report to DTI. London: DTI.
44. Scott, A., Steyn, G., Geuna, A., Brusoni, S. and Steinmueller, E. (2001) 'The Economic Returns to Basic Research and the Benefits of University-Industry Relationships: A literature review and update of findings.' Report for the Office of Science and Technology by SPRU Science and Technology Policy Research. Brighton: University of Sussex.

Figure 14: Number of public private co-authored publications per 100,000 inhabitants, 2001-2006



Source: European Innovation Scoreboard 2008; Thomson Reuters/CWTS

Figure 15: Intensity of research collaboration, 2009



Source: WEF, Global Competitiveness Reports; Question: In relation to Research & Development activity in your country, to what intensity level do you feel that businesses collaborate with local universities? 1 = Not at all intensively, 7 = Very intensively

9. Relevance of public research – commercial exploitation

Why is it significant?

An additional aspect of the influence of public research on innovation relates to the commercial exploitation of university scientific research. The entrepreneurial dimension recently attributed to universities confers on them an even more important role within the innovation system[45] and a greater potential to contribute to innovation and value creation.[46] The phenomenon of the entrepreneurial university has now become widespread in many countries including the UK, where commercialisation efforts in universities have undergone a progressive rationalisation and institutionalisation since the early 2000s.[47] This role of the entrepreneurial university involves a shift from acknowledging the impact of existent different pathways or channels on innovation, towards actively and strategically promoting them.

The existence of commercial exploitation of public research is an indication that the scientific knowledge provided by universities is relevant for firms in the development of innovations. University patenting has often been considered as an indicator of this aspect. Recently, licensing and the creation of spin-off companies have been considered as more adequate measures of the involvement and relevance of universities in the commercialisation of technology. The measurement of these proxies is however even more complicated than patent statistics.[48]

What is its relative importance?

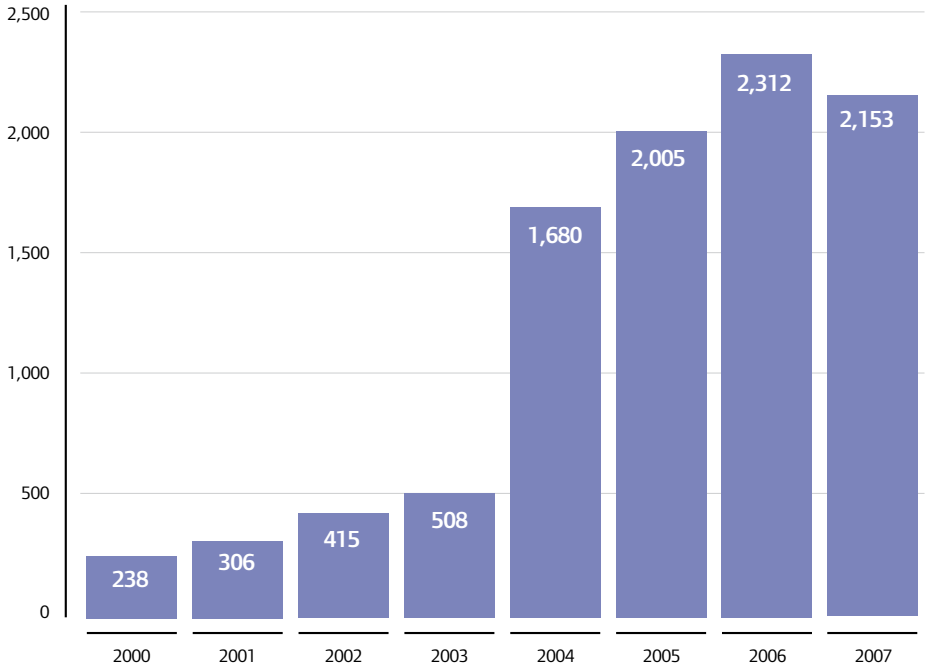
The commercial exploitation of university research is a key aspect of public research support for innovation. While positive values for the 'quality' and 'accessibility' dimensions give an indication of the existence of public science discoveries that might have commercial potential, licensing and the development and funding of spin-off and start-up companies constitute indicators of the actual use of public science outputs by firms, and provide an assessment of how relevant this knowledge is for commercial purposes and innovation in firms.

Standing of the UK

Due to non-availability of data for the comparator countries, this section analyses the UK trend. The number of licences has grown steadily since 2000 with a marked increase in 2004 which has been maintained until 2006, after which the indicator has started to decline (Figure 16). Data on start-up companies involving current or former HEI staff as founders show a relatively flat trend over the years 2000-2007 with a moderate increase in 2003. The trend is reversed in the second half of 2006 during which the indicator starts to decrease. Data on the number of spin-off companies show a decreasing trend from 2001 until 2004 in which year the indicator starts to grow steadily until the end of 2006 (Figure 17).

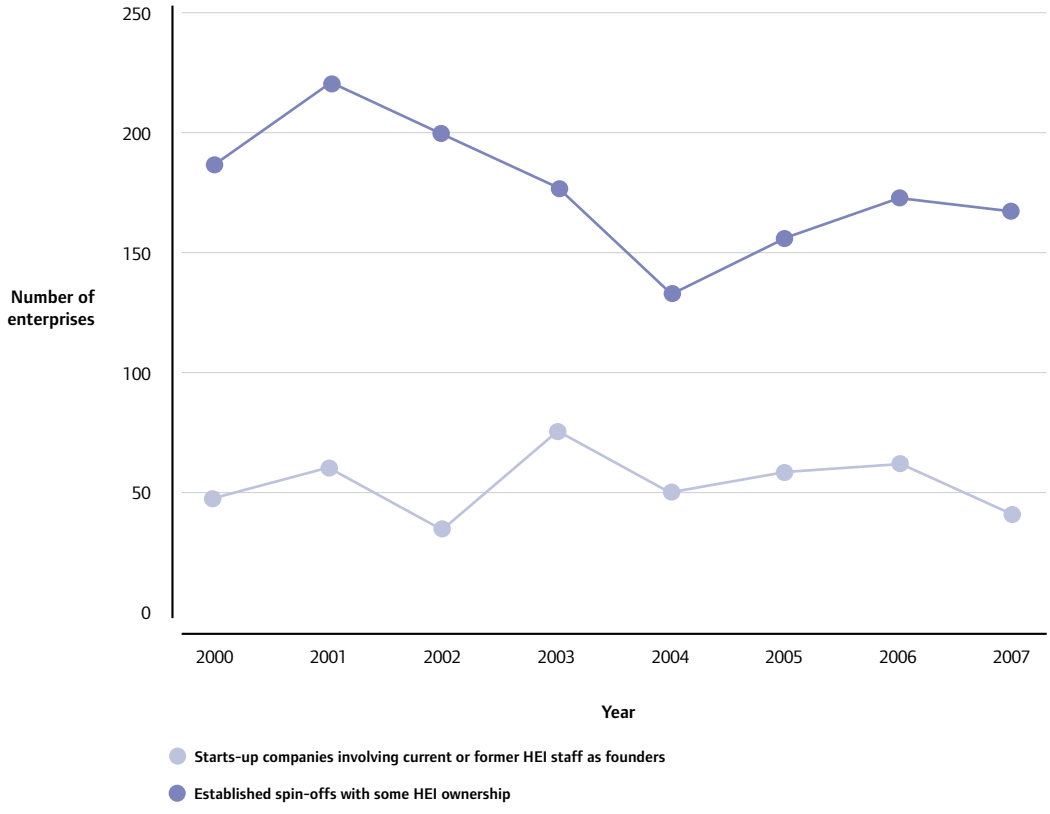
45. Mowery, D.C. and Sampat, B.N. Universities and Innovation. In Fagerberg, J., Mowery, D.C. and Nelson, R.R. (Eds) (2005) 'The Oxford Handbook on Innovation.' Oxford: Oxford University Press.
46. Drucker, J. and Goldstein, H. (2007) Assessing the regional economic development impacts of universities: A review of current approaches. 'International Regional Science Review.' 30(1), pp.1-27.
47. Geiger, R.L. and Sá, C.M. (2008) 'Tapping the Riches of Science: Universities and the Promise of Economic Growth.' Cambridge, MA: Harvard University Press.
48. Leydesdorff, L. and Meyer, M. (2009) The Decline of University Patenting and the End of the Bayh-Dole Effect. 'Scientometrics.' (Forthcoming).

Figure 16: Number of licences executed, UK, 2000-2007



Source: The UK HE bi-annual surveys

Figure 17: Number of established spin-offs and start-ups with HEI involvement, 2000-2007



Source: The UK HE bi-annual surveys

Public research

10. Quality of public research – citations

Why is it significant?

The number of citations of scientific articles in a country is often taken to be an important indicator of the quality of its academic publications (the citation period is usually the publication year plus a two years citation window).

The greater the number of citations a scientific publication achieves, the greater the likelihood that the publication is relevant and will have an important impact upon academic endeavours, the production of knowledge and, by association, the innovation process.

Despite being one of the most widely used proxies to assess the quality of public research, data on citations numbers are readily available only until 2002 for the UK (from the ERAWACTH database) and only for some of the comparator countries selected for our benchmarking exercise.

What is its relative importance?

The economy is increasingly knowledge-soaked. Quality research is a crucial underpinning for the innovation process. A strong performance as regards citations is likely to indicate that the UK is a centre of global research excellence and offers to companies deeply involved in the innovation process 'value for money' research support.

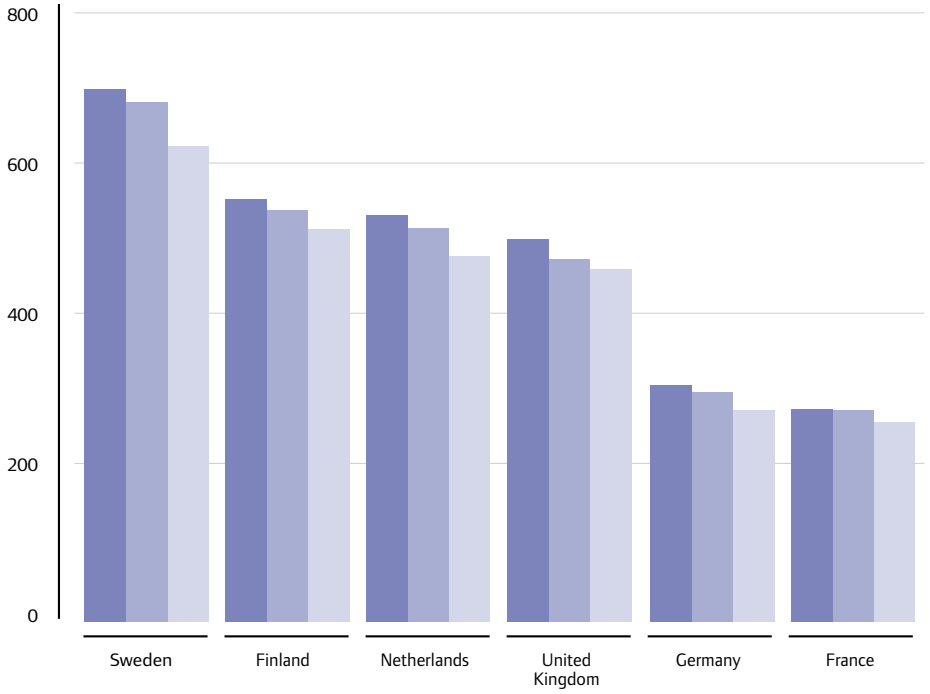
Comparative data for our selected EU countries are only available for the years 2000 to 2002, and shows that the UK remains positioned below the Scandinavian countries of Sweden and Finland, but above Germany and France (Figure 18). For the UK the indicator rose from 460 in 2000 to 498 in 2002. Over the same period, the number of citations (per 100,000 inhabitants) of Swedish, Dutch and German publications increased at a faster rate.

Standing of the UK

Recent research carried out by Evidence Ltd[49] suggests that the position of the UK may have improved. Summary data available in the public domain, indicate that the UK ranks first among the G8 nations as regards the number of citations in relation to public R&D spend. The UK's share of world citations was 11.8 per cent in 2008, and the UK's average citation impact improved between 2007 and 2008 by some 14 per cent. As regards 'impact' measured as citations per paper, the UK is 2nd amongst the G8 countries ahead of the USA but overtaken by Germany.

49. Evidence Ltd. (2009) 'International comparative performance of the UK research base.' London: DBIS. Data only available for UK, Germany, France and USA.

Figure 18: Number of citations per 100,000 inhabitants, 2000-2002



Source: DG Research Regional Key Figures Database (based on ISI – CWTS via DG-RTD)

11. Relevance of public research – patents

Why is it significant?

Knowledge produced in and by universities is increasingly important in the innovation process. University spin-outs and licensing agreements are two indicators of the production and commercialisation of knowledge produced in and by many of the UK's universities. University patents (filed and/or granted) is another indicator.

Recent data on these indicators (for 2000 to 2008) are only readily available for the US in Leydesdorff and Meyer (2009),[50] and for the UK in the HE bi-annual surveys. Primary data for the US, Canada, France and other European countries are collected by the AUTM (Association of University Technology Managers).

What is its relative importance?

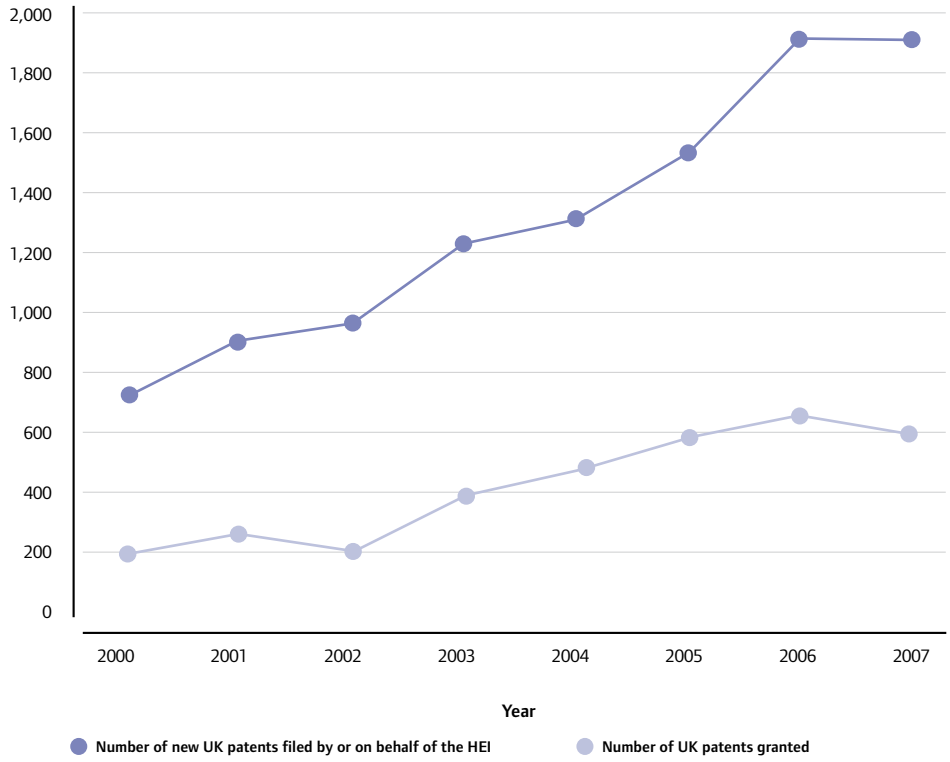
There is a strong correlation between patent filings and economic growth around the world. The importance of protecting intellectual property (IP) through the patent system in order to increase knowledge transfer and exploit research has been fully recognised. Marshalling and employing IP through the patents is a crucial element of the enabling infrastructure allowing UK companies to effectively compete in the global economy.

Standing of the UK

University filings and patents granted grew at a steady rate between 2000 and 2006; a small fall for patents granted was recorded in 2007 (Figure 19).

50. Leysdorff, L and Meyer, M (2009) The decline of university patenting and the end of the Bayh–Dole effect, Scientometrics Springer.

Figure 19: Number of UK patents filed and granted, UK, 2000-2007



Source: UK HE BI annual surveys (2000-2008).

Public research

12. Relevance of public research – invention disclosures

Why is it significant?

Knowledge produced in and by universities is increasingly important in the innovation process. The number of pre-patent invention disclosures is an indication of the commercial value of research undertaken in and by universities. Disclosures are associated with a product or process that has been conceived or developed which has potential commercial application. Disclosures are used to help determine whether the intellectual property may require some form of protection and/or the invention may be commercialisable.

What is its relative importance?

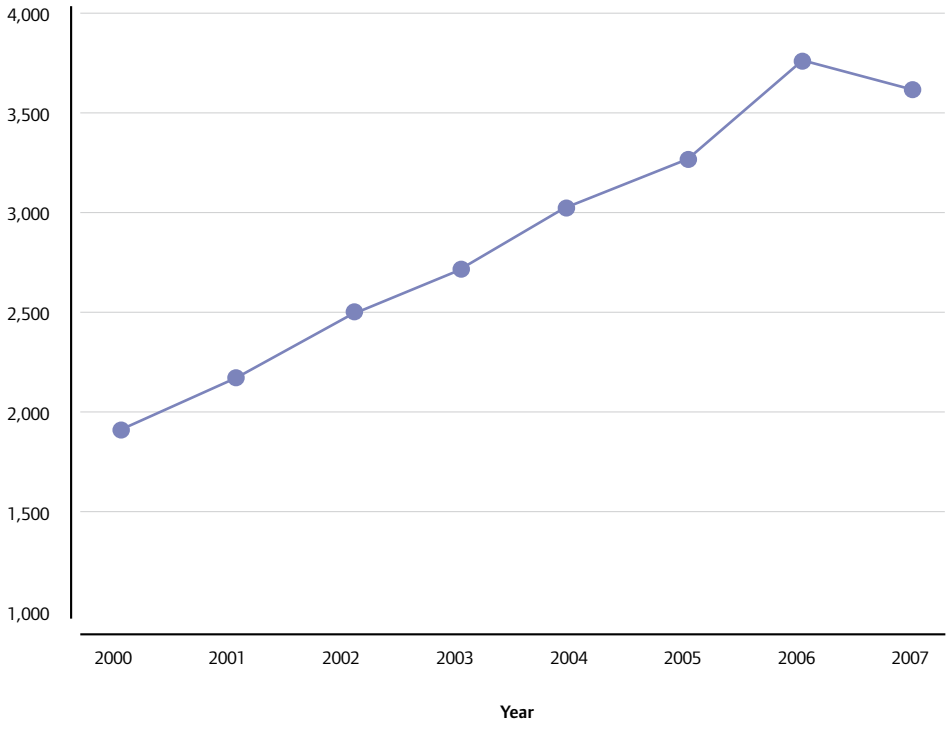
There is a strong correlation between invention disclosures and patent filings and, subsequently, economic growth. Disclosures occur before patent decisions are made. The greater the number of disclosures the greater the number of potential commercialisable ideas.

Standing of the UK

Data on university invention disclosures allowing a comparison of the UK with a range of countries over a consistently long time period do not exist. It does appear, however, that UK universities are producing a significant number of invention disclosures.

