Department for Business Innovation & Skills

ANALYSIS

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Industrial Strategy Conference 2013: Securing Jobs and a Stronger Economy

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Contents

Foreword

A year ago, in the face of unprecedented economic conditions, the Government set out its vision for a new partnership with business: Industrial Strategy. The strategy included five core areas: sectors, technologies, access to finance, skills and procurement. The objective was for Government and industry to plan and work together for the long term to deal with genuine market failures in these areas, and build the confidence to invest.

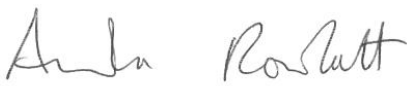
As part of the sector theme, the Government published an analytic paper that set out the value of taking a sector approach, alongside horizontal policy levers. The paper identified sectors with significant growth potential where joint government and industry action could achieve most value.

Since then, in conjunction with industry experts and other government analysts, we have reviewed the evidence for each sector. We considered future growth opportunities as well as barriers to growth, and reviewed the competitive environment in each sector. This approach ensured that each strategy is firmly evidence-based, and provides a clear view of the challenges that Government and industry need to tackle in partnership, if UK businesses of all sizes are to compete successful in domestic and overseas markets.

This new paper, published to coincide with the September 2013 Industrial Strategy Conference, brings together insights from analysis underpinning the sector strategies, focusing on the four themes of the conference – supply chains, innovation, skills and exports. It confirms that a sector approach may effectively complement more traditional horizontal measures. It identifies issues that are common across most or all of the sectors, but reminds us that there are also significant differences which will affect our policy response.

Finally, the paper incorporates the findings of new research undertaken to support a number of the strategies, including on nuclear and construction industry supply chains and developments in the information economy, and signals the need for continuing analytic work to support the implementation of the sector strategies over the coming months.

Amanda Rowlatt



Chief Analyst,
Department for Business, Innovation and Skills

1. Introduction

To invest and grow, business needs a good measure of policy certainty and a government that sticks to long-term plans to tackle economic weakness and instability. Accordingly, in September 2012 BIS Secretary of State Vince Cable announced a new industrial strategy setting out a more strategic and long-term approach.

The strategy included a particular sector focus and, in the year that followed, industry and government partnered to develop joint strategies for 11 sectors which are now being implemented and form a central part of the Government's growth strategy. Each of these strategies assesses how technologies, access to finance, skills and procurement can be used to develop the economic potential of particular sectors. As a result, action is being taken to address barriers to growth and make UK business more competitive across a range of key markets.

Progress on the new industrial strategy was marked by a conference in September 2013, at which stakeholders discussed how best to implement the joint plans of Government and business. Industry asked that the event focus further on how we can boost our efforts on supply chains, technology, skills development, and exports. This paper details the analytic insights developed from the sector strategies, which relate to the cross cutting issues discussed at the conference. Where appropriate we link the insights to existing analysis, but have not attempted to duplicate research already undertaken elsewhere.

Horizontal and sector support

Horizontal policies, such as those which support skills and technology development, have traditionally formed the bedrock of UK industrial strategy. Nevertheless, a sector-based approach continues to have an important policy role as a tool within industrial strategy. Economic conditions vary across markets and sector considerations give key insights into how to design and deliver horizontal policies more effectively.

In this vein, it is clear that the nature of supply and demand conditions shapes the competitive process in different ways across sectors, thereby influencing the structure of UK and global industries and their market potential. As such, sector considerations affect business incentives to invest in the key inputs of innovation and skills in different ways, which we unpack in this paper.

Similarly, the nature of industry supply also varies critically by sector. Our analysis takes a sector approach to shed light on the structure of the UK supply chain and how it has been affected by recent economic events, and assesses how future growth opportunities might vary by sector. This includes the potential to improve competition in the sectors and for UK firms to capture a larger share of supply chain business.

The last section of this paper sets out the potential growth opportunities of sector exports. Many UK businesses in these sectors compete in global markets, and economic opportunities are likely to shift away from developed markets towards developing and

emerging markets. Clearly there are strong links with the earlier sections of the paper in that the UK's performance on key enablers, particularly on innovation and skills, is likely to affect the extent to which the UK realises export growth opportunities.

Sector partnerships

The Government recognises that in a mature economy such as the UK it is important to work with stakeholders across a wide range of sectors. Within a spectrum approach government is, however, committed to building strategic partnerships with key sectors, and has given particular focus to developing business competitiveness in the following areas:

- advanced manufacturing, particularly aerospace including space, automotive, and life sciences including agri-tech;
- knowledge-intensive traded services, particularly professional/business services, the information economy and traded aspects of education;
- enabling industries such as energy (oil and gas, nuclear and offshore wind) and construction.

These are all sectors where societal drivers indicate there is likely to be significant increasing domestic and global demand; where UK business has the potential knowledge and skills to exploit new market opportunities (i.e. the UK has a comparative advantage in global markets in virtually all these areas); and, importantly, areas where a sector-based approach has a clear role. Further detail on the basis for choosing these sectors was set out in earlier analytic work[1].

In direct terms, the sectors cover over a third of the economy and support around 11m jobs (see Annex). In practice, their reach is much wider as some sectors, such as the information economy, are enabling sectors which support growth across a large part of the economy, whilst other areas such as those in advanced manufacturing sectors generate significant pull through of key goods and services elsewhere.

Looking ahead, there is clearly a great deal of uncertainty about precise growth rates in different sectors. However, a consideration of economic and societal drivers – such as rising per capita incomes in emerging economies, increasing demand for environmental products and demographic and lifestyle changes[2] – suggests that the areas of sector partnership are all likely to be subject to increasing domestic and global demand.

[1] For further details see BIS Economics Paper No. 18, *Industrial Strategy: UK Sector Analysis*, September 2012.
[2] Ibid.

Effective competition

A key principle in the Government's approach to industrial strategy involves a continuing commitment to open and competitive markets. Effective competition at sector level is essential for providing the right incentives for new businesses to grow and for firms to become more innovative. It reduces allocative inefficiency and helps ensure the most productive firms gain market share. More significantly, it enhances long-run dynamic efficiency, promoting innovation across sectors and increasing choice and quality for consumers.

Our analytic work paid close attention to the operation of competition in the sectors, assessing the state of the various markets, and scope for policy to reduce barriers to entry and incumbency advantage. A range of sector-specific factors relating to competition intensity were identified, which are now being taken forward in the strategies. For example, there are measures to improve the competitive position of firms at various stages in supply chains; a push to use the expertise of UKTI to promote brand recognition of less well known institutions in education exports; and the use of procurement policy to break up contracts and allow more small firms to compete effectively for offshore wind contracts.

There are therefore a range of measures being implemented which affect the way the government interacts in markets through procurement and other policy instruments. Industry is also active in, for example, the process of developing measures to encourage greater co-ordination and a more strategic approach to skills development which will have a key affect on the ability of a wider group of firms, including SMEs, to compete effectively.

2. Supply Chains

Summary

For most UK manufacturing and services, much of the demand for goods and services is sourced domestically. However, for higher-tech manufacturing and certain **knowledge services** such as R&D, a higher share is from imports. For example, some UK **manufacturing** sectors are highly integrated into global supply chains with foreign businesses accounting for around 20-30% of the value added in UK exports. This may partly reflect the greater influence of globalisation where activities have been moved to locations where they can be produced most cost-effectively.

Supply chains tend to be structured in different ways depending on the sector they support. In sectors such as oil and gas, a high degree of vertical integration takes place along the value chain where, for example, there is value in closely managing transaction costs and risks to ensure continuous supply. At the other extreme, sectors such as **construction** display a high level of fragmentation reflecting high levels of specialisation and risk transfer.

Supply chains are dynamic and changes in relative costs and assessments of risk have led to a re-evaluation of their structures by a number of companies with for example new models of collaboration between UK OEMs and suppliers. Such developments indicate opportunities for UK-based businesses to capture a larger share of supply chain business as businesses reappraise risks, low cost locations become more expensive, and firms in high cost locations develop business models based around flexibility and collaboration. A recent study by Oxford Economics and Atkins, commissioned by BIS, suggests that the UK **nuclear** supply chain has the capacity to capture over 40% of the value of a new reactor which could rise to about 60% with wider policy intervention and industry involvement.

But the extent to which the UK can capture some of the value will depend on businesses' ability to improve key capabilities, through investment in innovation and skills. Moreover, the Advanced Manufacturing Supply Chain Initiative (AMSCI) is the Government's key tool for fostering collaboration and supporting innovation within the supply chain and is a key policy for delivering the Industrial Strategy.

This chapter:

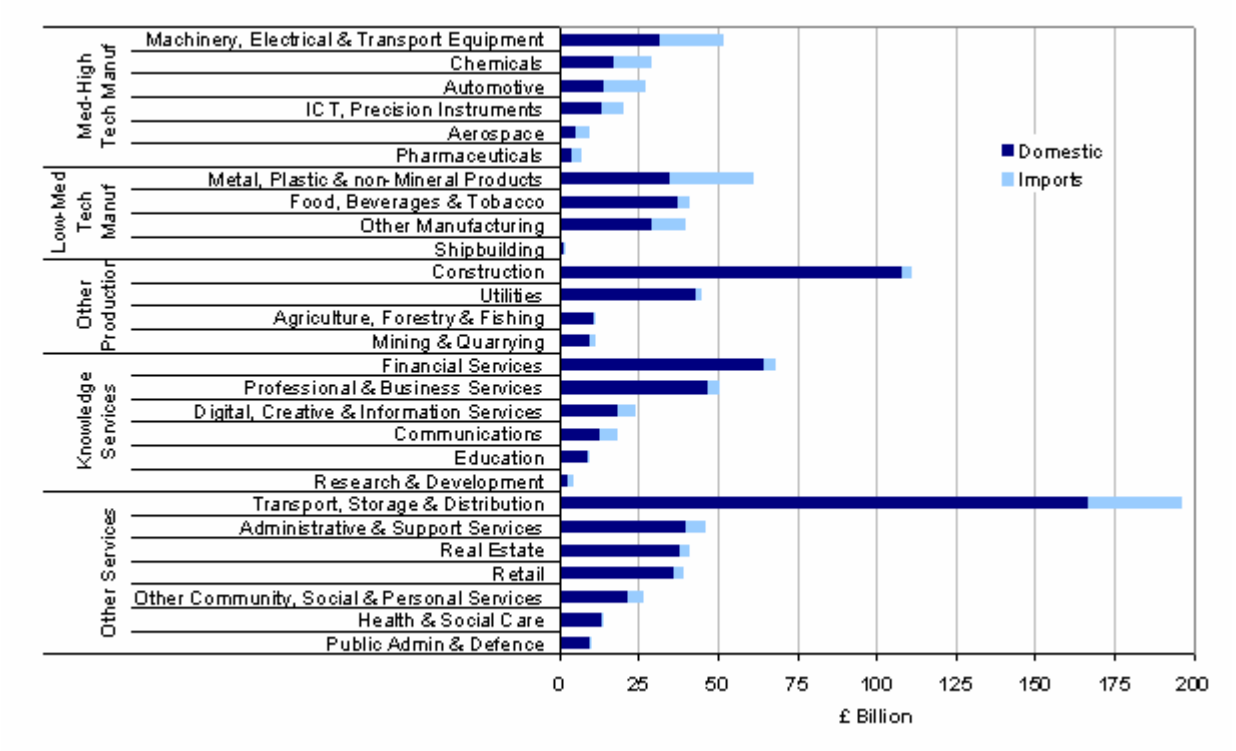
- Sets out the contribution domestic and overseas supply chains make to UK production;
- Considers why supply chains are structured in the way they are; and
- Looks at recent trends and drivers.

Economic importance of supply chains

Supply chains are a network of firms involved in the production and delivery of a specific product or service and may cut across a wide-range of manufacturing and service sectors.

For example, in the automotive sector the assembly of a particular vehicle will involve the procurement of products from manufacturing industries such as the chemicals, rubber and plastics, electronics, textiles, metals and non-metals sectors. It may also entail the procurement of relevant services such as design engineering services.

Figure 2.1: Supply chains - Intermediate consumption by sector (2005)



Source: BIS analysis of the ONS supply use data

The total spend by one sector on goods and services produced by another sector is referred to as intermediate consumption. Figure 2.1 sets out which sectors are the main sources of intermediate consumption of goods and services produced elsewhere in the economy. It shows, for example, that the transport, storage and distribution and construction sectors together accounted for a third (or about £275 billion) of total domestic intermediate consumption in 2005.

Such findings are reinforced by recent analysis of the OECD/WTO Trade in Value Added (TiVA) data[3] which shows that the share of foreign content in value added UK service exports is relatively low - at 7.9% for financial services and 5.7% for business services[4]. This indicates that like France, Germany and the US, UK service activities are relatively less reliant on global supply chains, partly due to the face-to-face nature of many of these activities, which limits opportunities for sourcing overseas. On the other hand, the share of foreign content in the value added of UK exports in transport equipment (e.g. aerospace and automotive), chemicals and machinery and equipment is relatively high (about 20-

[3] For summary of findings see OECD (May 2013) *Interconnected Economies: Benefiting from Global Value Chains*.

[4] Based on 2009 data.

30%). This shows that these sectors are highly integrated into global supply chains and more dependent on imported parts and components. Overall, the OECD study finds that both France and Germany are more integrated into the global supply chain than the UK.

Supply chain structures

Supply chains tend to be structured in different ways depending on the sector they support as they fulfil specific sector requirements. Knowledge of how businesses within a particular sector develop and manage their supply chains and their underpinning drivers is important when assessing economic impacts and sector performance. It is also important to our understanding of barriers that may inhibit UK growth and competitiveness.

Businesses have to consider a number of critical factors when deciding how to set up and manage their own supply chains and what degree of integration to adopt. These factors typically include: set-up costs, transaction costs, transaction risks and coordination effectiveness (see Table 2.1). However, these factors are often at odds with each other which makes management and supply chain optimisation highly complex.

Table 2.1: Criteria for supply chain integration decisions

Set-up costs	Transaction costs	Transaction risks	Coordination effectiveness
Cost of capital	Information collection & processing	Price volatility	Inventory levels
Systems development	Legal	Supply or outlet foreclosure; lead times	Capacity utilisation
Training	Sales & purchasing	Insulation of market from technical changes, new products etc.	Delivery and logistics, performance & quality

Source: McKinsey (1993) *When and when not to vertically integrate*

Supply chain structures, and the location of suppliers, are driven by industry perceptions of the costs, potential risk and benefits associated with different designs (Box 2.1). For example:

- **Vertical integration** is an extreme form of supply chain management and involves merging businesses that are at different stages of the value chain. Vertical integration could typically reduce some risks and transaction costs but it can involve high set-up costs and its co-ordination effectiveness may be ambiguous. This form of supply chain may be optimal for sectors where the management of transaction costs and risks is a priority to ensure continuous supply and meet certain demand (historically important in oil and gas), but less so when a large number of specialist products or multiple services are required which are highly project specific (as is often the case in **construction**).

- Businesses may also decide to **integrate horizontally**, that is, to acquire additional business activity at the same level of the value chain in a similar or different industry. According to a recent survey by KPMG (2013), nearly a third of manufacturing businesses surveyed said that they were planning mergers or acquisitions to capitalise on opportunities in new markets[5]. However, due to the scale of acquisition and restructuring costs, this form of integration may be only available to larger firms.

- Other forms of supply chain relationship include **long-term contracts**, **joint ventures**, **strategic alliances**, **technology licences** and **asset ownership** or **franchising**. These tend to involve lower capital costs and enable greater flexibility than full integration. Companies may instead choose to collaborate with their networks and increase sub-contracting to respond to project-specific requirements and changing customer needs.

Box 2.1: Forms of supply chain integration

(i) Vertical integration: Oil and gas sector

Companies in the oil and gas sector, such as BP and Statoil, often adopt a vertically integrated structure. This means that they are active along the entire supply chain from locating deposits, drilling and extracting crude oil, transporting it around the world, refining it into petroleum products such as petrol and distributing the fuel to company-owned retail stations, for sale to consumers.

(ii) Horizontal integration: Professional Business Services

Changes in technology, especially ICT, and the demands customers place on it mean that companies in the PBS sector are revising their business models. Increasingly firms have to offer a range of services to their clients, rather than specialising, which leads to horizontal integration.

(iii) Quasi integration: Life Sciences and Construction sector

In Life Sciences, supply chain leaders seek to streamline the network structure and use external suppliers where possible[6]. For example, Contract Research Organisations (CROs) are increasingly used for outsourcing of clinical trials. CROs now account for over 40% of annual research spending by pharmaceutical firms, compared to 4% in the early 1990s[7].

The UK construction sector is well known for its high level of fragmentation. SMEs account for over 99.9%[8] of UK construction contracting businesses. High proportions of SMEs reflect high levels of specialisation and risk transfer. A large number of small firms enable the industry as a whole to cope with variations in workload. However, a high level of sub-contracting has been traditionally at the root of low industry integration. For a typical large building project of £20- £25

[5] Source: KPMG (May 2013) *Global Manufacturing Outlook – Competitive advantage: enhancing supply chain networks for efficiency and innovation.*

[6] Source: The Boston Consulting Group (May 2013) *Rethinking the Pharma Supply Chain.*

[7] Source: BIS (2010) *Life Sciences in the UK*; BIS Economics Paper No. 2.

