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Manufacturing in the UK: An economic analysis of the sector

DECEMBER 2010

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Foreword

The strategy document “Path to strong, sustainable and balanced growth” sets out the Coalition Government’s commitment to returning the economy to a path of long-term growth which is sustainable and more balanced across regions and industries.

To help achieve this, the Government is launching a series of sector reviews, the first of which is the *Advanced Manufacturing Growth Strategy Review.* This sets out the Government’s ambitions for UK manufacturing and issues a call for evidence on the barriers currently inhibiting the growth and export performance of manufacturing industries.

This analytical paper, published alongside the *Growth Review Framework for Advanced Manufacturing*, provides evidence and analysis on the UK manufacturing sector. It sets out some of the characteristics of UK manufacturing and the way in which the sector has evolved in response to increased globalisation and international competition from emerging economies. In particular, it shows how modern manufacturing has extended beyond production to include activities such as research and development and design with many manufacturers offering associated services as a means of differentiating themselves from their low-cost competitors.

The paper uses case study examples to illustrate how different manufacturing industries may be expected to benefit from long-term changes in demand driven by rising incomes, technological progress, higher environmental standards, greener products and demographic and lifestyle change.

The paper also explores the extent to which UK manufacturers are well placed to take advantage of the new opportunities, taking account of current productive capabilities in the manufacturing sector and the barriers to innovation, growth and exporting that UK manufacturers continue to face.

I am grateful for the many contributions we have received in developing this analysis, including key insights from UK manufacturing industry. We welcome any comments you may have on the analysis set out in this paper.

Ken Warwick
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Executive Summary

The manufacturing sector is diverse, comprising a wide-ranging number of different industries, technologies and activities. Alongside established industries such as food and drink, aerospace, pharmaceuticals, electronics and automotive, new industries are beginning to develop based around new emerging technologies. These include low carbon, industrial biotechnology, nano-technology, digital and advanced materials such as composites.

In 2009, manufacturing was the third largest sector in the UK economy, after business services and the wholesale/retail sector in terms of share of UK Gross Domestic Product. It generated some £140bn in gross value added, representing just over 11% of the UK economy. It also employed some 2.6 million people, representing over 8% of total UK employment.

UK manufacturing and future opportunities in the global economy

A key feature of the latest phase of globalisation has been the globalisation of the manufacturing value chain. As a result of improvements in global transport infrastructure, advancements in information and communication technologies, and significant progress in the elimination of tariff and non-tariff barriers, manufacturers are now able to separate the different parts of the manufacturing value chain and carry out particular economic activities in different geographical locations around the world.

As the rate of globalisation has accelerated, competition in domestic and international markets for manufactured goods has intensified. As well as competition from other leading manufacturing countries such as the United States, France, Germany and Italy, UK manufacturers are now facing increasing competition from emerging economies which are steadily moving up the value chain into higher value activities and industries.

Manufacturers in developed countries, including the UK, have responded to the rise in globalisation and increased international competition by outsourcing and offshoring to emerging countries lower value activities in the company's value chain such as production. This has enabled them to enhance their productivity and reduce costs while at the same gaining important access to fast growing emerging markets.

At the same time, manufacturers in developed countries have sought to differentiate themselves further by shifting away from traditional business strategies based around the sale of a particular product to new models where the sale of a product is combined with associated services. This trend is referred to in the literature as the '*servitization*' of manufacturing. In 2005, the UK manufacturing sector accounted for around 14% of the total value of services exports.

Over the next few decades, domestic and global demand for products and services is anticipated to change. This will be driven by a range of factors including rising incomes, increased demand for higher environmental standards and greener products, demographic and lifestyle change, continuing technological progress and rapid growth in emerging markets.

These trends will influence the long-term growth prospects for UK manufacturing. The new product and geographical market opportunities generated as a result of these trends could lead to the emergence and expansion of new industries, particularly those based around new technologies. In some cases, these trends could lead to a revival of those manufacturing industries which previously may have been stagnating or in decline.

Manufacturing industries which could benefit from the expected changes in global and domestic demand include Life Sciences, automotive, electronics, food and drink, aerospace, space, composites and low carbon.

Strengths and capabilities in UK manufacturing

As globalisation has gathered pace, so the characteristics of UK manufacturing have changed significantly. Much of the activity in modern day manufacturing involves high levels of technological and non-technological innovation and investment in skills, knowledge and intangible investment such as branding, software, marketing and training. This has led to the development of new, better quality and more sophisticated products, and more innovative business models and processes.

In common with leading manufacturing countries such as Japan, Germany and the United States, the UK has increasingly specialised in higher-technology manufacturing industries such as aerospace and pharmaceuticals. This compares with emerging economies including Brazil, Russia, India and China which have specialised to a greater extent in lower technology industries such as textiles.

Over time, the competitive advantage of different countries in dynamic industries characterised by high levels of innovation and technological progress will change as new improved products are developed and brought to market. It is therefore important to consider also the UK's current strengths in different areas of technology as they can provide a useful indication of where the country's competitive advantages could lie in the future. Current patent activity suggests that the UK is presently relatively strong in the areas of organic chemistry, biotechnology/ pharmaceuticals and medical technology and weaker in the areas of electronics, optics and nano-technology and information technology.

Faced with increased competition from emerging economies, UK manufacturers must continue to develop their productive capabilities in order to remain internationally competitive. The UK compares well against the leading industrialised countries on various measures of innovation including research and development and investment in intangible assets.

The proportion of firms which are exporting is also increasing in many manufacturing industries. Engaging in other markets can prove highly beneficial for UK manufacturers since it enables them to keep at the forefront of ongoing developments in innovation and technology through greater exposure to new ideas and knowledge and access to customers/ suppliers and skills around the world.

The barriers to innovation, growth and internationalisation

Government intervention may be justified when markets for labour, capital, knowledge, goods and services fail to function properly. This is because, without remedial action, market failures may produce outcomes which do not deliver the maximum possible benefits for businesses, consumers, the wider economy and society.

The main types of market failure which may be found in manufacturing relate to skills, innovation, investment, supply chain collaboration and institutions. The actual nature and severity of these market failures may vary across the sector, reflecting the specific characteristics of the different manufacturing industries.

For example, firms may under-invest in important skills if they are unable to fully appropriate the benefits of their investment in training because some of the benefits spill over to other firms. The dynamic nature of modern manufacturing may also make it difficult for employers as well as employees to accurately predict the skills sets which could be required in the future.

The existence of spillovers associated with innovation activity, including research and development, may similarly reduce the incentive for firms to invest in innovation. Significant uncertainties around new market opportunities and co-ordination failures associated with the development and commercialisation of new ideas and products can also constitute major barriers to innovation and growth in certain manufacturing industries, particularly those based around emerging technologies.

UK manufacturers may also face barriers to internationalisation. Firms may not be fully aware of the potential benefits of exporting and lack the necessary knowledge and capability to successfully exploit overseas opportunities. Significant international differences in culture, language, and regulatory frameworks, particularly with respect to intellectual property protection can also discourage UK manufacturers to access overseas markets.

UK manufacturing in the global economy

Defining the UK manufacturing sector

The manufacturing sector is diverse, comprising a wide-ranging number of different industries, technologies and activities. These vary significantly in terms of the economic value they generate, reflecting differences in their use of particular factors of production (raw materials, physical capital, intangible investment, skilled and non-skilled labour, and knowledge) and the value which they are able to generate from them.

Manufacturing is the third largest sector in the UK economy, after business services and the retail sector[1] in terms of share of UK Gross Domestic Product (GDP)[2]. In 2009, the UK manufacturing sector generated around £140bn in gross value added (GVA)[3], representing just over 11% of the UK economy[4]. It also employed around 2.6 million people, representing over 8% of the UK workforce[5].

The manufacturing sector comprises a variety of industries. The full list, as current defined in the 2007 Statistical Industry Classification (SIC) code system for industry statistics, are as follows:

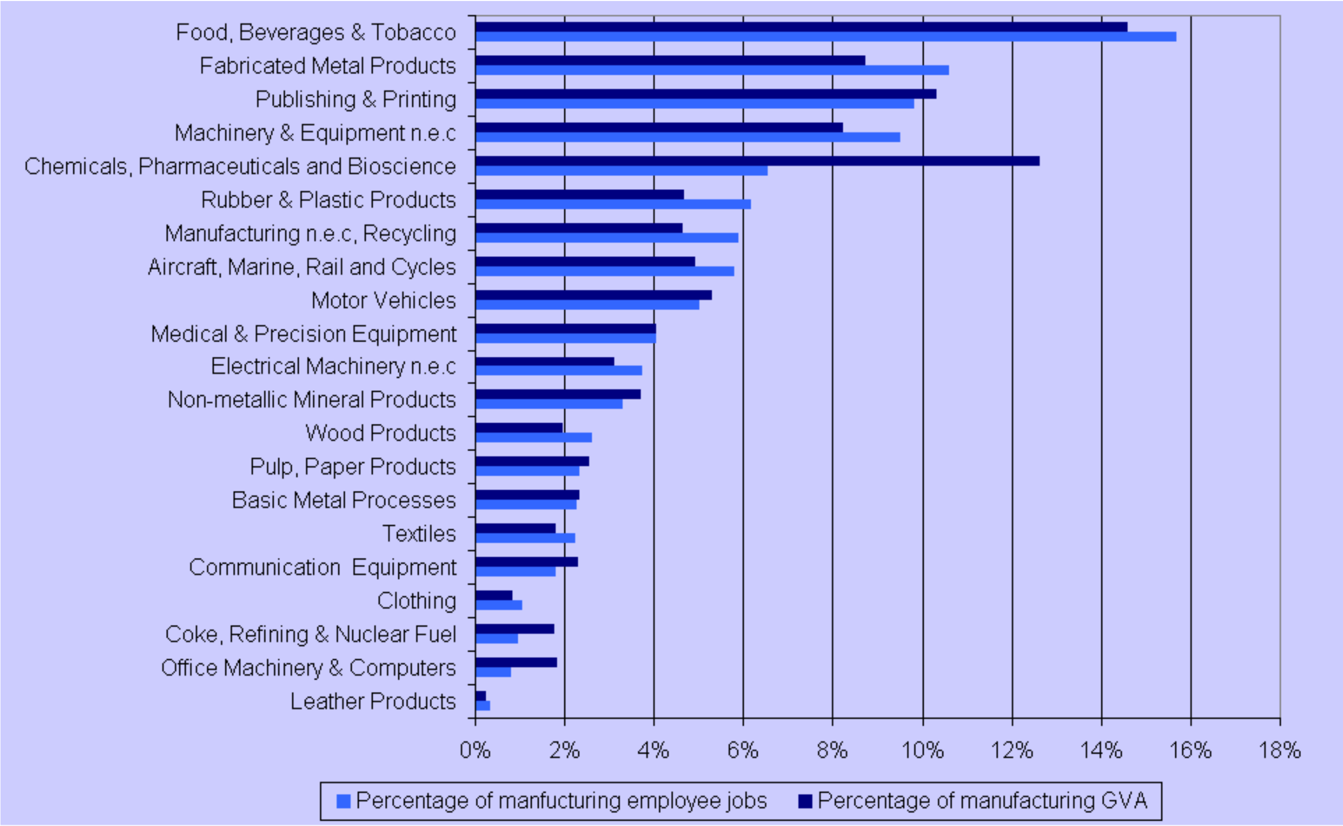
- Food, beverage and tobacco products
- Textiles and textile products
- Wood and wood products
- Pulp, paper and paper products
- Publishing and printing
- Coke, petroleum products and nuclear fuel
- Chemicals, chemical products and man-made fibres
- Rubber and plastic products
- Other non-metallic mineral products
- Basic metals and fabricated metal products
- Other machinery and equipment
- Electrical and optical equipment
- Transport equipment
- Other manufacturing

Some industries account for a relatively larger share of total gross value added and employment in the UK manufacturing sector. In 2009, four major industries – food, beverages and tobacco, chemicals and pharmaceuticals, publishing and printing and fabricated metals – were the main

[1] Wholesale and retail distribution
[2] National Accounts, Blue Book, Office for National Statistics (ONS)
[3] Ibid
[4] This compares with some £150bn in 2009 and £154bn in 2007 before the economic downturn
[5] Labour Force Statistics, ONS, 2010. Statistics relate to September 2009.

contributors to total manufacturing gross value added (GVA)[6] and employment, accounting for around 46% and 43% respectively (see Figure 1 below).