During 2001 and 2006 university invention disclosures increased on a year by year basis; 2007, however, saw a slight fall in the number of disclosures (Figure 20).

Figure 20: Number of invention disclosures, UK, 2000-2007



Source: UK HE BI annual surveys (2000-2008).

Entrepreneurship

13. Attitude towards risk of business failure

Why is it significant?

Fear of failure impedes new firm formation and activity. Fear of failure to start a business can have a negative effect on entrepreneurial attitudes even when opportunity recognition as well as start-up skills exists.

What is its relative importance?

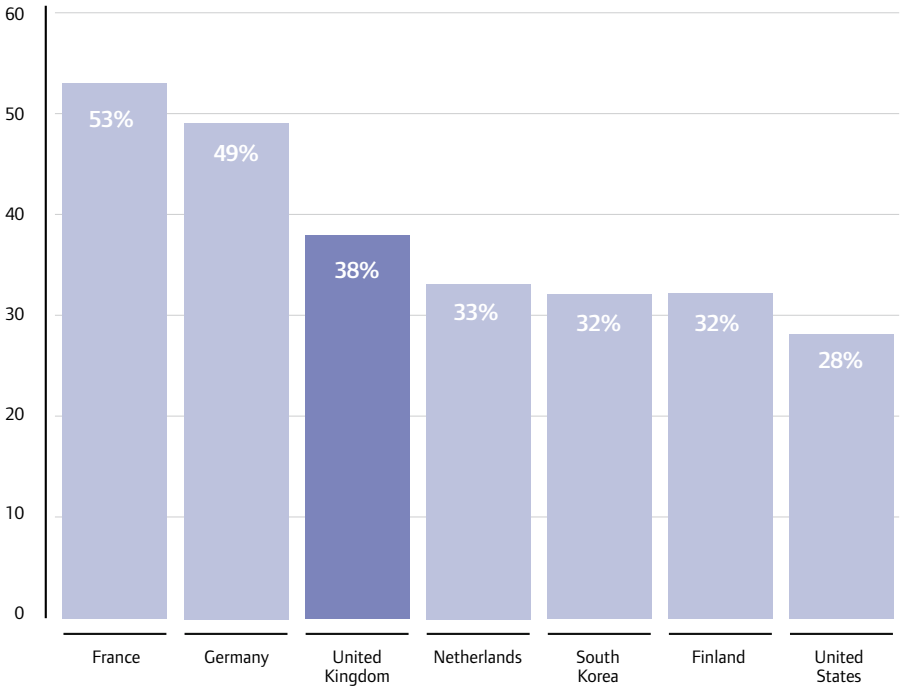
A strong risk-taking culture is a crucial enabling condition for the emergence of innovations that can find commercial tractability in the marketplace. According to the literature, out of the personal entrepreneurial traits, fear of failure is one of the most important obstacles preventing start-ups (Caliendo *et al.* 2009, Wagner 2003 and 2005).[51] High-risk aversion can retard nascent entrepreneurship.

Standing of the UK

The UK has a significantly lower fear of failure rate than France and Germany, but it is relatively high compared to the Scandinavian countries, and it is much higher than the US (Figure 21). Unfortunately fear of failure has been increasing in the UK (Figure 22).

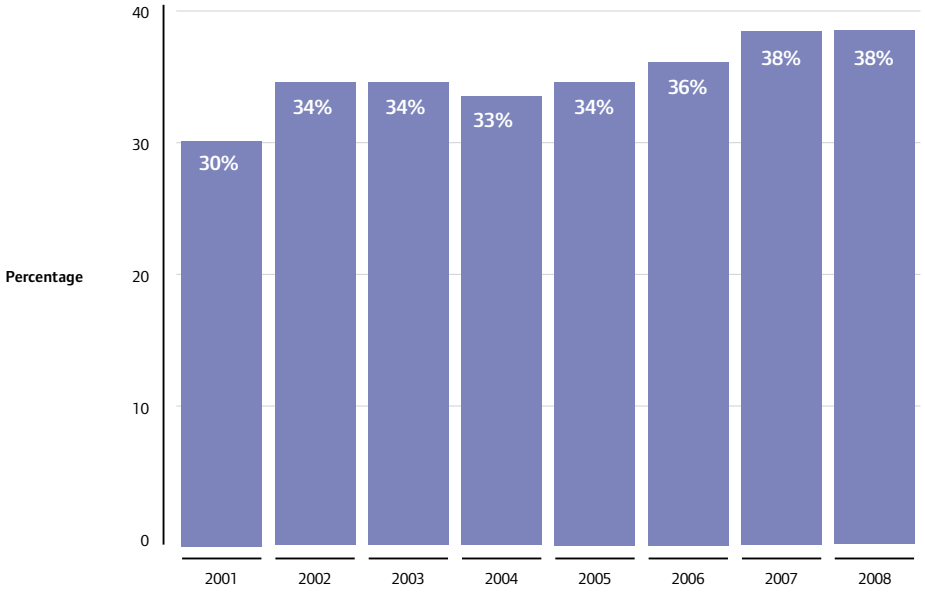
51. Caliendo M., Fossen, F.M. and Kritikos, A.S. (2009) Risk attitudes of nascent entrepreneurs – new evidence from an experimentally validated survey. 'Small Business Economics.' Vol. 32, pp.153-167; Wagner, J. (2003) Taking a second chance: Entrepreneurial re-starters in Germany. 'Applied Economics Quarterly.' 49, pp.255-272; Wagner, J. (2005) 'Nascent and Infant Entrepreneurs in Germany. Evidence from the Regional Entrepreneurship Monitor (REM).' University of Lueneburg Working Paper Series in Economics, No. 1. Lueneburg: University of Lueneburg.

Figure 21: Fear of failure rate, 2008



Source: GEM survey; Percentage of 18-64 population with positive perceived opportunities (individuals involved in any stage of entrepreneurial activity excluded) who indicate that fear of failure would prevent them from setting up a business.

Figure 22: Fear of failure rate in the UK, 2001-2008



Source: GEM survey

Entrepreneurship

14. Early-stage entrepreneurial activity

Why is it significant?

Entrepreneurship is fundamental to economic welfare. A strong entrepreneurial culture is an enabling condition for the emergence of innovations that find commercial tractability in the marketplace.

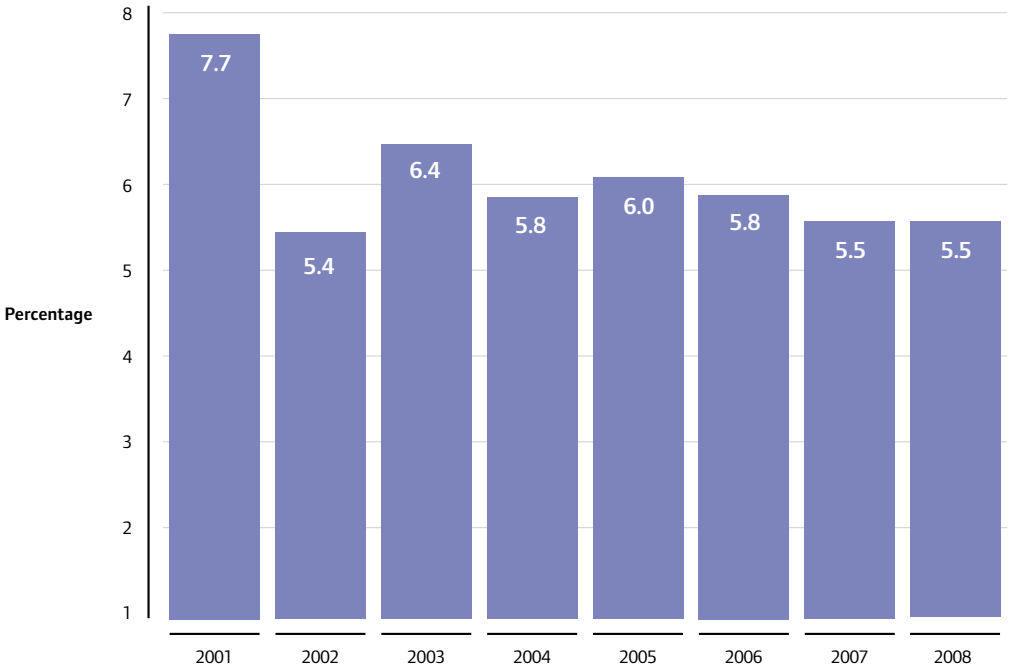
What is its relative importance?

A strong risk-taking culture is a crucial enabling condition for the emergence of innovations that can find commercial tractability in the marketplace.

Standing of the UK

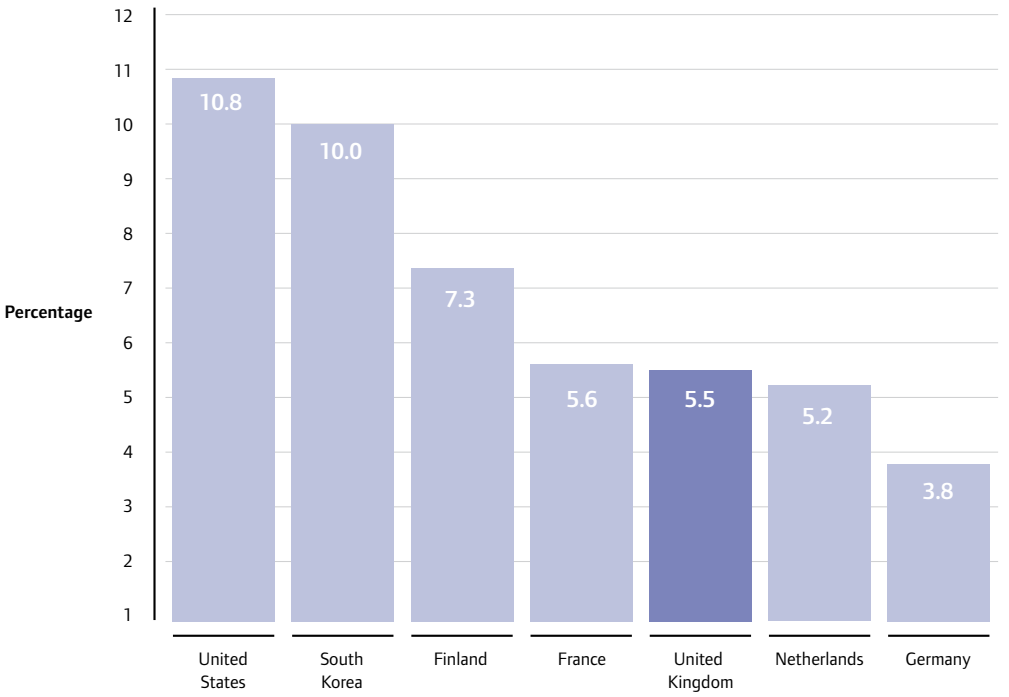
As illustrated in Figure 24, entrepreneurial activity is high in the United States and Korea and significantly lower in European countries (except for Finland). It is argued that the low levels of entrepreneurial activity in Europe reflect the relative risk aversion of European inhabitants and their declared relative preference for employment over self-employment. But it also indicates that there are good income alternatives available, through jobs or social security. In the UK, entrepreneurial activity peaked in 2001 and has been on a declining trend ever since that year (Figure 23).

Figure 23: Early-stage entrepreneurial activity, 2008



Source: GEM survey; Percentage of 18-64 population who are either a nascent entrepreneur or owner-manager of a new business (more than three months, but not more than 42 months)

Figure 24: Early-stage entrepreneurial activity, UK, 2001-2008



15. Intensity of local competition

Why is it significant?

Firms in a fully competitive market are more likely to innovate (Arrow 1962, and Scherer, 1984, 1992).[52] International experience, overall, supports the existence of a strong link between competitive intensity and innovation and productivity.

The direct measures of competition, such as indices of concentration or mark-ups, are plagued with problems of interpretation and accuracy. Firm dynamics, which generally describe competition as a process of entry and exit, and subjective measures of the intensity of competition facing firms in a sector or defined geography, are important and complementary lines of inquiry.

What is its relative importance?

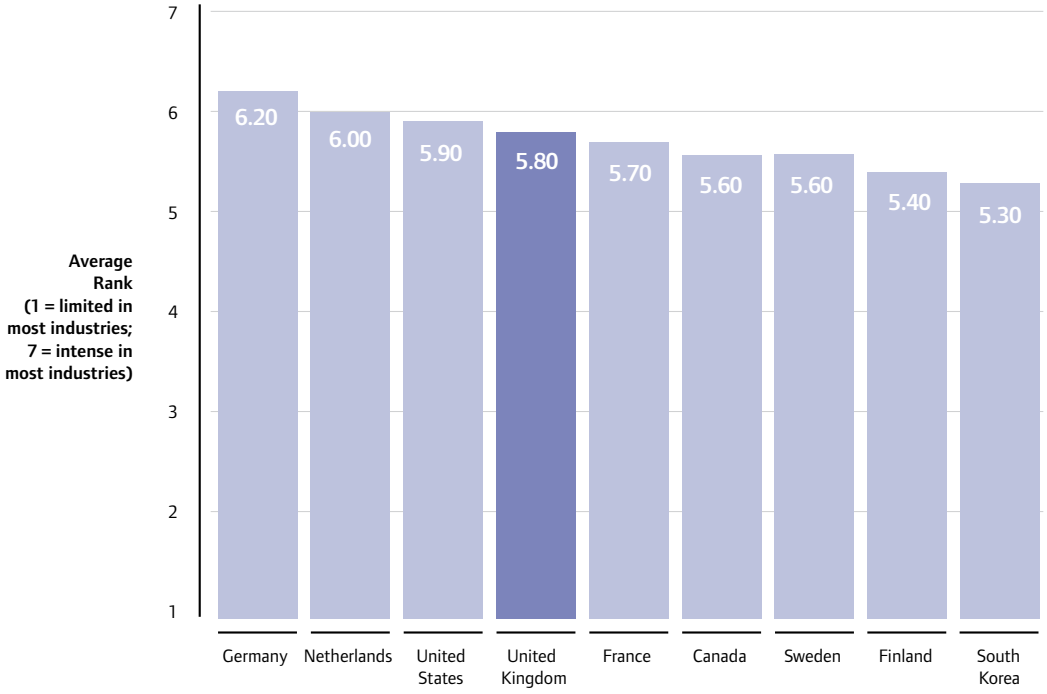
Both entry and exit are crucial elements of the market selection process which leads to the restructuring and evolution of industry. Therefore, the process of entry and exit of firms has long been held to play an important role in the evolution and adaptation of industry to change. Entry and exit are inherent parts of the dynamic competitive process that leads to some firms to grow and others to decline.

Standing of the UK

The intensity of local competition in the UK is perceived to be less strong than countries such as Germany, the Netherlands and the United States (Figure 25). However, administration data show a different picture – although somewhat dated, the data shows that in 2005, the UK had the highest business entry rate among the group of comparator countries (Figure 26); moreover, when looking at the business churn rate, there is an increasing level of domestic competition in the country over time (Figure 27).

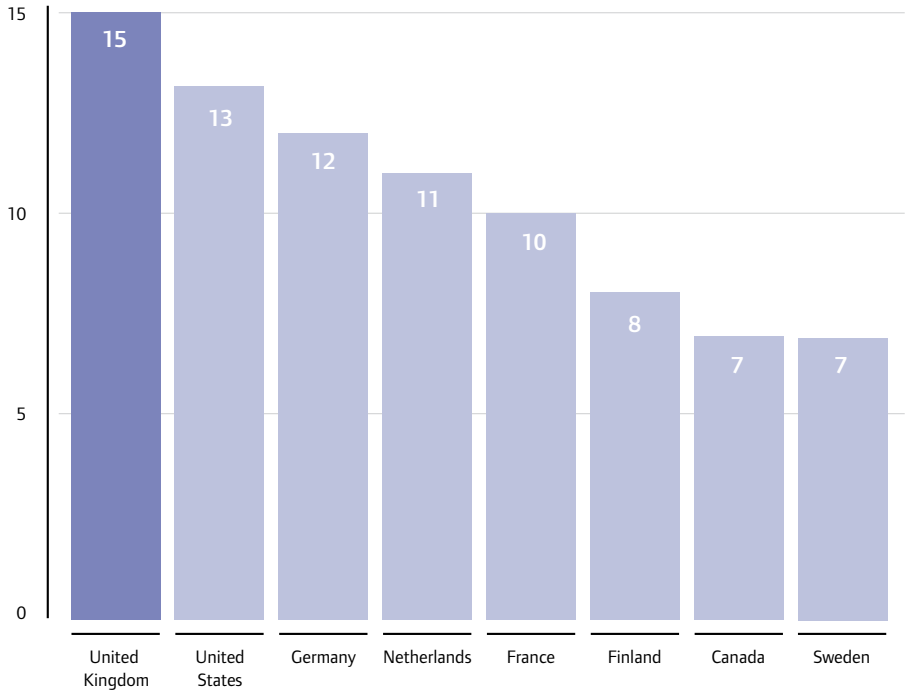
52. Arrow, K. (1962) Economic Welfare and the Allocation of Resources for Invention. In 'The Rate and Direction of Economic Activity.' National Bureau of Economic Research. Princeton: Princeton University Press; Scherer, F.M. (1984) 'Innovation and Growth: Schumpeterian Perspectives.' Cambridge, MA: MIT Press; Scherer, F.M. (1992) Schumpeter and Plausible Capitalism. 'Journal of Economic Literature.' Vol. 30, No. 3, pp.1415-34.

Figure 25: Intensity of local competition, 2009



Note: Averages, Q: Competition in the local market is (1 = limited in most industries, 7 = intense in most industries)
Source: WEF, Global Competitiveness Report

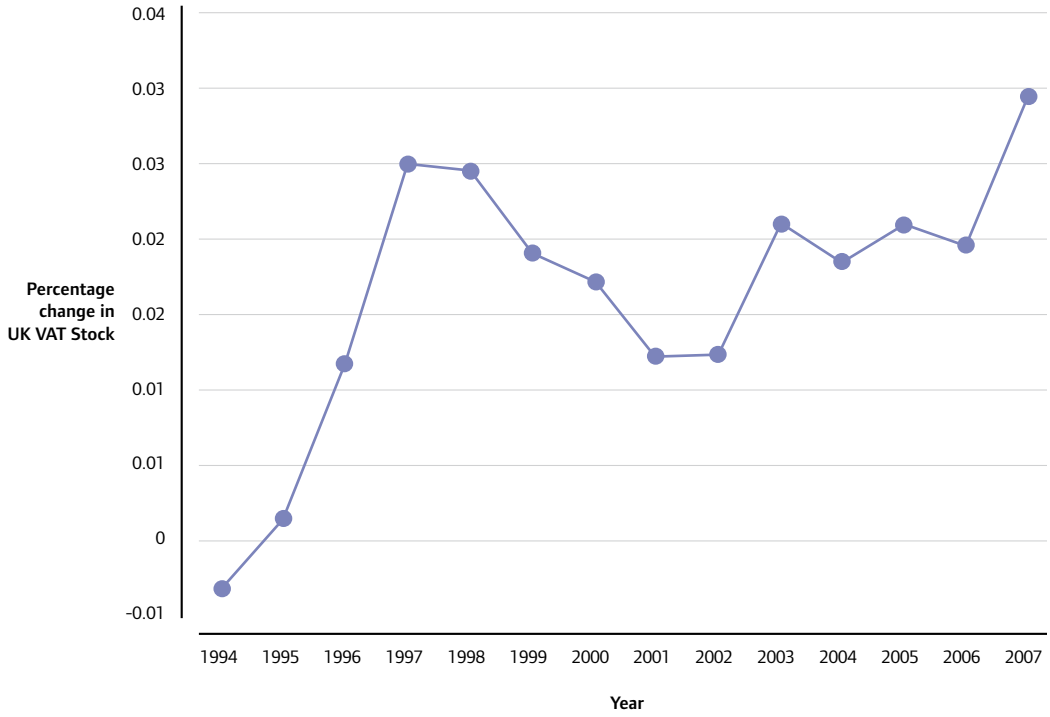
Figure 26: Business entry rate (New Registrations as a percentage of Total), 2005



Note: Business entry rate shows the number of new firms, defined as firms registered in the current year of reporting, expressed as a percentage of total registered firms. Data are collected on firm entry and exit and total firms

Source: World Bank, World Development Indicators

Figure 27: Business churn rate (as a percentage of Total), UK, 1994-2007



Note: Business churn rate shows the net change in VAT stock expressed as a percentage of total VAT stock at the start of the year.