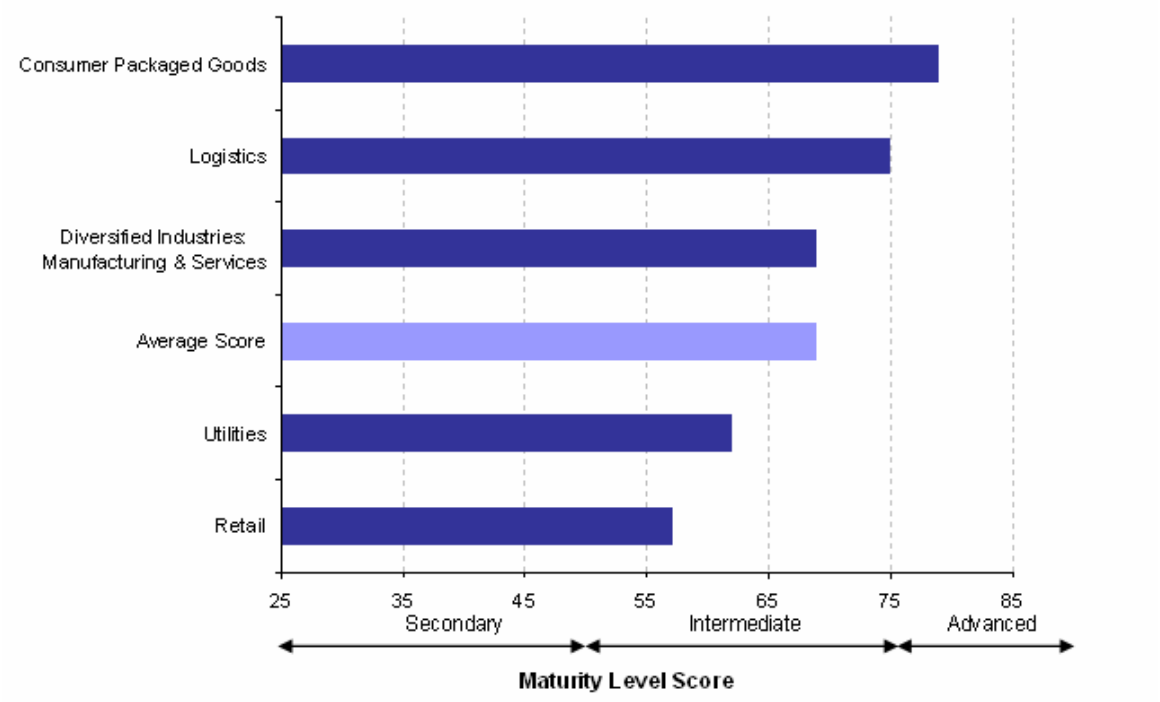
[8] Source: BIS Business Population Estimates for the UK and Regions (2012).

million, the main contractor may be directly managing around 70 sub-contracts, mostly of £50,000 or less. However, research shows that more contractors now integrate building services into their portfolio, replacing the need for a specialist mechanical and electrical contractor[9].

Sectors differ in the strength and depth of supply chain relationships. For example, a study on supply chain maturity by KPMG (2011) shows that the Consumer Packaged Goods (CPG) sector has the highest level of supply chain maturity and development among the sectors studied (see Figure 2.2)[10]. The CPG's strength in management of their supplier base is largely an outcome of their need to work closely with their suppliers to effectively meet customer needs. The CPG has a strong mix of in-house and outsourced logistics functions, which allowed many CPG organisations to retain overall accountability and control of their supply chain.

Although the study does not provide detailed analysis by all sectors, it shows that manufacturing and services are in line with the average for all sectors studied and have an intermediate supply chain maturity level. **Manufacturing** and **service businesses** score highly on customer relation management (reflecting their need to respond to customer needs and changing trends) and cost performance measures (particularly on cost visibility) but lag behind the CPG sector in supplier relation management and logistics.

Figure 2.2: Average Supply Chain maturity and development score by sector



Source: KPMG (May 2011)

Supply chains take time to evolve. In the case of emerging sectors or where there are paradigm shifts in technology, companies may face barriers to building supply chains –

[9] Source: EC Harris (2013) for BIS (forthcoming).

[10] Source: KPMG (May 2011) *Supply Chain Complexity: Managing Constant Change.*

leading to a constrained supply of key products and components, whilst on the other hand potential suppliers find it difficult to access new markets and sectors they have not supplied to previously (Box 2.2).

Box 2.2: Emerging supply chains

Offshore wind sector

The supply chain for the Offshore Wind sector is highly concentrated and shortages in certain supply chain areas have resulted in many companies revising their sourcing strategies. For example, two suppliers – Winergy (owned by Siemens) and Hansen (owned by Suzlon) – accounted for 70% of the market for gearboxes[11] in 2009. Recent gearbox supply shortages caused turbine manufacturers to re-evaluate potential sourcing strategies for key components, including the options for producing some of these in-house, in order to place greater certainty on supply[12].

On the other hand, many potential suppliers and SMEs who would want to supply to larger manufacturers and developers find it difficult to enter the market due to large costs and the OEM and Tier 1 firms' apparent preference for dealing with existing providers rather than new entrants.

Recent trends

Supply chains are dynamic and tend to transform as business perceptions of costs and benefits change. Recent events have led to a re-evaluation of supply chains by major companies, for example:

- **Risks are being reappraised:** While the risk of supplier failure has always been a key factor, supply chains are now facing new and increasingly volatile risk driven by the state of the global economy. Exchange rates are turbulent, borrowing costs have risen and bankruptcies by both customer and suppliers have left gaps in supply networks[13].

- **Locations previously seen as low cost are becoming more expensive**[14]. In traditionally more expensive locations, **new models of cooperation and collaboration between** OEMs and the value chain (see Box 2.3) have helped to optimise processes and further reduce costs:

[11] Source: Douglas-Westwood (2009).

[12] Source: Emerging Energy Research (2009).

[13] Source: KPMG (May 2011).

[14] For example, according to a recent study by the OECD *China Investment Policy 2013/01* investors are becoming more concerned about the rising costs in China, even though the picture for China is still very positive. The AlixPartners 2011 U.S. Manufacturing-Outsourcing Cost Index also shows that Mexico had the lowest landed costs for U.S. customers while other key low-cost countries, including India, Vietnam, and Russia, had higher costs but remained more competitive than China.

  - More integrated and collaborative supply chains can lead to more accurate forecasting, lower levels of working capital and the ability to quickly respond to the needs of the business.

  - New distribution models and increased competition from online rivals have forced manufacturers and retailers to become more responsive to the needs of their customers and seek new levels of flexibility in their supply chain. More flexible arrangements are therefore in some cases superseding dependence on a limited number of well-established providers, which may have long lead times and limited offerings.

- At the same time **new sustainability and regulatory requirements** have added new complexities to global supply chains. Supply chain operations are increasingly being impacted by developments and regulations outside the UK.

Box 2.3: New models of collaboration

Aerospace sector

The National Aerospace Technology Exploitation Programme (NATEP), designed by industry through the Aerospace Growth Partnership, will help small and mid-sized supply chain companies to develop innovative technologies, and thereby increase their ability to win new business with higher tier companies anywhere in the world. The £40 million scheme, supported with £23 million from the Advanced Manufacturing Supply Chain Initiative (AMSCI) and £17 million from industrial partners, aims to support the development of at least 100 new technologies in the aerospace supply chain.

High Performance Computing

High Performance Computing (HPC) can significantly improve knowledge-sharing and enable new ways of collaboration between businesses, suppliers and researchers. A recently launched N8 HPC Centre provides eight Northern Universities and industry with access to one of the UK's most powerful computers and will create opportunities for more effective collaboration with businesses. The centre operates Polaris, one of the 250 most powerful computers in the world that is capable of 110 trillion operations per second – equivalent to about half a million iPads. The centre enables academics and businesses to build more realistic models with large amounts of data and to undertake complex analyses in Life Sciences, energy, digital media, aerospace and other fields.

Advanced Manufacturing Supply Chain Initiative (AMSCI)

Launched in March 2012, AMSCI seeks to improve the global competitiveness of UK manufacturing supply chains by fostering collaboration and supporting innovative projects where the UK is well placed to take a global lead. The evidence shows that AMSCI is starting to make a positive impact on supply chain performance. Successful bids from AMSCI rounds 1 and 2 were appraised to have likely benefit-cost ratios ranging from between 2 and 25:1 and are projected to create or safeguard over 18,700 jobs.

Increased partnership and closer collaborative working between OEMs and suppliers has helped optimise processes and reduce costs over the last few years. There is, however, a potential for even greater economic gains driven by more effective collaboration and supply chain management, transparency and visibility from technology-enabled demand-driven supply chains. For example:

- **Greater use of partnering activity**. Half of the respondents from the KPMG survey (2013) said that partnerships, rather than in-house activity, would be key to their future innovation activity as partners become a source of new ideas. For example, companies such as Sainsbury's and Walkers in the food and drink industry work closely with their **agri-tech** suppliers to optimise their supply chains through the adoption of technology and investment in R&D.

- **Increased transparency** across supply chains helps foster better and faster communication and collaboration between partners. Many businesses could improve their performance and resilience to shocks by improving visibility across their supply chain network[15]. For example, in the **automotive** sector suppliers often do not know who to contact as prospective customers, while customers tend to be unaware of potential UK-based suppliers. This is particularly evident between UK SMEs and UK subsidiaries of global Tier 1 suppliers to vehicle makers.

- **Many global manufacturers are looking to source closer to home** or in more easily managed units. A majority of respondents from the five biggest economies where the KPMG survey (2013) was conducted said they expected to increase sourcing from their home country over the next two years. Almost all of these respondents expect R&D and product development to be carried out at home. Some 58% of respondents said that they would regionalise / localise supply chains to improve management of their supply chain risk[16]. Management of risk could be related to cost, quality or risk of climate change and sustainability. Businesses may also prioritise close proximity to suppliers to innovate and develop products in an iterative way to improve quality and be able to respond to customer needs quickly.

- **Manufacturers increase their proximity to local markets**. In addition, about 55% of businesses said they would diversify their manufacturing locations. However, the success in foreign markets requires long-term local relationships, a deep understanding of customer demand on the ground, and a market-savvy approach to regulatory and legal compliance.

- **Early supplier engagement** could further improve performance and reduce waste and costs. A recent study for BIS on supply chains in **construction**[17] showed that earlier and more extensive engagement of subcontractors was seen as a very positive step towards overall project performance and delivery which could come,

[15] According to the KPMG survey nearly half of companies said they lacked visibility beyond their Tier 1 partners. Only 9% of businesses said they could assess the impact of supply chain disruptions within hours.

[16] Source: KPMG (May 2013) *Global Manufacturing Outlook – Competitive advantage: enhancing supply chain networks for efficiency and innovation.*

[17] Source: EC Harris (2013) for BIS (forthcoming).

for example, from the avoidance of duplicated effort, adoption of value engineering ideas, improved coordination and the reduction of the number of design changes.

- **Enhanced supply chain management** could improve competitiveness and overall performance. The same EC Harris supply chain study for construction identified that further investment in the development of the quality of site management, skills development, career paths and technical and people management capability are necessary to optimise performance in **construction**.

- **Redesigning contracts** to allow greater risk sharing. If structured properly, such arrangements may encourage all businesses in the supply chain to quickly identify potential risks before they occur and take action to protect the viability of the supply network. Dynamic contracts can also be used to encourage service providers to deliver more innovative solutions to both manage risk and drive competitive advantage. For example, the research shows that in the **construction** sector contracts and procurement practices can have a key impact on early supplier engagement and project costs[18].

- **More competitive, flexible and transparent procurement** models can enable small and medium businesses to win contracts and ensure value for money for a taxpayer. For example, the recently set up **G-Cloud** programme is simplifying processes and creating a competitive marketplace, supported by a 'Cloud First' policy for central Government. This makes it easier for SMEs to supply to Government, demonstrated by the fact that SMEs have taken over 60 per cent of G-Cloud sales to date, which included among others a new correspondence contract awarded to a London based SME set to save BIS around £500,000 on current costs.

A key issue for growth is therefore whether demand can be cost effectively met by domestic suppliers compared to those based overseas. For most of manufacturing and services, much of the demand for goods and services is sourced domestically. However, for higher-tech manufacturing and certain knowledge services such as R&D – a high share is from imports. This may reflect the greater influence of globalisation where certain activities in the value chain have been moved to locations where they can be produced most cost-effectively. It may also suggest opportunities for the UK to re-capture some of that value. This could be achieved through better and more transparent procurement practices and enhanced process efficiency. Importantly, companies can also improve capabilities through investment in innovation and skills - Box 2.4 gives some sector-specific examples – and these issues are the focus of the next two chapters.

[18] Source: EC Harris (2013) for BIS (forthcoming).

Box 2.4: Potential economic gains from strengthening supply chains

Automotive sector

The analysis suggests that an extra £3 billion of total UK purchases per annum could be realised if the UK automotive supply chain is strengthened[19]. At present the UK sources around 40% of motor vehicle components domestically, whereas France and Germany source over 60% domestically. The UK is relatively weak in supplying intermediate components to other countries, both to major car producers and in sales of automotive products of final consumption.

Nuclear sector

According to a recent study by Oxford Economics and Atkins (2013) commissioned by BIS to inform its sector strategies, the UK supply chain supporting the nuclear sector has currently the capacity to capture about 44% (or £2.9 billion) of the total value of a new 1.65 GW nuclear reactor. However, with wider policy intervention and greater industry involvement this could increase to about 60% or £4.2 billion by 2030. For a 16.5GW reactor the direct impacts are estimated at £11.4 billion under current capabilities or £15.2 billion with supply chain improvements.

[19] Source: BIS (August 2012) *Growing the UK automotive supply chain: the road forward – 2012 update.*

3. Innovation

Summary

Innovation is a significant driver of economic growth and accounts for around a half of all labour productivity growth. Its relationship with growth is not, however, straightforward. Successful economies create innovation systems that encourage learning by doing, networking and collaboration supported by a stable and certain institutional framework.

In addition, economies that embrace General Purpose Technologies– for example the "eight great technologies"[20] – are likely to be more resilient and generate opportunities for new firms to challenge incumbents, and in doing so aid the process whereby more efficient firms and technologies replace the less efficient.

The analysis from the sector strategies suggests that:

In a number of sectors networking and collaboration has suffered which has limited the scope for learning by doing and the economic benefits that arise from it. Particular examples include the loss of applied R&D facilities in **agri-tech** and high levels of industry fragmentation in **construction**. In the case of the former, public investment in the Agri-Tech Catalyst and Centres for Agricultural Innovation will help commercialise agricultural technologies.

The **Information Economy** sector is a potentially rich source of general purpose technologies, particularly in the areas of data science, the "internet of things" and cloud computing. These will have a significant impact on the delivery of **Professional and Business services**. Other opportunities exist too, such as the potential for massive online open courses (MOOCs) to radically change **education** delivery, or haptic technology which allows manual skills to be practised virtually. The latter potentially has a very wide application across all sectors. The eight great technologies also include new advanced materials – important for **aerospace,** for example, robotics and synthetic biology.

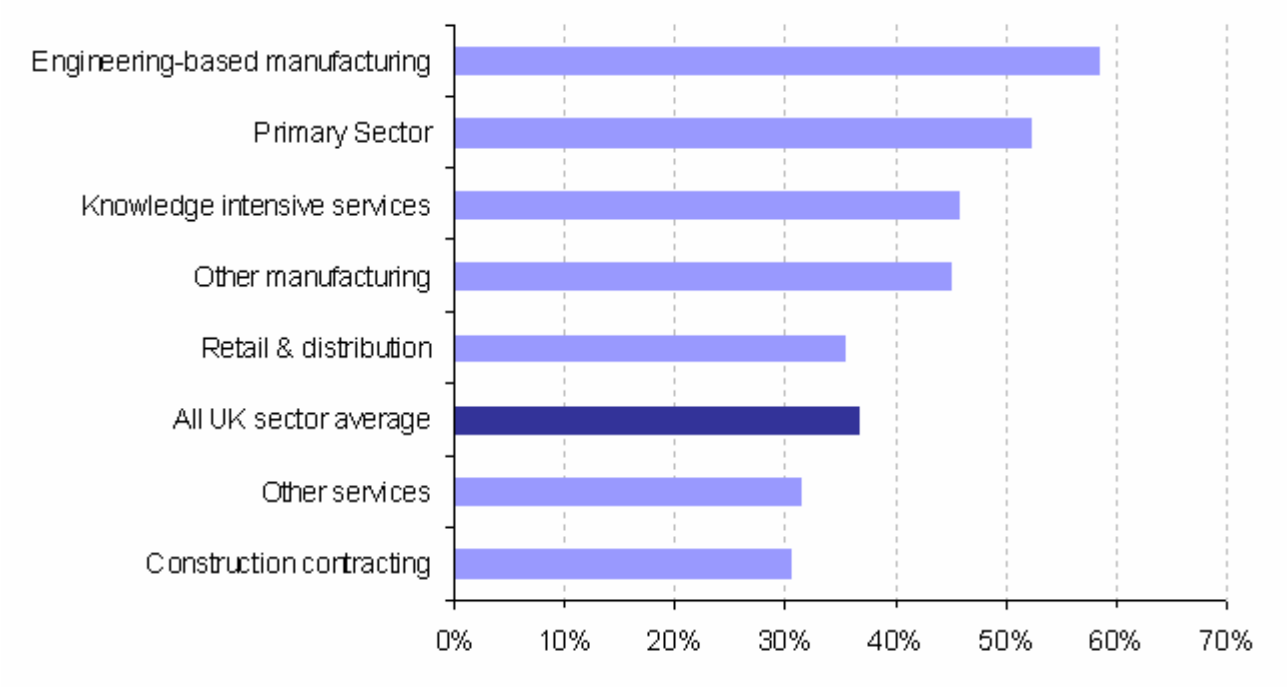
A stable and certain institutional framework is required for investment in long-lived assets with high up front costs. This is particularly the case for sectors like **Nuclear** and **Offshore wind** which rely on a predictable carbon price regime. It also applies to automotive where a transition to low carbon propulsion systems is required, which will also require the capture of additional inward R&D investment. In oil and gas, investments in technology and a stable tax regime are required to increase **oil and gas** recovery rates in the North Sea. The establishment of the Aerospace Technology Institute and the Advanced Propulsion Centre will increase the level, and certainty, of funding for R&D in advanced manufacturing.