Figure 1: Share of different industries to total manufacturing GVA and employment, 2009

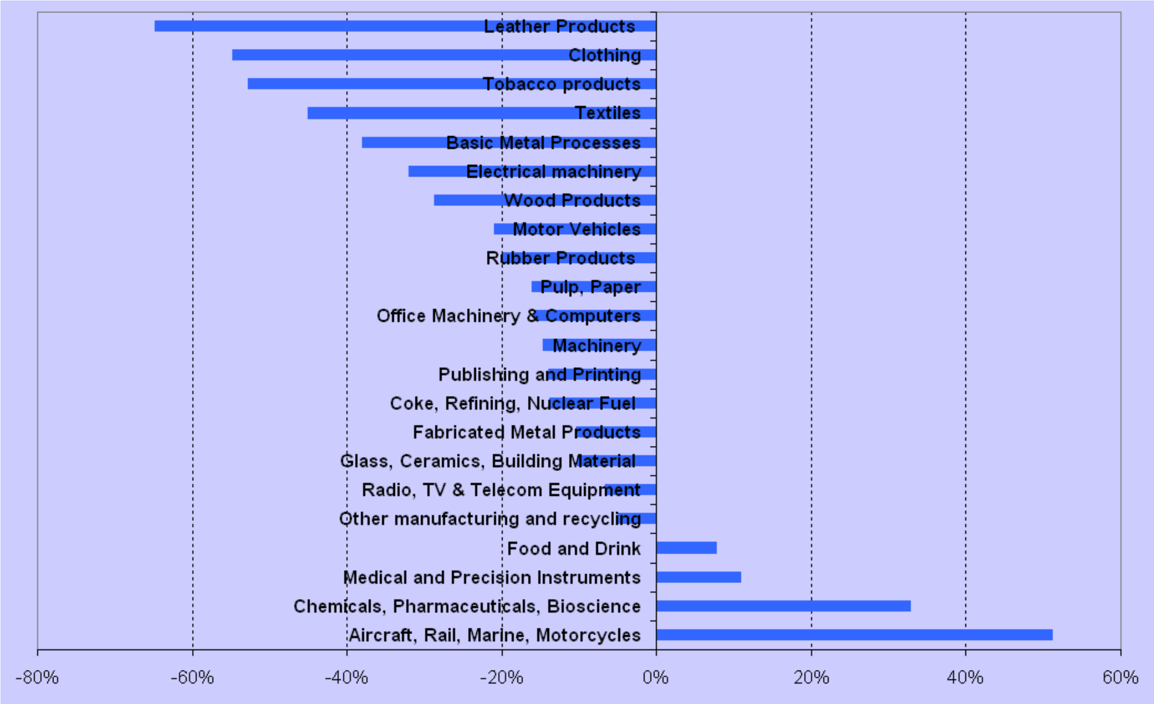


Source: ONS statistics, Employee jobs and National Accounts

Over the last fifteen years, there has been considerable change in the relative economic importance of different manufacturing industries. As Figure 2 overleaf shows, in terms of real value added relatively higher technologies industries have grown in size while relatively lower technology industries have contracted.

[6] Gross Value Added (GVA) is the difference between the value of output and the value of inputs used to produce it and is measure of an industry's contribution to GDP excluding taxes less subsidies.

Figure 2: Manufacturing sector percentage growth or contraction in real value added, 1994 - 2009



Source: BIS estimates based on ONS statistics, Employee jobs and National Accounts,

There is a high degree of interdependence between industries within the manufacturing sector. This is because the output of one manufacturing industry can often be a crucial input for another manufacturing industry. For example, the basic metals and fabricated metal industries produce metal sheeting for the automotive and wider transport equipment industries.

More broadly, manufactured products may be a factor of production for other sectors of the economy. For example, the electronics industries produce electrical and electronic components for the telecommunications and computer and IT services sectors while the manufacturing equipment industries produce important plant and machinery for the agriculture and construction sectors.

Table 1 overleaf reports the results of BIS analysis of UK input-output tables. It shows, for selected manufacturing industries, the share of output which is absorbed by other industries in the manufacturing and non-manufacturing sectors of the UK economy.

Table 1: Share of manufacturing output used as inputs in other industries, 2008

	% total output used as inputs in other manufacturing industries	% total output used as inputs in other non-manufacturing industries
Chemicals excl. pharmaceuticals	36.2%	9.9%
Pharmaceuticals	8.6%	36.3%
Rubber and plastic products	33.9%	33.8%
Other non-metallic mineral products	17.0%	57.7%
Basic metals and fabricated metal products	51.1%	11.9%
Machinery and equipment nec	17.7%	13.4%
Electrical and optical equipment	15.5%	24.5%

Source: BIS analysis of UK Input-Output tables, 2008

Manufacturing: a technology perspective

Manufacturing also comprises a number of technologies, some of which have the potential to become general purpose technologies (GPTs), capable of significantly transforming economic activity across all sectors of the economy, by enabling businesses to design, develop and introduce radically new products, processes and business models (see Box 1 below).

Box 1: General Purpose Technologies (GPTs)

Some newly emerging technologies have the potential to completely revolutionise economic activity. These are referred to as General Purpose Technologies (GPTs). Often cited examples of previous GPTs include steam, electricity, railways, motor vehicles, airplanes and more recently information and communication technologies (e.g. computers and the internet).

Bresnahan and Trajtenberg (1995) argue that for a technology to be classified as a GPT it should have three characteristics. First, it is should be *pervasive*, underpinning activity in most sectors of the economy. Second, there should be dynamic economies of scale, in that user costs should decline over time as the GPT improves. Third, it should promote innovation in the form of significantly new products and processes.

In the early stages of adoption, they argue, productivity may fall as firms adapt their business models and processes around the new technology. In the longer run however, productivity is likely to increase as new smaller firms with ideas and products based around the new technology enter the market, ultimately forcing out those firms which are based around the older technology.

Potential GPTs in the coming years could include low carbon technology, space enabled technology, biotechnology, nanotechnology, digital and advanced materials such as composites.

Source: DTI (2007) *Innovation Trends: Prioritising Emerging Technologies Shaping the UK to 2017* DTI Economics Paper No .8

Alongside established technologies such as information and communication technologies (ICT), new enabling technologies are emerging in the areas of materials, tools, transportation, power, information and communication and organisation[7]. A number of these have already begun to establish themselves as industries of significant economic importance in their own right. New enabling technologies include:

Low carbon and environmental technology

According to latest estimates by Innovas (2010), economic activities falling under the definition of the emerging low carbon and environmental sectors – including alternative fuel vehicles, alternative fuels, building technologies, carbon capture and storage technologies, renewable energy and waste management technologies – had an estimated value in the region of £112bn and employed roughly around 910,000 in 2008/9[8].

Advanced materials (e.g. composites)

The manufacture of composite materials comprises three elements: the production of fibre and resins, the production of semi-finished woven and pre-preg materials, and the production of composite components and structures. According to Ernst and Young (2010), value added of UK composite production was estimated to be in the region of £1.1bn in 2009[9].

Nanomaterials and nanotechnology

Nanomaterials and nanotechnology refers to the design, development, production and application of structures, materials and devices less than 0.000,000,1 meters in dimension. Estimates suggest that the UK accounts for around 5-15% of the global market, the value of which ranged from about £6bn to upwards of £183bn in 2007[10].

Biotechnology

The medical biotechnology sector is primarily focused on the invention, development and bringing to market of a range of new therapies based on technologies such as antibodies, recombinant proteins, and gene and cell therapy. In 2008, the UK medical biotechnology sector, comprised around 340 companies, generated around £5.5bn in turnover and employed around 37,000 people[11].

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[7] DTI (2007) *Innovation Trends: Prioritising Emerging Technologies Shaping the UK to 2017.* DTI Occasional Paper No 8.

[8] Innovas (2010) *Low carbon and environmental goods and services: an industry update 2008/09* http://www.bis.gov.uk/assets/biscore/business-sectors/docs/10-795-low-carbon-environmental-goods-analysis-update-08-09

[9] Ernst and Young (2010) UK *Composites Supply Chain Scoping Study for UKTI and BIS* – key findings (unpublished)

[10] Technopolis Group (2010) *Expertise and excellence in NINJ technologies.* Final national report to the RDA network

[11] BIS Bioscience and Health Technology Database, 2008 figures. Note data includes supply chain and services firms.

Digital technology

Digital forms part of the generic group of technologies known as information and communication technologies (e.g. computers and the internet). In 2008, the ICT sector, which includes hardware, software and computer services, generated nearly £100bn in gross value added, representing around 7% of GDP and employed some 1.2 million people. Digital technologies are fast becoming a key component of many consumer electronic products including mobile phones, MP3 players and digital cameras[12].

The impact of globalisation on UK manufacturing

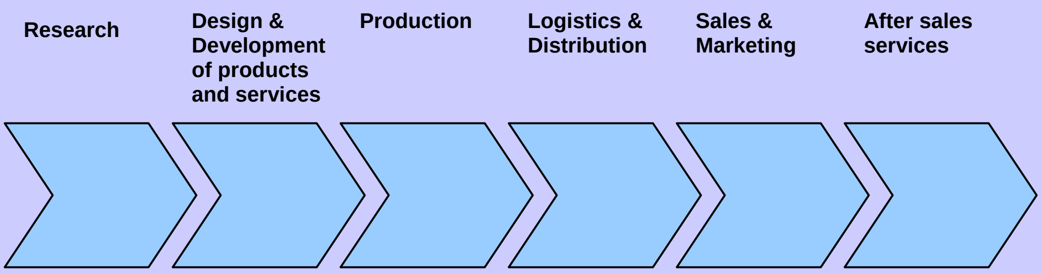
A key feature of the latest phase of globalisation has been the globalisation of the manufacturing value chain. Improvements in global transport infrastructure, advancements in information and communication technologies, and significant progress in the elimination of tariff and non-tariff barriers on manufactured goods has enabled information, knowledge, labour, capital, goods and services to travel over longer distances much more quickly and cheaply than before.

As a result of these developments, manufacturers are now able to separate out the different parts of the manufacturing value chain (as shown in Box 2 below) and carry out particular economic activities in different geographical locations around the world.

The globalisation of the value chain is more advanced in higher technologies industries. This is because higher technology manufacturing products are relatively more complex and many firms often no longer have the necessary capability in-house[13].

Box 2: The manufacturing value chain

Manufacturing is often perceived as merely production – the process of transforming raw materials and semi-finished products either into new more complex goods or for final sale to consumers. In reality, production is often only one aspect of the manufacturing process or *value chain* comprising a number of other vitally important functions as shown below.



As the rate of globalisation has accelerated, competition in domestic and international markets for manufactured goods has intensified. For many years, UK manufacturers have faced competition from other leading manufacturing countries such as the United States, France,

[12] Technopolis Group (2010) *Expertise and excellence in NINJ technologies.* Final national report to the RDA network
[13] OECD (2007) *Staying competitive in the global economy: moving up the value chain*

Germany and Italy which have similar strengths in terms of their stock of knowledge, skills, science and research base and investment in innovation, including research and development.

However, the UK is increasingly facing stronger competition from the emerging economies, in particular Brazil, Russia, India and China – collectively known as the BRIC countries – which are steadily developing productive capabilities in higher value manufacturing industries and activities where the UK has traditionally enjoyed a competitive advantage.

Outsourcing and offshoring in manufacturing

One of the ways in which manufacturers in developed countries, including the UK, have responded to the rise in globalisation and increase in international competition has been to outsource and offshore to other countries particular functions in the company's value chain.

Manufacturers have been motivated to offshore and outsource for three key reasons[14]. First, it enables firms to reduce costs and enhance their productivity[15]. Secondly, offshoring and outsourcing offers firms a means of entering and expanding in emerging geographical markets. Third, it provides an opportunity to gain access to strategic assets in other countries such as skilled workers, technological expertise or new ideas and knowledge.

Traditionally, manufacturing firms have tended to offshore and outsource low value, high volume functions such as production and assembly. This has mainly been because they are labour intensive activities and as such have been moved to lower wage cost countries to reduce costs. In some cases, however, firms have been motivated to transfer the final stages of the production to other countries in order to be closer to the point of final sale, particularly if slight modifications to the final product are needed to customise it for the local market[16].

The offshoring of lower value activities such as production has often been associated in the media with jobs losses as production moves abroad to lower wage countries such as China and India. Yet, recent research from the University of Nottingham (2009) suggests that this can actually result in job creation[17].

Increasingly, manufacturing firms are also offshoring and outsourcing higher value company functions including research and development. For example, in the pharmaceuticals sector, Contract Research Organisations (CROs) are increasingly used for outsourcing clinical trials. CROs now account for over 40% of annual research spending by pharmaceutical firms, compared to 4% in the early 1990[18].

The internationalisation of research and development has gathered pace in recent years as a result of further advancements in information and communication technologies, the growth in the number, and geographical spread, of multinational companies and the development of science and technology capabilities in emerging countries.

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[14] OECD (2007) *Staying Competitive in the Global Economy: Moving up the Value Chain:*
[15] Girma, S., Gorg, H. (2002) *Outsourcing, foreign ownership and productivity: Evidence from UK establishment level data GEP* Research Paper 2002/16. University of Nottingham.
[16] This is particularly true for electronic products. *Competitiveness in the UK Electronics Sector.* Report presented to the DTI in 2007 (unpublished)
[17] Hijzen,A., Jean, S., Mayer, T. (2009) *The Effects at Home of Initiating Production Abroad: Evidence from Matched French Firms*. GEP Research Paper 2009/24. University of Nottingham.
[18] BIS (2010) *Life Sciences in the UK – Economic analysis and evidence for 'Life Sciences 2010: Delivering the Blueprint'* BIS Economics Paper No. 2

The extent to which further offshoring and outsourcing of higher value added activities is likely to occur is uncertain. This is because emerging economies remain challenging places to do business. For example, China and India continue to struggle with corruption and bureaucracy and enforcement of Intellectual Property Rights remains poor[19].

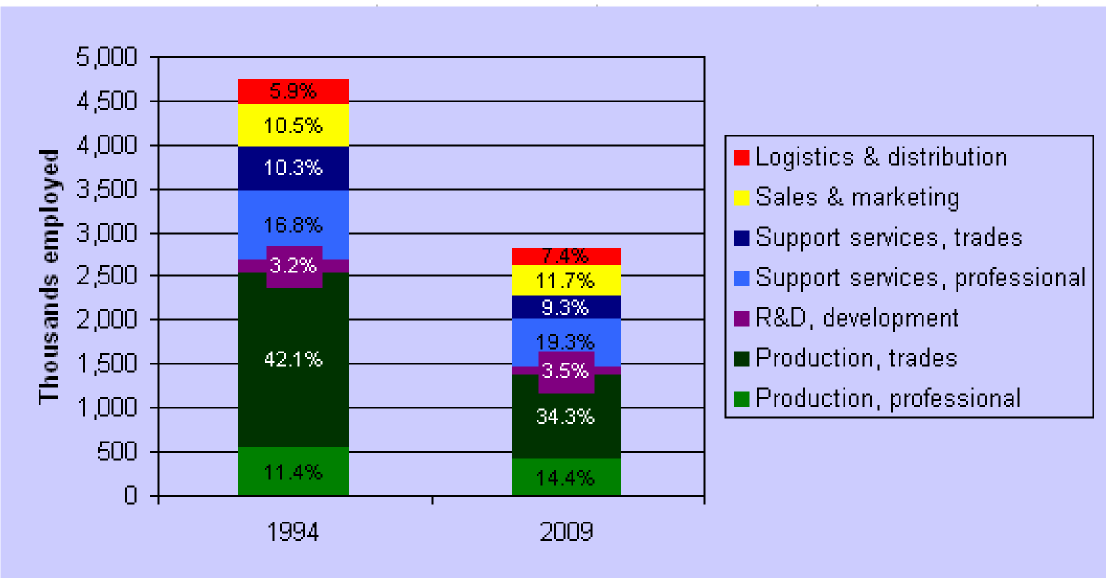
There is, however, emerging evidence that UK manufacturing is beginning to repatriate production work. A 2009 survey by EEF/BDO found that one in seven UK manufacturing firms were bringing production back closer to home on account of cost savings not being as great as anticipated, products were getting to market too slowly, or the quality of goods produced was not of a sufficiently high standard[20].

