The Case for Space:

The Impact of Space Derived Services and Data

Final Report - July 2009

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1 Executive summary

Further to the 2004/05 study on the economic contribution of the UK's space industry, this report supports the evidence that the sector is still among the UK's fastest growing…

- The UK space industry is a UK success story, growing in real terms by around 9% a year since 1999/00 – more than three times faster than the economy as a whole. And it has the potential to continue to grow as rapidly over the next decade as new technologies and applications are developed that rely on space derived data and services, including location based services for mobile phones, improved satellite data for weather forecasting and integrated applications involving more than one aspect of space data and services together with terrestrial complements.
- Strong growth in R&D investment will be needed to underpin future growth.

... and among the most productive…

- With GDP per worker around £145,000 in 2006/07, productivity is more than four times the UK average. In part, the space industry's high productivity reflects the very high levels of capital investment undertaken by firms in the sector. But the industry's labour force is also highly skilled, with more than 60% or workers being qualified to at least graduate level - compared to 30% for the UK active population.

…and a substantial industry in its own right…

- On a turnover of £5.9 billion, the UK space industry directly contributed around £2.8 billion to UK GDP in 2006/07. This means that it is comparable in size with the web design industry and larger than the market research industry, software publishing and even call centre activities.
- The presence of an upstream industry in the UK is likely to have stimulated benefits to the downstream sector that would not otherwise have materialised.
- Employment in the UK space industry reached 19,100 in 2006/07.

…supporting around 68,000 jobs in the UK both directly and through its spending…

- As well as being a substantial generator of activity in its own right, the space industry also helps to generate GDP and employment throughout the rest of the economy. For example, more than 35,000 UK jobs are supported by space industry purchases of goods and services from companies in its supply chain. And the spending of workers directly and indirectly employed by the space industry helps to support a further 13,600 UK jobs.
- In total, the space industry helps to support almost 68,000 jobs and generates about £5.6 billion in GDP through direct and economic multiplier impacts.

… and contributing to regional development throughout spending across the value chain…

- Despite the space industry being concentrated in a few regions (mainly the South East), it supports a high number of jobs in other UK regions through its purchases to suppliers and spending throughout the value chain.

The space industry also helps to improve the performance of the wider economy…

- But the contribution of the space industry to the UK economy goes much wider. In particular, there are a number of catalytic or spillover impacts whereby the space industry helps to facilitate improved supply-side performance of the UK economy, creating capabilities and enhancing productivity across the wider economy.