[20] General Purpose Technologies are technologies that have the ability to affect an entire economy, for example the internet or electricity. The "eight great technologies" were identified by David Willetts, Minister for Universities and Science. More information is provided in Policy Exchange (2013): http://www.policyexchange.org.uk/images/publications/eight%20great%20technologies.pdf

Innovation is a significant driver of economic growth and when you consider wider measures which go beyond investments in technology alone, innovation accounts for around a half of all labour productivity growth[21]. It also delivers significant benefits which are not recorded in national statistics. For example, innovations which reduce pollution or emissions will generate benefits which may not be recorded in market transactions.

All sectors contain innovative firms (Figure 3.1) but rates of innovation differ. This will, in part, reflect differences in demand – sectors that need to meet sophisticated demands will face greater pressure to upgrade products and services. Sectors also innovate in different ways and draw upon different sources of inputs (Table 3.1). For example even within manufacturing there is a difference between those sub-sectors that rely on developing new technologies by investing in R&D and those that rely on incorporating innovative technologies developed elsewhere.

Figure 3.1: Proportion of innovation active enterprises by broad sector (2008-10)



Source: BIS Community Innovation Survey 2011

[21] Source: BIS (2012) Annual Innovation Report 2012.

Table 3.1: Breakdown of innovation expenditure by sector as a proportion of total expenditure (2010)

	Primary sector	Engineering based Manufacturing	Other Manufacturing	Construction	Retain & distribution	Knowledge-intensive services	Other services
Internal R&D	19.1	75.6	17.3	7.7	4.9	52.6	7.7
External R&D	2.7	4.5	0.8	1.2	71.2	21.6	26.7
Capital (Machinery, equipment & software)	71.7	10.3	75.2	44.4	13.6	11.7	51.7
External knowledge	3.6	0.5	0.9	2.2	2.2	1.5	1.9
Training for innovative activities	1.8	0.3	0.5	4.0	2.1	2.2	2.5
All forms of design	0.5	7.8	3.8	3.4	1.0	5.5	4.4
Market introduction of innovations	0.6	1.1	1.5	37.0	5.0	4.8	5.2
All	100	100	100	100	100	100	100

Source: BIS Community Innovation Survey 2011

Over the last decade or so the UK has seen, in common with other economies, a blurring of the traditional boundaries between manufacturing and services. This is most evident when companies have developed service based business models to extract value from their investments in new and existing technologies. For example, defence companies provide integrated services that were once directly provided by the military; publishers are leveraging existing strengths to venture into mass market higher education, and equipment manufacturers offer the service provided by the equipment rather than treat the equipment sale as a one off transaction (e.g. power by the hour contracts for aircraft engines).

The relationship between innovation and growth is not, however, straightforward. More recent economic theories explain growth and associated changes in industrial structure as an evolutionary process emphasising: learning by doing and specialisation, the importance of institutions and markets and uncertainty. These suggest the government can influence the innovation system by:

- Encouraging “learning by doing” by supporting the spread of knowledge.
- Supporting the development of general purpose technologies to enable the UK and UK businesses to exploit the benefits these can potentially offer.
- Reducing risk and uncertainty through policy design to encourage investment in innovation.

Encouraging learning by doing by supporting the spread of knowledge

Learning by doing helps create highly specialised firms with access to specialised knowledge networks. However highly specialised firms are potentially vulnerable to shifts in technology or markets and if reliant on their own internal resources may be too slow to respond to these changes. This has led to the emergence of new innovation models[22] – such as Open Innovation – with companies seeking more of their ideas from networks of customers and suppliers. Collaboration within these networks helps increase the rate of learning whilst increasing the clock speed of the innovation system – through more rapid diffusion of new products, processes or ideas. There are challenges to doing this, where an infrastructure does not exist to provide a focus for collaborative effort. For example:

- In spite of having a world class science base in **Agri-tech**[23], the UK performs less well in building on its innovative ideas to develop new products and services that contribute to growth and exports[24]. This is in large part due to reductions in public funding for applied R&D which were initiated as part of general public sector spending cuts in previous decades. Much of the applied research infrastructure has been in decline over the last 20 years, with closure of university departments and applied research institutes, which have declined from 30 in 1985 to 8 in 2009.

- A decline in past government support for extension services may have impacted on the rate of adoption and diffusion of new technologies. This is because firms in **Agri-tech** and other R&D performing sectors may face a 'valley of death'[25], where development costs ramp up significantly but risks are perceived by investors to be too high.

Given the specific difficulties faced in commercialising agricultural technologies the Government will invest £70 million in an Agri-Tech Catalyst and provide £90 million for Centres for Agricultural Innovation. More generally recognising that a 'valley of death' exists, this Government funds the Technology Strategy Board, which aims to commercialise promising technologies from the science system and elsewhere. It provides support on a competitive basis and as a result provides support across a wide range of sectors, including those not covered by a sector strategy (Box 3.1).

Box 3.1: The Technology Strategy Board

The Technology Strategy Board helps businesses develop and bring innovative products and services more quickly to market. It stimulates and accelerates technology development and innovation in areas which offer the greatest potential for boosting economic growth and productivity. The TSB aims to support growth through:

[22] Source: Chesbrough, H. W. (2003) *Open Innovation: The new imperative for creating and profiting from technology*. Boston: Harvard Business School.
[23] The UK has the world's second largest share (17%) of top 1% cited papers in agriculture and biological sciences.
[24] See reports by the Government Chief Scientists Food Research Partnership, the All-Party Parliamentary Group on Science and Technology in Agriculture and the Taylor Review.
[25] Source: House of Commons Science and Technology Committee, *Bridging the valley of death: improving the commercialisation of research*, 2013.

a) Developing the future systems in energy, health and care, transport, food and future cities where significant market potential can be realised through tackling the societal challenges. These markets are estimated to be worth around £250 billion with the opportunity for the UK to capture an increasing global market share building on existing strengths.

b) Supporting innovative SMEs with the potential for high levels of growth, for example, through Smart.

c) Supporting the commercialisation of emerging technologies delivering the technologies and industries of the future.

d) Developing and building up the network of Catapult centres where the very best of the UK's businesses, scientists and engineers can work side by side on research and development - transforming ideas into new products and services to generate economic growth.

Published evaluations show that TSB programmes generate large direct economic benefits to participating companies and their supply chains. These suggest that the TSB generates additional economic output of between £5-£9 per £1 spent.

An extreme example of barriers to learning by doing occurs in the oil and gas sector where operational risks mean that end users want to implement technology with a proven benefit and do not want to be the first to trial a new technology. As a result, some SMEs may go out of business before their product is trialled. This feature is likely to have slowed down the implementation of **oil and gas** technology in the UK continental shelf.

In the **Information Economy**, supplier lock-in and lack of adoption of common standards may hamper roll-out of new technologies. Users might be concerned about their ability to move their information between suppliers and the need to learn how to use and apply new systems. For example, according to the Cisco CloudWatch Report, concerns about supplier lock-in is one of the barriers to wider adoption of cloud computing (however they are much less pronounced as barriers in 2012 (30%) than in 2011 (56%))[26]. The absence or non adoption of industry standards also remains an issue, with 76% of organisations saying they would welcome the development of a set of standards or guidelines for cloud computing – although this appears less urgent than in 2011 when 86% highlighted this concern[27]. In response, the Government is working through standards bodies and stakeholders to align programmes to influence standards at the international level.

Also, in this industry innovations may diffuse slowly:

- Where products are complex, consumers may find it difficult to judge their value. Uncertainties also originate from the rapid change of hardware and software as well as the overall difficulty of predicting how individuals will use new products.[28]. Products often require a critical mass of customers and some longevity in order to generate value, so information asymmetries can reduce the attractiveness of new

[26] Source: Cisco CloudWatch Report 2012: http://www.cisco.com/cisco/web/UK/assets/cisco_cloudwatch_2012_2606.pdf
[27] Ibid.
[28] Source: Tech Market View, "UK SITS [Software and IT Services] Market Trends & Forecasts—2012", 2012.

propositions. Similarly, asymmetric information relating to security and privacy issues can hold back the use of new technologies.

- Also some businesses may not know how to use software efficiently or how to benefit the most from IT services. This may particularly affect adoption of cloud computing and Big Data analytics which are still emerging concepts for most businesses. For example, the 2011 report by IBM and the Saïd School of Business at the University of Oxford found that a 'lack of understanding of how to use Big Data to impact business' is the key primary obstacle to uptake[29].

Particular issues can arise however in the provision of public goods such as shared facilities, e.g. windtunnels, and standards where individual companies cannot justify investment based on the benefits they alone receive. For example, in the UK, the aerospace engineering testing infrastructure has been drastically reduced with many large scale facilities either closed down or scaled back[30]. This compares with the US, France and Germany which have consolidated their own engineering testing infrastructure, and China and India which are investing in their own modern facilities[31]. More generally, the Government, via the Technology Strategy Board, supports the High Value Manufacturing Catapult which, through its network of technology and innovation centres, provides an infrastructure for helping advanced manufacturing businesses to bridge the gap between early innovation and industrial scale manufacturing.

Industry structure also affects the rate of innovation and diffusion. In **construction** - 40% of non-innovating architectural and engineering firms, and 32% of surveyed construction products businesses, attributed market barriers to their lack of innovation (Figure 3.2). These features arise from high levels of industry fragmentation and limited collaboration, sub-optimal knowledge transfer, issues around market uptake and awareness of benefits from innovation, and limited access to finance and a risk-averse attitude to innovation[32]. For this reason, the Industry Strategy commits Industry and Government to work with academic and research communities to, *inter alia*, bring forward more research, development and demonstration and remove barriers to innovation.

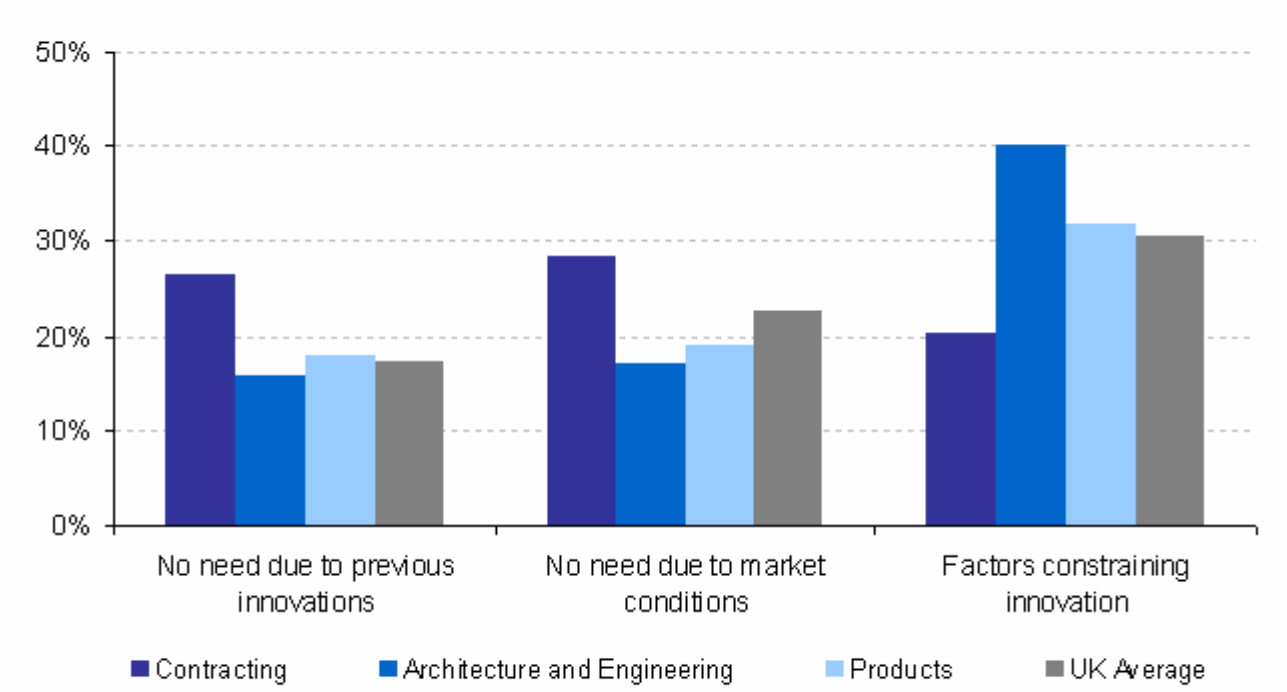
[29] Source: IBM and Said School of Business 2011: http://www.inpublishing.co.uk/news/articles/ibm_study_finds_growing_awareness_of_value_of_big_data.aspx

[30] Source: Association of Aerospace Universities (2011) *The UK Engineering Testing Infrastructure.*

[31] For example, ONERA (France), DLR (Germany), DNW (Netherlands), and INTA (Spain).

[32] See BIS (2013) *UK Construction: An economic analysis of the sector.*

Figure 3.2: Reasons for not innovating across surveyed business in construction subsectors (2010)



Source: BIS Community Innovation Survey (2011). Note figures on construction products should be treated with some degree of caution as they based on surveyed businesses only and not scaled up to the whole population level.

Supporting the development of General Purpose Technologies

General Purpose Technologies affect the entire economy and have the potential to radically change economies and society. Examples include the introduction of electricity, steam power and ICT. They typically require major investments in supporting infrastructure for their full benefit to be realised. They also lead to rapid investment in activities to learn about the capabilities and the most efficient use of the technology.

David Willett's speech in January 2013 set out the **eight great technologies**, each with the potential to make a transformative effect on the economy and wider society. Analysis by the Government Office of the Chief Scientist suggests that:

- **Technologies** to extract more value from data for scientific enquiry or economic benefit have the power to transform industries, and the UK has the potential to be a leading player in the development of the underpinning technologies.

- The UK has an opportunity to be a world leader in **satellites** and, in particular, analysing the data that they produce.

- **Robots and other autonomous systems** are a general purpose technology with applications ranging from assisted living for disabled people through to nuclear decommissioning.

- **Synthetic biology** makes it possible to engineer genes to heal, feed, and fuel us.

- **Regenerative medicine** will open up new medical techniques for repairing and replacing damaged human tissue.

- Although genetics is above all associated with human health, advances in **agricultural technologies** can put the UK at the forefront of the next green revolution.

- **New advanced materials** will enable technological advances in sectors from aerospace to construction. Quantum photonics is an exciting area where advanced materials and digital IT converge.

- One of the most important applications of advanced materials is in **energy storage** which, along with other technologies, will enable the UK to gain from the global transition to new energy sources.

The **Information Economy** sector includes examples of general purpose technologies which are likely to be transformative and should allow new firms to challenge incumbents. For example, advances in data generation and management enable firms to become more efficient or help them to create new markets or business models:

- By making it quicker, cheaper and easier for businesses to communicate and exchange information with their employees, suppliers and customers[33]. McKinsey research suggests that SMEs with a strong web presence grow more than twice as quickly as those with minimal or no presence, generate more than twice as much from exports and create twice as many jobs[34].

- By helping spread new ideas and technologies more quickly and widely through a variety of fora including search engines, blogs and wikis and facilitating greater collaboration through the creation of virtual networks. This can provide a platform for product or process innovations[35], promoting transformation of business models and organisational structures and the development of new or improved goods and services. For example, the UK has 10 out of Europe's top 20 e-learning companies in terms of innovation, scale, market impact and growth over the past year[36].

- By enabling businesses to access new markets which may not have previously been possible due to the existence of high barriers to entry or allowing the development of niche products. Studies suggest that ICT is a key enabler for

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[33] Source: Kretschmer, T., "Information and Communication Technologies and Productivity Growth: A Survey of the Literature", 2012 and OECD, "Broadband and the economy", OECD Digital Economy Papers, No 148, 2008, http://www.oecd.org/dataoecd/62/7/40781696.pdf and OECD, "The Internet and Business Performance", 2001.

[34] Source: McKinsey, "The Internet Matters", 2012.

[35] Source: Gretton, P., Gali J., Parham D., "The Effects of ICTs and Complementary Innovations on Australian Productivity Growth", Productivity Commission, Canberra, Australia, 2003: http://www.pc.gov.au/__data/assets/pdf_file/0004/9346/eictci.pdf

[36] http://edxusgroup.com/europes-20-fastest-growing-and-most-innovative-e-learning-companies-named-2/

businesses who "leapfrog"[37] existing methods and intermediaries in the market place. Information technology is leading to business model changes in **Professional and Business Services** as, for example, firms increasingly offer a range of services to their clients rather than specialising.