The 'servizisation' of UK manufacturing

Faced with stronger competition from lower cost countries, manufacturers in developed countries have sought to differentiate themselves further by shifting away from traditional business strategies based around the sale of a particular product towards new models involving the sale of a product combined with associated services[21]. This trend, referred to in the literature as the '*servitization'* of manufacturing[22], has led to the boundary between manufacturing and services becoming increasingly blurred in recent years.

This trend is reflected in changes in the composition of manufacturing employment in the UK. Figure 3 below shows that over the last fifteen years, there has been a shift in employment in manufacturing away from production sales towards professional support services, logistics and distribution, sales and marketing, and research and development activities.

Figure 3: Total manufacturing employment and structure by occupation, 1994 and 2009



Source: BIS analysis based on ONS Labour Force Survey data

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[19] BIS (2010) *Internationalisation of innovative and high growth SMEs.* BIS Economics Paper No5

[20] EEF (2009) *Manufacturing Advantage and uncertainty*

[21] According to the EEF (2009) service provision enabled many firms to bring in vital revenue during the economic downturn when stock orders fell. *Manufacturing Advantage: how manufacturers are focusing strategically in an uncertain worlds*

[22] Neely (2009) *The Servitization of Manufacturing: An Analysis of Global Trends Manufacturing*

Evidence suggests that the UK lags behind its main competitors such as the United States and Germany in terms of the proportion of manufacturing firms which offer complementary product services[23]. The main types of services offered by manufacturing firms tend to be design and development services, systems and solutions, maintenance and support, and retail and distribution[24]. Emerging findings from a recent EEF survey[25] reveal that services account for around between 15% and 20% of total revenue earned by UK manufacturers.

Further evidence[26] shows that firms in the UK manufacturing sector accounted for around 14% of the total value of services exports in 2005. As Table 2 below illustrates, manufacturing firms accounted for around a third of total exports of technical services (e.g. architectural and engineering services) and a third of total export income from royalties and licence fees.

Table 2: Contribution of manufacturing firms, as a percentage, to total services exports, 2005

Sector of economy	Business services	Telecom Services	Technical services	Other services	Royalties and license fees	*Share of total exports*
Real estate, renting and business activities	62.96	50.25	56.59	31.19	42.60	56.44
Manufacturing	**9.93**	**2.73**	**30.16**	**2.68**	**33.49**	**14.38**
Wholesale and retail trade	5.00	3.04	4.32	1.08	20.48	6.82
Financial intermediation	19.05	0.11	0.00	0.00	0.00	8.97
Community, social and personal services	1.98	7.26	0.72	48.12	2.78	3.51
Transport, storage and communications	0.61	36.02	2.59	0.58	0.42	6.72
Share of total exports	45.90	15.34	13.92	2.20	9.31	100.00

Source: Reproduced from Kneller et al. (2010)
Notes: The cells refer to the share of total services exported of a particular type (e.g. technical services) by firms from a particular industry (e.g. manufacturing). The columns therefore sum to 100%.

Changing global demand – sectoral opportunities

In the years ahead, domestic and global demand for products and services will change, driven by factors including rising incomes, growing demand for higher environmental standards and greener products, demographic and lifestyle change and technological progress

These trends will affect the long-term growth prospects for UK manufacturing. The new product and geographical market opportunities generated as a result of these trends may lead to the emergence and expansion of new industries, particularly those based around new technologies. In some cases, these trends could lead to a revival in those manufacturing industries which previously may have been stagnating or in decline.

[23] Ibid
[24] Ibid
[25] EEF (2009) *Manufacturing Advantage – How manufacturers are focussing strategically in an uncertain world* Survey by EEF/BDO.
[26] Kneller *et al.* (2010) *A study of the impact of exporting on service traders*. A final report.

Rising incomes

Per capital incomes in both developed and developed countries are forecast to rise further over the coming decades. This is likely to lead to a further shift in consumer spending towards more expensive, sophisticated and better quality goods and services. At the same time, consumers will increasingly demand products which offer greater functionality and convenience. Manufacturing industries which could benefit from this trend include Life Sciences, automotive and electronics (see Box 3 below).

Box 3: Rising incomes and UK manufacturing

Life Sciences[27]

As consumers become wealthier they will place a greater value on health, and consequently demand more healthcare and health-related products[28]. They will also be able to afford more expensive healthcare treatments, technologies and medicines which help prolong and improve their quality of life.

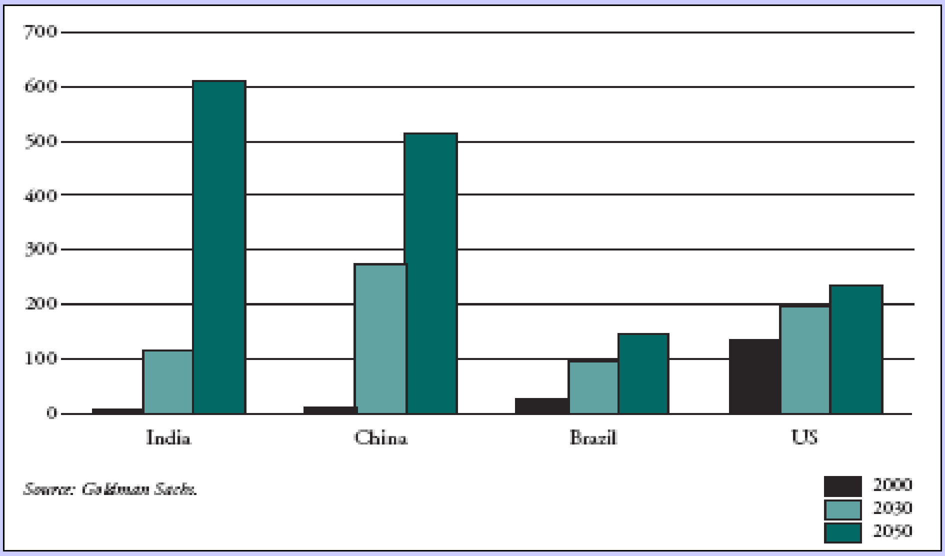
Increasing affluence, particularly in developed countries will also see rises in medical conditions and diseases associated with subsequent changes in environment as a result of further economic development. For example, rising CO_2 emissions and reduced air quality may serve to raise incidences of respiratory conditions such as asthma which requires treatment. Rising incomes may also lead to greater long distance air travel bringing about increased geographical spread of infectious diseases[29].

Automotive

Increased welfare could increase demand for cars in developing countries. Car ownership in China has doubled in the last five years and it already has the third highest car sales in the world. Car ownership in China and India is currently a fraction of that in developed countries such as the US. Over the coming decades, as these and other emerging economies grow, a very rapid rise in car ownership is projected.

[27] Including pharmaceuticals, medical technology, medical biotechnology, devices and diagnostics.
[28] Research by Gravelle and Smith (2001) and Hall and Jones (2004).
[29] TSB (2009) *Medicines and Healthcare: Strategy 2009-2012*

Projection of total cars owned (millions)



Luxury car manufacturers are already experiencing higher growth in China's markets as a result of greater demand for luxury name brands. By 2015, it is projected that demand for luxury vehicles in China will surge to 800,000 cars annually[30].

Demographic and lifestyle changes

United Nations' population forecasts suggest that the world's population is expected to grow from some 6.5 billion in 2005 to around 7.6 billion by 2020. At the same time, the trend towards an ageing population will continue. Longer life expectancies and declining fertility rates, particularly in developed countries, are expected to mean that by 2020, the proportion of people aged over 65 in the world will have risen from 7.3% to 9.4%[31]. Manufacturing industries which could benefit from this trend include Life Sciences, food and drink, electronics and automotive (see Box 4 below).

[30] See http://www.etftrends.com/2010/07/consumer-etfs-going-global-find-strength/

[31] Technology Strategy Board (2009) *Medicines and Healthcare Strategy: 2009-2012*

Box 4: Demographic and lifestyle change and UK manufacturing

Life Sciences

Older people tend to spend a relatively larger proportion of their income on healthcare than younger people[32]. Therefore, as people become older, the market for medicines and healthcare will rise. People's lifestyles are also likely to change further in the years ahead, particularly in developing countries as a result of rising incomes. This could lead to a further increase in medical diseases and conditions which require treatment such as asthma, obesity and stress-related disorders.

Food and drink

Growing awareness of health issues related to diet and nutrition will have an impact on the food and drink manufacturing industry. The UK has become a leading source of new foods with health propositions, demonstrated by the fact that in 2007, 36% of new health product launches in the European Union originated in the UK[33]. As consumers in other countries become more conscious of dietary health, UK firms are well placed to supply those markets.

Electronics and ICT

Demographic and lifestyle change will also generate new demand for more sophisticated medical devices, instrumentation and delivery of healthcare. For example, the development of new electronics and IT equipment could bring about improvements in telemedicine and telemonitoring services. This in turn could support greater independent living for older people by reducing the need for residential care and hospitals stays while electronic health records could enable the rationalization of data management systems thereby reducing costs for healthcare providers.

Automotive products

Changing demographics will not only impact on health related products and services. Manufacturers across sectors will have to adapt to changing demands of an older population. Future products, ranging from vehicles to home furnishings, may need to be designed in a more user-friendly way for older and disabled people. For example, in the US car manufacturers have already responded to changing demographics by making adaptations to door handle shapes, larger font sizes on the dashboard or better lighting on car gauges. By understanding common conditions of older people that might affect driving, such as cataracts or arthritis, designers have improved the accessibility of their products in ways that broaden their appeal to a wider audience[34].

[32] Ibid
[33] Institute of Manufacturing (2010) *Value of Food and Drink Manufacturing in the UK*. A report to the Food and Drink Federation.
[34] Deloitte (2009) *Innovation that matters. How innovation is currently supported in an ageing society*

Increased demand for environmental products and standards

Rising incomes and greater awareness of the environmental consequences of economic growth such as climate change and waste management could lead to increasing demand by consumers for higher environmental standards (e.g. better air and water quality) and 'greener products' which are more environmentally friendly and sustainable both in terms of production and consumption. Manufacturing industries which could benefit from these trends include automotive, aerospace, chemicals, space, and the wider low carbon and environmental goods and services sector (see Box 5 below).

Box 5: Increased demand for environmental products and standards and UK manufacturing

Automotive

In the UK, transport is responsible for around a quarter of total annual CO_2 emissions and almost half of total nitrogen dioxide emissions. The challenge and opportunity is to decarbonise road transport. The UK market continues to shift towards lower CO_2 emitting cars through the development of innovative solutions to the low carbon car concept. In 2008, 49% of the car market consisted of vehicle models with CO_2 emissions of 150g/km or below. This compares with 38% in 2007 and 8% in 1997. The share of the cars emitting less that 120g/km of CO_2 doubled between 2008 and 2009 to 11% of the market[35]. However, mass market electric and plug-in hybrid cars are not yet available in significant numbers.

Aerospace

With the upward trend in fuel prices and environmental concerns, there is strong demand for lighter aircraft, prompting the increased use of composites in airframes and components, and more efficient engines. The industry states that it has delivered a 50 per cent improvement in fuel efficiency in the last 30 years, and a 75 per cent reduction in noise nuisance[36].

Chemicals and chemistry-using sectors

The application of industrial biotechnology (IB), by the chemicals and chemistry-using sectors can contribute to sustainable low-carbon growth through the development of new and less carbon intensive products and processes. Research commissioned for IB-IGT[37] concluded that IB products, processes and technology offer important potential for primary energy and greenhouse gas savings. These findings are supported by sector examples recently published by the European Association for Bio Industries[38]. Industrial biotechnology can help meet existing low carbon targets and commitments to reduce greenhouse gas emissions. Furthermore, the

[35] BIS (2009) *Towards a Low Carbon Economy – economic analysis and evidence for a low carbon strategy*. BIS Economics Paper No 1. Estimates based on SMMT data.
[36] NESTA (2008) Total Innovation. Why harnessing the hidden innovation in high-technology sectors is crucial to retaining the UK's innovation edge
[37] Mortimer (2008) *Study into the potential energy and greenhouse gas savings of renewable chemicals and biocatalysts* for BIS Industrial Biotechnology Innovation Growth Team (IB-IGT)
[38] *How Industrial Biotechnology Can Help Tackle Climate Change,* EuropaBio, December 2008; www.bio-economy.net/reports/files/ib_and_climate_change.pdf

economic analysis highlighted that the wider adoption of IB by the chemicals sector could save up to 5.2 million tonnes of CO_2 per annum[39].