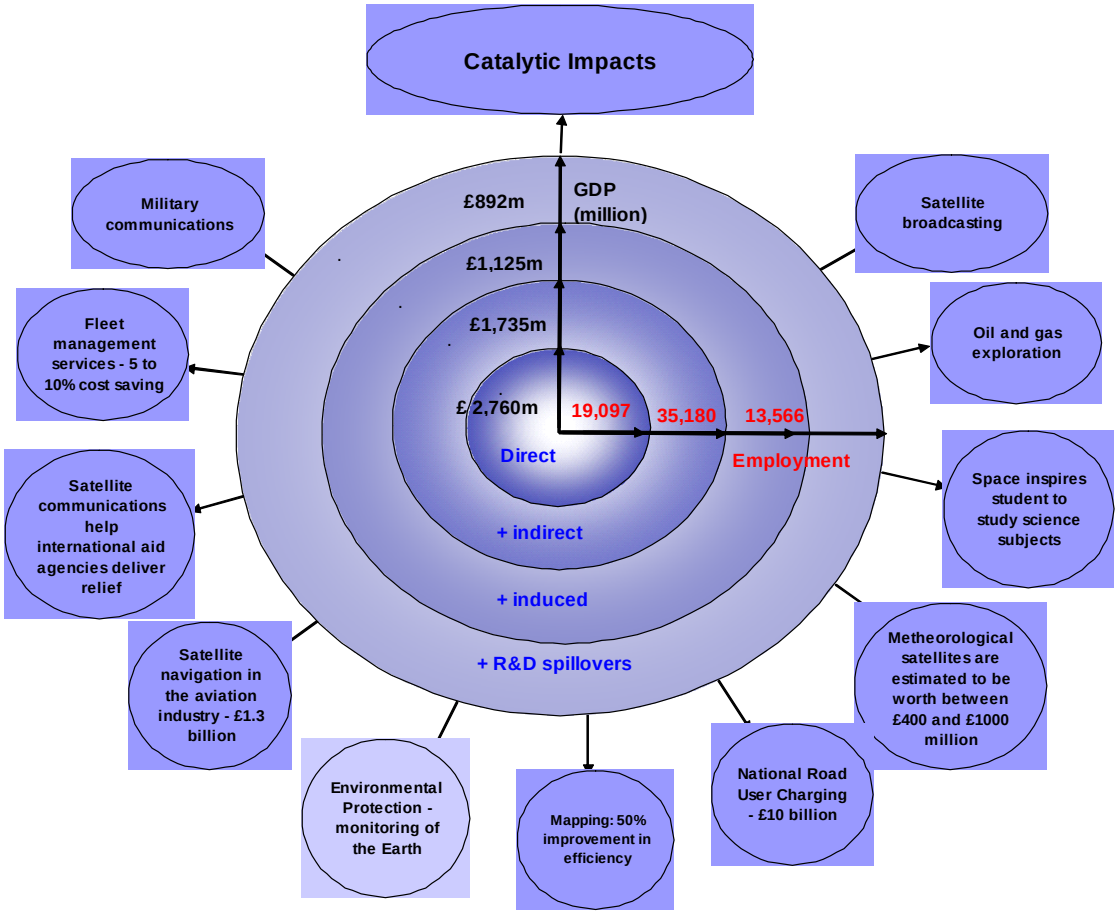
…partly through its substantial investment in R&D…

- Overall research and development (R&D) expenditure in the space industry was £130 million in 2006/07. This level of investment is equivalent in monetary terms to almost 5% of the industry's

direct value added (i.e., its GDP contribution). This means that the UK space industry is about three times more R&D intensive than the economy as a whole.

- The technological advances that come about as a result of R&D investment in the space industry can be transferred to firms in other sectors in the form of 'spillover' effects. Previous research by Oxford Economics suggests that such spillover effects are very large, with R&D investment by the aerospace sector generating a social return of around 70% - i.e. every £100 million invested in R&D leads to an increase in GDP of £70 million in the longer term.
- On this basis, we estimate that the space industry helps to generate £900 million a year of GDP in the UK due to the spillover effects of its R&D, on top of its £5.6 billion of direct and multiplier impacts. So, we calculate that the space industry overall currently contributes at least £6.5 billion a year to UK GDP (see Figure 1-1).
- Additionally, the application of space derived services and data further contributes to the UK economy by facilitating the provision of a wide range of services to business and consumers, and by enabling the UK's economic infrastructure to be used more efficiently (see Figure 1-1 for some examples). It is not possible to accurately quantify the value of all the additional benefits.

Figure 1-1, The contribution of the UK space industry and examples of catalytic effects



…but also by enabling communications across the globe…

- Many UK organisations operate in parts of the globe where land based communication are poor. For these organisations satellite based communications are of key importance. Included here are; the offshore oil & gas industry, deep sea shipping, international aid agencies and the aeronautical

industry. Satellite communications are also of significant importance in disaster recovery situations, or to businesses to offer guarantees of service continuity even if an event closes down land-based communication channels. This includes ensuring that "firms and markets can communicate with each other during an emergency, even if some lines of communication are not operational."

…improving the operation of the UK transport network…

- Improved transit based on satellite navigation will lead to time savings, falls in carbon emissions and less accidents, with a potential benefit to the UK economy of up to £10 billion a year.
- A National Road user charging (RUC) system, where charges are based on a combination of time, distance and space, using technologies based on satellite navigation, would bring benefits of £10-£12 billion to the UK.
- Location based services are applications that leverage the user's physical location to provide services. Although these applications are currently in their infancy, there exists the potential for large growth as it becomes commonplace to have a satellite positioning chip in mobile phones.