In addition, these technologies may enable individuals to overcome barriers to entering the labour market, e.g. those with child-care responsibilities[38], and increase access to public services[39]. The number of UK teleworkers is estimated at 1.9m in 2012, up from 0.7m in 1997[40] and distance selling online is becoming a major part-time work industry in the UK[41]. Advances also enable businesses to start up and grow in rural areas where barriers to enterprise may be greater than in urban areas. These advances in our ability to generate and manage data are likely to lead to numerous growth opportunities (see Box 3.2):

- **E-commerce and online transactions** allowing companies to increasingly integrate e-commerce and online transactions into their business models.

- **Internet of Things** (IoT) where more or less all devices can be connected to one another and communicate, and consumers allow devices to do more for them.

- **Advances in data science** will provide new techniques to analyse data sets so large and complex that traditional techniques are insufficient. At global level, available digital data grew from 150 exabytes in 2005 to 1,200 exabytes in 2010 and is projected to grow by 40% annually in the next few years[42] [43]. Estimates suggest business benefits could be £149 billion (2011 prices) over the next five years[44].

- **Cloud Computing** where software services or data are hosted remotely from users, while remaining accessible in any place or time, give users access to software and other services through more efficient pay-as-you-go models.

- **Cyber Security**: With more activities online this increases the need, and thus the demand, for cyber security products and services to protect this information and other types of assets, such as intellectual property or processes.

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[37] Source: Nesta, "System Innovation; Discussion Paper", 2013.

[38] Source: OECD, The Internet and Business Performance and OECD, "ICT Skills and Employment: New Competences and Jobs for a Greener and Smarter Economy", 2012.

[39] Source: OECD, "The Impact of Internet in OECD Countries", 2012.

[40] Teleworkers defined as people who mainly work in their home, or in different places using home as a base, in their main job, and who could not do so without using both a telephone and a computer. See ONS, "Labour Market Survey 2012", 2012.

[41] Source: Keynote, "Market Report 2013: Home Shopping", 2013.

[42] Source: UN Global Pulse, 2012, Big Data for Development: Challenges and Opportunities: http://www.unglobalpulse.org/sites/default/files/BigDataforDevelopment-UNGlobalPulseJune2012.pdf

[43] Source: McKinsey, 2011, Big data: The next frontier for innovation, competition and productivity: http://www.mckinsey.com/~/media/McKinsey/dotcom/Insights%20and%20pubs/MGI/Research/Technology%20and%20Innovation/Big%20Data/MGI_big_data_full_report.ashx

[44] Source: CEBR, 2012, Data equity; Unlocking the value of big data.

Box 3.2: The impact of the Information Economy sector

The information economy (IE) has an important influence on many other sectors of the economy:

In 2010 across the whole economy purchases of IE services[45] amounted to £68.5 billion and accounted for 5% of all intermediate consumption. The top 3 sectors - financial services, professional and business services and public administration - spent £26.3 billion on IE services[46].

Financial services and professional and business services are also the most IE intensive sectors[47] with IE intensity[48] at 15% and 8% respectively. Other IE intensive sectors include public administration, retail and pharmaceuticals[49].

Innovations are likely to further increase the sector's impact. The number of devices connected to the internet will grow dramatically over the coming years, though commentators differ on the scale. Ericsson predicts, for example, that there will be more than 50 billion connected devices in the world by 2020[50] compared to Google's smaller estimate of around 15 billion by 2018[51]. Cisco also foresees that traffic from wireless devices will exceed internet traffic from wired devices by 2015[52].

One estimate suggests that the UK cloud computing market (defined as access to IT assets as a service) was worth £3.3 billion in 2012, up by 12% on the previous year. Cloud-computing revenues are expected to grow by 16% on average each year to reach £6.1 billion by 2016[53]. CEBR estimated the potential benefits to the UK of the adoption of cloud computing from business creation to be worth £17 billion from 2010-2015, with net cost savings (taking into account the potential additional cost to switch to cloud computing) to reach £22 billion and business development opportunities to be worth £25 billion[54].

Increased use of technologies such as sensors and software and of information and data will also lead to growth opportunities. Pike Research[55] forecasts that global investment in smart city technology infrastructure will total $108 billion during the years from 2010 to 2020 and annual spending will reach nearly $16 billion by 2020.

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[45] Telecommunications services, computer programming, consultancy and related activities and information services.
[46] Source: BIS analysis of ONS data.
[47] Defined as those whose purchases of IE services were above the average level across the whole economy (5%).
[48] The ratio between the share of IE services expenditure and the share of total purchases.
[49] Source: BIS analysis of ONS data.
[50] Source: Ericsson, 2011, More than 50 million connected devices: http://www.ericsson.com/res/docs/whitepapers/wp-50-billions.pdf
[51] Source: Quoted in World Economic Forum, 2012, The Global Information Technology Report 2012, Living in a Hyperconnected World: http://www3.weforum.org/docs/Global_IT_Report_2012.pdf
[52] Source: Cisco quoted in World Economic Forum, 2012, The Global Information Technology Report 2012, Living in a Hyperconnected World: http://www3.weforum.org/docs/Global_IT_Report_2012.pdf
[53] Source: TechMarketView , "UK Software and IT Services Market Trends & Forecast 2013", 2013, p. 19
[54] Source: CEBR, 2010, The cloud dividend, Part one; http://uk.emc.com/collateral/microsites/2010/cloud-dividend/cloud-dividend-report.pdf
[55] Source: Pike Research; Global Investment in Smart City Technology Infrastructure.

General Purpose Technologies present major opportunities and challenges for the **education** sector across a range of areas, although Massive Open Online Courses are the most high profile. Other examples include haptic technology – a disruptive innovation which allows manual skills and techniques to be practised virtually – assistive technology, which enables people who might otherwise have been excluded (from education) due to disability to participate fully – and digital learning resources to support teaching and learning in schools and colleges. These developments could unlock significant growth opportunities: for example, the global e-learning market is forecast to grow at 23% per year over 2012-17 from $91 billion to $256 billion. Edu-gaming is forecast to grow by 40% per year over the same period, although the global market is much smaller ($2 billion in 2012).[56]

Reducing risk and uncertainty through policy design

In a number of sector strategies sustainability issues and increased environmental regulation have a big impact, either by providing incentives to innovate or banning the deployment of environmentally destructive technologies. The process can be highly disruptive, in the sense that existing industries and supply chains are radically reformed. This occurs because existing supply chains are highly specialised and find it more difficult to adapt to the new technology.

Targets, if supported by other policies, can help deliver the investment required to reform supply chains by providing greater market certainty. For example, the UK has legislated for an 80% reduction in greenhouse gas levels by 2050, relative to 1990. This is likely to have a major impact on the automotive sector where advanced powertrain vehicles should emerge from the early 2020s and hybrid and electric vehicles may account for as much as 60% of the UK consumer market and 40% of the world market by 2030, if the Committee on Climate Change and International Energy Agency scenarios are realised.

- The UK has considerable R&D capability in automotive, although in common with overseas competitors, it will need to manage the transition to low carbon propulsion systems and greater energy efficiency. The automotive strategy suggests that more work is needed to ensure that the global vehicle makers are fully aware of the opportunities that the transition presents to their business (Box 3.3).

- Innovation and R&D will be central to **nuclear** achieving a growing contribution to the UK's energy mix, which could be between 16 and 75 GW up to 2050. A TSB review identified opportunities for the UK supply chain. These build primarily on UK strengths in areas such as non-destructive testing (NDT), condition monitoring, decommissioning, waste disposal, and advanced manufacturing and materials[57]. R&D for the development of new technology might include R&D into Small Modular Reactors and R&D into the commercialisation of 4th Generation technology (Box 3.4).

[56] Source: *Education Sector Factbook 2012*. GSV EDU: http://gsvadvisors.com/wordpress/wp-content/uploads/2012/04/GSV-EDU-Factbook-Apr-13-2012.pdf

[57] Source: House of Lords, 2011.

- By 2050, innovation in **offshore wind** has the potential to deliver cost savings of £45 billion and create UK business worth £18 billion.[58] Because the technology is at an early stage of development, energy costs remain high in comparison with other renewable energy sources and compared to current fossil fuel prices, so policies have been put in place to create an incentive to invest in this technology. Estimates suggest that innovation has the potential to drive down costs of offshore wind by 25% by 2020 and 60% by 2050,[59] potentially reducing the cost of offshore wind power to about £100/MWh by 2020 and £60/MWh by 2050.

Box 3.3: Reshaping the UK automotive supply chain to meet environmental targets

Managing the transition to a low carbon economy will require technology prioritisation, collaboration with existing research frameworks and significant R&D investment in advanced powertrains and propulsion systems. This will help secure UK production as the market grows. UK success will also depend upon our ability to attract investment by OEMs and tier 1 suppliers as most of the UK's vehicle makers and tier 1 suppliers are overseas-owned and have a natural preference to conduct R&D domestically. Capturing inward R&D investment is a huge challenge, but is not impossible, and if successful can help embed and even grow the UK automotive sector.

Generally, businesses prefer a stable policy framework to encourage growth and investment. This was raised in several sector strategies, including the Professional and Business Services sector strategy. Other examples include:

- Policy certainty is required to attract private investment into long-lived assets with high up front costs. This is particularly the case for sectors like **Nuclear** and **Offshore Wind** which rely on a predictable carbon price regime. Uncertainty around the funding which Governments make available to industry and the wider tax and regulatory framework can affect the potential risks, returns and costs of research and technology programmes and lead to programmes being altered, deferred, scaled back or in some cases, transferred to other locations overseas. A review of the evidence on regulation and innovation, which is set out in BERR Economics Paper No 4 identified policy and regulatory uncertainty as one of the barriers to innovation activity[60].

Box 3.4: Capabilities of UK nuclear industry

The capability in the UK's national nuclear laboratories and industry is smaller and more fragmented than it has been in the past. However, there remains a core capability covering a range of subject areas in both nuclear fission and fusion. As a product of national pressures and market forces, fission R&D is mainly concentrated on current reactor operations, waste management and

[58] Source: Offshore Wind Technology Innovation Needs Assessment (TINA): http://www.lowcarboninnovation.co.uk/working_together/technology_focus_areas/offshore_wind/

[59] The innovation impact potential represents what experts inputting into the TINA identified as "aspirational but feasible".

[60] Source: BERR (2008) *Regulation and innovation: evidence and policy implications* BERR Economics Paper No. 4.

decommissioning and not on forward-looking areas of interest such as fuel development and advanced reactor systems. Fusion R&D is focussed on the longer term and is funded mostly as a global multilateral initiative. This difference between short-term and long-term funding has an impact on the strategic planning of research and on the management of future capability.

- In the oil and gas sector investments in technology and the need for a stable tax regime are required to increase oil and gas recovery rates in the North Sea. Over 41 billion barrels of oil equivalent have been recovered from the UK but we currently leave half of oil and gas reserves in the ground. A further recovery of 15-24 billion barrels could be achieved with investment in increased oil recovery (IOR) and enhanced oil recovery (EOR) techniques. This would increase production within the UK Continental Shelf by up to 4% over the next 35 years supporting supply chain operations well beyond 2050.

- The establishment of the Aerospace Technology Institute (Box 3.5) and the Advanced Propulsion Centre will increase the level, and certainty, of funding for R&D in advanced manufacturing, which should put the UK industry in a much better position to compete for internationally mobile work.

Box 3.5: Policy certainty in Aerospace – The Aerospace Technology Institute

Industry has indicated the crucial need for long term certainty from the Government on the availability of public sector R&D funding. Industry is ideally looking for stability that goes beyond the life of a single government spending review round or even a single parliamentary term. The Government, for its part, recognises the need to improve the way R&D funding is matched to the specific needs of a very long-cycle sector such as aerospace so that it compares more favourably with the approach taken elsewhere in Europe and beyond. To address this, the Government and industry have agreed to create a new UK Aerospace Technology Institute (ATI) and to support a long-term, targeted technology strategy. Government funding for the ATI will reach £150 million annually by 2014/15 and will be committed for a seven-year period. Industry is committed to matching this investment. Based on the potential for technology to sustain or grow the UK's future market share, and taking into account industry's estimates of future revenues, the ATI and the associated increased investment in R&D could deliver significant net benefits to the UK and secure between 45,000 to 115,000 more jobs in aerospace and its supply chain by 2030. The alternative would be a significant decline in UK market share and employment.

- Protection of intellectual property rights is an important issue for many **Education** technology firms. Dependent on revenues from intellectual property rights and licensing, the business model behind education technology needs to look beyond purely educational applications so that any cross-over into the wider business and social world can be exploited.

Having considered the role of innovation in sector and supply chain performance, we next present analysis relating to the skills issues raised during the development of the industrial strategies.

4. Skills development

Summary

The evidence from the strategies is that there is significant current and potential future demand for skills across many of the sectors due to either retirement (**nuclear** and **oil and gas**) and/or strong sector growth (the **Information Economy** sector and **Professional and Business Services**). Whilst the UK has only a low current level of skills shortages they are impacting on firm performance and the economy's overall competitiveness, and are increasingly likely to do so as demand for skills grows.

In part there is a lack of supply reflecting unsuitable qualifications and courses where education establishments have not kept pace with developments in industry (e.g. the **Information Economy** sector). But businesses also have a significant role to play. They already invest substantial effort and cost in training, but attracting sufficient numbers of suitably qualified individuals will mean thinking more strategically about their skills resource and a more effective approach to investing in it. This will mean not only focusing on the available compensation package offered, but also the availability of training to demonstrate the sector's commitment to individual development, flexible ways of working, and a career path that appeals to a more mobile labour force. For many firms - in sectors from **construction** and **oil and gas** to **aerospace** and **automotive** - this will mean improving the level of management skills too, to ensure that best use is made of existing skills.

It is clear that many sectors need to do more to improve their appeal to a wider section of society, particularly in terms of gender (**oil and gas**, **construction** and **nuclear**) and socio-economic background (**Professional and Business Services**). For many sectors, this will mean a more concerted and co-ordinated effort to change the image of their sector and to engage with potential sources of talent, some of which will not be from traditional sources.

The talent of our current and future workforce is an intrinsic part of securing competitive advantage and a critical driver to stimulating growth. More generally, the establishment of industry sector councils provide the opportunity for sectors to take a more co-ordinated and strategic approach to skills and training. In November 2012, the Government launched round two of the Employer Ownership Pilots. The level of interest was high and proposals have come from a wide range of leading businesses including a substantial number of ambitious proposals to take "end to end" responsibility for skills through industrial partnerships.

The talent of the UK's current and future workforce is an intrinsic part of securing competitive advantage for businesses and a key driver to stimulating greater competition in markets and economic growth. Crucially, it is about ensuring UK businesses can continually innovate in a rapidly changing world and respond effectively to the growing challenges and opportunities from globalisation. Importantly too, it is about creating the conditions for more businesses to compete effectively in high value markets in the future.

Skills are the key to all aspects of future economic success of UK businesses, from managing change as a result of evolving consumer demands, to dealing with new technologies and increased competition from emerging economies. More fundamentally, skills are important for firm survival and studies suggest firms that train their staff are twice

as likely to survive as those that don't do so[61]. It is good news is that the majority of UK firms provide training to their staff, though still a concern that two fifths do not. If the UK is to raise its level of competitiveness to the level of the best in the world then it will need to meet the skills challenges identified in the sector strategies.

All the strategies set out their skills challenges but there is a particular focus on those faced in **Professional and Business Services**, **automotive**, **aerospace**, **agri-tech** and the **Information Economy** sector. Skills challenges often originate with poor uptake of the subjects demanded by particular sectors from early education, affecting the image of the sector's professions. For instance, as school age ICT courses continue to lose popularity, many young people might infer that the information economy field does not offer an exciting professional career.

An economy's skills mix is driven by two forces which shape labour market outcomes such as employment, vacancies and wage rates. First, firms' demand for skills depends on both what firms produce and the way in which they produce it. When firms operate high value product strategies, they are likely to demand higher skill levels. Second, individuals and employees make choices about training and qualifications based upon perceptions of what is interesting or valuable. These choices may be constrained by public or private institutions (e.g. type of skills training on offer) or rules which limit transferability of qualifications or knowledge. Given the size of stocks relative to flows, historic choices are more likely to determine the type of skills supply at any given time.

Imbalances between supply and demand are likely to exhibit themselves in higher vacancies or unemployment and rising or falling wages for that skill group. In cases where skills are in excess demand employers are likely to experience skills shortages. This chapter therefore looks at the evidence during the process of developing the industry strategies on:

- Employers' demand for skills
- The existence of skills shortages.
- Employer's investment in training.

Demand for Skills

Increased competition from emerging economies and the need to continue to improve the UK's competitiveness is leading to an increased focus on moving firms up the value chain. This in turn has highlighted the need for skills at a higher level and in greater quantity than previously employed by many sectors.

[61] Source: Collier et al. (2007) Training and establishment survival. SSDA: http://www.ukces.org.uk/assets/ukces/docs/publications/ssda-archive/research-report-20-training-and-establishment-survival.pdf

This competitive pressure might be expected to drive the demand for higher skills levels from employers but the evidence for this has been limited to date.

- UKCES data shows that just over half of businesses provided training in the last year, with many of the remainder seeing no need for additional training. Only 54% of employees received any type of training in the last year (including on the job training) and for many of those employees health & safety and induction will have featured heavily, rather than activities that drive higher individual and firm performance.

- There is also a concern that the UK is not developing quickly enough relative to other leading economies and sufficiently driving up skills demand nor sufficiently exploiting new emerging markets to achieve the growth sought. UKCES analysis finds that, for instance, only a third of employers across the UK report that they have high value product strategies, which demand higher skills. Furthermore, the rate at which the UK is growing high skilled jobs is particularly low, with a growth rate ranked 20th out of 27 OECD countries. A key question is therefore whether UK firms are being sufficiently ambitious and raising the demand for skills.