Source: ONS

Competition

16. Intensity of foreign competition

Why is it significant?

Foreign competition and foreign ownership can be potentially fruitful sources of innovative ideas and products for domestic firms. This is because foreign competition raises competitive pressures, and foreign ownership has a positive effect on innovation because of the resources that foreign parties, in particular multi-national enterprises, are able to draw upon and contribute to the domestic firm, which cannot necessarily be reproduced by smaller, indigenous firms. These resources consist of finance, technology, knowledge and managerial expertise (Love *et al.*, 1996 and Rogers, 1998).[53]

What is its relative importance?

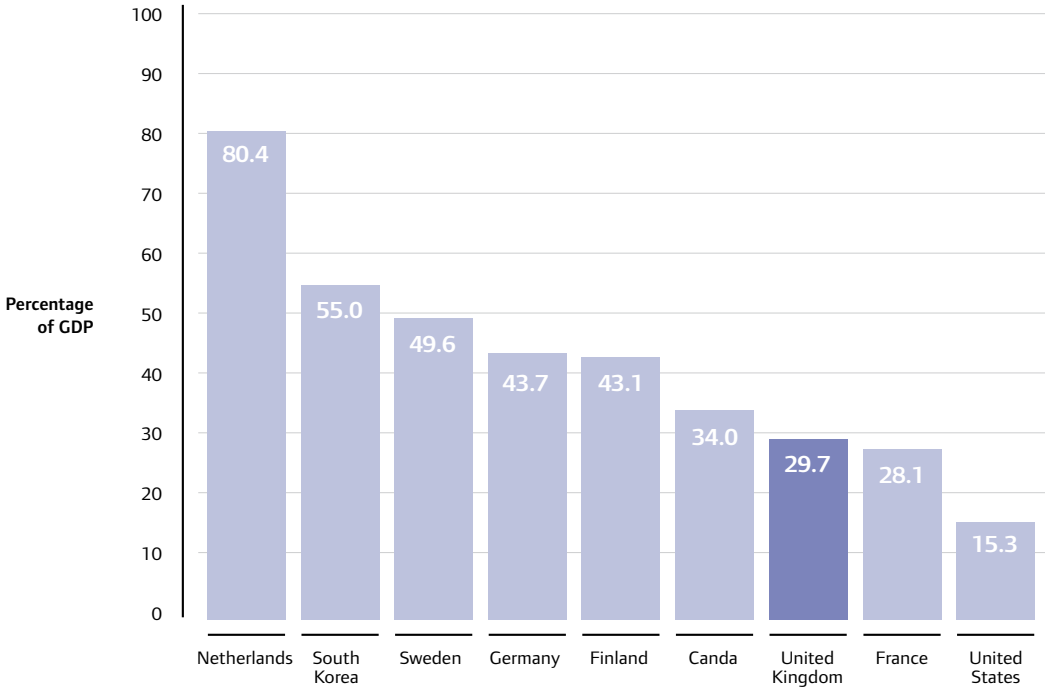
No robust and consistent relationship between innovative activity and foreign ownership can be drawn from the empirical literature thus far. Two separate studies on Scottish and West German manufacturing firms show a significant and positive relationship between innovation and foreign ownership (Bertschek, 1995; Love *et al.*, 1996).[54]

Standing of the UK

Exposure to foreign competition, as measured by the Trade to GDP ratio, is the highest in Netherlands reflecting the open nature of the economy (Figure 28). The ratio is low for the United States and the UK (and to some extent a reflection of their large GDP base). However, Germany is a larger economy than the UK, its trade to GDP ratio is considerably higher than the UK given its export orientation. As regards FDI, Figure 29 shows that the UK has benefited from high levels of FDI in recent years (2005 onwards); although Sweden tops the league table.

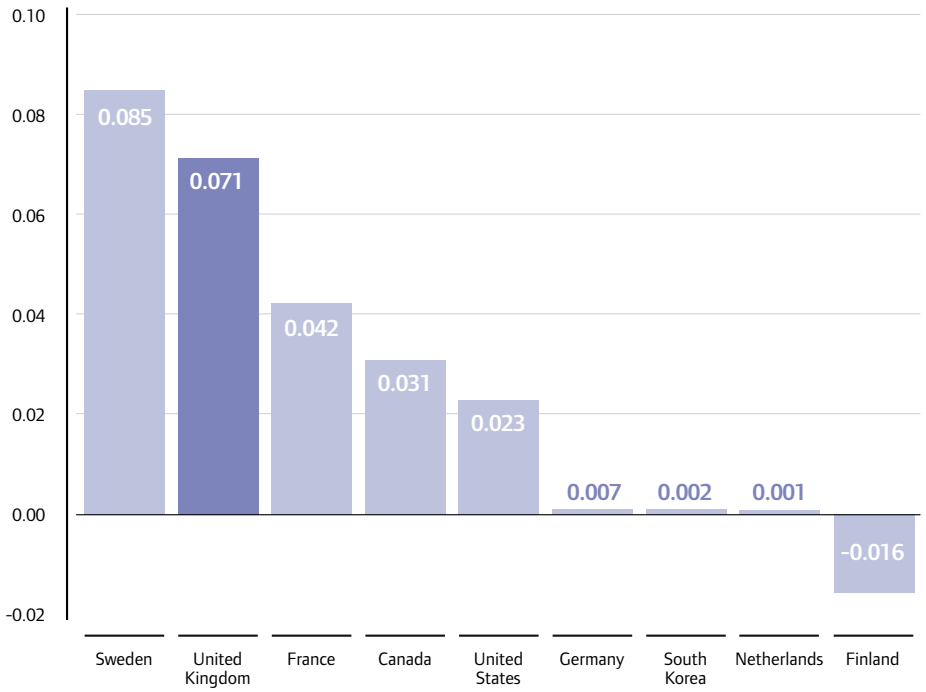
53. Love, J., Ashcroft, B. and Dunlop, S. (1996) Corporate Structure, Ownership and the Likelihood of Innovation. 'Applied Economics.' 28, pp.737-46; Rogers, M. (1998) 'Research and Development, Intangible Assets and the Performance of Large Australian Companies.' Melbourne Institute of Applied Economic and Social Research Working Paper 2/98. Melbourne: University of Melbourne; Rogers, M. (1998) 'Innovation in Australian Enterprises: Evidence from the GAPS and IBIS Databases.' Melbourne Institute of Applied Economic and Social Research Working Paper 19/98. Melbourne: University of Melbourne.
54. Bertschek, I. (1995) Product and Process Innovation as a Response to Increasing Imports and Foreign Direct Investment. 'Journal of Industrial Economics.' 43(4), pp.341-57. Love, J., Ashcroft, B. and Dunlop, S. (1996) Corporate Structure, Ownership and the Likelihood of Innovation. 'Applied Economics.' 28, pp.737-46.

Figure 28: Trade to GDP ratio, 2008



Source: World Bank, World Development Indicators; (Exports + Imports) / (2 x GDP)

Figure 29: Net FDI Inflows relative to GDP, 2008



Source: World Bank, World Development Indicators; Net foreign direct investment (inflows – outflows) expressed as a percentage of GDP

Demand

17. Consumer confidence index

Why is it significant?

Companies need to be placed in environments that are adaptive to innovations. Private responsive demand is composed of end user demand and of firm demand. The marketing literature has placed great emphasis on the importance of user confidence in innovation and the willingness of users to adopt innovations (Dekimpe *et al.* 2000, Tellis *et al.* 2003).[55] Levie has developed a consumer confidence index (Levie 2009),[56] based on a survey of private consumers in 30 countries. This index covers 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: In the next six months, you are likely to buy a new product or service? In the next six months, you are likely to try products or services with new technology? In the next six months, new products or services will 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.

What is its relative importance?

The consumer confidence index is a good proxy for the uptake of innovation from firms. The obvious challenge of indicators for responsive demand is that they are always confined to certain products or types of products. In addition, diffusion analysis is often done as one-off studies rather than delivering time series data. There are no publicly available datasets that systematically capture the actual diffusion of innovations on a regular basis and thus could even provide an international comparison of countries as to their eagerness to adopt innovation. Therefore, this index can give some indication as to the inclination of consumers to absorb innovation and to relate to them in a positive way. In addition, the index is international and it is planned to have it done on a regular basis.

Standing of the UK

Table 4 shows that consumer confidence in the UK is above comparator countries such as Finland, the Netherlands, and Japan, but slightly below Ireland and the US. Among the 13 countries used by Levie, as seen as innovation driven (in contrast to factor or efficiency driven), the UK is exactly in the middle position (7th). Among the group of comparator countries for which data are available the UK is second to the US, although it has decreased between 2006 and 2008 while in the US it has improved. The prevailing recession may supress confidence levels further.

55. Dekimpe, M., Parker, P. and Sarvary, M. (2000) Global Diffusion of Technological Innovations: A Coupled-Hazard Approach. 'Journal of Marketing Research.' 37 (February), pp.47-59; Dekimpe, M., Parker, P. and Sarvary, M. (2000) Globalization: Modeling Technology Adoption Timing Across Countries. 'Technological Forecasting and Social Change.' 63, pp.25-42; Tellis, G.J., Stremersch, S. and Yin, E. (2003) The International Takeoff of New Products. 'Marketing Science.' 22, S.188–208.
56. Levie, J. (2009) 'The IIIP Innovation Confidence Index 2008.' Glasgow: University of Strathclyde.

Table 4: Consumer confidence index

	2006	2008
United States	58	60
United Kingdom	55	50
South Korea	:	44
Finland	44	42
Netherlands	38	:
Australia	:	:

Source: Levie 2009, sorted for 2008 data

Demand

18. Demand as innovation source

Why is it significant?

As stated in the rationale for demand as WFC above, knowledge and ideas for innovations do not stem from within organisations or from public research only, but from demand. There is quite a way to go until simple indicators are developed and regular data are provided. This part of the WFC demand is thus underdeveloped; nevertheless, the three indicators provided, buyer sophistication (based on WEF), and level of cooperation with customers (CIS 4), give some first indication about capabilities to signal needs and the level of interaction between suppliers and consumers.

What is its relative importance?

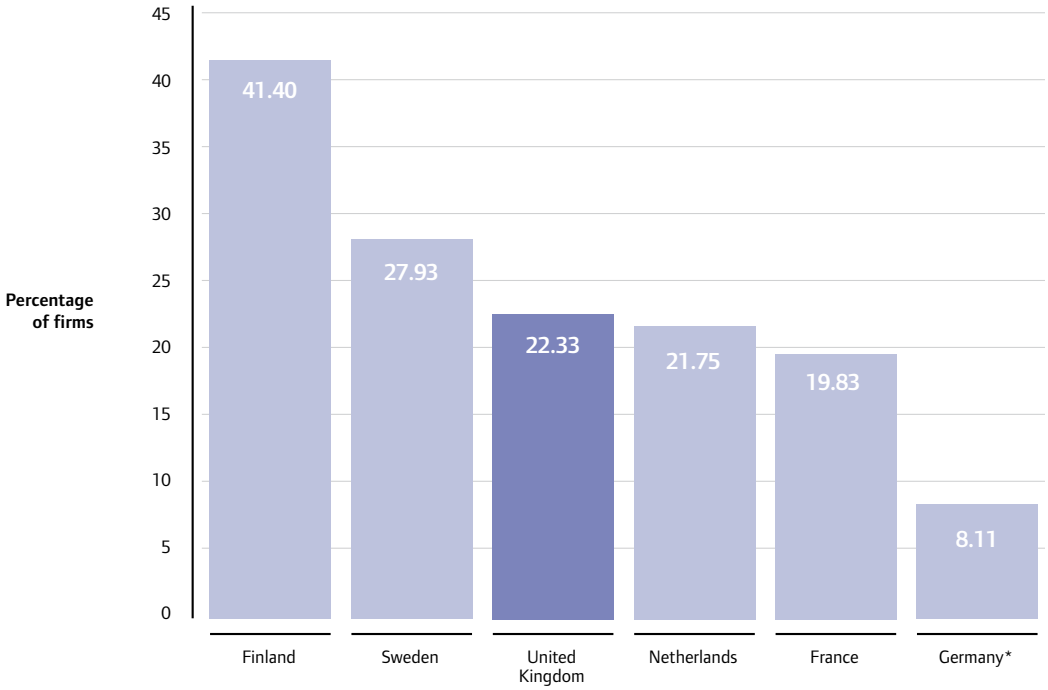
On the basis of a range of case studies (in the tradition of e.g. von Hippel 1986, Guerzoni 2007, Prandelli *et al.* 2008)[57] and there is evidence from other countries[58] that the importance of this dimension is highly undervalued. The indicators provided here can only be a (weak) proxy for the importance; they cover only two – albeit critical – dimensions. Buyer sophistication indicates the capabilities of users not only to absorb leading edge technologies, but also to understand their own needs and signal needs to producers. The level for cooperation with customers indicates the extent to which customers are involved in the innovation process and thus, the higher this interaction, the greater the stimulus to innovate.

Standing of the UK

When asked about cooperation with customers the UK firms have a middle ranking position in the Community Innovation Survey (Figures 30). Moreover, the innovative companies in the UK have been less active integrating innovation stimulus (Figure 31). On the basis of these data, it appears that the lack of receiving and absorbing signals from the demand side is an important issue; not so much a lack of openness on behalf of firms in general. This is in line with the broadly poor level of buyer sophistication across countries, as assessed by business managers (Figure 32). While this measure has fallen sharply in recent years, it is a similar picture across our comparator group.

57. Guerzoni, M. (2007) 'The impact of market size and sophistication on innovation: The patterns of demand.' Presentation to the conference, Appropriability, proximity, routines and innovation, Copenhagen, June 18 2007; Prandelli, E., Sawhney, M. and Verona, G. (2008) 'Collaborating with Customers to Innovate: Conceiving and Marketing Products in the Networking Age.' Cheltenham: Edward Elgar; von Hippel, E. (1986) Lead Users: A source of novel product concepts. 'Management Science.' 32(7), pp.791-805.
58. Gault, F. and von Hippel, E. (2009) 'The prevalence of user innovation and free innovation transfers: Implications for statistical indicators and innovation policy.' MIT Sloan School of Management working paper. No.47 22-09.

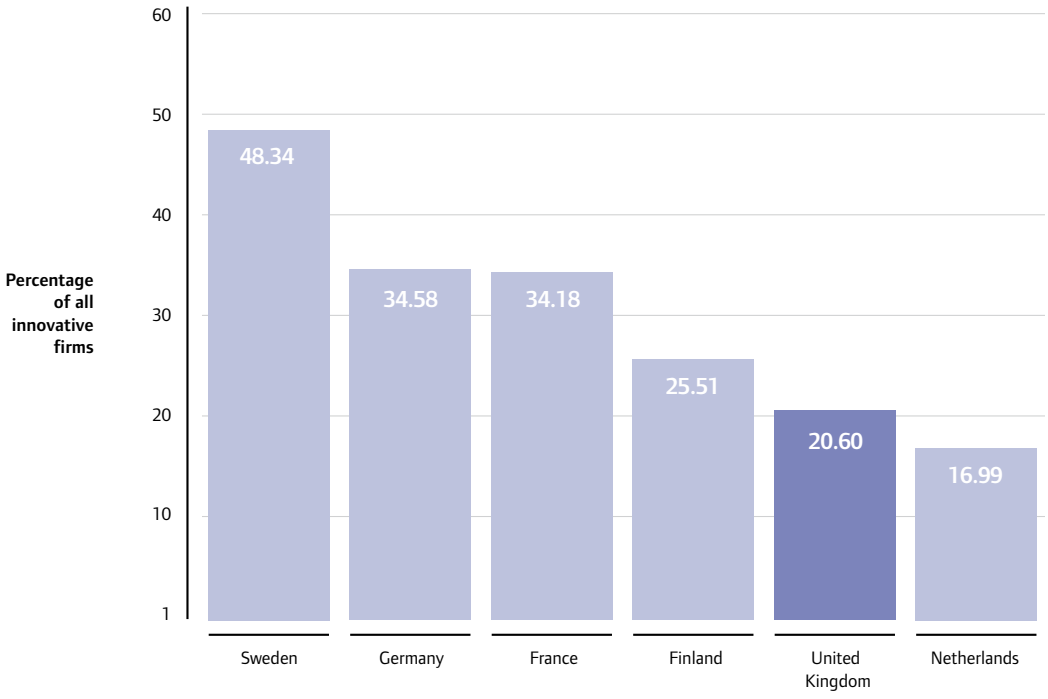
Figure 30: Cooperation with customers, 2002-2004



*share of all innovative firms, it is not possible to distinguish private and public customers

Source: Community Innovation Survey 4

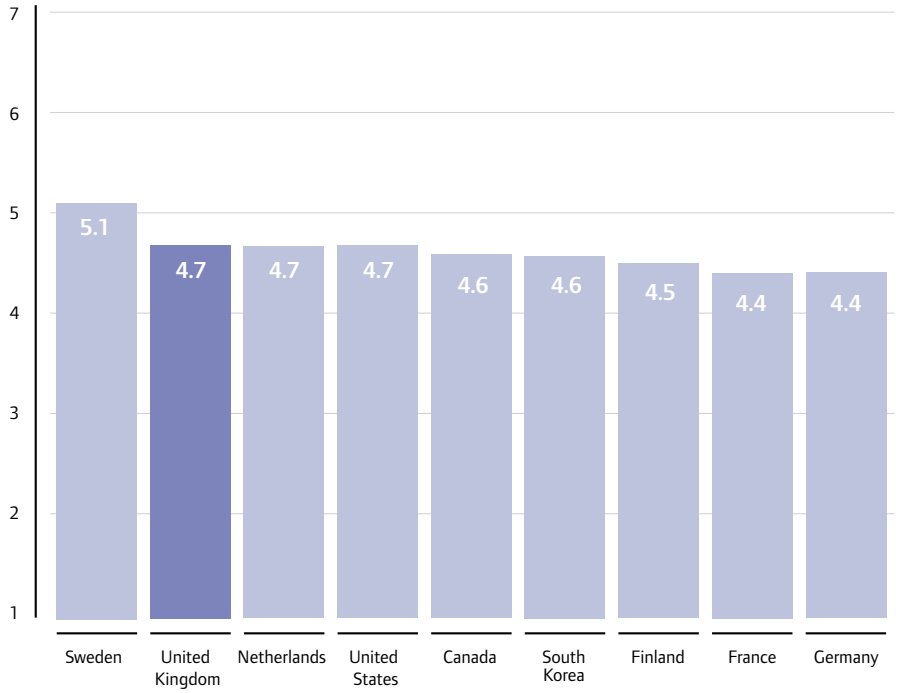
Figure 31: Share of companies making high use of sources for innovation from customers, 1998-2000



Note: share of all innovative firms, for the same variable in CIS 4 and CIS 5 there is no data for the UK available

Source: Community Innovation Survey 3, 1998-2000

Figure 32: Buyer sophistication, 2009



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)

Source: WEF, Global Competitiveness Report

Demand

19. Firm-level technology absorption

Why is it significant?