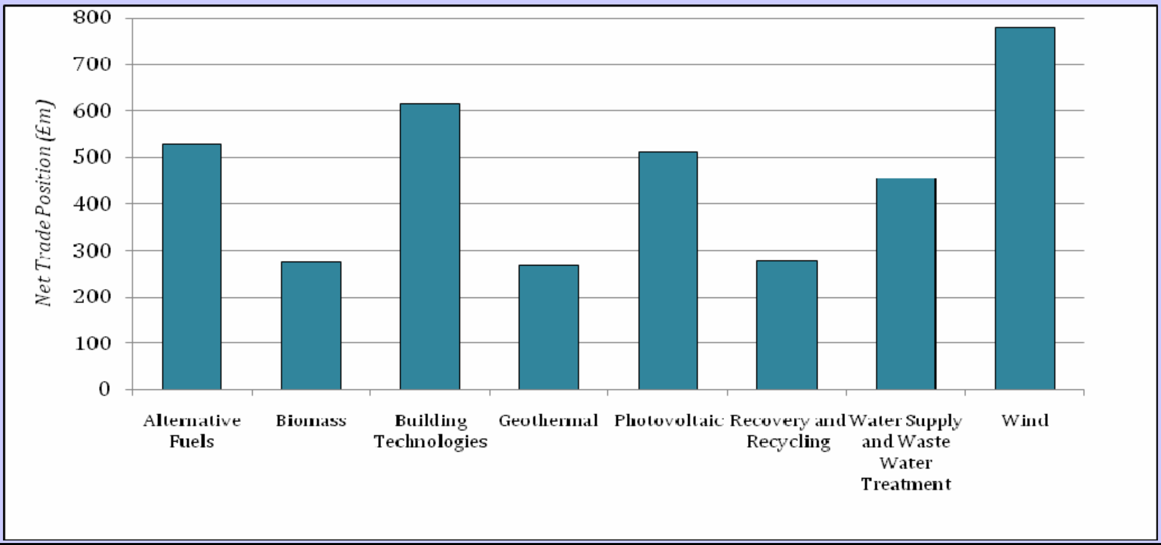
Space[40]

UK enterprises have developed capabilities in instrumentation and data manipulation that could help them secure a strong commercial position when new market opportunities arise. The commercial market for telecommunications and earth observations (EO) is taking more time to develop than initially expected. Most of the market for EO products remains in the public sector, such as environmental and climate monitoring, but commercial opportunities might follow rising public sector demand for information and data to aid policy formulation and activities to address some key defining societal challenges such as climate change and security.

Low carbon and environmental goods and services

Recognition of the importance of sustainable use of natural capital for long-term economic growth[41] will lead to increasing demand for goods and services which lower the impact of economic activity upon the environment. The global low carbon and environmental goods and services (LCEGS) sector is estimated by Innovas to grow by 4% over the next five years[42]. All LCEGS sub-sectors have positive net trade positions, the largest of which are in wind energy, photovoltaic, building technologies, alternative fuels, water supply and waste water management

Net trade position of LCEGS subsectors (£m)

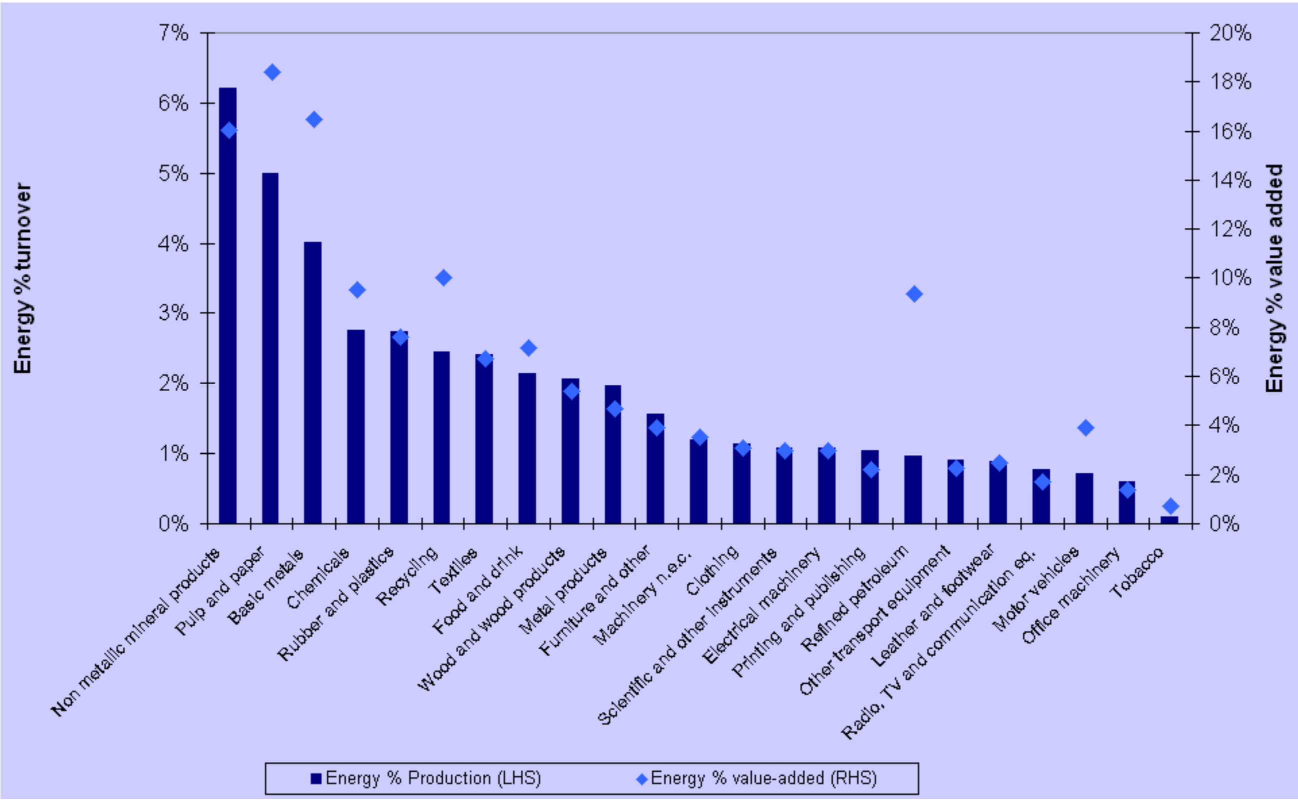


[39] Quantitative modelling of industrial biotechnology and renewable chemicals – ADL.
[40] BIS (2010) *The Space Economy in the UK: An economic analyses of the sector and the role of policy*. BIS Economics Paper No 3.
[41] Defra (2010), *Economic Growth and the Environment*
[42] Innovas (2010) *Low carbon and environmental goods and services: an industry update 2008/09* http://www.bis.gov.uk/assets/biscore/business-sectors/docs/10-795-low-carbon-environmental-goods-analysis-update-08-09

It is important to recognise that the demand for greater environmental standards and products represents a challenge for UK manufacturers as well as an opportunity. Stricter targets on carbon dioxide emissions could mean that those manufacturing industries which are relatively more energy intensive must make greater efforts to become more energy efficient (see Figure 4 below).

In some sectors, increased environmental efficiency can produce savings opportunities for businesses. Estimates from a study for Defra found that in 2007 UK businesses could realise potential annual savings of around £6.4bn through low-cost or no-cost resource efficiency measures. For example, it was found that savings of £463m per year could be made in the chemicals, rubber and plastics sector – breaking down into £189m from energy efficiency, £235m from waste measures and £39m from water efficiency measures.[43]

Figure 4: Energy intensity of different UK manufacturing industries, 2009



Source: BIS analysis based on ONS Annual Business Inquiry data

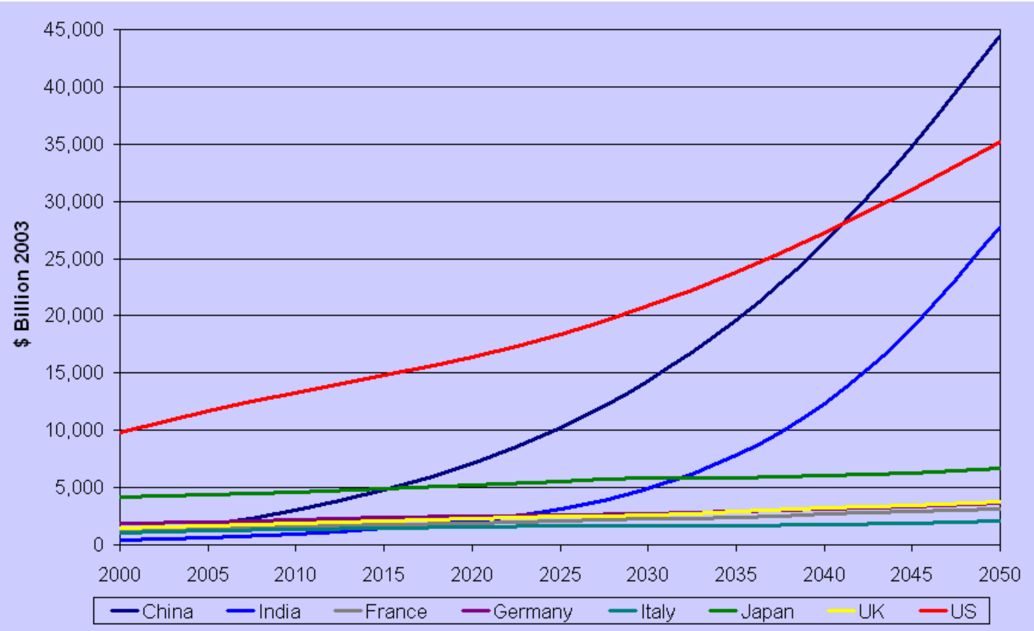
[43] Oakdene Hollins (2007), *Quantification of the business benefits of resource efficiency – a research report completed for Defra*

A major long term challenge to ensure resilient growth in UK manufacturing is the need to adapt to future environmental risks, such as those arising from the changing climate. A recent CBI report identified the importance to businesses in including an evaluation of climate risk in their overall assessment of business risks[44], and a failure to adapt would harm future capabilities for growth.

Growth in emerging markets

The World Bank (2007) predicts Gross Domestic Product in developing countries to more than triple by 2050 with rapid expansion in China and India. PwC (2006) forecast that by 2050 the 'E7' economies, comprising the BRIC countries together with Indonesia, Mexico and Turkey could be around 25% larger than the current G7 economies (see Figure 5 below)[45].

Figure 5: GDP projections for selected countries to 2050



Source: Goldman Sachs, Dreaming with the BRICS (2003);

These trends are likely to create substantial export opportunities for UK manufacturers. These could be greatest in developing countries such as China and India where a growing middle class will bring about increased demand for more expensive and better quality manufactured goods.

Official trade data shows that the value of UK manufactured exports to emerging markets has risen in recent years. This can be attributed to a rise in the number of exporting firms and an increase in the average value of their exports. The shaded areas in Table 3 overleaf identify where this growth has been highest over the period 2002-2008. It reveals that some of the highest rates of growth in the value of exports have been in higher technology products to emerging markets such as Brazil, Mexico and the Middle East.

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[44] CBI (2010), *Whatever the weather: Managing the risks from a changing climate*
[45] The PwC study also predicts that in Purchasing Power Parity (PPP) terms, by 2050 the E7 economies will become even 75% larger than the current G7.

Table 3: Emerging markets and export growth

	Russia	China	India	Brazil	S.Africa	Saudi	Mexico	USA	German	Japan
IT & Electronics										
Security										
Telecoms Equip										
Household Goods										
Recreational										
Environment										
Transport Infrastructure										
Clothing										
Giftware										
Paper & Packaging										
Textiles & Furnish										
Energy										
Food & Drink										
Automotive										
Healthcare Equipment										
Biotech & Pharma										
Metals & Minerals										
Chemicals										
Construction										
Creative & Media										
Engineering (inc Aero)										
Agriculture										

Source: BIS (2010) UK trade performance: Patterns in UK and global trade growth; derived from HMRC's Trade Data. BIS Economics Paper No 8.

Technological progress

A number of new enabling technologies are beginning to emerge which potential applications in a wide-ranging number of sectors and industries (see Table 4 below).

Table 4: Emerging technologies and potential end-use applications

Sector	End-use application
Digital	• Consumer electronics and ICT sectors
Micro and nanoelectronics	• Automotive • Medical instrumentation • Consumer electronics • Spacecraft • Aeronautics • Defence • Green technologies
Nanotechnology and nanomaterials	• Aerospace • Space • Automotive • Life Sciences • Electronics and ICT • Green technologies • Food and drink
Industrial biotechnology	• Life Sciences • Chemicals • Green technologies
Photonics	• Life Sciences • Green technologies • Electronics and ICT
Advanced materials (e.g. composites)	• Green technologies (e.g. batteries) • Plastics (e.g. smart packaging) • Aerospace • Automotive • Transport equipment • Electronics and ICT

Source: Technology Strategy Board strategy documents (various)

These new emerging technologies will enable the development of new and better quality goods and services that meet increasingly sophisticated consumer demands for increased functionality and convenience, creating new market opportunities and new customers (see Box 6).

Box 6: Technological progress in UK manufacturing

Advanced composites

The shift to a low carbon economy and competitive pressures will create further demand for lightweight composites products and new manufacturing processes. The world composites market is predicted to grow from £53bn to £74bn by 2013, driven initially by the aerospace and wind energy sectors where demand for composite materials is expected to grow by around 15% and 13% each year respectively[46].

According to independent research[47] there is market-led opportunity over the next five years to step change the scale and global competitiveness of the UK composites industry. The UK is well placed to meet growing global and domestic demand given its strength in design of composites structures and engineering skills in wing, rotor and fluid dynamics. Composites demand in the UK is therefore forecast to grow faster than international markets, largely driven by growth in offshore wind and aerospace sectors.