In terms of the sector analysis, there was a clear distinction between the more mature manufacturing sectors where employment growth has generally been muted (such as **aerospace**, **automotive**, **construction**, and **energy**) and those sectors where markets are growing strongly driven by technology, environmental and demographic changes (**Professional and Business Services**, **Life Sciences**, **education**, and the **Information Economy** sector). For each of these sectors the challenge varies, with the former having to attract high skill individuals against a background of generally declining numbers. For the latter group there is the challenge of accessing a growing volume of high skill employees often in competition with other sectors. In the **Information Economy** sector, businesses report difficulty finding the right specialists.

Figure 4.1: Employment Growth in IS Sectors (2010-20)

Source: UKCES (2011) Working Futures 2010-20

For all sectors, replacement demand is set to grow strongly over the next 10 years as skilled workers retire and are replaced (Figure 4.1). In **construction** and **Professional and Business Services** this will be exacerbated by the need for additional posts created by strong anticipated growth. Finally, for sectors such as offshore wind and nuclear where demand has until recently been at very low levels there is the possibility that significant skills needs could become apparent in a very short time if further investments are forthcoming. For example:

- Strong recent growth in the **offshore wind** sector has seen employment rise fourfold between 2007 and 2010 and could increase further to a total of 30,000 direct jobs by 2020[62] . Given 47% of the current workforce is employed in managerial, professional and associated professional occupations and 36% are in skilled trades, it seems likely there will be significant growth in demand for skilled labour in competition with other energy sectors, with implications for vocational training.

- Future skills shortages are anticipated to arise in the **nuclear** and **oil and gas** sectors if demand continues or starts to grow quickly. The demographics of workers mean that many are expected to retire in the next 10-15 years. This is most marked in the **nuclear** sector where 70% are expected to retire by 2025 giving rise not only to a large demand for replacement labour but representing a significant loss of experience and expertise that is not easily passed on (Box 4.1).

Box 4.1: Nuclear Workforce Model and skill needs in Nuclear sector

The Nuclear Workforce Model (NWM) is being developed to deliver robust labour market intelligence for the UK's entire civil nuclear programme (including new build, existing and new operations and decommissioning). It is being supported by government, industry and the Nuclear Energy Skills Alliance. NWM can generate future skills scenarios and aggregate demand data to allow comparison with supply, and subsequent gap analysis. And it records the workforce currently employed within the existing nuclear estate (including 28 nuclear facilities at 21 sites), together with forecast future demand, including future decommissioning needs.

Initial findings have helpfully identified several categories of skills need. Examples of recruitment demand include:

a) for operations, decommissioning and fuel processing: 320 new recruits per year at Level 2/3, and 200 per year at Level 4/5

b) for health physics: 100 new recruits immediately required at Level 2/3, and 150 at Level 4/5

c) project/programme management: 700 required across Levels 2/3 and 4/5.

Various actions to address these needs have been identified and are being taken forward.

[62] Source: Offshore Wind Industrial Strategy (2013).

As well as competitive pressures, product and technology developments are also increasingly altering the demand for key skills across the range of sectors. For example:

- In **construction**, the increasing demand for low carbon and energy efficient construction, greater opportunities in off-site manufacturing and technology deployment, means that a skilled and flexible workforce will be vital for the UK construction sector's future performance and competitiveness. Changes in the sector's skills needs are particularly relevant for management and professional occupations, with increasing demand for higher level skills[63].

- The skill needs of the **agri-tech** sector are rapidly changing with a move towards technology, and higher level scientific and managerial skills to match advances in informatics, precision farming and engineering. Many of the skills now demanded by the sector are inter-disciplinary, with a combination of mathematics, computing and biology needed to decode plant, animal and microbial genomes. As the exiting workforce nears retirement, there is a risk of skill shortages arising in certain niche areas, such as agronomy, plant pathology, and agricultural engineering.

- The continued progression of IT into a range of other sectors is also affecting skills demand. In 2011 there were 1 million IT jobs in the economy: 400,000 IT jobs in the **Information Economy** sector (40%) and a further 600,000 in other sectors of the economy (60%)[64]. In the **Information Economy** sector the issues are much more around accessing specific IT skills to meet a range of business needs such as Big Data and cloud computing and the limitations of the **education** sector to meet its fast-changing needs.

- In **Professional and Business Services** product and technology development is changing both the business models that firms adopt, providing greater flexibility in meeting business needs (through home-working etc) and changing the nature of the demands the sector faces – where business solutions increasingly require at least some IT input. In **education** growth in e-learning is expected to bring opportunities that will require access to increased IT skills to a greater extent than previously.

Skills shortages and deficiencies

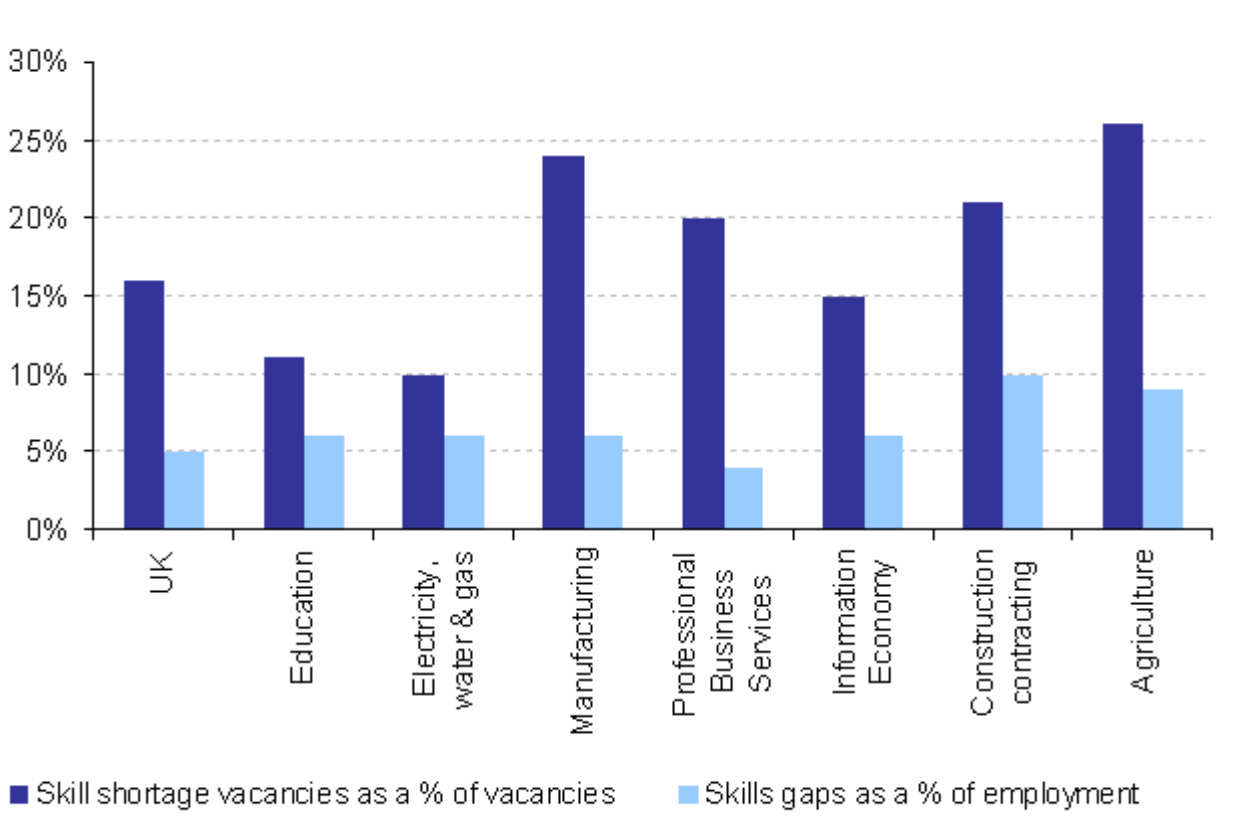
Whilst skills shortage vacancies are generally low in the UK (only 3% of employers report such a shortage), significant skills deficiencies were already noted in many of the sectors analysed, usually showing up as relatively high skills shortage vacancies. The sectors selected as part of the Government's industrial strategy are generally seen as those which are high tech, high skilled and/or with the potential for growth. It is therefore not surprising that skills issues have featured significantly amongst the factors potentially limiting future growth.

Figure 4.2 below shows higher than average skills shortage vacancies across a range of sectors, and at or above 20% of all vacancies, for **automotive**, **Professional and Business Services**, **construction** and **agriculture**. Other sectors also report specific

[63] Source: UKCES (2012) *Construction Sector Skills Assessment.*
[64] Source: BIS analysis of ONS data.

skill shortages e.g. in **aerospace** levels of higher skills vacancies are at above average levels, and in **construction** hard to fill vacancies are reported to be in professional and skilled trades. **Offshore wind**, too, reports above average skill shortage vacancies due to skills shortages and in the **Information Economy** sector businesses report difficulty finding the right specialists. These shortages impact on business success through lost orders, increased costs and a greater burden on existing workers. For some sectors such as **oil and gas**, other **energy** sectors, **aerospace** and **construction** it has also meant having to rely on foreign migrant labour to meet specific skills needs, raising concerns amongst firms in these sectors about future migration policy. In the **oil and gas** sector, in particular, high levels of skills demand are leading to increased competition for staff.

Figure 4.2: Skills Shortage Vacancies and Skills Gaps



Source: UKCES (2012) UK Commission's UK Employer Skills Survey 2011

A common theme amongst the sector strategies was the shortage of current and future IT and Science, Technology, Engineering and Mathematics (STEM) skills:

- Although STEM skills are only a small proportion of total shortages, their significance to the economy mean that they cannot be ignored. For example, the lack of such skills was particularly noted in the energy and advanced manufacturing sectors where increased competition from overseas business is putting an ever greater premium on R&D, innovation and technical expertise.

- One fifth of all employers in the UK that report a skill shortage vacancy say they are not able to find the advanced IT skills they need in the external labour market. A

lack of basic IT skills is reported by 16% of employers with a skills shortage vacancy. The picture is similar for skills gaps as 17% of employers mention a lack of advanced and basic IT skills[65] in their existing workforce.

Given the current and expected increase in demand for STEM and IT skills across many sectors, it is not surprising to note that increased competition between sectors is identified as the cause of skill shortages in several sectors (particularly **energy** and **aerospace** sectors), although in reality it may simply be that such skills are rewarded more in other parts of the economy and these sectors have not taken the steps they need to ensure that they offer an attractive career path and are positively working to appeal to the broadest range of candidates.

Recent analysis by the UKCES reveals that there is sufficient supply of STEM skills to meet demand, although STEM employers are more likely to experience skills shortage vacancies than other employers (21% vs 16% of all vacancies), perhaps because not all holders of STEM skills work in STEM jobs[66]. Holders of STEM qualifications also enjoy a wage premium, particularly when employed in STEM jobs, indicating their value to employers. The lack of STEM skills was particularly noted in the energy and advanced manufacturing sectors where increased competition from overseas is putting an ever greater premium on R&D, innovation and technical expertise. The importance of STEM skills to many of the industrial strategy sectors, our competitiveness and our economy overall mean they cannot be ignored.

There was some evidence (**oil and gas** and **Information Economy**) that SMEs were worst affected by skills shortages given their limited ability to either influence supply or pay the premium wages needed to attract skills in short supply.

For other sectors the lack of supply of skilled labour seems to reflect in part unsuitable qualifications and courses where the education establishments have failed to keep pace with developments in the industry. For example:

- In the **automotive** sector there is a view that apprenticeships are too fragmented and don't give a sufficiently broad base to serve the industry.

- For other sectors, skills challenges originate with poor uptake of the subjects demanded by particular sectors in early education. For example, as early age IE courses continue to lose popularity, many young people might infer that the information economy field does not offer an exciting professional career.

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[65] Source: UK Commission for Employment and Skills, "Employer Skills Survey 2011", 2012.

[66] UKCES (2011) Supply of and demand for high level STEM skills: http://www.ukces.org.uk/publications/the-supply-of-and-demand-for-high-level-stem-skills

- In the **Information Economy** sector it was reported that curricula focus more on using technology than those skills required in the sector such as programming and creativity. Employers did not think that the statutory school ICT curriculum in England was sufficiently challenging, focused too much on using IT applications and students were not excited by course content. In response, the Government is reforming what is taught in this subject area in schools. A new computing curriculum which places greater emphasis on teaching the principles of computational thinking and practical programming skills is due to become compulsory in September 2014.

- Finally, in sectors such as the **Information Economy**, **Professional and Business Services** and **automotive** there were concerns expressed about the work readiness of school leavers. However, UKCES data for the economy as whole shows that on average around two-thirds of employers are satisfied with school leavers. Those that did express a concern felt that a lack of work experience and motivation were bigger problems than a lack of skills.

- As well as high and in some cases persistent levels of skills shortages in some sectors, it was clear that gender imbalance was adding to the problems of limited supply. Certainly, the **energy** and more mature manufacturing sectors stood out for the gender imbalance of their employees, but even newer sectors such as the **Information Economy** face difficulties in attracting female recruits – in this sector only a quarter of employees are female. A gender imbalance was particularly noted in relation to the **automotive**, **oil and gas**, **construction** and **aerospace** sectors.

As well as the problem of recruiting the right skills to ensure future success it was clear from our analysis that in some sectors there was more that could be done to improve the existing skills gaps that persist within the current sector workforces. Whilst the skills gap of those in employment tends to be relatively low they can mask some persistent problems. These skills gaps arise as a result of a variety of reasons including: a limited focus on training because margins don't permit it or competition for such skills is too great, unable to recruit staff with necessary skills, incomplete training or poor staff retention or a weakness in management which means the problem is not tackled strategically.

In particular, a lack of management skills was identified as a concern in a number of sectors. These include **construction** where new analysis demonstrated the central role of effective management on the outcome of projects. Due to the disaggregated nature of the construction supply chain and the one-off nature of projects, there is a high dependence on the successful co-ordination of activities both on-site and off-site by project managers in the supply chain. This capability is becoming more important as the construction supply chain is engaged at an earlier stage in the project, and as project teams integrate to a greater degree to improve efficiency. Similar issues were also identified in the **aerospace** and **automotive** sectors where the need to maximise the value of supply chains is also important. More fundamentally, all sectors will require strong management skills to help tackle future skills needs in a more strategic way and to face the demands of a more competitive trading environment.

Investment in training and skills

The vast majority of the individuals that will be in a job in 10-15 years are already employed. Current and future inflows of skills to the labour market will therefore have a limited impact on the state of skills needs in the sector in the short term. Instead, the most obvious way of meeting the skills needs of the UK economy in the short term is to invest in training the current workforce.

Employers invest approximately £49 billion a year in training and skills in the UK[67]. Whilst this figure is impressive, questions remain about its adequacy and individuals' participation in training has been declining over time. A majority of employers train but this reaches just over half (54%) of all employees. Most of the training provided is specific to an employee's job but induction and health and safety training follow closely behind and in some industries make up the bulk of training provided. Average spend per trainee in the UK is £3,275 per annum.

In manufacturing, the level of training spend was below average as was the number of employers providing training. In both **aerospace** and **automotive**, the number of employers providing training was slightly above average but this did not translate into more employees receiving training, and in **automotive** the number of days training was also below average even though both sectors report skills shortages. Amongst **Information Economy** companies there is a tendency to recruit trained individuals from higher education rather than recruiting and then training individuals to the required standard.

In other sectors such as **energy** the picture is more positive in terms of employers providing training but the proportion of employees receiving training is no greater than average. Given the nature of the sector it is perhaps not surprising that there is a stronger emphasis on health and safety/induction activities than in other sectors.

The reasons for this lack of focus on training vary including cost, time and a lack of suitable provision but as already mentioned above, management decisions and a limited focus on longer-term and more strategic resource planning seems to play a part. Other reasons include anticipated low or uncertain returns to investment in training and the lack of financial resources required to undertake the training. For example:

- In sectors as diverse as **construction** (Box 4.2) and **Professional and Business Services** there is a significant prevalence of self-employed workers for whom the choice is between learning or earning, and in markets where barriers to entry are low and competition high it may make more sense (at least from a short-term perspective) to earn now and look to improve skills on the job. For those sectors with a large number of smaller companies such as the **Information Economy**, sector barriers to training may be felt more acutely and SME managers may not recognise the value of investing in skills.

[67] Source: UKCES (2012) The UK Commission's UK Employer Skills Survey 2011. UK results. UK Commission for Employment and Skills, Wath Upon Dearne.

- In sectors such as **oil and gas** where competition for some skills is significant, employers may be unwilling to invest in training when the benefits may accrue to another employer in the future.

- There is also evidence that **Information Economy** companies are less willing to train people to the required level. Some 16% of information economy enterprises had recruited from higher education trained individuals in the last 2-3 years, compared to 10% in the wider economy, and only 4% FE college leavers compared to 8% nationally[68]. Although average job training spend per trainee in the **Information Economy** sector is higher than the UK mean (£5,213 against £3,275), it is split across fewer training days and a smaller proportion of companies who have formal training plans and budgets.

- There is a concern that current incentive structures mean businesses will continue to poach skilled labour from each other, rather than find a way of increasing total supply or ensure that such skills are allocated appropriately.