In addition to the consumer demand, firms' adoption of innovation is important. End consumer demand is only a fraction of the overall purchase within an economy, and many firms exclusively supply to other firms. In addition to the effect on the supplying firm, demand for new technologies has primary effects on the demanding companies. Bhide has argued that downstream activities and the diffusion of technologies can potentially result in much higher economic effects through productivity gains (and multiplication and network effects) than the production of the innovation in the first place.[59] This analysis is backed by data from Eaton and Kortum, who find that growth in UK, West Germany and France was based much more on results of R&D produced abroad than home grown R&D.[60] The main indicator for firm adoption that we have is the assumption of elites based on the Global Competitiveness Report (WEF various years), which asks about the ability of companies to absorb new technology. On the basis of CIS data, Arundel and Hollanders have empirically shown that technology absorption is strongly correlated with innovation performance of countries.[61]

What is its relative importance?

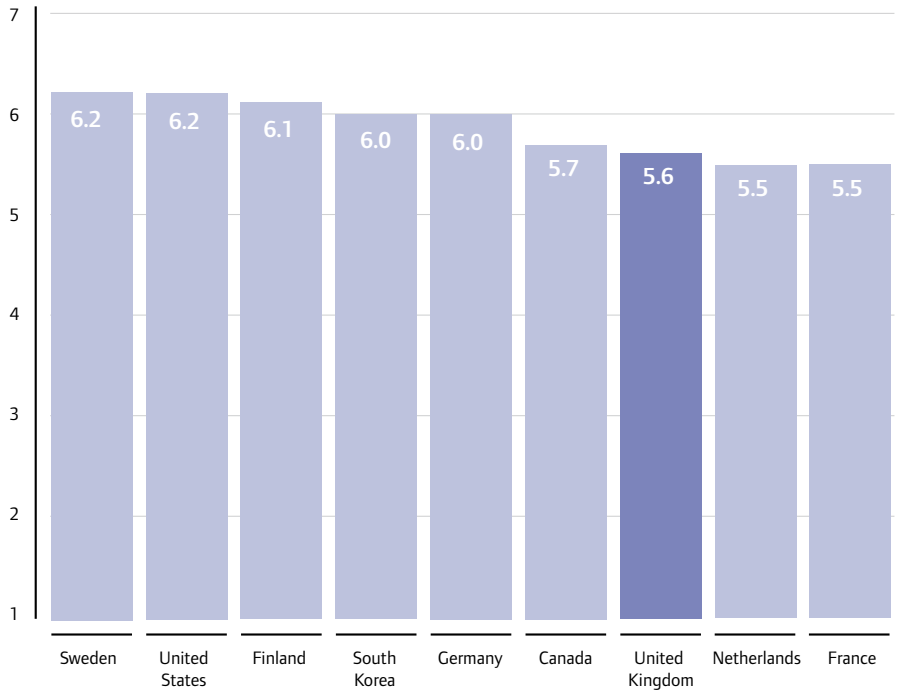
The indicator is demand side, but has supply side implications. The importance of this indicator is twofold. It signals the ease with which companies in a country absorb new technologies, and in doing so it signifies the second dimension of technology demand, i.e. the ability of industry (the demanders) to modernise, thus improve their own ability to innovate.

Standing of the UK

The inter-firm markets for innovation, measured as firm level technology absorption, are slightly better assessed than buyer sophistication. Nevertheless the UK trails the US, Sweden, Finland and Germany slightly, and is roughly in line with France, Canada and Netherlands (Figure 33).

59. Bihde, A. (2006) 'Venturesome Consumption, Innovation and Globalization.' Paper for a Joint Conference of CESifo and the Center on Capitalism and Society, Perspectives on the Performance of the Continent's Economies. Venice, 21-22 July 2006.
60. Eaton, J. and Kortum, S. (1995) 'Engines of growth.' NBER Working Paper No 5207. Cambridge, MA: National Bureau of Economic Research.
61. Arundel, A. and Hollanders, H. (2007) 'Differences in socio-economic conditions and regulatory environment: explaining variations in national innovation performance and policy implications.' INNO-Metrics Thematic Paper. Brussels: European Commission, DG Enterprise. Available at: www.proinno-europe.eu/admin/uploaded_documents/eis_2007_Socio-economic_conditions.pdf

Figure 33: Firm level technology absorption, 2009



Note: Averages, Question: Companies in your country are (1 = not able to absorb new technology, 7 = aggressive in absorbing new technology)

Source: WEF, Global Competitiveness Report, various years, sorted for 2008

Demand

20. Size and inclination to buy innovation

Why is it significant?

Public demand makes up roughly 16 per cent of GDP in the UK. The potential of using public demand to spur innovation is enormous (Georghiou 2007, Edler 2009).[62] Arundel and Hollanders (2007), Dalpé (1994) and Rothwell/Zegveld (1989)[63] have shown that public procurement and innovation performance are linked. In terms of indicators, it is not only the size of public demand (vs. private demand), it is the ability and willingness to procure (risky) innovations and the extent to which public bodies are eager to engage in innovation co-production (triggering), in initiating products into the market (market introduction) or in contributing to an accelerated diffusion. One indicator is the perception of business as regards the government purchasing of new technology; a second indicator is size, approximated by the value of public procurement tenders that are openly advertised.

What is its relative importance?

Innovation through public procurement can trigger innovation in industry and better and more efficiently achieve societal goals ('more value for money'). Therefore, it is important to know the potential of government budgets that can be spent for innovation. And the share of GDP that is openly advertised for tender is an indication of potential government contracts which promise to have a critical mass mobilising for innovation, as publication is only a requirement above a certain value threshold. A second indicator reflects the suppliers' perspective as regards the extent to which the government buys new technology, and what purchasing behaviour business leaders associate with government purchasing.

Standing of the UK

The UK is the country in Europe that has the highest value of public procurement (which is publicly advertised) relative to GDP. The potential for innovation through public procurement in the UK is high (see Table 5).

In terms of concrete public procurement of innovation (advance technological products), the UK is rated far below the US or South Korea (see Figure 34). Within the European comparator countries, the UK ranks behind Finland, Sweden and the Netherlands, and is at the same level as France and slightly higher than Germany. This rather poor assessment is relatively stable over time, and it shows that, although the policy strategies described above are timely, there is room for significant improvement.

62. Edler, J. *et al.* (2009) Demand Oriented Innovation Policy. In Smits, R., Kuhlmann, S. and Shapira, P. (Eds) 'The Co-Evolution of Innovation Policy – Innovation Policy Dynamics, Systems and Governance.' Cheltenham: Edward Elgar. (Forthcoming); Edler, J., Georghiou, L. (2007) 'Public procurement and innovation – Resurrecting the demand side. In 'Research Policy.' 36, pp.949-963; Georghiou, L. (2007) 'Demanding Innovation: Lead markets, public procurement and innovation.' NESTA Provocation 02. London: NESTA. Available at: http://www.nesta.org.uk/assets/documents/demanding_innovation

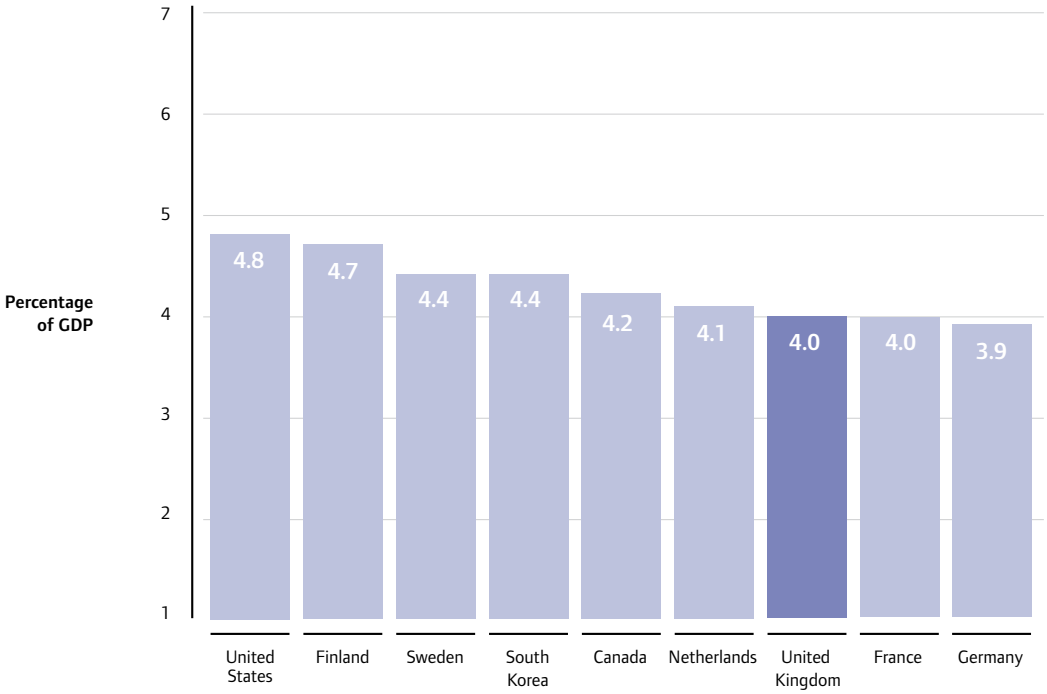
63. Arundel, A. and Hollanders, H. (2007) 'Differences in socio-economic conditions and regulatory environment: explaining variations in national innovation performance and policy implications.' INNO-Metrics Thematic Paper. Brussels: European Commission, DG Enterprise; Dalpé, R. (1994) Effects of Government Procurement on Industrial Innovation. 'Technology in Society.' 16(1), pp.65-83; Rothwell, R. and Zegveld, W. (1981) 'Industrial Innovation and Public Policy.' London: Frances Pinter.

Table 5: Public procurement which is openly advertised as a percentage of GDP, 2001-2007

	2001	2002	2003	2004	2005	2006	2007
United Kingdom	3.7	3.8	7.2	4.6	3.5	4.6	4.0
Finland	2.3	2.2	2.5	2.9	3.3	3.1	3.6
France	2.7	3.1	3.7	2.8	3.0	3.4	3.4
Sweden	4.6	3.8	3.6	3.3	3.2	3.1	3.1
Netherlands	2.5	1.8	1.7	1.8	1.6	2.3	1.8
Germany	0.9	1.3	1.8	1.2	1.6	1.7	1.1

Source: EUROSTAT Note: based on the calls for tenders published in the Official Journal of the European Communities, value calculated as product of averages of prices in published calls and the number of those calls. There is no indication as to the share of calls per country that is advertised, most likely in countries with strong decentralised administrations the number of non published, below threshold calls will be higher, and thus there is a systematic underestimation of the share of public procurement for countries like Germany.

Figure 34: Government procurement of advanced technology products, 2009



Note: Averages, Question: In your country, government procurement decisions result in technological innovation (1 = strongly disagree, 7 = strongly agree)

Source: WEF, Global Competitiveness Report, various years, sorted for 2008

Demand

21. Uncertainty of demand as an obstacle to innovation

Why is it significant?

The lack of demand for innovation is likely to prevent many businesses from pursuing the development of innovative business models, services and products.

There are two variables in the Community Innovation Survey that can throw some light on the nature of uncertain demand for innovation:

- The first is that there is "No need to innovate because there isn't the demand for innovations, high important factor of hampering innovation activities".

- The second is "uncertain demand for innovative goods or services, high important factor of hampering innovation activities".

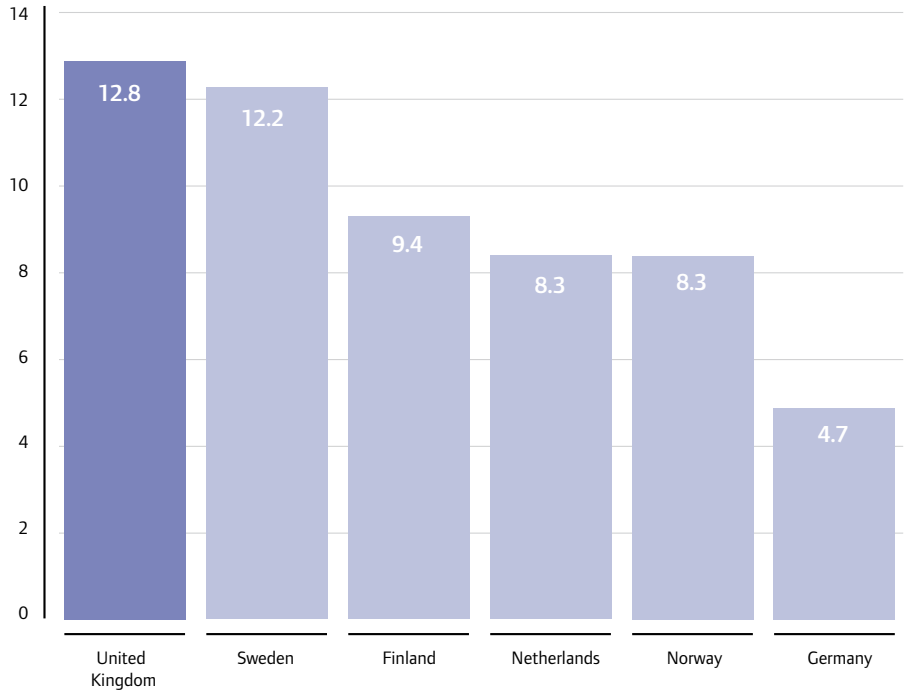
What is its relative importance?

Demand driven innovation is significant. Uncertainty concerning demand for innovative services and products is likely to result in a number of businesses adopting a cautious attitude towards the innovation process and, perhaps, scaling back their efforts, or even in extreme circumstances withdrawing from the innovation process. However, the CIS data indicate that it is only for a small proportion of businesses that uncertainty of demand for innovation is a concern. Other demand conditions appear to be of greater importance.

Standing of the UK

Unfortunately, data for the UK is only available for the period 2002 to 2004. Figure 35 shows that for the UK the share of innovative companies who rate uncertain demand for innovation as a major hindrance on the innovation process is higher than in all but one of the nine comparator countries.

Figure 35: Uncertainty of demand as an obstacle to innovation, 2002-2004



Skills

22. Expenditure on education as a percentage of GDP

Why is it significant?

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 basic skills such as literacy and numeracy yield a significant positive return (e.g. Sianesi, 2003; Dearden *et al.*, 2000).[64] And higher wages imply higher productivity, which in turn suggests higher innovativeness. 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" (Cohen and Levinthal, 1990)[65] – 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.

64. Sianesi, B. (2003) 'Returns to Education.' London: Institute for Fiscal Studies; Dearden, L. *et al*. (2000) 'The Returns to Academic, Vocational and Basic Skills in Britain.' DfEE Skills Task Force research paper. London: DfEE.

65. Cohen, W.M. and Levinthal, D.A. (1990) Absorptive Capacity: a new perspective on learning and innovation. 'Administrative Science Quarterly.' Vol. 36(1), pp.128-152.

What is its relative importance?

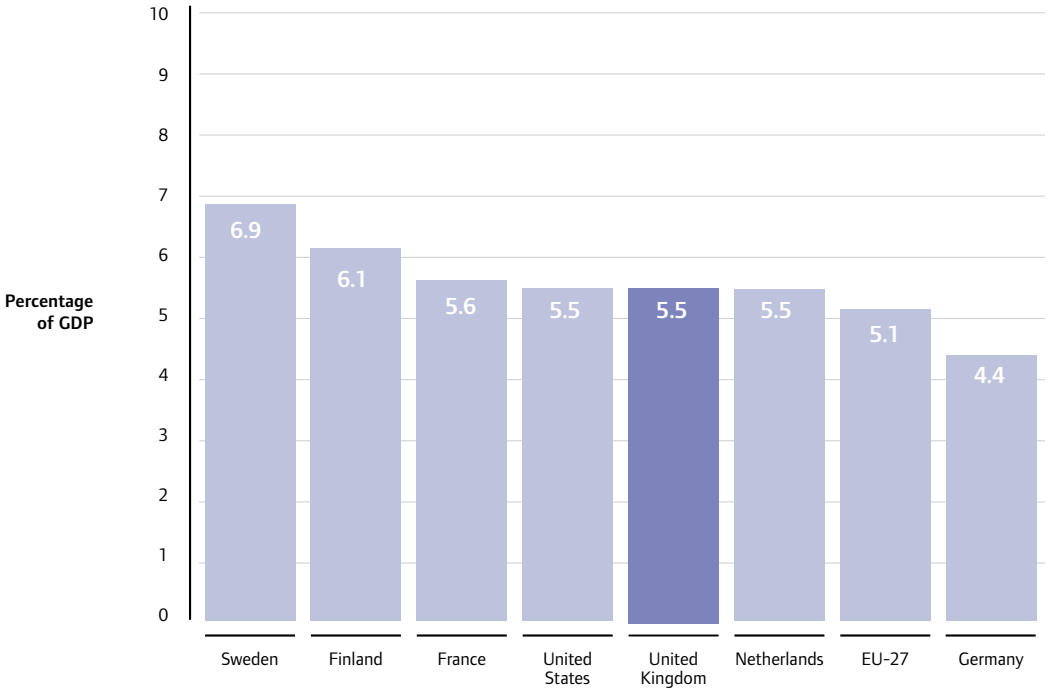
The general education expenditure index is, in the context of innovation, complementary to the more S&T-related HRST index, and the evidence suggests that both are key to fostering innovation.

Standing of the UK

Total expenditure on education as a proportion of GDP in the UK is around the average of our comparator countries – Sweden and Finland show significantly higher ratios, while that of Germany is significantly lower (Figure 36).