New generation aircrafts, such as Airbus A380, A400M, A350XWB and Boeing 787, are increasingly using advanced composite materials in their airframes and engines. Composites will enable the aerospace industry to build aircraft which is easier, quicker and cheaper to maintain and also more lightweight and energy efficient, therefore helping to meet stricter standards on fuel emissions. The opportunities in the UK wind turbine blade and aerospace markets alone will be worth an estimated £22bn by 2020[48].

Advances in composites technology and lowering cost of production could create new uses in a wide range of sectors and applications including construction, marine, offshore oil and gas.

UK manufacturing: future strategic challenges

To continue competing effectively in the global economy, UK manufacturers must make further efforts to differentiate themselves from lower cost countries including China, India and Brazil which are steadily moving into higher value industries and activities.

This means firstly that UK manufacturers must continue to innovate. They must develop and bring to market new, more sophisticated and better quality products and adapt their business models in ways that add further value to the manufactured products which they supply. By responding quickly to the new opportunities created by predicted changes in global demand and the emergence of new technologies, UK manufacturers can exploit first mover advantage, obtaining a larger share of new product and geographical markets.

[46] Global Composite Market 2009-2014; Materials, Markets and Technologies, Lucintel (2009)
[47] Ernst & Young (2010) UK Composites Supply Chain Scoping Study for UKTI and BIS – key findings
[48] BIS (2009) The UK Composites Strategy

At the same time, UK manufacturers must also continue to become more internationalised. By engaging in international markets, UK manufacturers can keep at the forefront of ongoing developments in innovation and technology through greater exposure to new ideas and knowledge and access to customers/ suppliers and skills around the world.

The remainder of this paper considers the extent to which UK manufacturing is well placed to continue competing effectively in the global economy and take advantage of the new opportunities which may created by anticipated changes in long-term global demand.

Strengths and capabilities in UK manufacturing

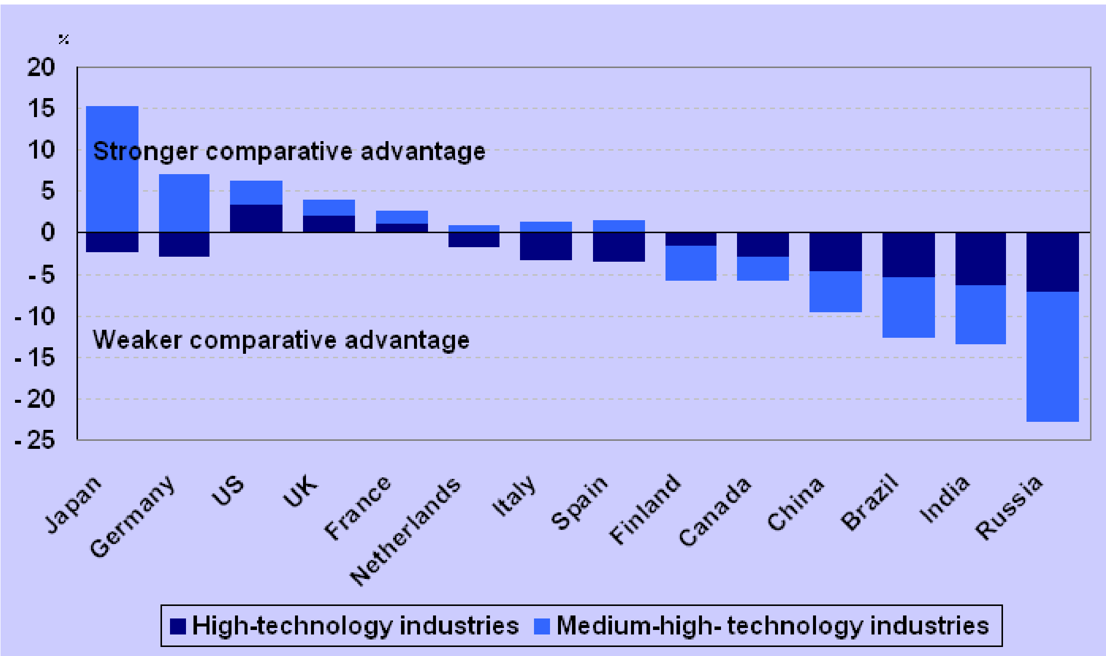
The changing nature of UK manufacturing

As globalisation has gathered pace, so the face of manufacturing has changed significantly. Much of the activity in modern day manufacturing is characterised by high levels of technological and non-technological innovation and investment in skills, knowledge and intangible investment such as branding, software and marketing. This has led to the development of new, better quality and more sophisticated products, and more innovative business models and processes.

In common with leading manufacturing countries such as Japan, Germany and the United States, the UK has increasingly specialised in higher technology manufacturing industries such as aerospace and pharmaceuticals. This compares with emerging economies including Brazil, Russia, India and China which have specialised to a greater extent in lower technology industries such as textiles.

This is illustrated in Figure 6 below which shows, for selected countries, the contribution of high and medium-high technology industries to the manufacturing trade balance. A positive figure indicates that a country is recording a larger trade surplus for these industries compared to the manufacturing sector as a whole. In this way, it provides an indication of an individual country's competitive advantage in a particular industry.

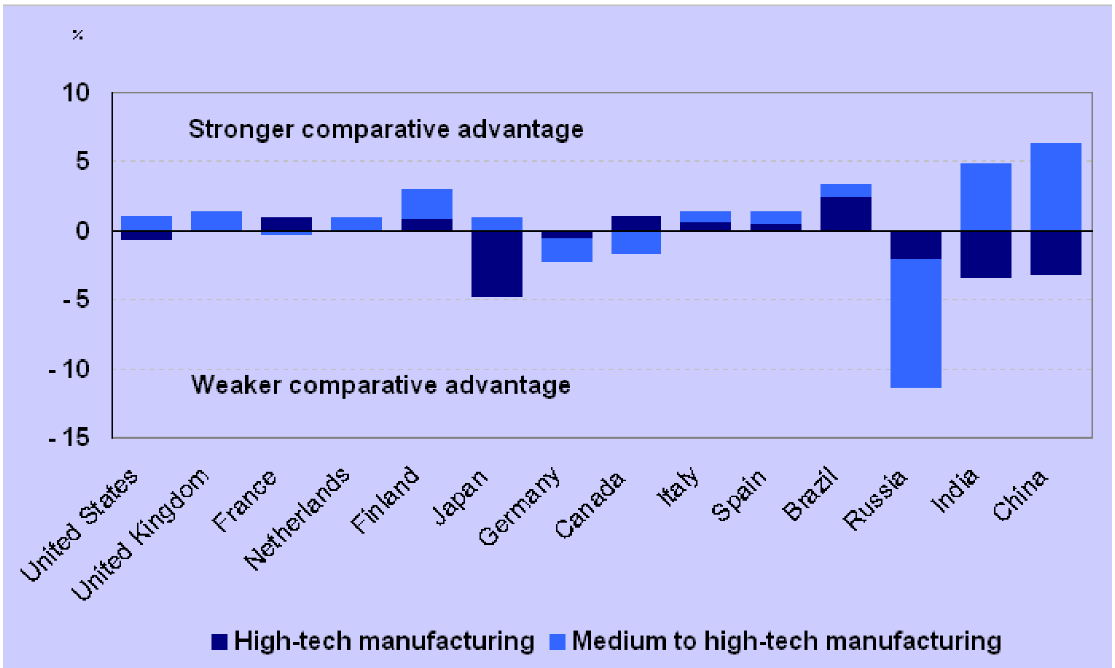
Figure 6: Competitive strengths in high and medium-high technology, 2007



Source: OECD STAN database

As Figure 7 below clearly shows, the contribution of high and medium-high technology industries to the manufacturing trade balance of Brazil, China and India improved between 1997 and 2007. This evidence suggests that these countries in particular are steadily moving into higher value manufacturing industries and activities.

Figure 7: Changes in competitive strengths in high and medium-high technology, 1997-2007



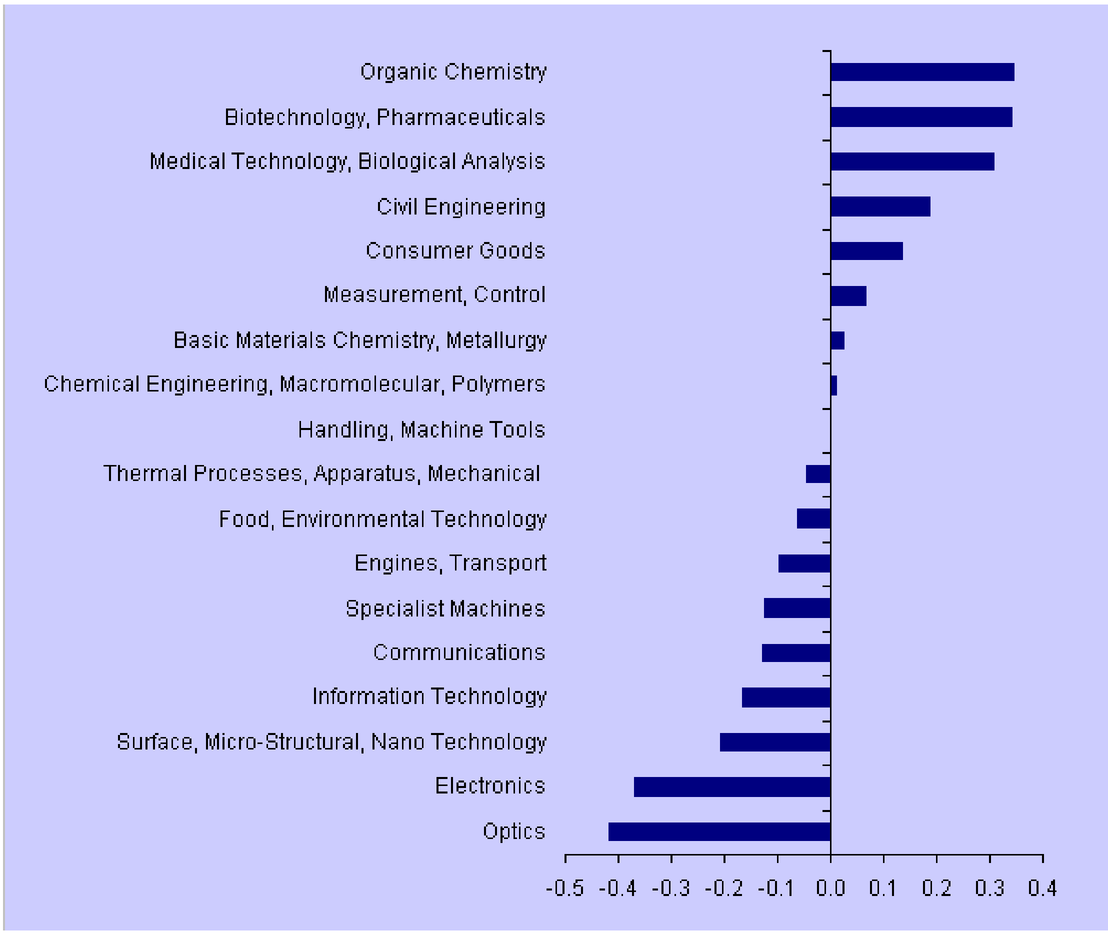
Source: OECD STAN database

In dynamic industries characterised by high levels of innovation and technological change, the competitive advantage of individual countries is likely to alter over time as new improved products are developed and brought to market. It is therefore important to consider also the UK's current strengths in different areas of technology as they can provide a useful indication of where a country's competitive advantage could lie in the future.

Figure 8 below shows the relative strength of the UK in various broad areas of technology on the basis of patent data. While a useful indicator of innovation performance, comparisons should be treated with a certain degree of caution as not all industries use patents to the same extent to protect their intellectual property.

Current patent activity suggests that the UK is presently relatively strong in the areas of organic chemistry, biotechnology/ pharmaceuticals and medical technology and weaker in the areas of electronics, optics and nanotechnology and information technology.

Figure 8: UK Revealed Technological Advantage, 2002-2006



Source: BIS calculations from World Intellectual Property Organisation data

Performing a similar analysis for the UK's major competitors reveals that[49]:

- The **United States** is stronger in biotechnology / pharmaceuticals and medical technology and weaker in optics, electronics, thermal processes / apparatus and engines / transport
- **France** is stronger in organic chemistry, engines / transport and weaker in optics, information technology and electronics
- **Germany** is stronger in engines / transport, thermal processes / apparatus and organic chemistry and weaker in optics, information technology, communications and electronics
- **Japan** is stronger in optics and weaker in biotechnology / pharmaceuticals, medical technology and organic chemistry

With regards emerging economies:

[49] BIS (2010) *Economic Growth (Main Paper)* BIS Economics Paper No 9

- **China** is stronger in food / environmental, basic chemistry, biotechnology / pharmaceuticals and medical technology and weaker in engines / transport, optics and machine tools
- **India** stronger in organic chemistry, biotechnology / pharmaceuticals and medical technology, but weaker across the board elsewhere
- **Brazil** stronger in food / environmental and mechanical engineering but weaker in electrical engineering and electronics
- **Russia** stronger in medical technology, chemistry and environmental technology but weaker in electrical engineering

Innovation capability in UK manufacturing

Innovation is defined as the successful exploitation of new ideas. It can involve the development of new designs, concepts, technologies, products, processes, business models, organisation structures and management practices. Innovation also encompasses much more than just research and development activity.

Innovation has a key role to play in promoting productivity growth through the development of more valuable products or services, the development of new technologies, processes and business models which increase firm-level efficiency, and through the generation and diffusion of new ideas and knowledge. Box 7 illustrates examples of innovation capabilities in various manufacturing sectors in the UK.