- The need to improve management skills within UK firms (especially in manufacturing and the **oil and gas** sectors) to ensure a more strategic and long-term approach to skills planning was also highlighted.

The key issue therefore is how industry responds to these challenges. The Industry Councils provide the opportunity, in many instances for the first time, for firms within an industry to come together with Government and other partners and find solutions in a co-ordinated way which benefit the whole of the sector and its supply chain, not just the largest employers, for example in the automotive and aerospace sectors.

Box 4.2: Investment in training in the construction sector

In the construction sector, only 17% of sole traders provided training for themselves or indirect staff compared to 41% in the wider sector; and the self-employed are half as likely to participate in training as employees generally in the sector. Of more concern, given the identified skills shortages in this sector, only 27% of businesses in the sector had training plans and 19% a training budget compared to 38% and 29% respectively for the UK as a whole[69].

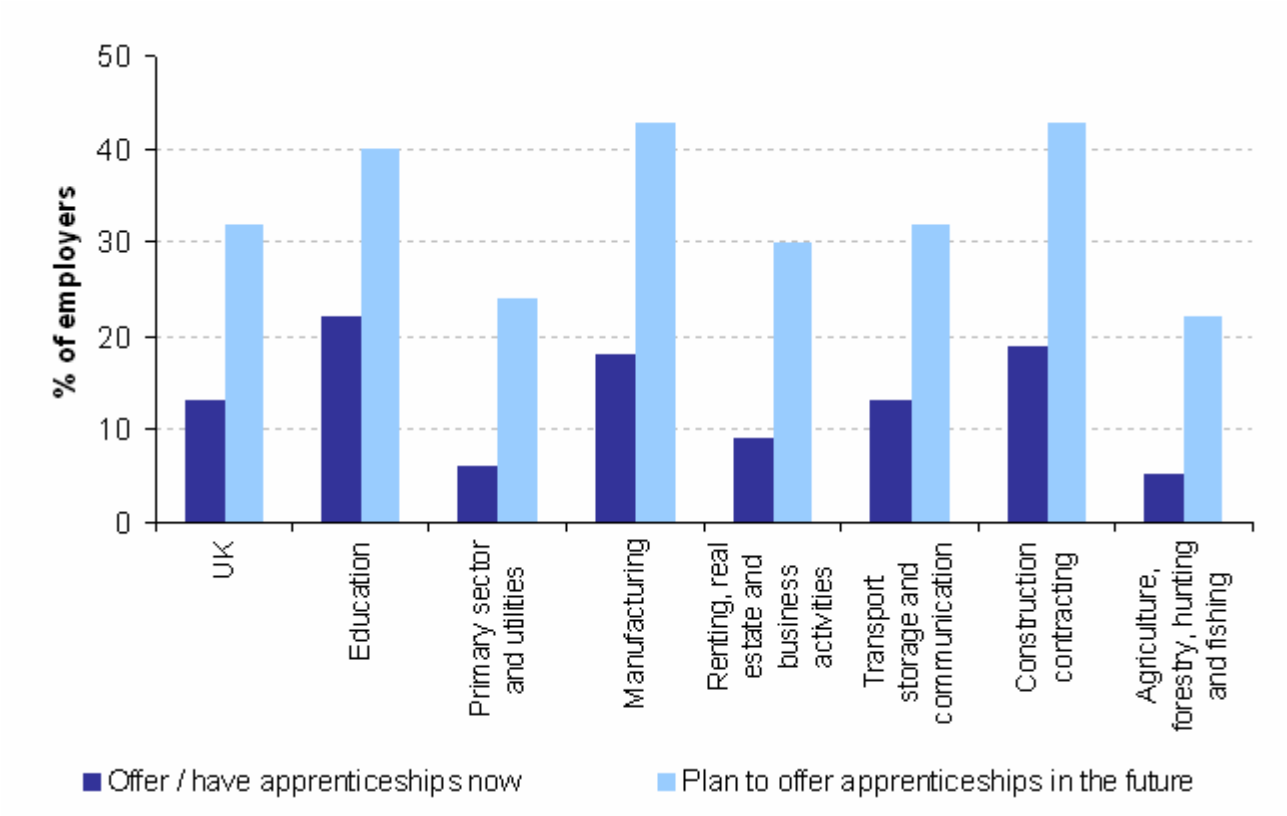
Many sectors are now starting to realise that to meet their future skills needs they will have to broaden their appeal beyond their traditional recruitment routes. This will mean using new recruitment routes such as higher apprenticeships in sectors such as **Professional and Business Services**, improving engagement between schools, higher and further education and businesses and finding ways to demonstrate the appeal of careers in more mature sectors such as manufacturing and **energy** to a younger and more diverse group of employees.

[68] Source: UK Commission for Employment and Skills, "Employer Skills Survey 2011", 2012.

[69] Source: BIS (2013) *UK Construction: An economic analysis of the sector.*

Apprenticeships and vocational qualifications have traditionally been a key means of ensuring a supply of appropriately skilled labour for many of the sectors analysed including automotive, aerospace and construction. They are considered a cost effective means of providing training by employers that use them[70]. However, concerns have been expressed about the quality and consistency of the training provided. For example, in the **automotive** sector there are concerns about whether apprenticeships are sufficiently broadly based and in **construction** the economic downturn has led to a sharp fall in numbers completing apprenticeships. However, in nearly all the sectors analysed there was an anticipated growth in the use of apprenticeships as a means of meeting future skills needs (Figure 4.3). This is particularly true in sectors such as **PBS** where higher apprenticeships are seen as a means of increasing the pool of skilled workers available to the sector. Indeed, the sector strategy aims to treble the number of higher apprenticeships within five years. The success of these higher apprenticeships will depend, though, on the perception of such qualifications by other employers and indeed students choosing between different career paths. In addition, finding a way of allowing SMEs to access such a resource remains a challenge, with those in the information economy, in particular, reporting difficulties in accessing high calibre candidates.

Figure 4.3: Anticipated Future Growth in Apprenticeships



Source: UKCES (2012) UK Commission's Employer Perspectives Survey

[70] Source: UKCES (2012) UK Commission's Employer Perceptions Survey.

Besides the creation of industry councils the industrial strategies have promoted the opportunity for employers to take the lead on action to address their sector's skills priorities.

In November 2012 the Government launched round two of the Employer Ownership of Skills Pilot (EOP) with £250 million for innovative solutions for how government and employers, in partnership, can provide the skilled people the country needs. The level of interest was high with employers bidding for over six times the amount available and successful bidders offering almost £1.2 billion in matched funding. Employers are clearly willing to act.

Proposals have come from a wide range of businesses across and beyond the industrial strategy sectors. Many take a collaborative approach with a focus on innovative ways to encourage smaller firms to train for the first time, helping young people into work through high quality work experience, pre-apprenticeships, traineeships and apprenticeship programmes tailored directly to employer needs. The bids involve a large number of employers, universities, colleges, training providers, unions and other key partners in the skills landscape.

In the **automotive** and **aerospace** sectors a total of £53 million is available to support employer ownership proposals. In the **energy** sectors, the support totals nearly £40 million, with over £25 million available in **construction**; some £22 million for the **Information Economy**, almost £2 million for **Professional and Business Services**, and £1 million in **agri-tech**. The proposals also included a substantial number of ambitious bids to take "end to end" responsibility for skills through industrial partnerships in industrial strategy sectors. For example, these involve taking steps to encourage business growth, ambition and investment in people.

Industrial partnerships will be established from the strongest employer leadership to ensure that sectors develop and use the talent of their people to support growth and competitiveness. They will be driven by the growth agenda and their activities reflect industry requirements which could include recruitment of talent, skills development, progression, job design and productivity measures.

The exact model and responsibilities of industrial partnerships will vary according to the needs of sectors and employers. Where there is a clear market failure, industrial partnerships provide an opportunity to align and connect public and private investment in employment and skills to wider sector growth challenges and strategies. By giving these partnerships responsibility for developing the talent their sector needs to be successful, we ensure people gain skills that have genuine value and the workforce contributes to industry competitiveness.

Having assessed the skills issues in the sectors covered by industry strategies, we turn to consider a key measure of potential success, if the UK manages to improve the capability of sectors and their wider supply chains, that is, the success in future export growth.

5. Export growth

Summary

The UK has long benefited from being an open trading nation and, not surprisingly, nearly all sector strategies cited the ability to succeed in an increasingly globalised economy as key to their future success. They contained a range of measures to promote inward investment and exports in order to exploit these trends. Prospects for trade vary, however, by sector and the various sector analyses picked up on opportunities from a range of sources, notably:

Environmental regulation is creating new demand for low-carbon technologies and resource efficiency, and UK measures to boost low-carbon energy have put it in a strong position to leverage existing strengths and benefit from growth in energy markets.

Technological advances present major opportunities for a range of sectors - from automotive to agriculture technology - and investing in appropriate R&D will be crucial in maintaining this position. IT and data related services have grown rapidly in recent years and the UK is well placed to benefit from this trend.

Rising populations and increasing per capita incomes in a large number of developing and emerging markets is likely to lead to increased demand for consumer goods, and higher-value goods and a wider range of services from a growing and aspiring middle-class. To exploit this development, the UK can leverage its strong branding (e.g. in education) and existing strengths (e.g. in Professional and Business Services).

Looking ahead trade agreements provide further potential growth opportunities. The EU is pursuing an ambitious programme of trade negotiations, of which the recently launched Transatlantic Trade and Investment Partnership (TTIP) with the US is the most significant. Concluding TTIP and other trade agreements could in the long run increase EU GDP by some 2%.

The UK has long benefitted from being an open trading nation and in an increasingly open and globalised world economy the ability to succeed in such conditions is crucial for future growth. UK exports were £493 billion in 2012 representing 31% of GDP making the UK a significant trading nation. Trade can be a major contributor to growth with both exports and imports adding value to the UK economy. This is recognised in the increased efforts in recent years to boost trade liberalisation further and, during the recent economic downturn, to protect the gains already made despite pressure to protect local industry interests.

UK trade has traditionally been dominated by trading partners in the developed world, including the EU27 (48%) and US (13%) reflecting similar patterns of production and demand. This remains the position despite strong growth in the countries of the Far East, such as the Asian Tigers over the last 20 years, and more recently in China and India, as many of the industrial strategy documents make clear. However, there is also a strong sense that the balance of trading partners is beginning to change as these economies catch up, leading to a shift in patterns of both the demand and supply of traded goods.

Over the last 10 years the BRICS[71] share of UK trade has doubled from 4.1% in 2003 to 8.4% in 2012.

Along with the shifting patterns of demand from West to East over the last two decades we have also seen shifts in the nature of trade. Whilst manufactured products continue to dominate trade statistics there has been growing recognition of the value of trade in services, including both those that are embedded within manufactured goods (after-sales, advice and consultancy) and an increase in directly traded services aided by measures such as the EU Services Directive. The value of the UK's trade in business services more than doubled over the last 10 years, rising from £41.5 billion in 2003 to £87.5 billion by 2012. Parallel imports have been an increasing feature of trade between developed countries recognising the value that purchasers place on choice. There has also been an increasing recognition of the importance of imports and the role of international supply chains in contributing to trade success.

Looking ahead there are potential opportunities that may be generated through trade agreements, whether multilateral, plurilateral or regional/bilateral. The EU is pursuing an ambitious programme of trade negotiations, of which the recently launched Transatlantic Trade and Investment Partnership (TTIP) with the US is the most significant. Concluding TTIP and other agreements could in the long run increase EU GDP by 2%. These negotiations also provide an opportunity to address regulatory and other behind-the-border barriers that can limit exporting opportunities.

Future export opportunities

Given the importance of trade to future growth it is not surprising that nearly all sector strategies highlighted it as a key future success measure. For example, the industrial strategies identified a range of measures to promote UK exports (Box 5.1).

Box 5.1: Measures to promote UK exports

Automotive

The £3m Automotive Investment Organisation will lead on attracting inward investment to the UK, as Government and industry work together to grow the UK supply chain and win more overseas business.

Professional and Business Services

A new network of senior business envoys will champion UK capabilities overseas. In addition, UK Trade and Investment will arrange trade missions specifically for the Professional and Business Services sector. This will build on the UK's position as an international hub of for Professional and Business Services firms.

Education

[71] Brazil, Russia, India, China and South Africa.

Establish Education UK to help UK business take advantage of high value opportunities overseas – securing contracts worth £3 billion by 2020. Education UK will support UK businesses to win major projects around the world, fostering the development of UK consortia and helping to develop high quality bids for business that individual suppliers just couldn't win alone.

In addition, the strategy aims to grow the number of overseas students in UK universities by up to 20 per cent over the next five years – an extra 97,000 students.

The prospects for trade and the drivers of future growth vary by sector, reflecting a number of key drivers. They were:

- **Environmental regulation** which is creating demand for low-carbon technologies and resource efficiency.

- **Technological advances** present opportunities in a range of sectors, from automotive to agricultural technology, as a growing population with rising incomes demand ever more efficient production of goods and services. In addition, new technologies are also leading to the creation of entirely new markets in areas such as the **Information Economy** (Big Data), and even more established sectors such as Oil and Gas (e.g. shale gas extraction).

- **Growing demand** in a large number of developing and emerging markets as a result of rising populations with increasing per capita incomes. This is likely to lead to increased demand for consumer and higher-value goods, and a more sophisticated range of services from a growing and aspiring middle-class.

The impact of these drivers on individual sectors and the likely UK response are set out in more detail below.

Environmental Regulation

Environmental regulation and specifically measures to reduce the carbon content of production have had the greatest impact on the energy markets where global growing demand is adding to the challenge faced by all economies. UK policy measures to boost low-carbon energy have put the UK in a strong position to benefit from future growth in these markets. For example:

- There is a growing global demand for renewable energy to meet climate change targets, security of supply and increasing demand for energy. The **offshore wind** sector is predicted to deliver up to £18 billion in net exports by 2030.

- Currently, UK civil **nuclear** exports are relatively small: £240 million in 2010/11[72]. Operations and decommissioning are the major part of UK civil nuclear exports -

[72] Export figures do not include the additional sizeable contribution from other areas like financial, legal, education and training, technical or fuel cycle services.

around half of UK exports by value[73]. There is, however, significant potential for growth, especially as nations develop nuclear energy to provide them with more energy security and insurance against the rising cost of fossil fuels[74]. By 2020, the global decommissioning market is estimated to be worth £50 billion per annum, with between 82 and 145 reactors retired by 2030, mostly in Europe.

- The global green and sustainable building industry is forecast to grow by 22.8% per annum until 2017[75] as a result of increasing low carbon regulatory requirements and greater societal demand for greener products. As the world's sixth largest low carbon market[76], the UK is well placed to take advantage of these opportunities.

- The **Professional and Business Services** sector identified the carbon reporting and management market as a source of future growth with the UK already seen as global leader in relation to legal and financial advice for green energy investment and promoting standards for carbon reporting.

Technological Advances and Development of New Markets

The UK has a particular strength in technologically advanced manufacturing sectors such as automotive and aerospace and the key to future success will be in maintaining this comparative advantage by investing in appropriate R&D, for example through continued support of the Aerospace Technology Institute and the Advanced Propulsion Centre. Our strong R&D base has also given the UK an advantage in newer sectors which are based on technological advances.

- The UK has a comparative advantage in **aerospace**, accounting for around 6% of total world exports[77]. Since 2007, UK aerospace exports have risen significantly from £12.7 billion to £22.3 billion in 2012, and in 2011 the UK recorded a trade surplus for the first time since 2007 (Figure 5.1). This sector is reliant on importing key components. For example, in aerospace the rise in imports in line with exports reflects the fact that many of the intermediate goods used in the manufacture and final assembly of aircraft and aero-engines are sourced from abroad.

[73] Source: LCEGS 2010/11. Analysis of LCEGS data reveals that the UK has a high Revealed Comparative Advantage in consultancy, research and development and decommissioning.

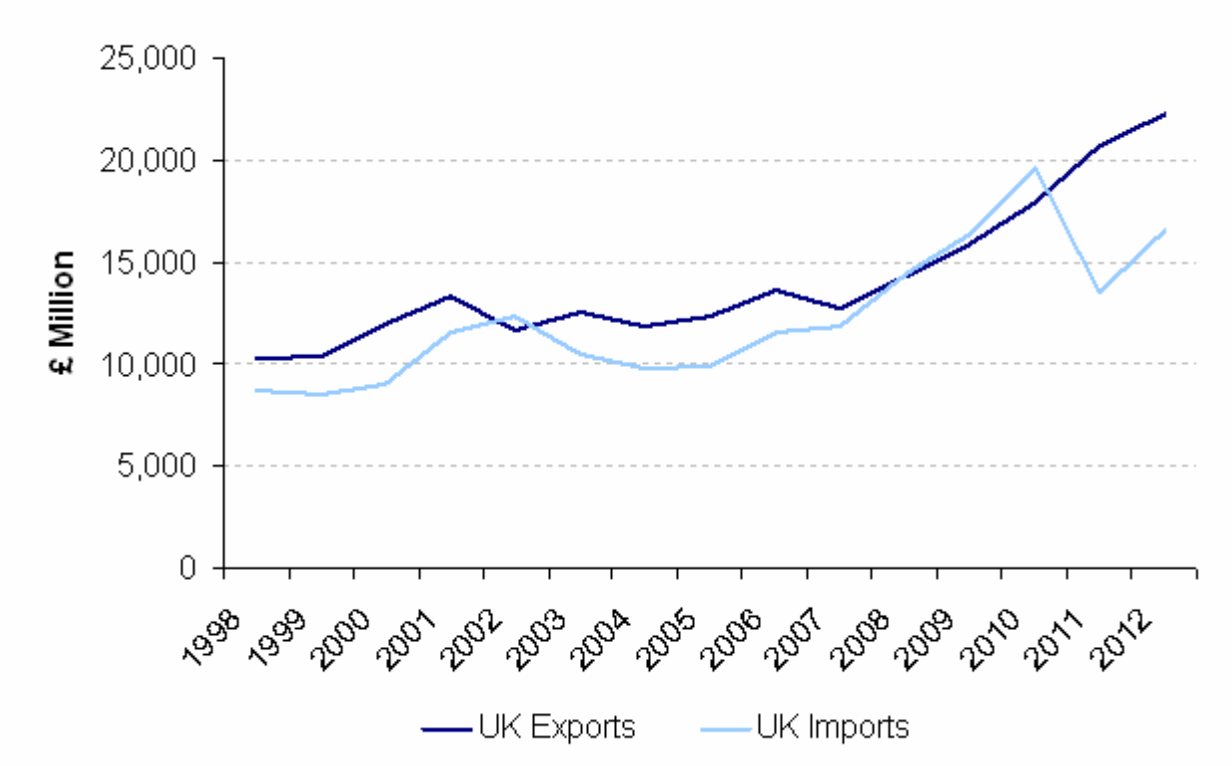
[74] Based on these current plans, global investment is estimated to be in the order of £930 billion, with significant international procurement expected to be around £25 billion a year to 2025.