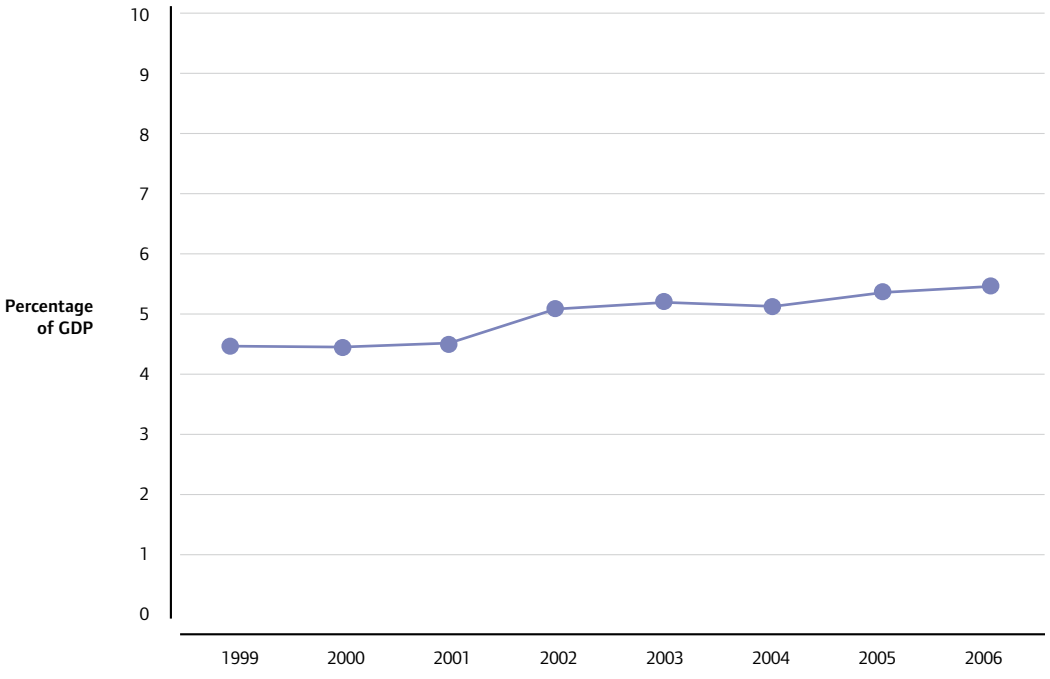
The UK ratio has increased rapidly since the turn of the century, its rate of growth far outstripping that of most of the comparator countries and, as with the HRST index, suggesting that the UK will shortly catch up and overtake some of its competitors (Figure 37).

Figure 36: Expenditure of education as a share of GDP (percentage), 2006



Source: Eurostat

Figure 37: Expenditure of education as a share of GDP (percentage), UK, 1999-2006



Source: Eurostat

Skills

23. Share of population with tertiary education

Why is it significant?

In general, higher education will equip a student with a depth of specialist (technical) knowledge and an ability/expectation to tackle higher-order problems (organisational) that goes far beyond the skills attained in school or subsequently at work. People thus trained ought to be more productive, flexible and innovative across their working lives.

Higher education is believed to be associated with higher levels of confidence in one's abilities and competence, which bear on people's propensity to attempt more challenging tasks and to innovate. Moreover, there is a growing expectation that higher education will also include general instruction in enterprise and entrepreneurship.

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 good evidence as to the impact of such population-wide changes on the innovativeness of sectors or entire economies.

What is its relative importance?

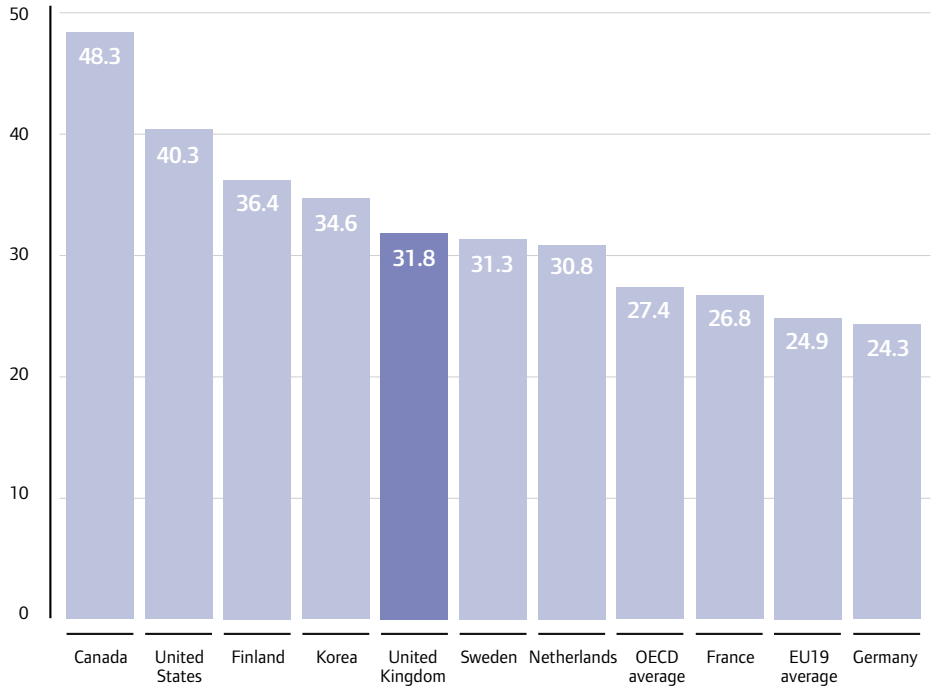
This is arguably the most significant of all of the measures related to the general population, inasmuch as it provides a good indication of the breadth of the availability of higher order skills and confidence needed by innovative, knowledge-based enterprises.

Standing of the UK

All countries are seeking to increase the proportion of the population that has completed higher or tertiary education, and the share of young people having completed tertiary education is a useful leading indicator.

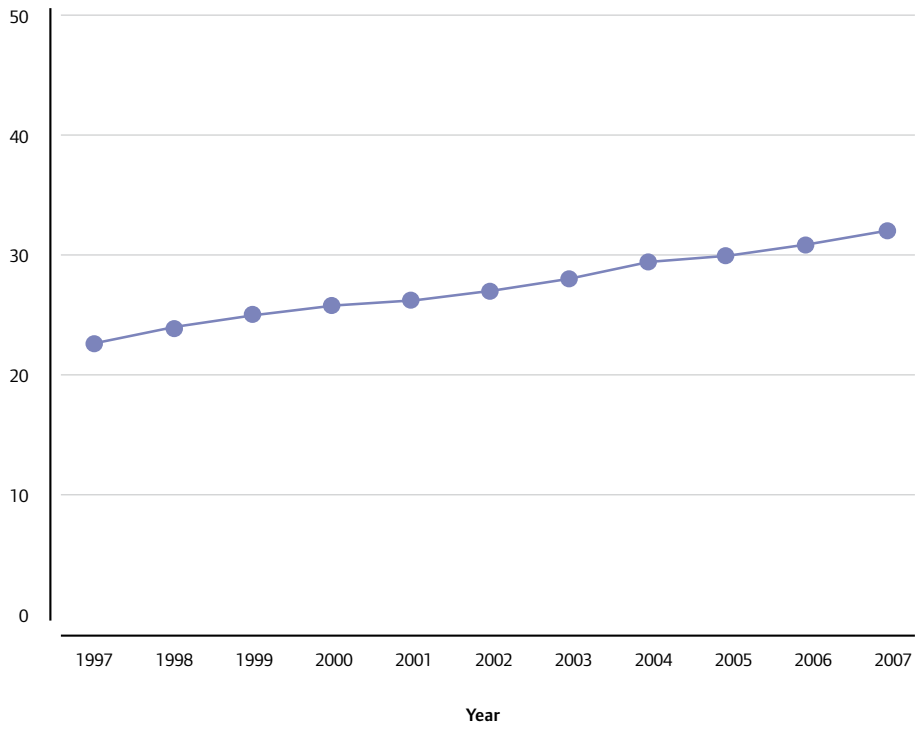
The OECD statistics on 'population with tertiary education' show a figure for the UK of 32 per cent for the share of the population of working age (25-64) with a tertiary qualification, which is ahead of both the OECD (27 per cent) and EU averages (25 per cent). However, the UK lags significantly behind Canada which tops our mini-league with a figure of 48 per cent. On a positive side, the data show a consistent improvement in UK's performance on this indicator over the period 1997-2007 (Figure 39). 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.

Figure 38: Share of 25-64 year-old population with tertiary education, 2007



Education at a glance: OECD indicators

Figure 39: Share of 25-64 year-old population with tertiary education, UK, 1997-2007



Education at a glance: OECD indicators

Skills

24. Percentage of high-skilled labour in the workforce

Why is it significant?

The level of availability of skilled 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. In the Index survey, UK firms asserted that the availability of skilled labour was the single most important factor impacting their innovation success. Therefore, the percentage of skilled labour in the economy is a key indicator for the innovative potential of the UK.

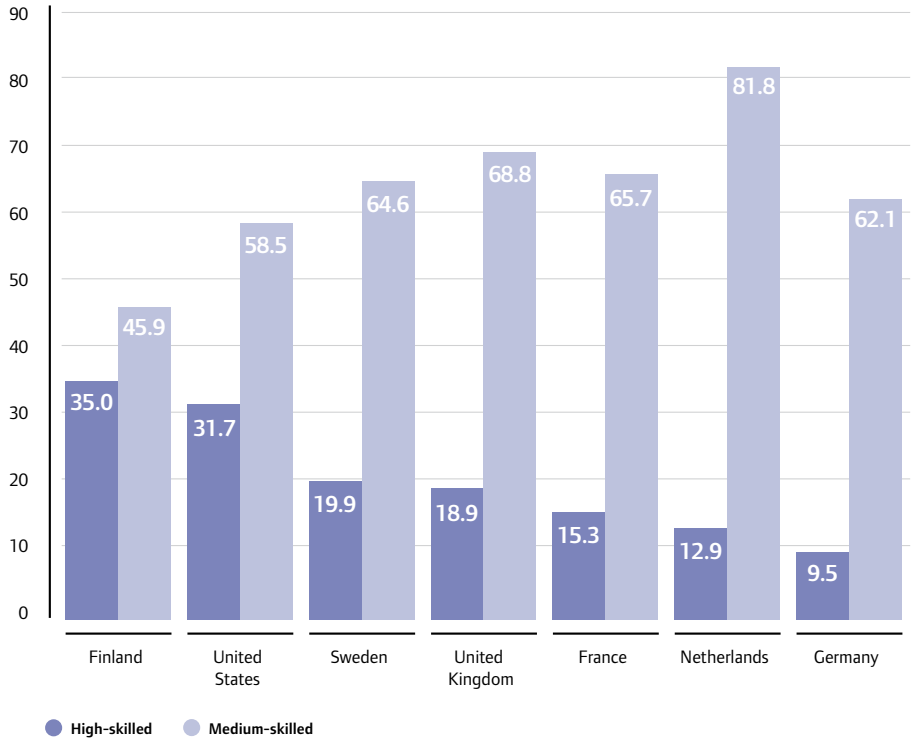
What is its relative importance?

Compared to other indicators to assess the UK's standing with regards to human capital, this indicator is the most insightful, in that it shows how skilled labour contributes to the UK economy in comparison to other countries. A poor showing on this indicator would suggest that the UK needs more skilled labour to allow firms to innovate and stay competitive.

Standing of the UK

18.9 per cent of UK employees are high-skilled. While this puts the UK ahead of France, the Netherlands and Germany, and on par with Sweden, it also means that the UK trails the US by a margin of 13 percentage points and Finland by a margin of 16 percentage points. The UK can only partially compensate with medium-skilled labour, where it is second to the Netherlands and leads the US by ten points, and Finland by 22. Overall, the lack of high-skilled labour in the UK can be a key disadvantage for innovative firms that compete globally.

Figure 40: 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)

Skills

25. Human Resources in Science and Technology (HRST)

Why is it significant?

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'. 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 and absorption of innovations. Numerous studies support the hypothesis that a skilled and trained workforce fosters productivity and innovation (e.g. Dearden *et al.*, 2000;[66] who finds that increases in the worker skill profile is associated with complementary increases in firms' innovativeness).

66. Dearden, L. *et al.* (2000) 'The returns to academic, vocational and basic skills in Britain.' Skills Task Force and DfEE Research paper. London: DfEE.

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.

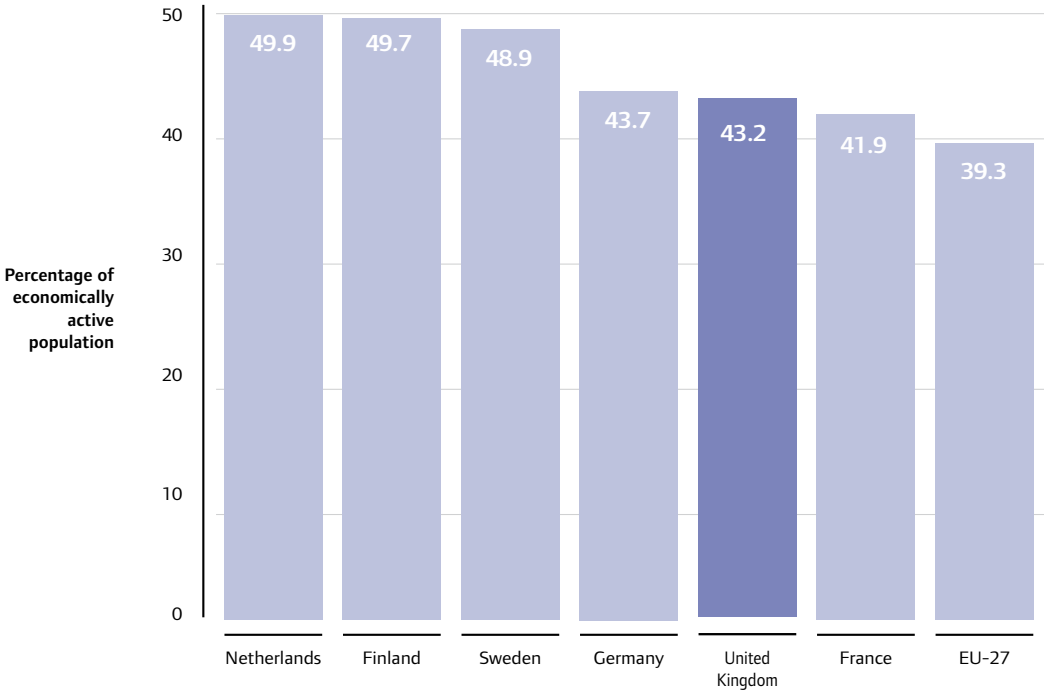
What is its relative importance?

This indicator captures a number of attributes of company employees shown in the literature to be strongly innovation-related. These include direct R&D professionals and others whose contributions provide vital inputs for innovation generation, adaptation and absorption.

Standing of the UK

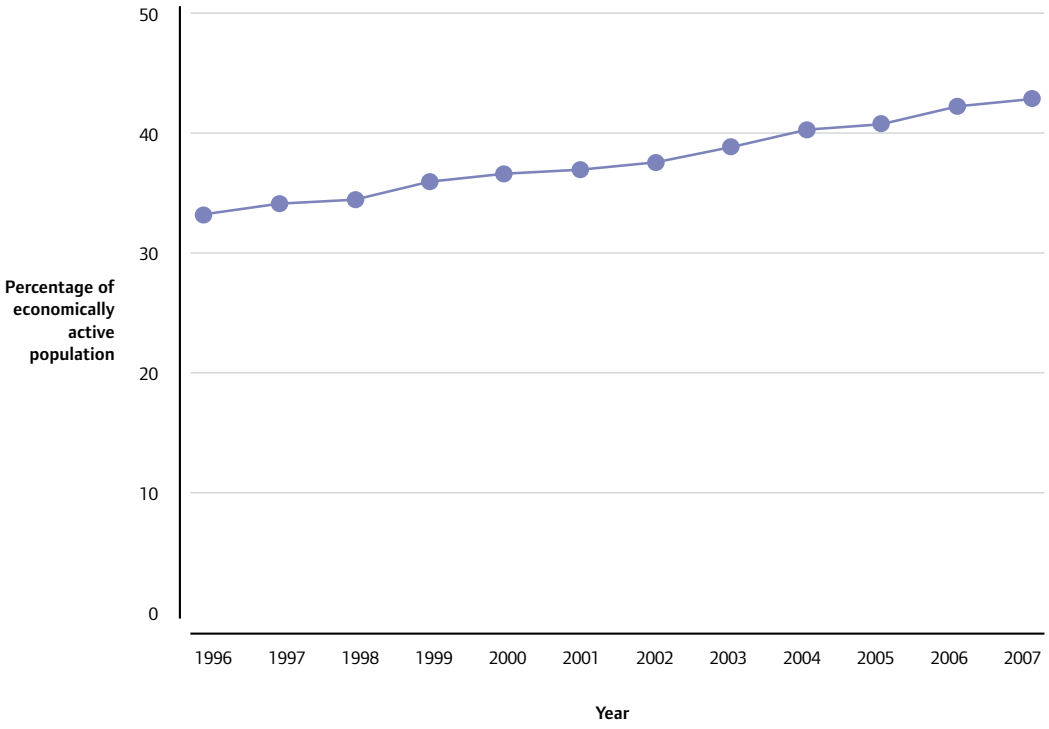
While the most recently available statistics indicate that the UK ranks below four of our reference EU countries (and slightly above France), it ranks above the EU-27 average and only the Nordic countries and the Netherlands show significantly higher ratios (Figure 41). There is also evidence of 'catching up'; the UK has increased its proportion of HRST workers in the workforce by more than any of the comparator countries since 2001 (Figure 42).

Figure 41: HRST as a percentage of economically active population, 2007



Source: Eurostat, sorted for 2007.

Figure 42: HRST as a percentage of economically active population, UK, 1996-2007



Source: Eurostat, 2008.

Skills

26. Intensity of researchers in industry

Why is it significant?

The share of all workers employed as professional scientists and engineers is an important indicator of the capacity of an industrial system to produce technological innovations. Research personnel play a critical role in the creation of technological innovations, and are treated as one of the major factors of production in studies of technical change and economic growth.

What is its relative importance?

Despite its significance to levels of innovation, the share of researchers employed arguably does not constitute a 'framework condition', but rather a direct input to innovation that employers decide in light of opportunities and the behaviour of the competition. Certainly, the level of researcher intensity varies much more between economic sectors than it does amongst businesses within sectors. However, the striking differences in the aggregate statistics across countries does suggest that there are possible supply side issues too, wherein a country is producing too few trained scientists and engineers or that other sectors (education, government) is able to recruit these deep specialists.