Box 7: Innovation capabilities in UK manufacturing sectors

Automotive: luxury vehicles and low carbon vehicle technologies

The UK automotive industry's existing strengths in world-leading premium and high-end vehicle manufacture, including light-weighting aluminium technologies, are being reinforced by a growing expertise in ultra low carbon and related technologies. This is evidenced by the UK's recent success in attracting a series of major groundbreaking low carbon investments by global automotive companies, including: Nissan's decision to build Europe's first mass market electric car (the Leaf) in Sunderland; the manufacture of the hybrid Toyota Auris and engine in the UK (the first hybrid engine to be built outside Japan); and Ford's £1.55bn investment in new low carbon engine projects at Dagenham and Bridgend.

Pharmaceuticals and Medical Biotechnology

The pharmaceuticals sector is the most research intensive sector in the UK economy[50] where productivity (output per employee) rose 77% in nominal terms between 1998 and 2007[51]. In 2007, UK medical biotechnology companies had the highest number of drugs in clinical development in Europe[52] and drugs which originated in the UK took a 16% value share of the world's top 100 selling drugs in 2008, second only to the US[53].

Food and Drink

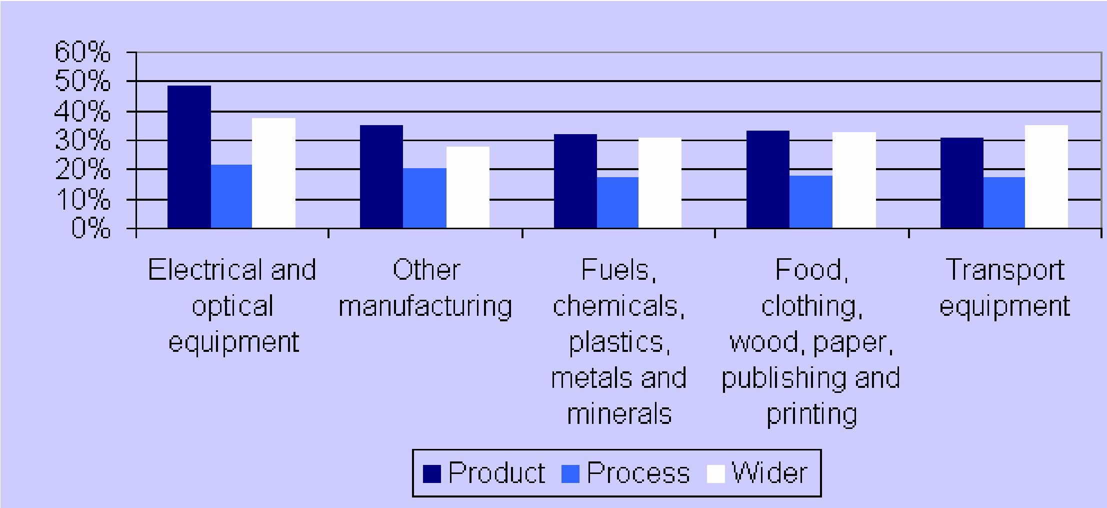
The food and drink manufacturing industry is a dynamic sector focussed on improving its competitiveness and efficiency in response to the challenges and opportunities of globalisation. This has led to consumer benefits of lower prices and greater choice. Innovation is a key focus of the industry, which accounts for over 4% of total R&D spend reported in the annual R&D Scoreboard. Areas of opportunity are in food science, food technology, biotechnology, nanotechnology, I.T., engineering and sustainability best practice, including energy management (reducing the overall carbon footprint of a business).

First results from the 2009 UK Innovation Survey[54] indicate that over 70% of firms in the UK manufacturing sector are engaged in innovation activity[55] with the highest proportion in the electrical and optical equipment industry[56]. There are some variations across the sector in terms

[50] NESTA (2008) *Total Innovation: Why harnessing the hidden innovation in high-technology sectors is crucial to retaining the UK's innovation edge*
[51] Calculations based on the ONS 1998-2007 data
[52] Ernst and Young (2008) Beyond Borders: Global biotechnology report
[53] ABPI (2010) Did you know? *Facts and figures about the pharmaceutical industry in the UK*
[54] The UK Innovation Survey samples around 29,000 UK enterprises with 10 or more employees. BIS (2010) UK Innovation Survey: Science and Innovation analysis
[55] BIS (2010) *UK Innovation Survey: Science and Innovation analysis.* The UK Innovation Survey defines a firm as innovation active if it is engaged in any of the following: a) the introduction of a new or significantly improved product or process; b) engagement in innovation projects not yet complete or abandoned, and; c) expenditure (activities) in areas such as internal research and development, training, acquisition of external knowledge or machinery and equipment linked to innovation activities.
[56] ONS (2010) First findings from the UK Innovation Survey 2009

of the proportion of manufacturing firms involved in product, process and wider innovation activity (see Figure 9 below)[57].

Figure 9: Innovation activity, by type, across manufacturing industries



Source: 2009 UK Innovation Survey

Research and development

The overwhelming majority of research and development (R&D) in the UK is carried out by businesses in the manufacturing sector. Of the £16bn spent by UK businesses on R&D in 2008[58] approximately £12bn, or around 75%, was by manufacturing businesses. Box 8 illustrates examples of R&D capabilities in UK manufacturing.

[57] Product innovation refers to the design, development and commercialisation of new and improved tangible goods and services. Process innovation refers to the introduction of new and improved means of producing and delivering goods and services. Wider innovation refers to the adoption of new organisation structures, business models and management practices

[58] Business and Enterprise Research and Development (BERD), ONS, 2009.

Box 8: Research and Development capabilities in the UK manufacturing sector

Offshore wind

The UK has world-class research and testing facilities at NAREC in Northumberland, and the UK is investing in developing these further. Mitsubishi and Gamesa have committed to building R&D centres in the UK, and Vestas already have an R&D facility on the Isle of Wight.

Nanotechnology

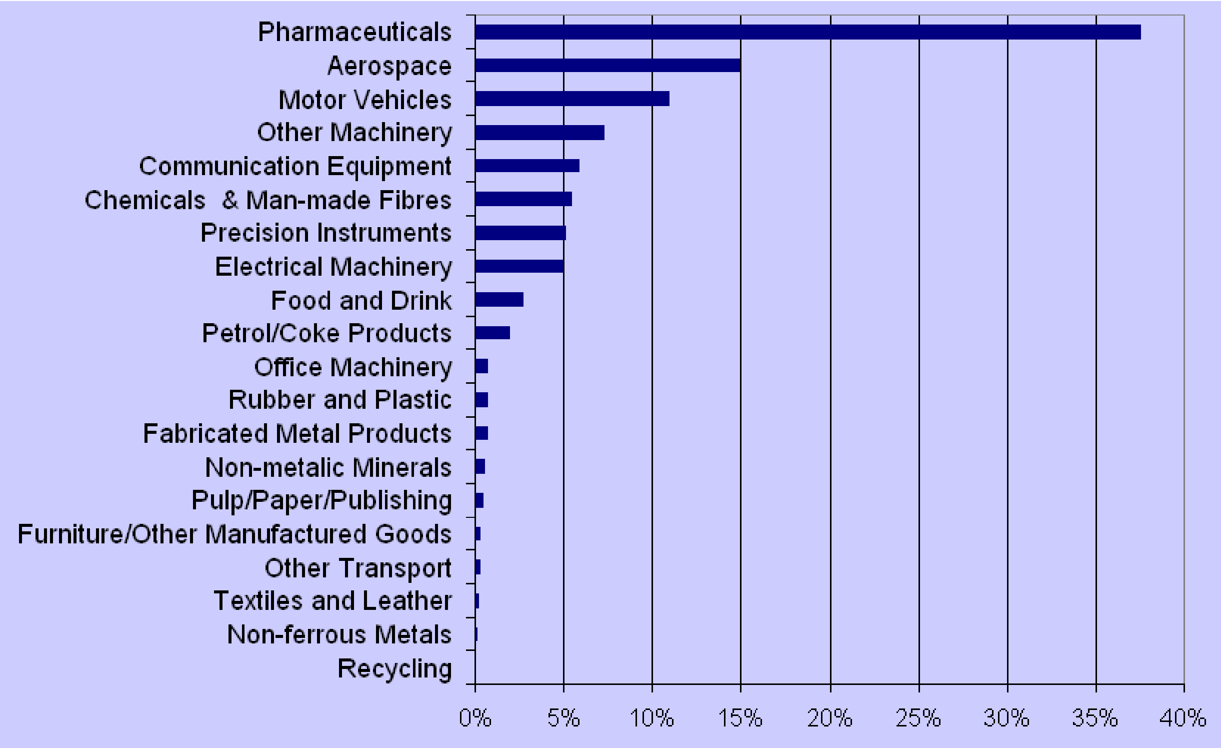
The UK has a world-class reputation in nanotechnology research, with a nationwide network of research institutes and universities and involving approximately 1,500 research scientists focusing on the development of nanotechnologies. The UK has over 35 universities and a strong research communities undertaking nanotechnology research including two world-class interdisciplinary research centres on nanofabrication in Cambridge and bio-nanotechnology centre in Oxford, with further research strengths in modelling, tissue engineering, imaging, devices and informatics.

Marine energy

The UK has world class testing facilities at EMEC in Scotland, NAREC in Northumberland and Wave Hub in Cornwall and is investing in developing these further. Some of the world's first commercial marine devices are being developed and tested here in the UK. For example, Aquamarine Power has deployed at EMEC in the Orkneys and Ocean Power Technology Ltd will be the first company to use Wave Hub in Cornwall.

Within the UK manufacturing sector, there are significant industry differences in terms of R&D activity. As Figure 10 below shows, the majority of R&D is carried out in higher value industries, in particular the pharmaceuticals, aerospace, motor vehicles and electronics related industries. These industries, together, accounted for an estimated 75% of total business spending on research and development in the UK manufacturing sector in 2008.

Figure 10: Share of business R&D expenditure across the UK manufacturing sector, 2008



Source: UK Business Enterprise Research and Development, 2008

There are marked international differences in research and development intensity[59] in manufacturing as shown in Table 5 below. In high-technology manufacturing, research and development intensity in the UK is lower than in France and US but is comparable with Japan and Germany. Such comparisons should however be treated with a certain degree of caution as they may in part reflect differences in the mix of high-technology industries in these four countries. Research and development intensity in China appears to be significantly lower levels compared to more developed nations.

Table 5: Research and development intensity in manufacturing by technology intensity, 2006

	UK	US	Japan	Germany	France	China
High-tech	26.8	38.4	28.9	21.3	32.8	5.0
Medium-tech	7.2	9.5	14.4	9.8	15.0	2.7
Low-tech	2.0	1.6	2.5	0.8	1.8	0.8

Source: OECD STAN database
Note: Figure for China is 2007

[59] Research and development intensity is defined as research and development expenditure as a percentage of value added.

Investment in intangible assets

In addition to research and development, manufacturing firms also invest in intangible assets such as software, design and other aspects of product-development, brands, training and business process improvements as a way of further improving their competitiveness and their ability to deliver to market products which consumers demand. Box 9 illustrates an example of UK capability in design in the electronics sector.

Box 9: Design capability in the UK Electronics sector

Electronics

The UK has Europe's largest independent semi conductor design industry, accounting for half the market in application-specific integrated circuit design and 40% of Europe's independent electronics design overall[60]. It offers a large pool of hardware and software designers with relevant experience within equipment manufacturers, silicon vendors, fabless manufacturers, for example CSR, and key IP providers such as ARM.

Results from the 2009 UK Innovation Survey, reported in Table 6 below, provide insights into the extent to which firms in different manufacturing industries invest in intangible assets. Besides internal research and development, a comparatively larger percentage of firms in all manufacturing industries invest in advanced machinery, computer hardware and software, training and design. This compares with activities such as acquisition of external knowledge which is undertaken by a relatively small percentage of firms in all manufacturing industries.

Table 6: Percentage of firms engaged in particular intangible investment activities, 2006-2008

	Food, clothing, wood, paper, publishing and printing	Fuels, chemicals, plastics, metals and minerals	Electrical and optical equipment	Transport equipment	Other manufacturing
Internal R&D	40%	40%	57%	38%	47%
Acquisition of external R&D	11%	12%	22%	18%	11%
Advanced machinery	28%	32%	33%	26%	33%
Computer hardware	38%	33%	47%	31%	35%
Computer software	43%	38%	50%	33%	39%
Acquisition of external knowledge	13%	13%	17%	15%	12%
Training for innovative activities	26%	29%	37%	30%	28%
All forms of design	25%	28%	46%	32%	37%

[60] National Microelectronics Institute figures

Work on investment in intangible assets at the sectoral level is still in development. Analysis by Gil and Haskel (2008) indicated that the manufacturing sector accounted for around half of total spending on intangible assets in 2004.

The Work Foundation (2010) has reported estimates of investment in different intangible assets as a percentage of GDP (see Table 7 below). These estimates are not directly comparable owing to differences in data quality and coverage and the year to which they relate. Accordingly, they should be treated with some care. Nonetheless, they suggest that the UK compares well the US, and better than many leading European manufacturing countries.

Table 7: Investment in intangibles as a percentage of GDP, 2004

	UK	US	Japan	France	Germany	Italy
Design	1.2	1.8	1.8	2.2	0.9	0.8
Brand equity	1.2	1.7	1.0	1.5	0.8	1.2
Human capital	3.1	1.4	0.4	2.3	1.9	1.4
Organisational capital	2.2	3.1	1.6	2.8	1.4	0.6
Software	1.9	1.7	2.2	0.9	0.9	0.7
All intangibles	13.0	13.5	10.5	12.6	10.1	7.4

Source: Work Foundation (2010) *Knowledge Economy Strategy, 2020*

Standards can be also considered an intangible asset. According to Swann (2000) standardization is an essential part of the microeconomic infrastructure as it can enable innovation and act as a barrier to undesirable outcomes (e.g. poor product quality). Standardization is not just about limiting variety by defining norms for given technologies in given markets. It can also bring about increased credibility and focus as well as critical mass in markets for new technologies.