[75] Source: IbisWorld (April 2012) *Report Top 10 Fastest Growing Industries.*

[76] Source: K-Matrix, Low Carbon and Environmental Goods and Services data (2010-11). Note all figures include the supply chain.

[77] Source: ITC database.

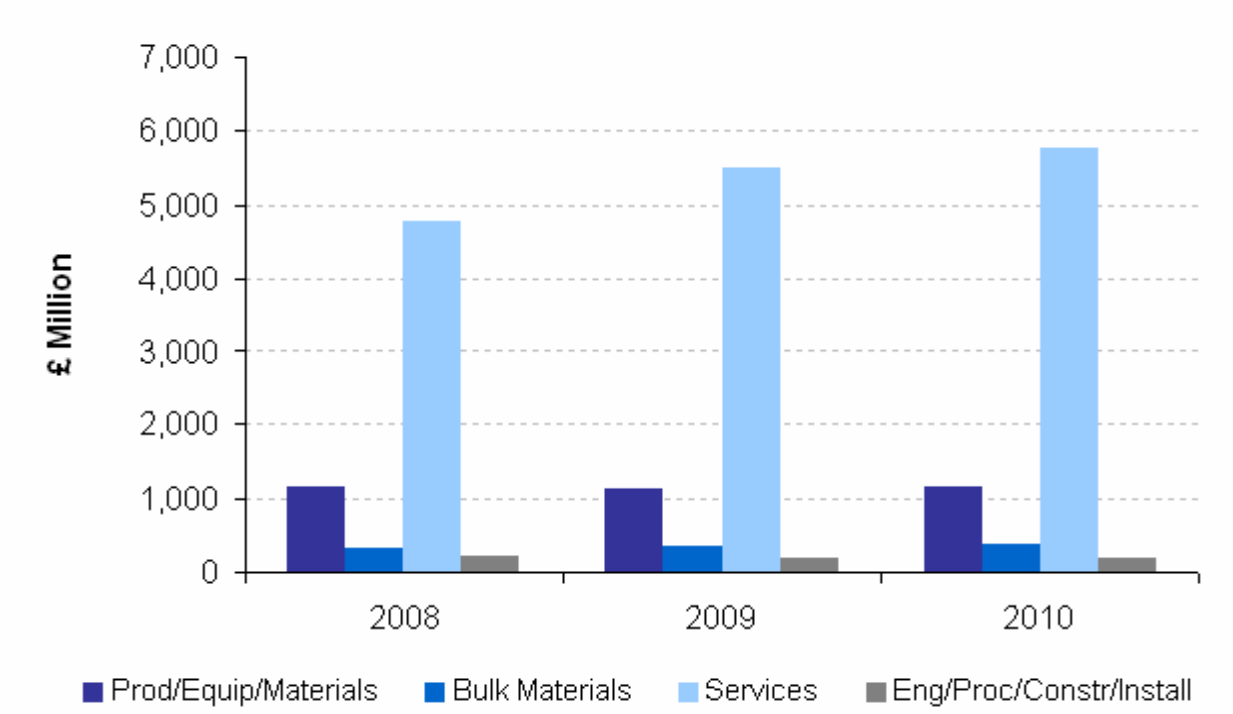
Figure 5.1: Aerospace exports and imports (1998-2011)



Source: MQ10 data, current prices, seasonally adjusted

- In the **oil and gas** sector the demand for UK goods and services are derived from the location of oil and gas production around the world. Data for Scottish firms suggests sales are substantial – over £7 billion in 2010 (Figure 5.2). The BP World Energy Outlook 2030 and IEA data suggest that Brazil, Iraq and Libya provide medium term opportunities where the UK supply chain could look to increase exports. This is particularly in areas of strength for UK industry such as: diving, drilling services, logistics and seismic services. Longer term opportunities include the Falkland Islands, Ireland, Kenya, Lebanon, Mexico and the Faroe Islands – territories that are starting to further explore their offshore resources.

Figure 5.2: Total international sales by Scottish firms in the oil and gas sector



Source: SCDI data

- The **Agri-tech** sector comprises a wide range of products - from fertilisers and tractors to biotechnology. The largest market for UK products is the EU and the most important products are wheeled tractors, fertilisers, insecticides and fungicides (Table 5.1). This could be a large market for UK companies and an opportunity for UK firms to capture future growth. Agriculture (and agri-tech) makes an important contribution to growth in countries like China, India and Brazil, and supports the livelihoods of a large proportion of their populations, providing opportunities for UK firms to sell products and expertise.

Table 5.1: UK agri-tech trade with main markets (2011)

	EU	Other Western Europe	Eastern Europe	North America	Latin America & Caribbean	Asia & Oceania	Middle East & North Africa	Sub-Saharan Africa
% of UK exports	60%	5%	1%	9%	10%	11%	2%	2%
% of UK imports	82%	3%	3%	4%	0.3%	3%	5%	0.1%

Source: BIS analysis of the HMRC trade data

- **IT and related data services** have grown rapidly in recent years giving rise to a number of new markets in which the UK is well placed to take advantage of future predicted global growth. They include:

- ***Cyber security*** – The UK was ranked number one in the Economist Intelligence Unit's Cyber Power Index in 2011[78]. The UK also has Centres of Excellence in Cyber Security Research to strengthen and enhance research capability and skills in this area. There are currently 11 universities across the country which have received this recognition[79]. Furthermore, the increased digitisation of information and services as well as the growing uptake of mobile devices are likely to offer growth opportunities in the cyber security sector. UKTI research estimates that the global cyber security market was worth £123 billion in 2011 with annual growth rates of 10%, positioning cyber security as the fastest-growing segment of the security market[80].

- ***Smart Cities*** -The pace of urbanisation in the developing world brings opportunities for UK companies with smart solutions and new and innovative technologies in Built Environment, Energy, Health and Digital. Smart grid and storage technologies are a major potential source of exports for the UK. Pike Research[81] forecasts that global investment in smart city technology infrastructure will total $108 billion during the years from 2010 to 2020 and annual spending will reach nearly $16 billion by 2020. The TSB also estimated that a global market for integrated city systems, potentially worth £200 billion annually, could develop by 2030[82].

- ***E-commerce*** - The UK has an advanced online market, and cross border trading therefore offers particular opportunities to increase UK businesses' online presence and sales in both domestic and international markets. There is a particular opportunity in the European market as the UK is the second most preferred destination for EU cross-border e-commerce with 24% of orders placed, compared to Germany (27%)[83]. Given that between 88% and 93% of UK businesses offer some distance selling[84] and there is appetite among a third of EU retailers for cross-border trade, there is a strong opportunity for UK firms to benefit from their position in the EU cross-border market, which could be worth up to €204 billion annually[85].

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[78] Source: Economist Intelligence Unit, 2011, Cyber Power Index, Findings and Methodology, commissioned by Booz Allen Hamilton, http://www.boozallen.com/media/file/Cyber_Power_Index_Findings_and_Methodology.pdf

[79] For a list of these universities please see the Academic Centres of Excellence in Cyber Security Research - EPSRC.

[80] Source: UKTI, 2013, Cyber Security – UK's approach to exports: http://www.ukti.gov.uk/defencesecurity/item/503520.html

[81] See Pike Research, Global Investment in Smart City Technology Infrastructure.

[82] Source: TSB, 2012, Future Cities Catapult, vision and scope: https://connect.innovateuk.org/c/document_library/get_file?uuid=93413bc6-e3d2-4ace-afc7-b7554136b7b6&groupId=6764506

[83] Source: Flash Eurobarometer 300, "Retailers' Attitudes towards cross-border trade and consumer protection", 2011.

[84] Source: Civic Consulting, "Consumer Market Study on the functioning of e-commerce and Internet marketing and selling techniques in the retail of goods", 2011.

[85] Source: European Commission, "A coherent framework to boost confidence in the Digital Single Market of e-commerce and other online services", 2012.

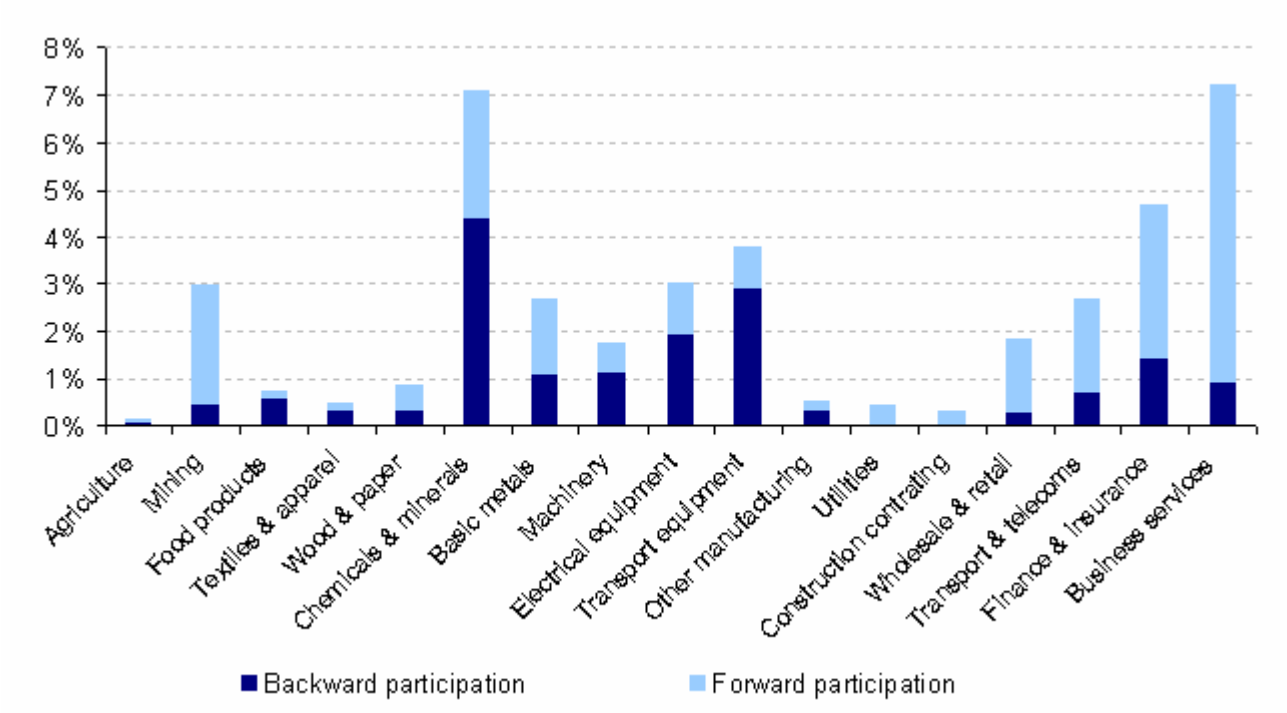
- **Big data -** excellence in data handling means that UK organisations could significantly benefit from exporting their expertise in big data analytics.

Opportunities may also arise where Information Economy companies develop products and services for other sectors where the UK has global leadership - financial services, fashion, creative and media, among others.

Growing Incomes and Changing Patterns of Demand

The UK is benefitting or forecast to benefit from increased demand for embedded or associated services across a range of sectors. For example, the UK's contribution to other countries exports is higher (24%) than other countries contribution to UK exports (17%). However, this does vary significantly by industry; typically other countries contribution to UK exports is much higher in manufacturing; and the UK's contribution to other countries exports is much higher in services - especially business and financial services - as shown in Figure 5.3 below.

Figure 5.3: Gross Value Chain participation by industry (2009)

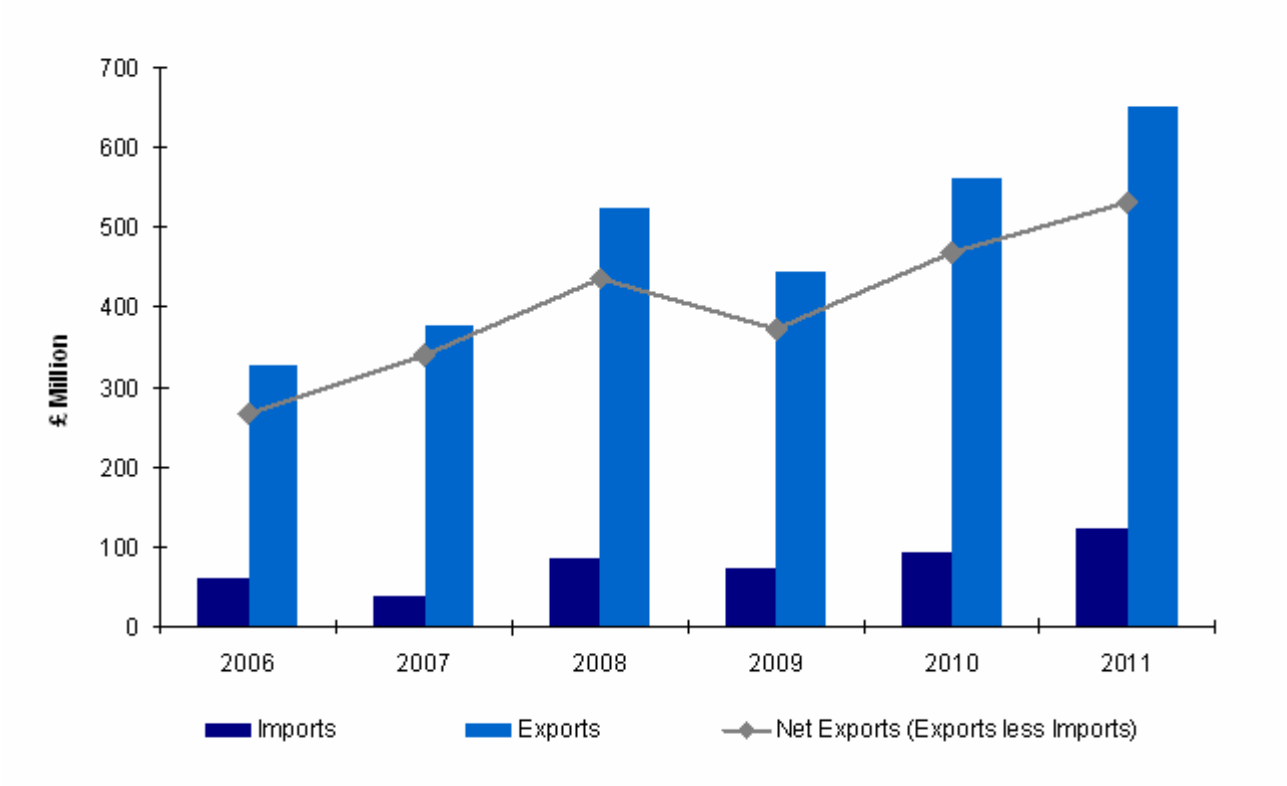


Source: OECD TiVA data
Note: Backward participation is when the UK uses other countries intermediates in its exports and forward participation is when other countries use the UK's intermediates in their exports. The industry level indicator is expressed relative to UK's total exports (instead of industry exports) in order to take into account the importance of the industry in the total export composition of the UK.

For example:

- The UK has a trade surplus of about £530 million in 2011 (see Figure 5.4) in exports of architecture and surveying services.