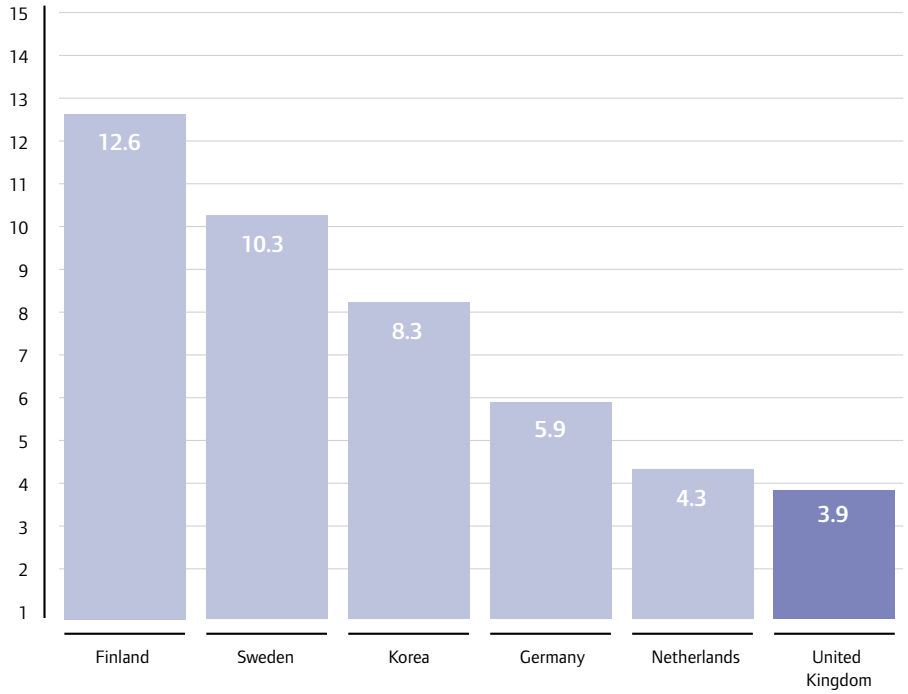
For this reason researcher intensity (numbers of researchers per unit of total business employment) is not used as one of our 'key' indicators, but is included here for completeness.

Standing of the UK

Figure 43 shows the number of researchers (in the private sector, with a university degree) per 1,000 industrial employees. The UK is seen to be well below the 'norm' of our reference countries, with less than a third of the 'researcher density' of Finland, and less than one-half that of the US, Sweden and Korea.

Moreover, time series data for this indicator shows that while the UK's position is worsening over time, countries such as Korea, France and Germany are demonstrating a steady increase in researcher density (Table 6). This suggests that, to the extent that innovation is driven by formalised business R&D activity, the UK is not well equipped in comparison with its foreign competitors. This implication from the human capital statistics is supported by R&D expenditure statistics: business expenditure on R&D as a proportion of GDP is below the OECD average and (just) below the average of EU-27.

Figure 43: Intensity of researchers in industry, 2007



Note: Business Enterprise Researchers per 1,000 employed in industry
Source: OECD Science & Technology Indicators

Table 6: Intensity of researchers in industry, 2000-2007

	2000	2001	2002	2003	2004	2005	2006	2007
Canada	5.7	6.1	6.0	6.1	6.2	6.3	. .	. .
France	4.7	5.0	5.4	5.7	6.2	6.0	6.4	. .
United States	9.7	10.0	10.3	11.2	10.6	10.3	10.5	. .
Finland	11.7	12.8	12.9	14.4	14.3	13.2	13.4	12.6
Sweden	. .	9.4	. .	9.8	9.9	12.8	12.9	10.3
Korea	3.9	5.3	5.4	5.8	5.9	7.0	7.8	8.3
Germany	5.2	5.4	5.3	5.6	5.6	5.8	5.9	5.9
Netherlands	3.4	3.7	3.4	3.3	4.0	3.9	4.9	4.3
United Kingdom	3.8	4.0	4.2	4.3	4.1	4.0	4.0	3.9

Note: Business Enterprise Researchers per 1,000 employed in industry; sorted for 2007
Source: OECD Science & Technology Indicators

Skills

27. Adaptability of the workforce

Why is it significant?

Absorptive capacity – 'the ability of a firm to recognise the value of new, external information, assimilate it, and apply it to commercial ends' (Cohen and Levinthal, 1990)[67] – is increasingly recognised as an important quality that characterises the most innovative businesses.

Absorptive capacity reflects a certain outward looking and acquisitive mindset and ability across the senior management team and the workforce more generally, and is believed to be central to both innovation and the early adoption/adaptation of others' innovations (diffusion).

67. Cohen, W.M. and Levinthal, D.A. (1990) Absorptive Capacity: a new perspective on learning and innovation. 'Administrative Science Quarterly.' Vol. 36(1), pp.128-152.

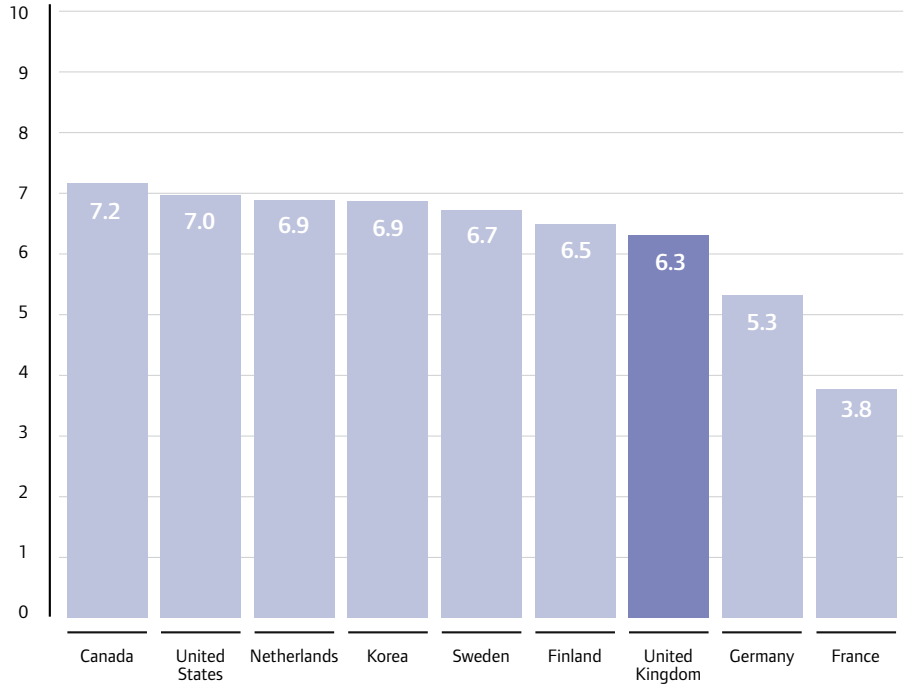
What is its relative importance?

The concept of workforce adaptability and flexibility is an important one, and is a quality that national education and training systems make a significant contribution to: it is not simply the responsibility of the employer to require and reward such behaviour. Unfortunately, however, its qualitative nature means that 'hard' measures are elusive, and we have to rely on subjective surveys of informed opinion.

Standing of the UK

Figure 44 shows the data collected by the IMD for its 'World Competitiveness Yearbook' on adaptability of the labour force – 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 in Figure 44 imply that the UK workforce may be more rigid in their outlook and expectations, and possible less adaptable and less minded to innovate.

Figure 44: Adaptability of workforce, 2009



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

Skills

28. Employees' ICT skills

Why is it significant?

High levels of ICT skills are a key requirement for many people to work effectively and efficiently, and this is arguably becoming ever more the case with the pervasiveness and central importance of ICT in the workplace.

Equally, the intrinsic programmability of ICT systems and software presents significant opportunities for both incremental improvements to internal procedures and wholly new services. A high-level of ICT literacy and confidence amongst the workforce is believed to be a good proxy for ICT-based innovation in products and processes.

ICT skills enable innovative procedures to be effectively applied and implemented, enabling both new activities and lower-cost processes for existing procedures.

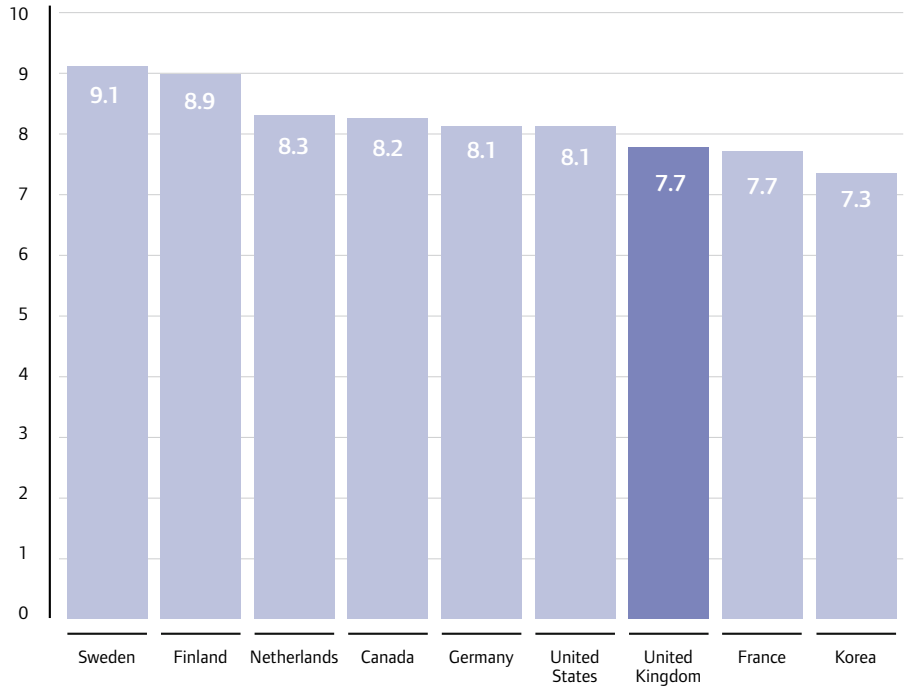
What is its relative importance?

The level of ICT skills/confidence in the general population of working age is one of the three most important metrics for general innovation skills, ranking alongside workforce adaptability and staff training. A skilled workforce is vital for fostering innovation and providing absorptive capacity. Because of the universality of ICT, it probably represents the most appropriate area for broad comparisons of skill levels of the workforce.

Standing of the UK

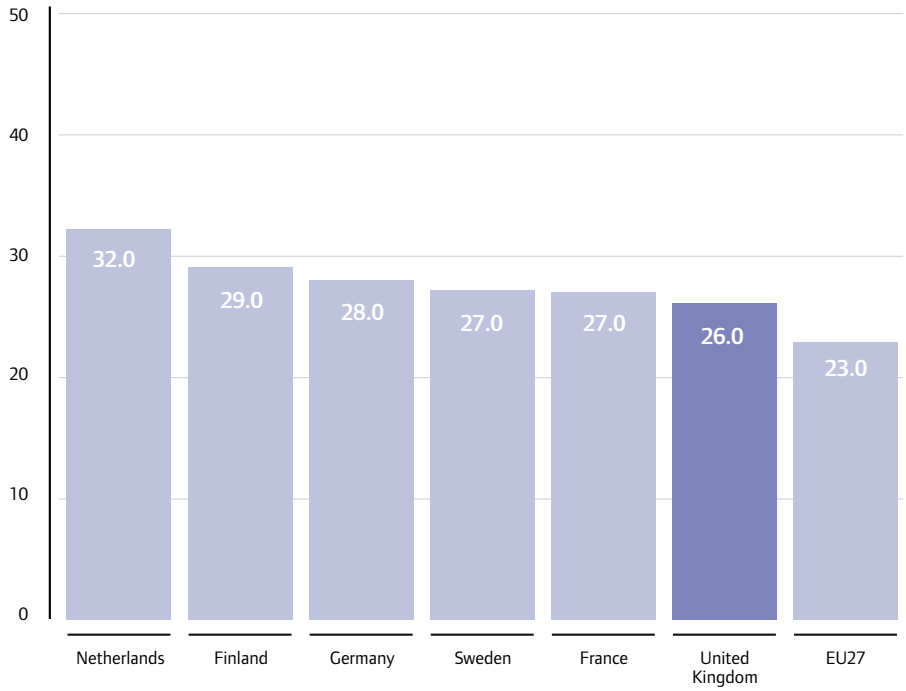
Figure 45 shows employer ratings (on a 1-10 scale) of the adequacy of the supply of ICT-skilled employees. The UK is above only South Korea of our comparator countries on this measure, although the majority are clustered closely, someway below the US and Sweden. The IMD data do place the UK above Portugal, 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 (Figure 46).

Figure 45: Employees' ICT skills, 2009



Source: IMD WCY Executive Opinion Survey based on an index from 0 to 10; Information technology skills are readily available

Figure 46: Percentage of population with high level of basic computer skills, 2007



Source: Eurostat; Individuals' level of computer skills – Percentage of the total number of individuals aged 16 to 74; Low level of basic computer skills: Individuals who have carried out 1 or 2 of the 6 computer-related items. Medium level of basic computer skills: Individuals who have carried out 3 or 4 of the 6 computer-related items. High level of basic computer skills: Individuals who have carried out 5 or 6 of the 6 computer-related items.

Skills

29. Training – availability and usage

Why is it significant?

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. Here we look at international comparisons of perceptions of both the availability of training services and investment in them.

What is its relative importance?

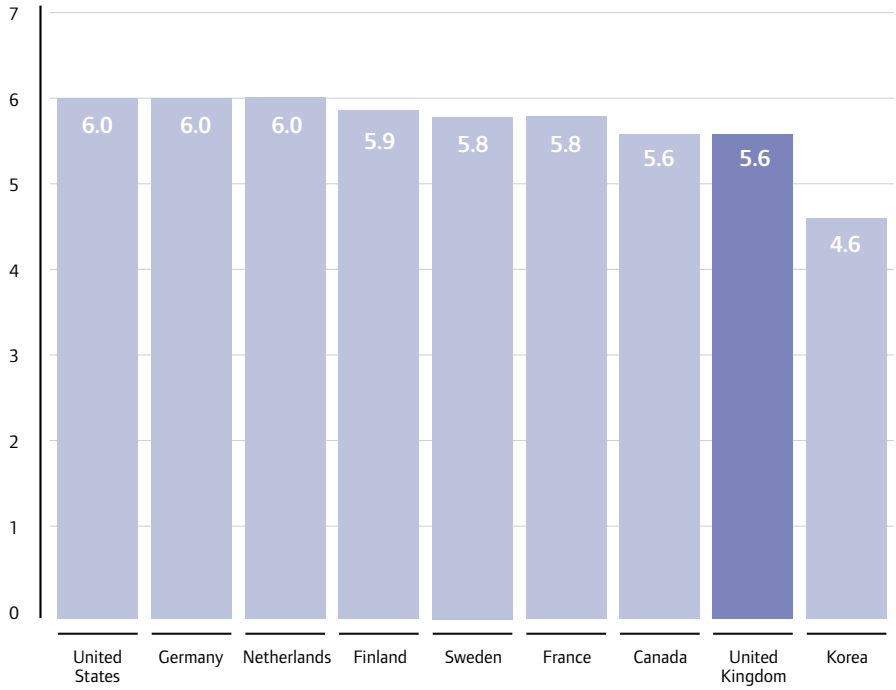
Given the length of time people are in work, 40-50 years, and the rate at which technology, markets and regulations change, the quality and volume of training provided to the working population must be as important an innovation framework condition as the level of educational attainment of the general population.

Standing of the UK

Figure 47 presents data from the World Economic Forum (WEF) survey of business executives, relating respectively to perceptions of the availability of training services and investment in such services, both on 1-7 scales. 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).

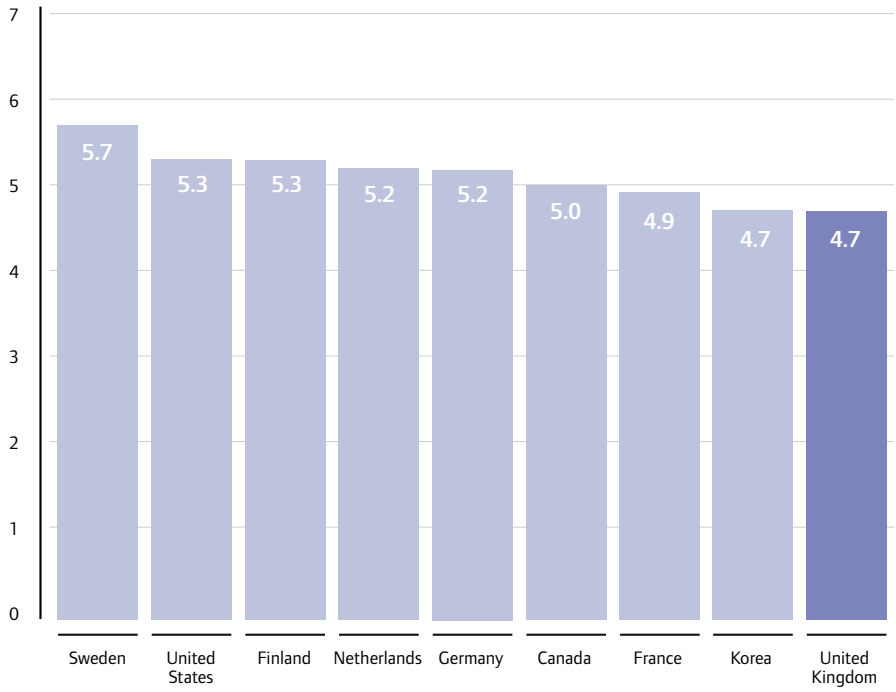
Regarding perceptions of availability, the UK ranks among the bottom three although differences among the group of comparator countries are not significant – the only exception being South Korea. Regarding investment in training, however, differences are more pronounced, with UK employers judged to show significantly less enthusiasm for training than all others (Figure 48). The implication is that the UK workforce will be less well equipped than many others to deal with new techniques and innovations.

Figure 47: Local availability of specialised research and training services, 2009



Source: WEF, Global Competitiveness Report, 2009

Figure 48: Extent of staff training, 2009



Source: WEF, Global Competitiveness Report, 2009

Skills

30. Training needs for innovators

Why is it significant?

This indicator reveals 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.

What is its relative importance?