Box 10: Development of standards in the UK Nanotechnology sector

As with many newly emerging technologies, there are still significant challenges to overcome in taking nanotechnology-enabled applications to market. The UK has played a leading role in the development of international nanotechnologies **standards**. One example of this is through the work of the British Standards Institute (BSI). With Government assistance, it has developed a wide range of Publicly Available Specification standards for nanoscale technologies, providing important and useful guidance for researchers and companies. BSI British Standards' publications can help solve these problems at every stage in the development of a product or service, from idea formulation to implementation, covering crucial aspects of safety, reliability and quality and defining terminology. The UK also chairs both the ISO and CEN standards committees on nanotechnology.

Skills capability in UK manufacturing

Generic and specialist skills also play an important role in promoting productivity. A skilled workforce enables firms to respond innovatively and flexibly to increasing international competition, developing and applying new ideas and knowledge which result in new higher value products and more efficient processes, business models and organisational structures[61]. Box 11 below provides an example of UK skills capability in the Life Sciences sector.

Box 11: Skills capability in the UK Life Sciences sector

The Life Sciences industry is highly knowledge-intensive. Its competitiveness and development depends on the ability of companies to access highly skilled and innovative scientists, clinicians and technologists. Early stage trials in which compounds are first used on humans are particularly dependent upon strong scientific support since this early work takes place at the point of maximum scientific uncertainty.

The Life Sciences industry relies heavily on an adequate supply of high quality STEM (Science, Technology, Engineering and Mathematics) graduates entering academia, industry and the healthcare sector, particularly those who have studied a biological science degree.

There has been an improvement in the education levels of manufacturing workers with 17.1% holding a degree in 2009 compared with only 9.7 in 1994 – almost double (see Table 8 overleaf). Educational attainment was already considerably higher among production and support service professional, research and development, and sales and marketing workers and this is still the case – 31.7% of these employees held a degree in 2009 compared with only 3.1% of the remaining manufacturing workforce[62].

The upskilling of individuals across all occupational groups coupled with a shift in employment towards the more highly skilled occupations has resulted in an overall rise in educational attainment in UK manufacturing.

[61] BIS (2010) *Supporting analysis for 'Skills for Growth: the national skills strategy* BIS Economics Paper No 4.
[62] BIS calculations based on ONS Labour Force Survey, 2009 data

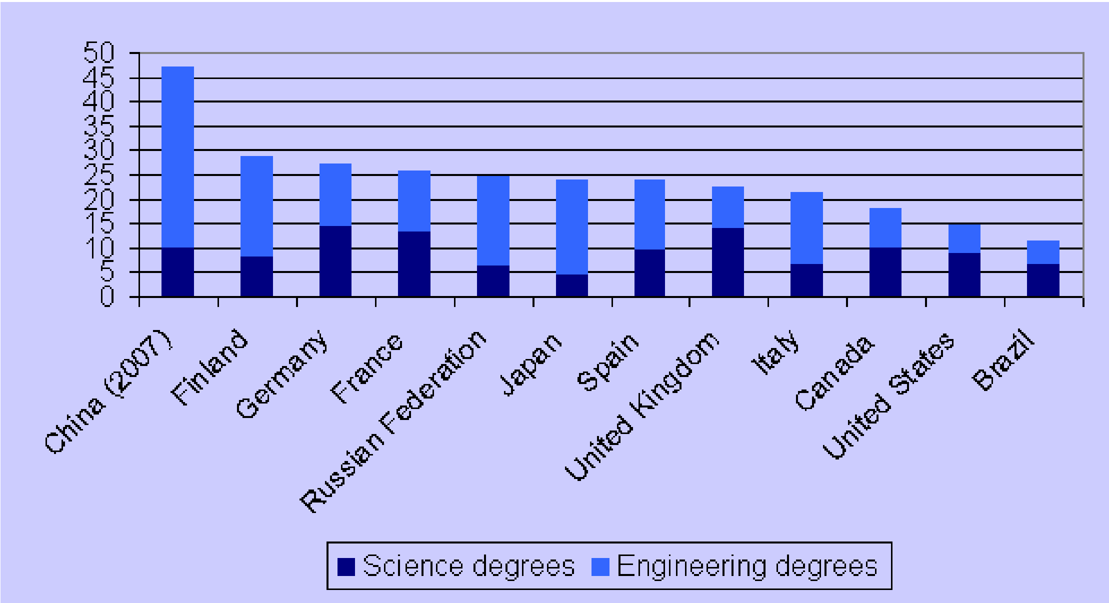
Table 8: Educational attainment of individuals according to broad occupational group

	Employment share (%)		Proportion with NVQ level 3 and above (%)		Proportion with degree or equivalent (%)	
Occupation	**1994**	**2009**	**1994**	**2009**	**1994**	**2009**
Production, trades; Support services, trades; Logistics and distribution	58.3	51.0	35.0	37.7	1.6	3.1
Production, professional; Research and development; Support services, professional; sales and marketing	41.8	49.0	63.2	69.8	22.8	31.7
All manufacturing	**100**	**100**	**45.8**	**53.5**	**9.7**	**17.1**

Source: BIS calculations based on ONS Labour Force Survey data

As Figure 11 below shows, the UK lags behind its main competitors such as China, Germany, France and Japan but ahead of the United States in terms of the proportion of employees in the manufacturing sector with a first degree in science or engineering.

Figure 11: Percentage of employees in manufacturing with science and engineering degrees at first-stage university level, 2006



Source: OECD STAN Database

Exporting capability in UK manufacturing

There are no recognised measures to assess whether a country is engaging effectively in global value and supply chains. One partial indicator that is often used is the percentage of firms which are selling into overseas markets.

Firms which export tend to be larger, more productive, have higher absorptive capacity ('*know how*') and more likely to engage in research and development or wider innovation activity than firms which do not export. Although such characteristics are associated with exporters, not all firms with these characteristics export. This is indicative of barriers to entering export markets.

Work by Harris and Li (2010) shows that a higher proportion of firms in the manufacturing sector export relative to the services sector[63]. This reflects in part the higher tradability of goods than services. The percentage of firms which export varies significantly across the manufacturing sector (see Table 9 below).

Chemicals (including pharmaceuticals), medical instrumentation and basic metals are the industries containing the highest proportion of exporting firms. The first two are industries in which the UK is known to have a competitive advantage. All three industries have shown the strongest growth in terms of the number of firms which export. This has been partly driven by a decline in the total number of businesses operating in the industry as less efficient, and possibly non-exporting firms, exited.

Table 9: Percentage of UK establishments exporting, by industry, 2000-2006

Industry (1992 2-digit SIC)	2000	2004	*2006*
Mining & quarrying	22.0	32.9	38.5
Food & drink	37.3	35.1	44.4
Textiles	62.1	56.7	61.3
Clothing & leather	28.5	46.6	59.7
Wood products	22.9	19.9	24.0
Paper	43.6	44.5	67.1
Publishing & printing	20.4	29.4	40.6
Chemicals	73.7	78.4	86.5
Rubber & plastics	55.9	50.8	60.2
Non-metallic minerals	36.1	44.1	46.3
Basic metals	69.8	73.3	80.6
Fabricated metals	32.4	39.2	44.8
Machinery & equipment n.e.s.	57.2	67.7	71.4
Electrical machinery	67.7	58.4	66.4
Medical etc instruments	63.9	68.0	80.5
Motor & transport	55.3	53.4	65.0
Furniture & manufacturing n.e.s.	39.7	38.5	50.9

Source: Harris and Li (2010)
Weighted data from Community Innovation Survey 3 and 4, Authors own calculations
Firms over 10 employees

[63] Harris, R. and Li, C. (2010) *Study of the Relationship between Innovation, Exporting and the use of E-Commerce.* Final report submitted to UKTI 2010

It is important to emphasise that innovation including research and development are interrelated with exporting. Firms which invest in research and development and engage in wider innovation activity are more likely to export. Among manufacturing firms, exporting has also been found to increase the probability of engagement in research and development[64].

The mechanisms through which international activity can have a positive impact on investment in product/service development have been identified in a recent survey[65]. International activity enables firms to invest more time and money in new product development (NPD), increase the money available for NPD and increases the return on investment in NPD. This is supported by an evaluation of the impact of UKTI trade services on R&D that was carried out by Aston University in 2010. This found that trade support generates additional R&D of around £65k per firm. Another study found that UKTI clients are three to four times more likely than comparator groups to hold intellectual property[66].

Manufacturing firms seem to be more likely to benefit from increased return on investment in NPD than those in the services sector. This evidence suggests that international activity helps firms to overcome cost barriers to investment in NPD. The ability to generate revenue from international activity to invest in NPD reduces the need to seek finance from external sources and this may reduce the associated risk to the firm of borrowing capital.

Table 10: Impacts on investment in product/ service development, by sector

	Sector	
	Production	Services
Base	***297***	***586***
Invest more time and money in NPD	39%	38%
Increase money available for NPD	39%	37%
Increase Return on investment in NPD	51%	43%

Source: 2010 UKTI International Business Strategies, Barriers and awareness survey

[64] Harris, R. and Li. C. (2010) *Study of the Relationship between Innovation, Exporting and the use of E-Commerce*. Final report submitted to UKTI 2010
[65] OMB (2010) *UKTI International Business Strategies, Barriers and Awareness Survey*. Report submitted to UKTI in June 2010.
[66] Ibid

The barriers to innovation, growth and export

Government intervention may be justified when markets for labour, capital, knowledge, goods and services fail to function properly. This is because, without remedial action, market failures may produce outcomes which do not deliver the maximum possible benefits for businesses, consumers, the wider economy and society.

The main types of market failure which may be found in manufacturing relate to skills, innovation, investment, supply chain collaboration and institutions. The actual nature and severity of these market failures may vary across the sector, reflecting the specific characteristics of the different manufacturing industries.

Skills related market failures

Skills and training spillovers

Skills and training can often give rise to externalities or 'spillovers'[67]. This is a term used to capture the idea that other firms may benefit from investment in an individual's skills by a firm. This means that the benefits to the wider economy and society from investment in skills and training may be greater than the private benefits to individuals and firms.

Spillovers may arise under a number of circumstances. First, all firms in a collaborative arrangement or industrial cluster may benefit from the decision by one partner to hire a skilled worker (e.g. a highly qualified scientist, engineer or technician). Second, there may be research and development and knowledge spillovers associated with firms *poaching* skilled workers from other firms[68].

The externalities and spillovers associated with skills workers (whether through poaching or in the form of industrial clusters) may be relatively stronger in knowledge intensive industries including high-tech manufacturing (e.g. aerospace, engineering, pharmaceuticals) and in particular new emerging technologies such as Low Carbon (see Box 12 below).

[67] BIS (2010) *Supporting Economic Analysis for 'Skills for Growth: the national skills strategy'* BIS Economics Paper No 4.
[68] See Howells (2005) reporting evidence gathered by Fleck on poaching by engineering firms in the West Midlands.

Box 12: Skills and training spillovers in the UK Low Carbon sector

There are externalities associated with training. Developing the skills that are necessary for the transition to the low carbon economy have wider environmental, economic and technological benefits which are not captured by employers or employees participating in the training. For example, training in one company on energy management could have positive spillover benefits into that company's supply chain. This concern primarily affects the provision of generic science, technology, engineering and mathematics skills that are useful to a wider spectrum of firms across the economy meaning there is greater incentive to try to free-ride on the investment in skills undertaken by other firms by poaching the newly-trained employees, instead of making the investment in human capital themselves. This can result in widespread underinvestment in the generic skills required to make the transition to a green economy.

Source: BIS (2009) *Towards a Low Carbon Economy.* BIS Economics Paper No 1

If firms are unable to fully appropriate the benefits of training their workforce, for example because employees leave for a job elsewhere, then this may lead to underinvestment in skills, particularly if the costs of training (e.g. financial cost of training, lost output as a result of employee being absent from the workplace) are high, as in the case of the aerospace industry[69].

Informational failure around future skills needs and opportunities

The dynamic nature of modern manufacturing makes is difficult for employers as well as employees to accurately predict what employment opportunities are likely to be generated in the future and the knowledge, skills and industry experience that will be required.

In the face of such uncertainty about future demand for particular skills, firms and individuals may be further discouraged from investing in skills and training. This is because in addition to the cost of training, there is the risk that once the training has been completed, employers and employees may still not have the required skill sets. This problem is likely to be more serious for manufacturing industries based around newly emerging technologies such as low carbon and Life Sciences as the degree of uncertainty about future skills needs is likely to be relatively greater (see Box 13 below)[70].

Box 13: Uncertainties around future skills needs in the UK Life Sciences sector

The complex, cross-cutting and fast-moving nature of the Life Sciences market means that employers may be unable to accurately judge what types of jobs will be required in the future and which skills will be needed for employment in the industry. The market may also not provide sufficiently strong signals about the demand for particular skills sets which may increase the uncertainty which employers and employees may face. This may lead to underinvestment in the critical skills required, including insufficient information and guidance to those interested in pursuing a career in Life Sciences.

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

[69] SEMTA (2009) Skills and the future of advanced manufacturing.
[70] BIS (2010) Life Sciences Paper. BIS (2008) Low Carbon Paper

Innovation and knowledge transfer

Spillovers from innovation activity including research and development

Innovation activity, including research and development (R&D) can also often give rise to externalities or 'spillovers'. The return on innovation activity is often uncertain and can involve high levels of investment with long pay-back periods. If there is a high degree of uncertainty that firms will be able to fully appropriate the economic benefits then they may under invest in innovation.