Figure 5.4: UK Trade in architecture and quantity surveying services

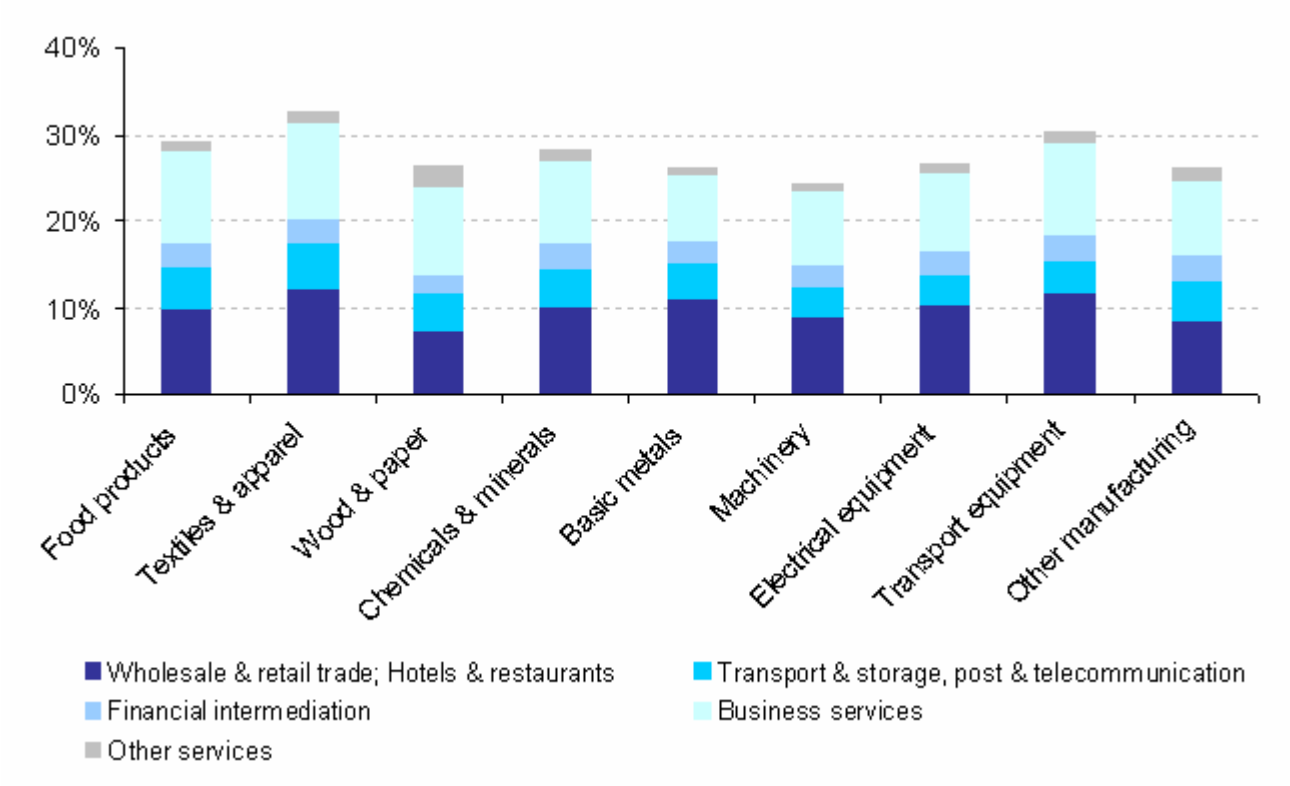


Source: ONS Pink Book 2012

- **Professional and Business Services** (PBS) generated exports of £47 billion and a trade surplus of £19 billion in 2011 (a third of total services surplus). Key export markets are the EU (£20 billion), US (£12.2 billion) and Switzerland (£4 billion). The UK sector has a revealed comparative advantage in business services[86]. Nearly one-fifth of firms operate internationally (above the whole economy average), and a quarter of UK firms that sell their goods and services internationally are from the PBS sector so remaining competitive is crucial to future success. PBS also makes a marked contribution to other sectors competitiveness, by helping their clients innovate, and through dissemination of knowledge and best practices. For example, around a third of UK manufacturing exports include value added from services: a large proportion of which comes from professional and business services (Figure 5.5).

[86] This strength is probably underestimated by trade statistics which don't fully capture the extent to which PBS firms operate overseas, either by travelling to the customer destination or establishing an overseas commercial presence.

Figure 5.5: Services value added embodied in manufacturing exports by industry (2009)



Source: OECD

- The UK has a reputation for high quality **education** with number of truly international education brands. The UK's position as the 'home of English' makes it an attractive destination for international students at all levels of education, and presents export opportunities in areas such as education-related publishing. Total UK education exports were around £17.5 billion in 2011, making education the fifth largest services export sector in the UK, ahead of both insurance services and computer and information services. The sector is currently the second largest global market after healthcare,[87] with total global expenditure estimated to be US$4.5 trillion in 2012.[88] As a result of demographic change and high levels of expenditure by emerging economies, the sector is forecast to grow by a compound annual growth rate of 7% per year over 2012-17, resulting in a global market size of US$6.3 trillion in 2017.[89] Within this expansion, educational technology and English language teaching are predicted to be the fastest growing markets (Box 5.2).

[87] Source: *GCC Education Industry Report*, 2010. Produced by Alpen Capital.
[88] Source: *Education Sector Factbook 2012*. GSV EDU.
[89] *Ibid.*

Box 5.2: Educational growth markets

Internationally mobile students - The UK is the most popular destination for students studying English outside of their home country, attracting nearly 50% of students globally in 2011. English Language Teaching (ELT) in the UK was worth £2.5 billion, representing 35% of the global market by value.[90] Globally, the majority of internationally mobile students are in the HE sector – 4.3 million in 2011.[91] The UK is the second most popular destination for these students, with a market share of 13% in 2011.[92]

The Higher Education Funding Council for England (HEFCE) and the British Council estimate[93] that the number of internationally mobile students coming to the UK will grow by 3.7% per annum until 2020. The global English language sector is forecast to grow by 25% per annum over 2012-17;[94] and the Independent Schools Council believes that the number of international pupils in the UK can increase at 3% per annum in the near future.

Transnational Education (TNE) - The market for students studying English in their home country is estimated to be worth over US$50 billion in 2012.[95] This market is forecast to be one of the fastest growing parts of the education sector, with compound annual growth of 25% per annum over 2012-17,[96] the vast majority of which will be students studying in their own country.

In 2012 there were 1.4 million pupils studying at British Schools Overseas (BSOs), with fee revenue estimated to be £9.6 billion.[97] The number of pupils at BSOs is forecast to grow to 2.75 million in 2022, with fee income rising to £17.2 billion.[98]

In 2011/12, there were 570,000 studying for a UK HE qualification at institutions abroad or via distance learning.[99] Approximately 75% of UK HEIs now engage in transnational education, in more that 200 countries. The ten largest providers account for 75% of all TNE provision.

Education Products and Services - British qualifications such as the General Certificate of Secondary Education (IGCSE) and Cambridge International A Level are the national secondary qualifications in some countries; the IGCSE is the world's most popular international qualification for 14-16 year olds. Information provided by awarding bodies suggests that the total income from overseas activities was around £210 million in 2011.

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[90] Source: Study Travel Magazine, 2011 Special Report, December 2012 edition.
[91] As measured by nationality. *Source:* OECD Education at a Glance 2013, box C4.1.
[92] Source: OECD Education at a Glance 2013.
[93] Based on reports from HEFCE and the British Council.
[94] Source: *Education Sector Factbook 2012*. GSV EDU.
[95] Source: BIS calculations based on *Education Sector Factbook 2012*.
[96] Source: *Education Sector Factbook 2012*. GSV EDU.
[97] Source: ISC Research Ltd.
[98] Ibid.
[99] Source: HESA Aggregate Offshore Record.

In 2011, total education-related publishing export income, from both physical and digital products, was worth £858 million.[100] According to the British Educational Suppliers' Association (BESA), in 2011 exports of educational supplies and equipment were estimated to have been worth £507 million. This was expected to rise to £580 million in 2013.[101] BESA has identified the following areas in particular as target regions for future exports: the Gulf, East Asia and the EU. We have identified Brazil, China, India, Indonesia, Mexico, Saudi Arabia and Turkey and the Gulf region as priority countries to seek opportunities to increase the UK's international education provision and influence.

[100] Source: The Publishers Association Yearbook 2011

[101] Source: BESA research report: Education Export Market Performance Outlook, January 2012.

6. Conclusions

Industry supply chains

The nature of industry supply chains varies critically by sector, and our analysis takes a sector approach to identify the contribution they make to UK production; why the UK supply chain is as it is now; and what opportunities exist for UK based businesses to capture larger share of supply chain business.

For most of manufacturing and services, much of the demand for goods and services is sourced domestically. However, for higher-tech manufacturing and certain knowledge services such as R&D, a high proportion is from imports. For example, some UK manufacturing sectors are highly integrated into global supply chains with foreign businesses accounting for around 20-30% of the value added in UK exports. This may partly reflect the greater influence of globalisation where activities have been moved to locations where they can be produced most cost-effectively.

Supply chains tend to be structured in different ways depending on the sector they support. In sectors such as oil and gas, historically, a high degree of vertical integration takes place along the value chain where, for example, there is value in closely managing transaction costs and risks to ensure continuous supply. At the other extreme, sectors such as construction display a high level of fragmentation reflecting high levels of specialisation and risk transfer.

Supply chains are dynamic and changes in relative costs and assessments of risks have led to a re-evaluation of their structures by a number of companies with, for example, new models of collaboration between UK OEMs and suppliers. These developments indicate opportunities for UK based businesses to capture a larger share of supply chain business as firms reappraise risks, low cost locations become more expensive, and firms in high cost locations develop business models based around flexibility and collaboration. A recent study by Oxford Economics and Atkins, commissioned by BIS, suggests that the UK supply chain has the capacity to capture over 40% of the value of a new reactor which could rise to about 60% with wider policy intervention and greater industry involvement.

The extent, however, to which the UK can capture some of the value will depend on businesses ability to improve key capabilities in innovation and skills, and the impact of continued targeted public support, such as that provided by the Advanced Manufacturing Supply Chain Initiative (AMSCI).

Investment in innovation and skills

Innovation is a significant driver of economic growth and accounts for around a half of all labour productivity growth. Its relationship with growth is not, however, straightforward. Successful economies create innovation systems that encourage learning by doing, networking and collaboration, supported by a stable and certain institutional framework.

In a number of sectors, networking and collaboration has suffered which has limited the scope for learning by doing and deriving the economic benefits that arise from it.

Particular examples include the loss of publicly funded applied R&D facilities in Agri-tech; the potential need for increased use of standards in the Information Economy sector, and high levels of industry fragmentation in the Construction sector. Targeted support, such as public investment in an Agri-Tech Catalyst and Centres for Agricultural Innovation, will help address this.

General Purpose Technologies, including the "8 great technologies", have the potential to radically reshape industries and wider society. They include new advanced materials – important for aerospace – such as robotics, and synthetic biology. The Information Economy sector is a potentially rich source of General Purpose Technologies, particularly in data science, the 'internet of things' and cloud computing. These will have a significant impact on delivery of Professional and Business Services. Other opportunities exist too, such as the potential for massive online open courses to radically change education delivery, or haptic technology which allows manual skills to be practiced virtually. The latter potentially has a very wide application across all sectors.

To benefit from new opportunities, a stable and certain institutional framework will be required for investment in long-lived assets with high up front costs, particularly for sectors like Nuclear and Offshore wind which rely on a predictable carbon price regime. It also applies to automotive, where a transition to low carbon propulsion systems will also require the capture of additional inward R&D investment. In oil and gas, investments in technology and a stable tax regime are needed, to take advantage of significant opportunity to increase recovery rates in the North Sea. The establishment of the Aerospace Technology Institute and the Advanced Propulsion Centre will increase the level, and certainty, of funding for R&D in advanced manufacturing.

Innovation by firms has implications for skills demand as skills are a derived demand and depends on the product market strategies adopted by firms. The talent of the UK's current and future workforce is an intrinsic part of securing competitive advantage and economic growth. The evidence from the strategies is that there is significant current and potential future demand for skills across many of the sectors. But whilst the UK has relatively low levels skills deficiencies, they are often concentrated in key roles within sectors and have been persistent for some time. Consequently they impact on firm performance and the economy's overall competitiveness.

In part there is a lack of supply of some skilled labour reflecting unsuitable qualifications and courses where the education establishments have failed to keep pace with developments in industry. But businesses have a significant role to play. Attracting sufficient numbers of suitably qualified individuals will mean thinking more strategically about firms' skills resource. This will mean not only focusing on the available compensation package offered, but also the availability of training to demonstrate the sector's commitment to individual development, flexible ways of working that are more suited to those with caring responsibilities, and a career path that appeals to a more mobile labour force. For many firms this will mean improving the level of management skills too, to ensure that best use is made of existing skills.

It is clear that many sectors need to do more to improve their appeal to a wider section of society, particularly in terms of gender (Oil and Gas, Construction, Information Economy and Nuclear) and socio-economic background (Professional and Business Services). For many sectors this will mean a more concerted and co-ordinated effort to change the image

of their sector and to engage with potential sources of talent, some of which will not be traditional sources. More generally, the establishment of industry sector councils provides the opportunity for sectors to take a more co-ordinated and strategic approach to skills and training. Through round two of the Employer Ownership Pilots the Government is helping employers to tackle the skills challenges that matter to them, and supporting the creation of industrial partnerships to take end-to-end responsibility for skills in industrial strategy sectors.

Growth opportunities

The sector strategies cover markets where societal drivers indicate there is likely to be significant increasing domestic and global demand and where UK business has the potential knowledge and skills to exploit new market opportunities (i.e. the UK has a comparative advantage in global markets in virtually all these areas). Unsurprisingly, therefore, nearly all sector strategies cited the ability to succeed in an increasingly globalised economy as key to future success. Prospects for trade vary, however, by sector and the various sector analyses picked up on opportunities from the following areas:

- **Environmental regulation** is creating new demand for low-carbon technologies and resource efficiency, and UK policy measures to boost low-carbon energy have put it in a strong position to benefit from future growth in the energy market. For example, there is growing global demand for renewable energy to meet climate change targets, security of supply and energy demand. The UK Offshore Wind sector is predicted to deliver up to £18 billion in net exports by 2030. Professional and Business Services identified carbon reporting and management as a source of future growth.

- **Technological advances** also present major opportunities for a range of sectors from Automotive and Aerospace to Agricultural technology as growing populations, with rising incomes, demand ever more efficient production of goods and services. In addition, new technologies are also leading to the creation of entirely new markets in areas such as the Information Economy (e.g. Big Data) and even more established sectors such as Oil and Gas (e.g. shale gas extraction).

- The rising populations, and increasing per capita incomes in a large number of developing and emerging markets, is likely to lead to **increased demand** for consumer goods and higher-value goods and a greater range of services from a growing and aspiring middle-class. Examples of opportunities include increased exports of Professional and Business Services and Educational exports, building on well-established UK brands.

Looking ahead trade agreements provide further potential growth opportunities. The EU is pursuing an ambitious programme of trade negotiations, of which the recently launched Transatlantic Trade and Investment Partnership (TTIP) with the US is the most significant. Concluding these ambitious agreements could in the long run increase EU GDP by some 2%.

Finally, our sector analytic work has identified evidence of significant variations in competitive conditions across the various strategy sectors, giving insights into how to design and deliver horizontal policies more effectively. It will be important to ensure that the Government continues to interact with sectors in a pro-competitive way, and that we support the ability of a wide range of firms to compete and grow, in order to secure most benefit from a sector approach for UK economic growth.

Annex: Economic contribution of industrial strategy sectors

	Output (GVA billion)	% of UK Total	Employment	% of UK Total
Aerospace	£7.3	0.5%	118,000 [i]	0.4%
Automotive [ii]	£11.2	0.8%	129,000	0.4%
Construction [iii]	£90	6.7%	2.93 million	10%
Education [iv]	£88.2	6.4%	2.77 million	8.7%
Information Economy [v]	£58	4.2%	885,000	4.8%
Life Sciences [vi]	£11.8	0.9%	160,000	0.5%
Nuclear [vii]	N/A	N/A	ca. 40,000	0.1%
Offshore Wind [viii]	N/A	N/A	ca. 4,000	0.01%
Oil and Gas	£24.8	1.8%	35,000 [ix]	0.1%
Professional Business Services [x]	£153	11.2%	3.8 million	12.0%

Source: Industrial Strategies and ONS data - Annual Business Survey 2011 or National Accounts and Workforce Jobs, 2012; unless stated otherwise. See notes below.

Notes: Direct sector comparisons should be made with some caution as they may be based on different data sources and time frames.

(i) Includes direct jobs only. The Aerospace Strategy identified about 230,000 direct and indirect jobs in the aerospace sector.

(ii) Source: ONS Annual Business Survey 2011 provisional results.

(iii) Construction includes construction contracting industry, provision of construction related professional services, and construction related products and materials. GVA figures from the ONS Annual Business Survey (2011 provisional results), employment figures from the ONS Labour Force Survey (Q1 2013 non-seasonally adjusted).

(iv) Education statistics include economic contribution of domestic and foreign students but exclude educational products and services.

(v) For the purpose of the Strategy, Information Economy is defines as: Software, IT services and Telecoms services. In addition to the 885,000 jobs directly provided by information economy businesses, there are estimated to be a further 600,000 IT jobs in other sectors of the economy. Note that the wider ICT sector contributed around **8% (£105 billion**) to GVA (at current prices) and there were around **1.3 million** jobs in the ICT sector in **2011**.

(vi) Source: ONS Annual Business Survey (2011) and BIS Bioscience and Health Technology database.

(vii) Source: Industrial Strategy: UK's Nuclear Future (2013). There are no GVA stats available. Commercial turnover estimated at £4 billion.

(viii) Source: Industrial Strategy and RenewableUK; 2012 data.

(ix) The Oil and Gas Industrial Strategy identified that some 400,000 jobs are supported directly and indirectly by the upstream oil and gas industry.

(x) Source: Industrial Strategy for Professional and Business Services based on ONS statistics. GVA data for 2011 and employment data for 2012.

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Department for Business, Innovation and Skills
1 Victoria Street
London SW1H 0ET
Tel: 020 7215 5000

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