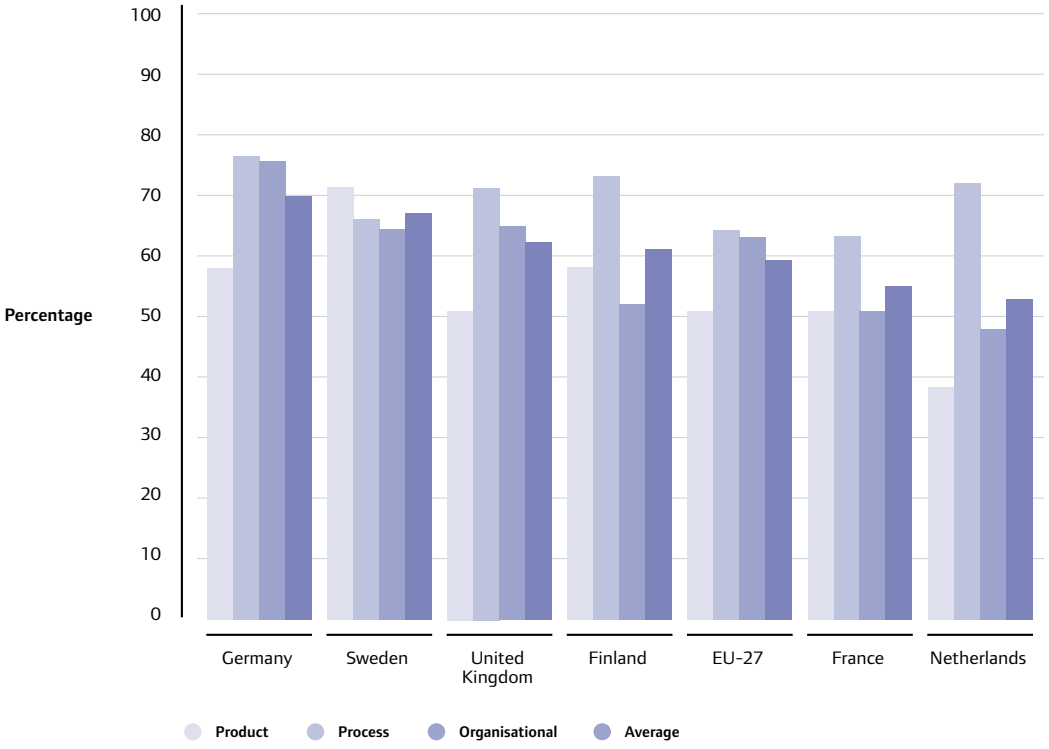
This is a useful additional indicator to complement the more general 'in-work' training metrics, showing differences across countries (and no doubt sectors, were data available) in employers' aggregate views of the need to update staff skills in light of company innovation.

Standing of the UK

Figure 49 shows data from Innobarometer survey (2007) 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 skill 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 49: Training needs for innovation, 2007



Source: Innobarometer Analytical Report 2007

Skills

31. Participation in life-long learning

Why is it significant?

The proportion of the population between 25 and 64 that participates in 'life-long learning' 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 is measured as the number of people who reported undertaking some form of education or training course.

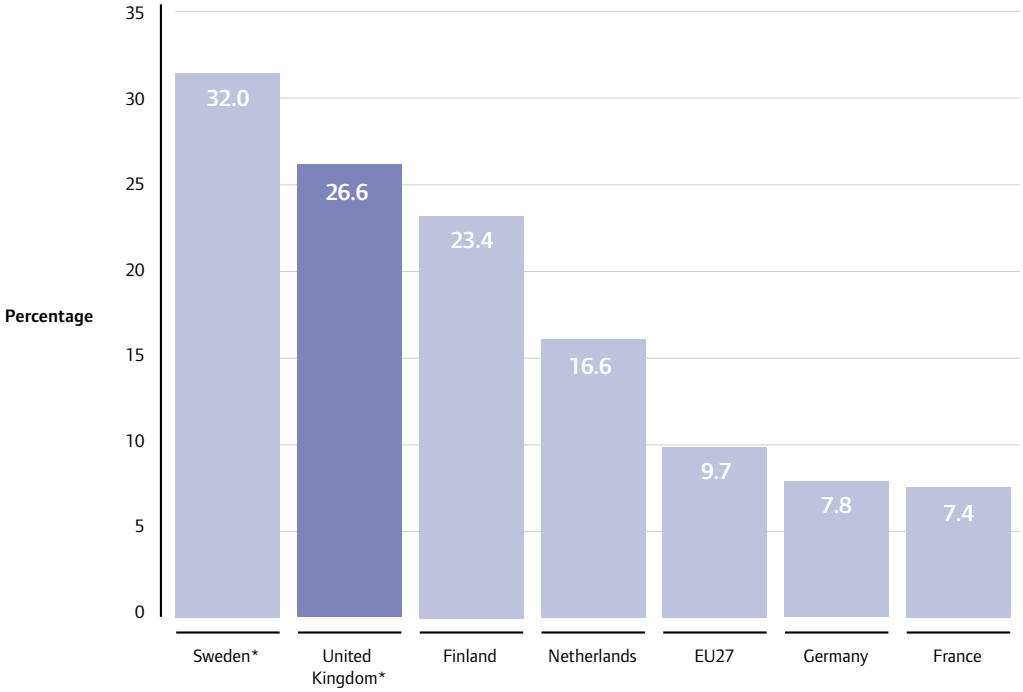
What is its relative importance?

This is perhaps a better measure of social cohesion and policy, rather than innovation. It is often seen as a measure of social progress, however it might also be seen as an indication of a country's ability to animate and reskill large sections of a population confronted with major industrial or technological change.

Standing of the UK

The data suggest that the UK is performing well against other comparison EU countries, with Sweden highest. Some caution should be taken as the training may not necessarily be employment-related, but the indicator suggests UK adults engage in ongoing learning.

Figure 50: Proportion of adult population that participates in 'life-long learning', 2007



*2006

Source: Eurostat; Participation in any aspect of life-long learning activities (formal or informal)

Access to finance

32. Availability of credit

Why is it significant?

Banks – with their available capital and distribution and support network – play an instrumental role in the financing of innovation of more mature firms which have an established track record (as compared to high-tech start-ups).[68]

What is its relative importance?

Banks are the main source of external finance for businesses – a Eurobarometer Survey of 2005[69] shows that 79 per cent of small- and medium-sized enterprises (SMEs) use bank loans to finance their operations, while only 2 per cent use venture capital. Similarly, a UK-based survey shows that debt finance and asset-backed lending together account for the majority of external finance supplied to firms.[70]

Standing of the UK

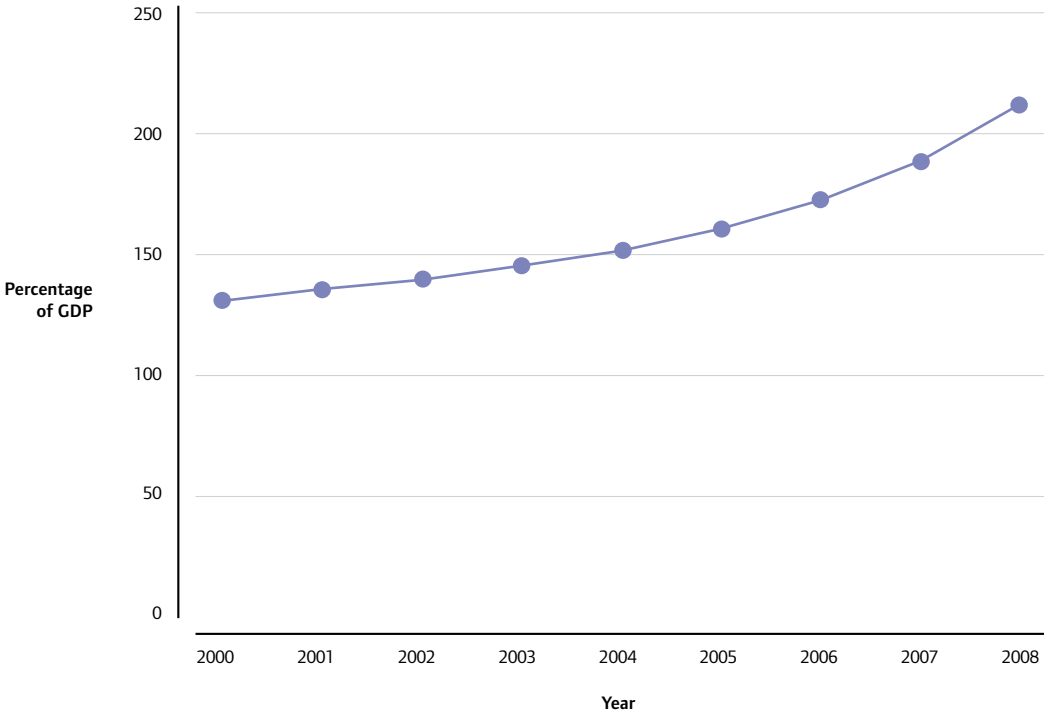
A key measure of the availability of credit is the ratio of credit towards the private sector from deposit taking financial institutions relative to GDP. Credit provided to the private sector (households and enterprises) includes loans, trade credits and other accounts receivable, that establish a claim for repayment.

Figure 51 shows that the flow of credit to the private sector in the UK (relative to GDP) has continued to expand in recent years. In 2008, the UK overtook US and Netherlands to take the top position in our table of comparator countries (Figure 52).

However, evidence from the Bank of England's lending survey indicates a tightening of credit conditions in 2008 and 2009. Lenders have significantly reduced the supply of credit due to concerns about the state of the economy and changing attitudes towards risk. This does not necessarily contradict the data presented in Figure 51. In 2008, both the UK GDP and flow of credit to the private sector shrank in absolute terms – the contraction in GDP was however more than the fall in outstanding credit.

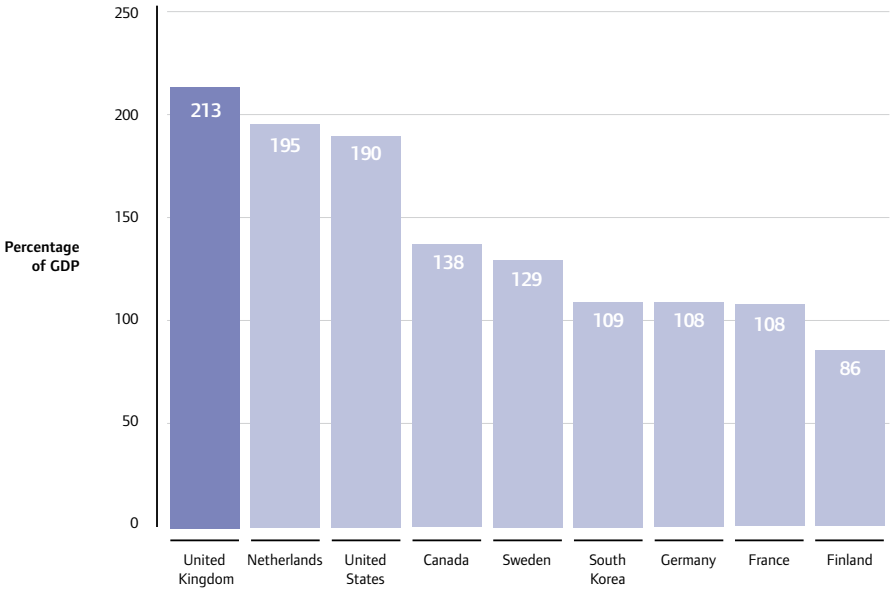
68. OECD (2004) 'Financing innovative SMEs in a global economy.' Paris: OECD; Levine, R. and Zervos, S. (1998) Capital Control Liberalization and Stock Market Development. 'World Development.' 26(7), pp.1169-83.
69. European Commission (2005) 'SME access to finance.' Flash Eurobarometer 174. Brussels: European Commission.
70. UK Survey of SME Finances 2007. Cambridge: Centre for Business Research.

Figure 51: Domestic credit to private sector (percentage of GDP), UK, 2000-2008



Source: World Bank, World Development Indicators (2008).

Figure 52: Domestic credit to private sector (percentage of GDP), 2008



Source: World Bank, World Development Indicators (2008).

Access to finance

33. Stock market capitalisation

Why is it significant?

Stock markets are essential for enabling companies to raise capital by selling securities to investors. Exchanges where such securities can be bought and sold provide investors with much needed liquidity. Therefore, well functioning stock exchanges are instrumental for the development of innovative companies because they can provide both fresh capital for their large-scale expansion and new product development and opportunity for the seed and early-stage investors to trade their stakes, realise capital gains (or losses), and ultimately redeploy their capital into new investment opportunities. The literature emphasises the role of stock markets in supporting the development of VC industries by providing attractive exit routes to investors.

What is its relative importance?

In the UK, the stock market plays a central role in financing investment, monitoring companies and reallocating corporate control (OECD 2004).[71] According to the literature, stock markets can be an important source of finance for funding R&D activity and overall the literature suggests that there is a positive relationship between stock markets and innovation.[72]

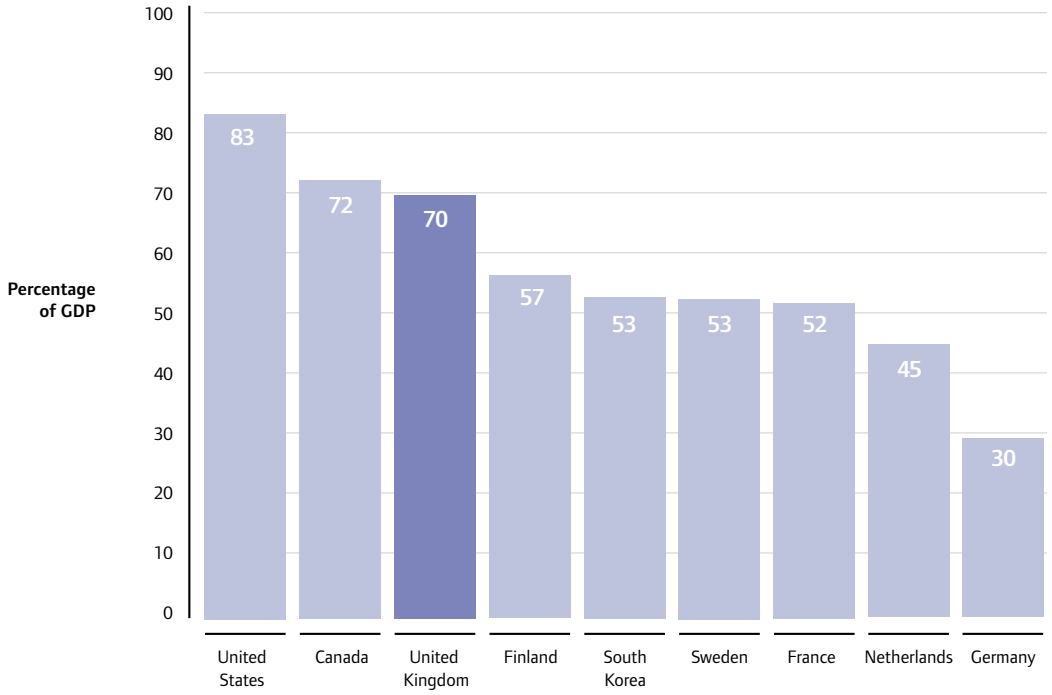
Standing of the UK

Both the size of stock market, as indicated by market capitalisation as a proportion of GDP, and market liquidity, as indicated by total value traded, illustrate the overall development of the stock market and the ease of exit.

UK equity markets are extremely strong. In our group of comparator countries, UK ranks third on stock market size (Figure 53) and second on liquidity (Figure 54) – having recently lost its leading position to the US. With a market capitalisation of GBP 1,288 billion the London Stock Exchange is one of the largest in the world (source: World Federation of Exchanges, 2008). Apart from it, which tends to focus on the needs of larger firms, the UK also has secondary markets, such as AIM and OFEX.

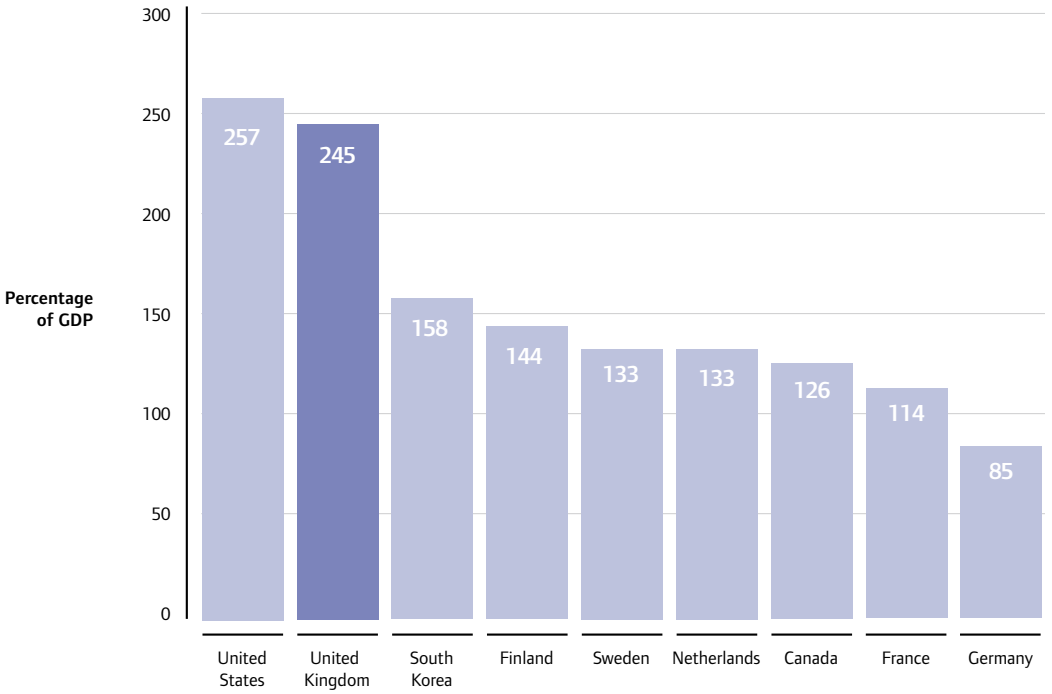
71. OECD (2004) 'Promoting Entrepreneurship and Innovative SMEs in a Global Economy: Towards a more Responsible and Inclusive Globalisation.' Paris: OECD.
72. Michelacci, C. and Suarez, J. (2004) Business creation and the stock market. 'Review of Economic Studies.' 71, pp.459Ð81; Brown, J.R., Fazzari, S.M. and Petersen, B.C. (2007) Financing Innovation and Growth: Cash Flow, External Equity and the 1990s R&D Boom.' 'Journal of Finance.' 64(1), pp.151-185.

Figure 53: Market capitalisation of listed companies (percentage of GDP), 2008



Source: World Development Indicators, World Bank (2008).

Figure 54: Total value of stocks traded ratio*, 2008



*This measure equals total value of shares traded on the stock market exchange divided by GDP.

Source: World Bank, World Development Indicators.

Access to finance

34. Availability of venture capital

Why is it significant?

Venture capital is regarded as an important source of equity funding for new, fast growing entrepreneurial companies because they require significant capital upfront to develop new products in advance of sales (Oakey, 1984).[73] Studies have shown that venture-backed firms are responsible for a disproportionate number of patents and new technologies and bring more radical innovations to market faster than lower-growth businesses that rely on other types of finance (Kortum and Lerner, 2000).[74] Venture capital investment in early-stage firms has been responsible for helping to create and grow many of today's most iconic global technology companies including Intel, Apple, eBay, Google and Genentech. High-growth, venture-backed firms are more likely to generate new industries. Examples include personal computers, cellular communications, microcomputer software, biotechnology, and overnight delivery (NESTA, 2009).[75]

73. Oakey R. (1984) 'High-Technology Small Firms: Innovation and Regional development in Britain and the United States.' New York: St. Martin's.
74. Kortum, S. and Lerner, J. (2000) Assessing the impact of venture capital on innovation. 'Rand Journal of Economics.' 31:4, pp.674-692.
75. NESTA (2009) 'Reshaping the UK economy.' London: NESTA.