R&D spillovers will vary across different industries of the manufacturing sector as some industries are more R&D intensive than others (see Figure 10 above). Consequently, R&D spillovers may be of greater concern for a select number of manufacturing industries such as aerospace, pharmaceutical and space (see Box 14 below)

Box 14: R&D spillovers in the UK Space Sector

The UK space industry is characterised by high levels of cost, and financial and technological risk. Satellite manufacturing faces significant technological and scientific hurdles that require intensive efforts in terms of R&D. Owing to the high costs and risks associated with the development process and the long gestation period to commercialisation, companies are often deterred from investing in less directly commercially focused forms of R&D without heavy government support. High levels of R&D also imply significant economies of scale in space activities and important spillovers that may be captured by others. For example, space technologies cover a wide range of areas including materials, automation, robotics, electronics, sensors, optics, communications, power and energy devices. Therefore, there are opportunities for space technologies to be applied in a number of other sectors including defence, aerospace, transport, energy, Life Sciences, medical engineering and healthcare[71].

Sources: BIS (2010) *The Space Economy in the UK*. BIS Economics Paper No 3.

Informational failure around new manufacturing ideas and processes

Some firms, particularly small and medium sized enterprises (SMEs), may experience difficulties accessing knowledge of the latest industrial ideas, technologies and practices or finding professional support and advice on how these can be applied to their business. For example, in manufacturing there is evidence to suggest that many manufacturing firms are not aware of the economic and financial benefits of greater automation (see Box 15 below).

[71] House of Commons Science and Technology Committee (2007) *2007: A space policy*

Box 15: Automation in UK manufacturing

Automation can involve the use of industrial robots or electro-mechanical devices under the control of microprocessors performing handling or processing functions.

To succeed on world markets, manufacturers have to develop competitive products and processes through their technological strengths. This could be achieved by investing in manufacturing systems, the benefits of which more than offset labour cost advantage typically held by the lower cost economies such as China and India. Automated systems deliver these benefits and therefore enable UK manufacturing to compete successfully in overseas markets.

Benefits of automation included lower production and assembly costs, better product quality, increased resource and energy efficiency, improved customer response and care and high employee satisfaction and performance.

One of the barriers to adoption is a lack of information that firms, particularly SMEs, have about the potential benefits of automation. This is due in part to the lack of professional impartial advice available to firms. SMEs interviewed as part of the study recognise that they tend to be as automated as their UK counterparts, but less automated than their German equivalents. Increases in productivity are being achieved, but not fast enough to keep up with the increases achieved in Germany.

Source: EAMA (2010) unpublished

Demand and market opportunity uncertainties

Uncertainty over future demand for yet unproven technologies and new products could lead to underinvestment in new innovative technologies and products where the UK has already developed capabilities and has a technological competitive advantage compared to other countries.

Such products are often referred to as *experience goods.* These are goods or services that have particular characteristics which are difficult to observe in advance, but can be ascertained upon consumption (e.g. product quality). Experience goods may pose difficulties for consumers in accurately making consumption choices. An example of an experience good based on a novel technology is the low carbon vehicle (see Box 16).

Box 16: Uncertainty of demand in the UK Electric Vehicles sector

Buying a vehicle is a major purchase and so consumers want to be sure they are getting a reliable product. Low carbon technology which involves unfamiliar powertrains such as electric cars presents a risk to most buyers as they are not used to driving such vehicles. They have no experience of the vehicle's reliability and are unsure what it may be worth in three years time when they might be looking to sell the vehicle. While such risk aversion may be understandable, it can significantly impair the roll-out of innovative low carbon technologies. This can create a vicious circle where consumers will not buy a new product until it is proven, but the product cannot be proven until it is bought and consumers get used to running it.

Source: BIS (2009) *Towards a Low Carbon* Economy. BIS Economics Paper No 1

Informational failures around future market opportunities has been a particular problem affecting the civil nuclear chain where uncertainties about the potential future return has discouraged further investment by UK businesses (see Box 17)

Box 17: Uncertainties in the UK Civil Nuclear Supply Chain

The civil nuclear new build supply chain is complex with a wide range of components covering pre-build activities such as engineering, design and legal services, all aspects of construction and operations (from plant and equipment activities, to nuclear fuel supply and waste management.

A key concern is that UK businesses may not properly assess the market opportunities due to failures in the market from information asymmetries and uncertainties over the potential future returns from investing in new nuclear supply chain capacity. Lack of certainty may mean that they will not make the timely investments required to take advantage of the increase in demand across the supply chain. This certainty is needed to ensure that investments are made in both physical capital (facilities) and human capital (training to ensure that the necessary skills base is in place).

Source: BIS (2009) *Towards a Low Carbon Economy*. BIS Economics Paper No 1.

Co-ordination failures

There may also be significant co-ordination failure problems. For example, firms may lack knowledge of the opportunities and benefits of collaborating on new projects or have sufficient incentive to disseminate valuable information about new ideas, technologies, products and processes. Alternatively, they may experience particular difficulties forming collaborative arrangements not only with other firms across the supply chain but also with the wider research and science base.

Co-ordination failure may be a particular problem for newly emerging technologies where the technological and commercial risks may be significant and those technologies whose value is highly dependent on other complementary technologies and product being developed and adopted. In the absence of co-ordinated action, firms may be reluctant to continue on a unilateral basis because the commercials risk are too great. This is a particular problem for low carbon vehicles (see Box 18 below)

Box 18: Co-ordination failure in the UK Electric Vehicles sector

There may be poor coordination between the rollout of the charging infrastructure and the deployment of electric vehicles (EVs). There is evidence to suggest that potential EV drivers are concerned about the limited range of EV and therefore may require infrastructure to charge the EVs to have confidence and enable demand to grow. However, without the potential for near-future and high utilisation of the infrastructure, the private sector is less likely to invest in it. Also, what investment might take place is likely to do so only in a few areas of potential high density and this might restrict the wider spread of the vehicles and hence limit the economies of scale that can be achieved. This may have knock-on effects on the electric vehicle supply chain (e.g. electric batteries).

Source: BIS (2009) *Towards a Low Carbon* Economy. BIS Economics Paper No 1

Uncertainty over the characteristics of new products and goods which incorporate new ideas and technologies and a lack of experience of certain goods can in essence lead to a chicken and egg problem. This can create a ‘critical mass’ problem whereby the level of market demand needed to bring about widespread adoption by users is not reached (see Box 19).

Box 19: Critical mass in emerging technologies

There might be a significant critical mass problem where a new technology tends to be very expensive: R&D can be considerable and this investment needs to be recouped. Therefore new vehicles with innovative technology – such as the electric car with expensive batteries – have a considerable price premium. Over time, however, increasing sales volumes can lead to lower prices through economies of scale and learning by doing. However, if costs will only fall when sales are high, sales may never get off the ground until costs fall. This can mean that the new low carbon technology never achieves significant penetration because it remains too expensive. This is sometimes described as the ‘technology hump’ where innovators require help in the early stages to get the product to market at a reasonable cost so over time it can generate sufficient sales to bring down its cost and compete without support.

Source: BIS (2009) *Towards a Low Carbon* Economy. Economics Paper No 1

Investment and access to finance

Some investment projects involving a science and technology component may be characterised by particularly high levels of cost and risk with long pay-back periods. These types of investments can be especially hampered by difficulties obtaining appropriate and affordable finance. This can be a particular problem for manufacturing industries such as aerospace and Life Sciences (see Box 20).

Box 20: Investment and access to finance in the UK Aerospace and Life Sciences sectors

Aerospace

New large civil aircraft and engine projects often involve high development costs, long development periods, significant technological and market risks and long pay-back periods. These characteristics may explain the unwillingness of capital markets to fund early stage development.

Life Sciences

Taking a prospective new pharmaceutical ingredient or drug from the research lab to product launch takes from 10 to 15 years. Therefore, building a successful bioscience company requires significant funding from third party investors over a long period. Typically, a bioscience company needs different types of funding as its pipeline matures, and the level of funding increases dramatically over time.

Uncertainty and information asymmetries about the likelihood of success of potential drug candidates and of new medical technologies, and the potential size of the market may all preclude investments in Life Sciences as SMEs might struggle to obtain sufficient financing to undertake research and development.

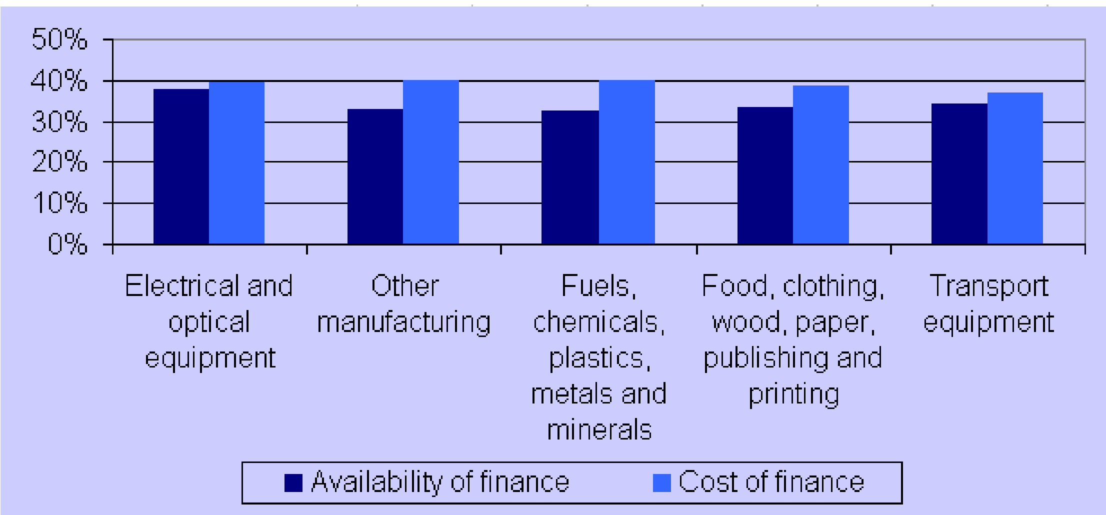
Problems with access to finance may be particularly acute for academic spin-outs or very young companies which require seed funding to develop a concept. Early stage Life Sciences companies developing innovative products and technologies also require follow-on investment for continuous product development.

Source: BIS (2010) *Learning lessons from six successful sectors* BIS Economics Paper No 6; BIS (2010) *Life Sciences in the UK*. BIS Economics Paper No 2

There may be significant uncertainties around the likelihood of success of new ideas, technologies and products, particularly at the initial design and development and demonstrator phases of the innovation process. This can also make access to finance difficult.

Figure 12 below shows the proportion of firms identifying the availability and cost of finance as potential barriers to innovation. This information is taken from the 2009 UK Innovation Survey. It shows that the availability and cost of finance is viewed as an important barrier to innovation by a relatively larger proportion of firms in medium-high and high-technology industries, in particular electronic and transport equipment.

Figure 12: Barriers to innovation: Access to finance (2006-2008)



Source: 2009 UK Innovation Survey
Note: Percentage of firms reporting availability and cost of finance as an important or very important constraint to innovation

Barriers to internationalisation

When deciding whether to enter overseas markets, firms face information asymmetries. They may not be fully aware of the potential benefits of exporting and lack the necessary knowledge and capability to successfully exploit overseas opportunities. This can lead to some firms deciding not to export, or if they do, to under invest in their exporting capability or engage in lower levels of export activity than they would otherwise might.

UK firms that choose to export will not only face traditional tariff barriers to trade but also a number of non-tariff barriers including[72]:

- Gaining access to networks and contacts in overseas markets. This includes establishing a dialogue and building a relationship with actors in the market
- Navigating unfamiliar business environments, including differences in language and culture
- Procedural barriers such as product standards and other aspects of the legal and regulatory framework
- Having the capability to understand the competitive environment and to identify and assess potential opportunities and risks
- Finding the confidence, management time and other resources to investigate and pursue opportunities in overseas markets

[72] BIS (2010) *Internationalisation of Innovative and High Growth SMEs*. BIS Economics Paper No 5

The barriers faced by UK firms tend to be relatively greater in fast growing emerging markets. In these markets, legal and regulatory barriers and language and cultural barriers are most commonly encountered.

Manufacturing firms seem to face more of these barriers than firms in the services sector. For example, in a recent survey, 70% of manufacturing firms indicated that they had experienced at least one barrier, compared to 64% of service sector firms (Table 11). Evidence suggests that the barriers to internationalisation are relatively greater for innovative active firms.

Table 11: Type and number of barriers to internationalization by sector

The table shows the % firms reporting very significant barriers (% giving ratings of 4-5), using a 1-5 scale, where 1 = not difficult, and 5 = extremely difficult	**Total**	
	Production	*Services*
Base: All exporters	*287*	*552*
Types of barriers		
Legal & regulatory	42%	40%
Customs	30%	25%
Contacts	32%	25%
Information	18%	15%
Resource	22%	19%
Language & cultural	19%	19%
Bias	18%	17%
Number of barriers		
At least one barrier	70%	64%
- One	17%	17%
- Two	16%	15%
- Three	11%	12%
- Four or more	25%	20%
No significant barriers	30%	36%

Source: OMB (2001) 2010 UKTI International Business Strategies, Barriers and Awareness Survey

It has been argued that the barriers to internationalisation are relatively greater for SMEs because resource barriers are higher due to their more limited supply of human and financial resources, expertise and contacts[73]. This is reflected in Table 12 overleaf which shows that compared to larger companies, the percentage of small and medium manufacturing firms which export is relatively lower.

Table 12: Incidence of exporting in UK manufacturing by firm size, 2000-2006

	2000	2004	*2006*
10-49	36.7	39.4	53.6
50-249	64.2	65.6	76
250+	72.5	72.9	80.7
Total	43.9	47.0	55.2

Source: Weighted data for CIS3/4/5 from Harris, R. and Li, Q.C. (2009) A study of the relationship between exporting, innovation, and the use of e-commerce, Interim Report submitted to UKTI December 2009

[73] OECD (2008) *Removing barriers to SME access to international markets*

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