What is its relative importance?

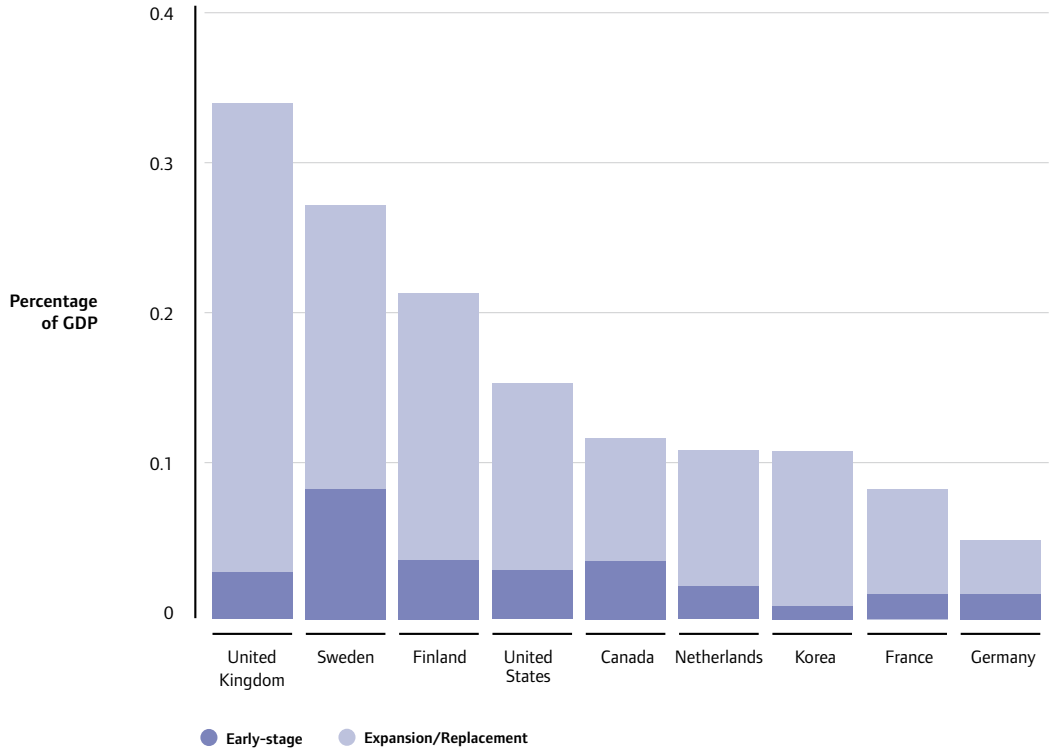
Venture capital is the most appropriate form of financing innovation, as it can provide investors with the potential profits that they deem are required to assume the risks involved – since innovation involves risk, this has to be reflected in the potential rewards for financiers.

Standing of the UK

While the UK is above other countries on venture capital investments measured as a percentage of GDP, it is below the other countries in venture capital investment in the important expansion stage in 2007. It ranks behind Sweden, Finland and the US in early-stage investments (upstream seed and start-ups) measured as a percentage of GDP (Figure 55).

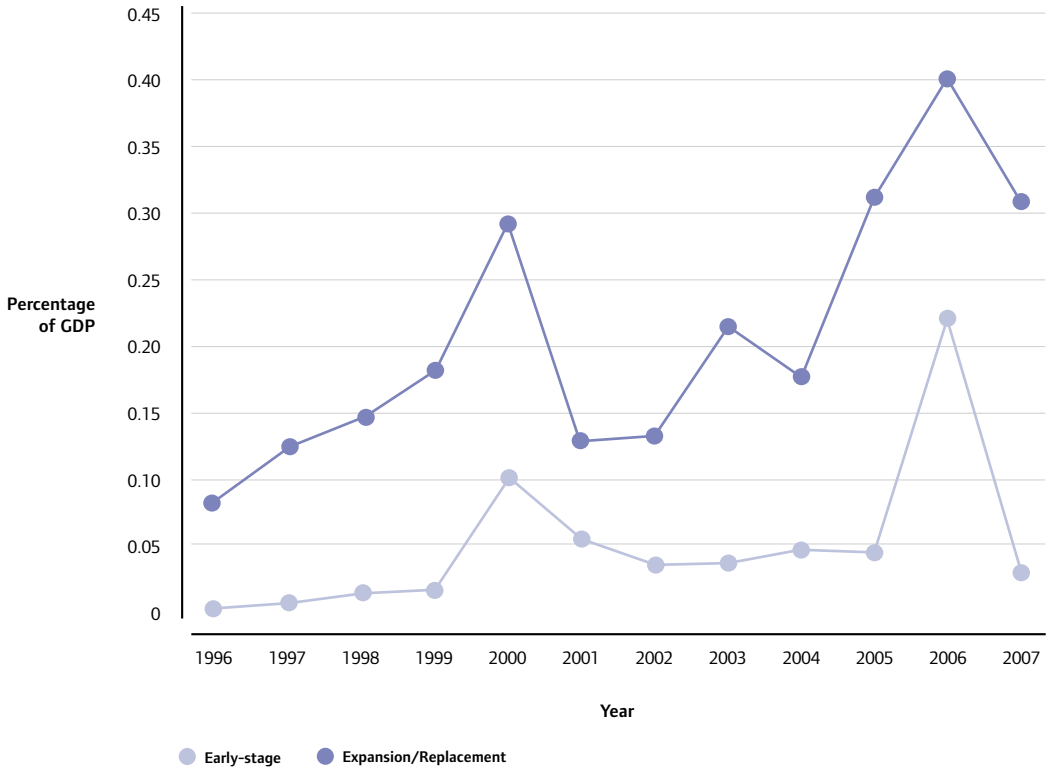
VC investments in the UK peaked in 2006 and have fallen sharply since. There is a noticeable shift in VC activity from early to later stages (Figure 56). This shift is more pronounced in the UK as compared to the other countries.

Figure 55: Venture capital investments as percentage of GDP, 2007



Source: Eurostat; for Korea, data is only available for 2003 (source: Nordic Innovation Monitor)

Figure 56: Venture capital investment as a percentage of UK GDP 1996-2007



Source: Eurostat

35. Access to finance

Why is it significant?

The presence of financial services per se as reflected by size and depth does not imply their accessibility by the different types of users within an economy. Accessibility, along with availability (size and depth of the financial system as a whole), has a significant effect on a country's real activity, economic growth and overall welfare (The Financial Development Report, 2008).[76]

What is its relative importance?

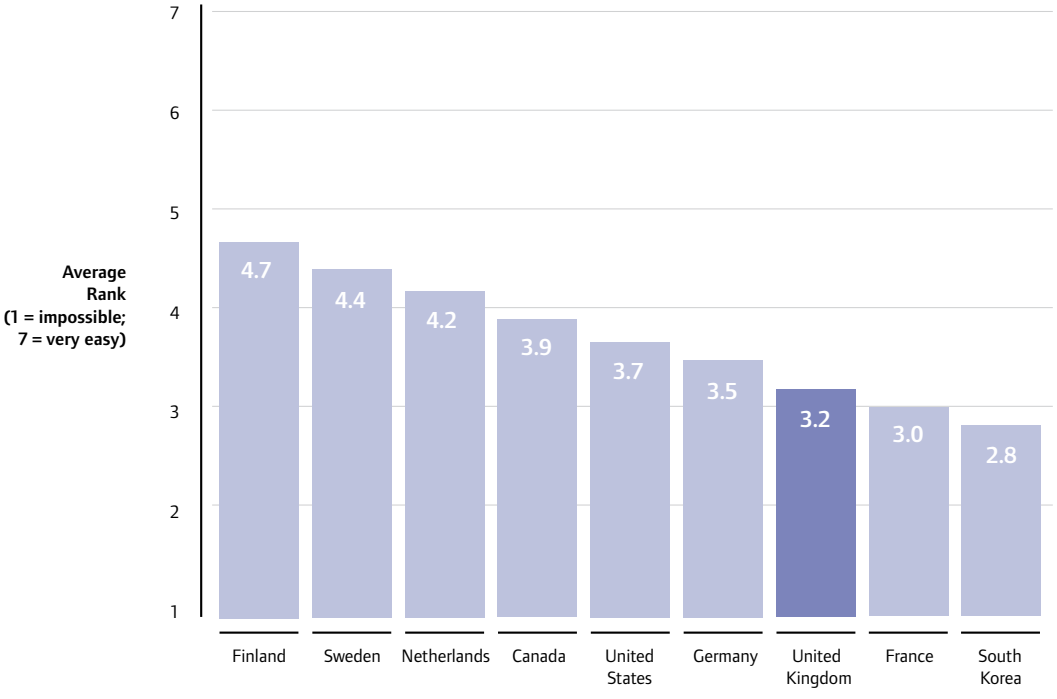
Survey evidence from the CIS demonstrates that innovation is often obstructed or abandoned due to lack of access to finance. At least 40 per cent of innovation active enterprises rated cost (47 per cent) and availability (40 per cent) of finance as a 'medium' to 'high' barrier to innovation.

Standing of the UK

The UK's relative position is less strong on indicators measuring 'access' (Figures 57-59). This implies that even though the UK has a very high ratio of financial assets to GDP (availability of finance), this has not translated into enhanced access for end users of capital within the country. The question as to why the UK is unable to translate relatively strong performance in areas such as venture capital or banking into ease of access to capital as assessed by businesses may be an important line of inquiry.

76. World Economic Forum (2008) 'The Financial Development Report 2008.' Geneva: World Economic Forum. Available at: http://www.weforum.org/pdf/financialdevelopmentreport/2008.pdf

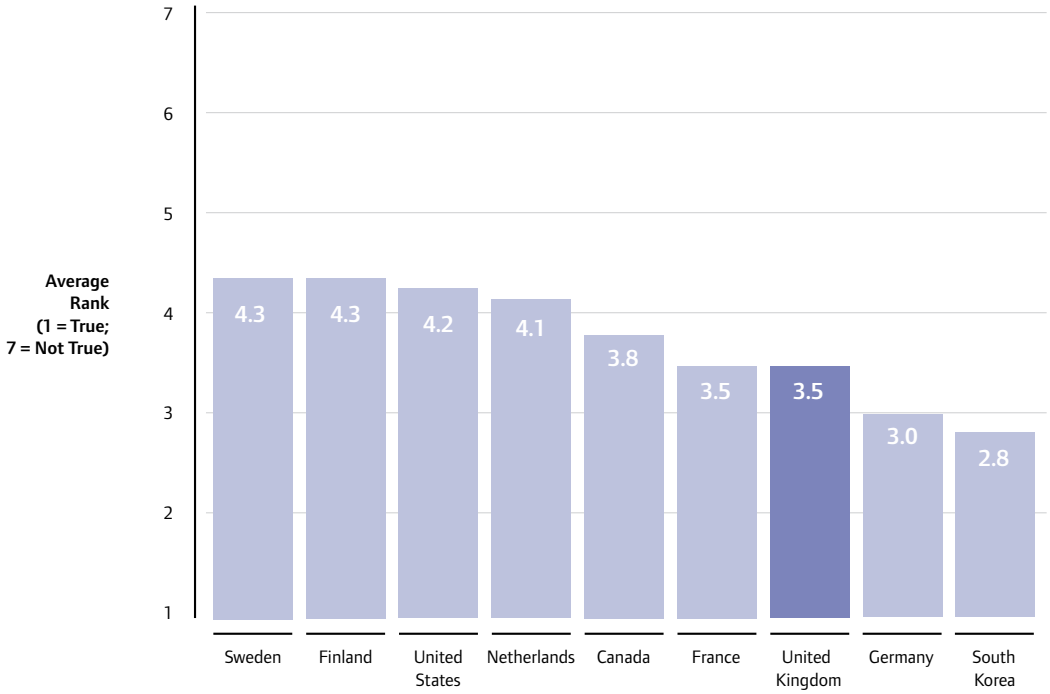
Figure 57: Ease of access to loans, 2009



Note: Averages; the indicator measures how easy is it to obtain a bank loan in a country with only a good business plan and no collateral (1 = impossible, 7 = easy)

Source: WEF, Global Competitiveness Report

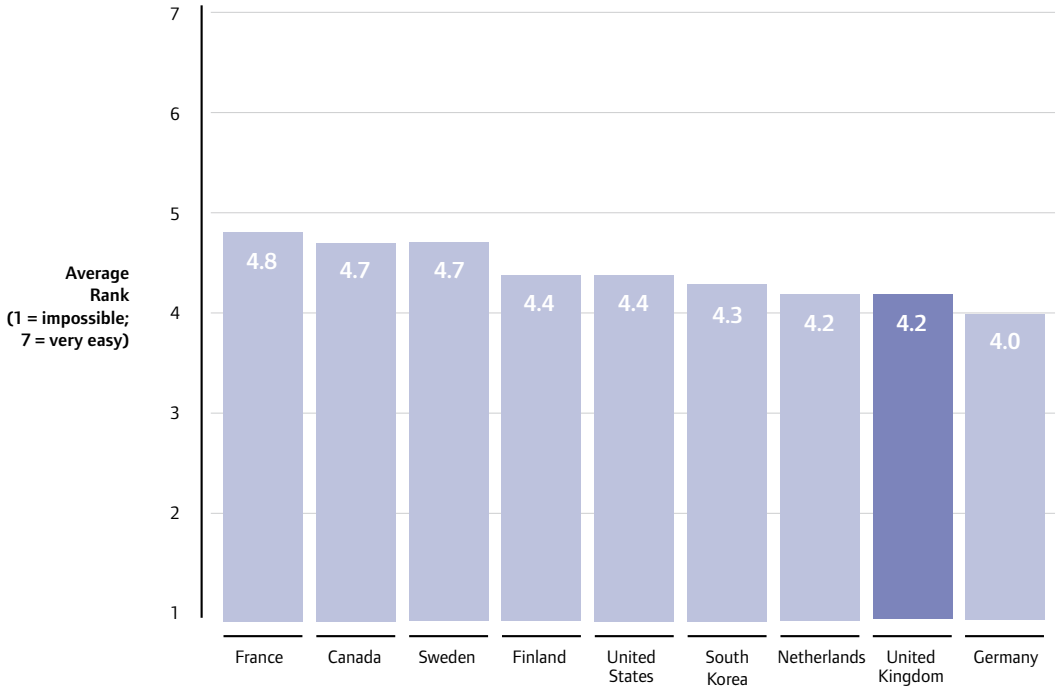
Figure 58: Venture capital availability, 2009



Note: Averages; the indicator measures the ease with which entrepreneurs with innovative but risky projects can find venture capital in a country (1 = not true, 7 = true)

Source: WEF, Global Competitiveness Report

Figure 59: Ease of access to local equity markets, 2009



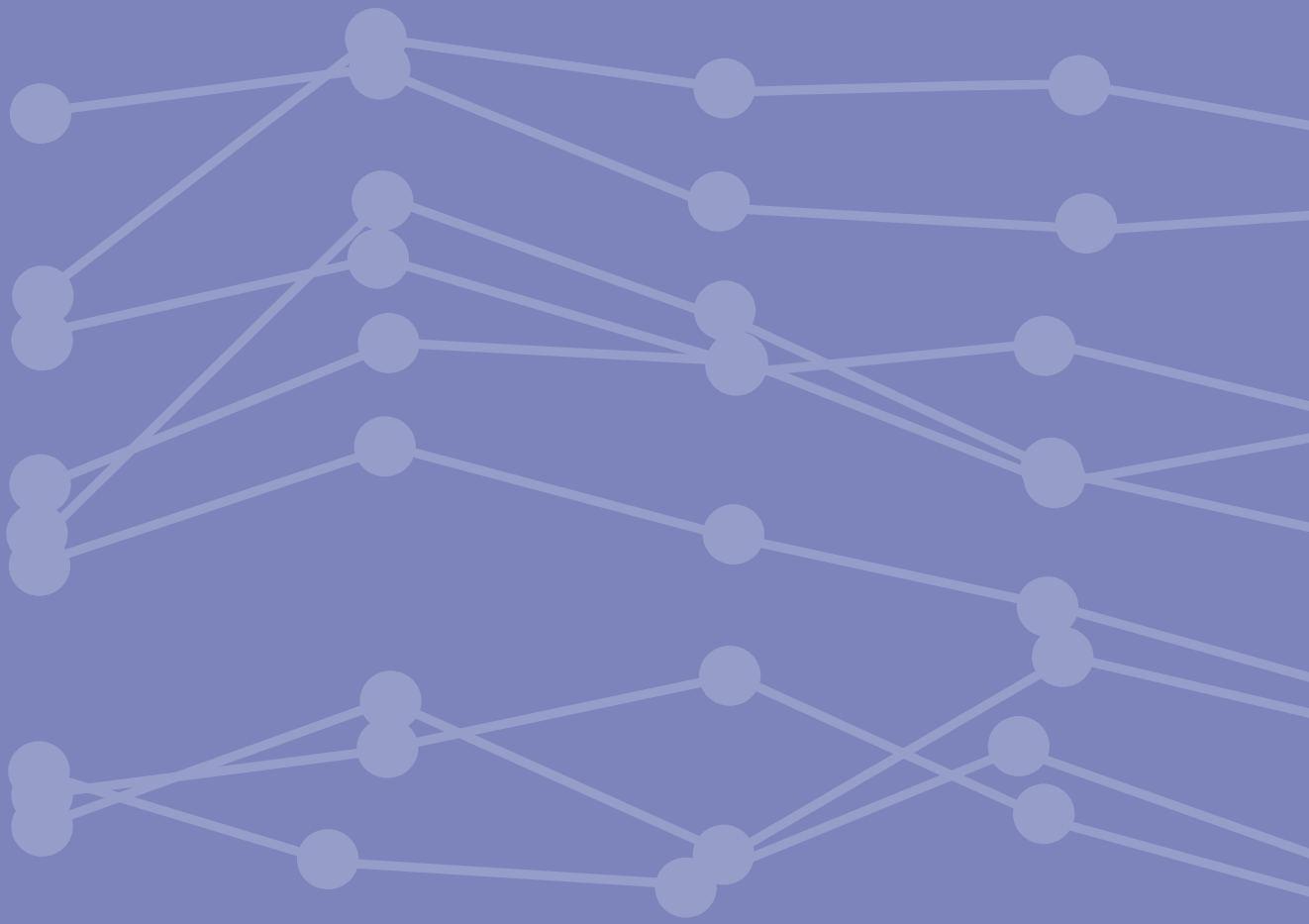
Note: Note: Averages; the indicator measures how easy it is to raise money by issuing shares on the stock market in a country is (1 = impossible, 7 = very easy)

Source: WEF, Global Competitiveness Report

Acknowledgements

This report is based on work undertaken by: Dr Nicholas Miles and Charu Wilkinson, GHK Consulting; Professor Dr Jakob Edler and Dr Mercedes Bleda, Manchester Institute of Innovation Research; Paul Simmonds and John Clark, Technopolis; together with additional analysis and commentary by NESTA.

NESTA Making Innovation Flourish



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