…enhancing the accuracy of weather forecasts…

- The weather affects all aspects of the UK economy, from causing delays in transport, to increasing demand for electricity, to loss of life due to unexpected weather patterns. The value of improvements to weather forecasting brought about by the use of satellite data is estimated at between £400 and £1000 million to the UK every year.

… helping protect the environment…

- Earth observation has become an essential tool for monitoring climate change (such as measuring water levels), emergency responses (by for instance, providing an accurate picture of areas affected by flooding), natural resources (such as sources of pollution), sustainable development (such as applications in agriculture), or population dynamics (observing air quality).

…and inspiring people to study science

- Space inspires young people to study science subjects - space was the second most popular factor motivating physics degree involvement. The additional taxation revenues, from a science graduate compared with a non-graduate, to the Exchequer over a graduate's working lifetime is around £135,000.

The UK space industry has a great growth potential…

- Despite the current economic slow down, the UK space industry is forecasted to grow, on average by about 5% a year until 2020. Raising R&D intensity could help sustain even stronger growth of perhaps 7% a year – in line with growth in the last 3 years. However, a sustained decrease in R&D, or if the recession impacts even more severely on UK companies, growth could fall to just 3%. These scenarios imply that the industry will directly employ between 22,000 and 30,000 people and contribute between £4.1 and £7 billion to GDP in 2020.
- Under these assumptions, the UK space industry is estimated to support between 72,800 and 115,000 jobs in total, including direct and multiplier (indirect and induced) impacts, with a value added contribution to GDP of between £8.4 and £14.2 billion in 2020.

… which can be realised with strong R&D investment.

- The scenario analysis shows that, under the current R&D spending patterns, the UK space industry in 2020 will support a further £1.3 to £2.2 billion of GDP in the UK due to spillover effects of the R&D it will undertake, and potentially much more if support to funding allows R&D intensity to be increased, by increasing productivity even further, and by allowing the UK space industry to remain competitive in the international marketplace.

2 Introduction

2.1 Approach and report structure

In order to meet this challenging brief a number of complementary approaches have been adopted. Where available, existing data have been gathered and this information has been supplemented by case studies and desk based research. Input-output modeling techniques have been developed for the multiplier work, and econometric research underpins the forecasts and the quantification of the research and development 'spillover'[1] effects. These techniques and data sources are all discussed in greater detail during the relevant sections of the report.

The report is structured as follows:

- Chapter 1 is an executive summary.
- Chapter 3 discusses the direct value of the space industry to the UK economy today.
- Chapter 4 examines the research and development spillover benefits the space industry brings to the UK economy.
- Chapter 5 discusses the wider benefits of the space industry to the UK economy.
- Chapter 6 discusses the prospects for the space industry.

[1] 'Spillovers' in this context are defined as an effect on someone's profit or welfare arising as a byproduct of some other person's or firm's activity.

3 The UK space industry today

Key Points

- The UK space industry directly employed around 19,000 workers in 2006/07.
- The UK space industry has a turnover of £5.9 billion and its direct contribution to UK GDP is estimated to have been around £2.8 billion in 2006/07.
- The downstream space industry is around six times as big as the upstream.
- Value added per head in the UK space industry is around four times the UK average at £145,500 per annum.
- The workforce is well qualified. Some 62% of the overall space workforce are graduates.
- The UK space industry helps to support 68,000 jobs in total, allowing for those people employed by suppliers of the space industry, and for the jobs dependent on the spending of the employees of the space industry and the companies supplying them.
- UK space industry contributes overall around £5.6 billion a year to UK GDP, taking into account direct, indirect and induced impacts – equivalent to nearly 0.5% of UK GDP.

3.1 Introduction

This chapter firstly discusses the employment and GDP directly supported by the space industry and the productivity of the industry. The chapter then summarises the different multiplier impacts of the industry.

3.2 Definition of the space industry

The space industry is not well defined in standard government industry classifications (SIC) and hence data are not available from sources such as the Office for National Statistics[2]. The key sources of information on the economic importance of the space industry are the 2008 BNSC Size and Health survey and the BNSC space sector mapping study. The estimates presented here draw heavily on these statistics but have been supplemented by our own research.

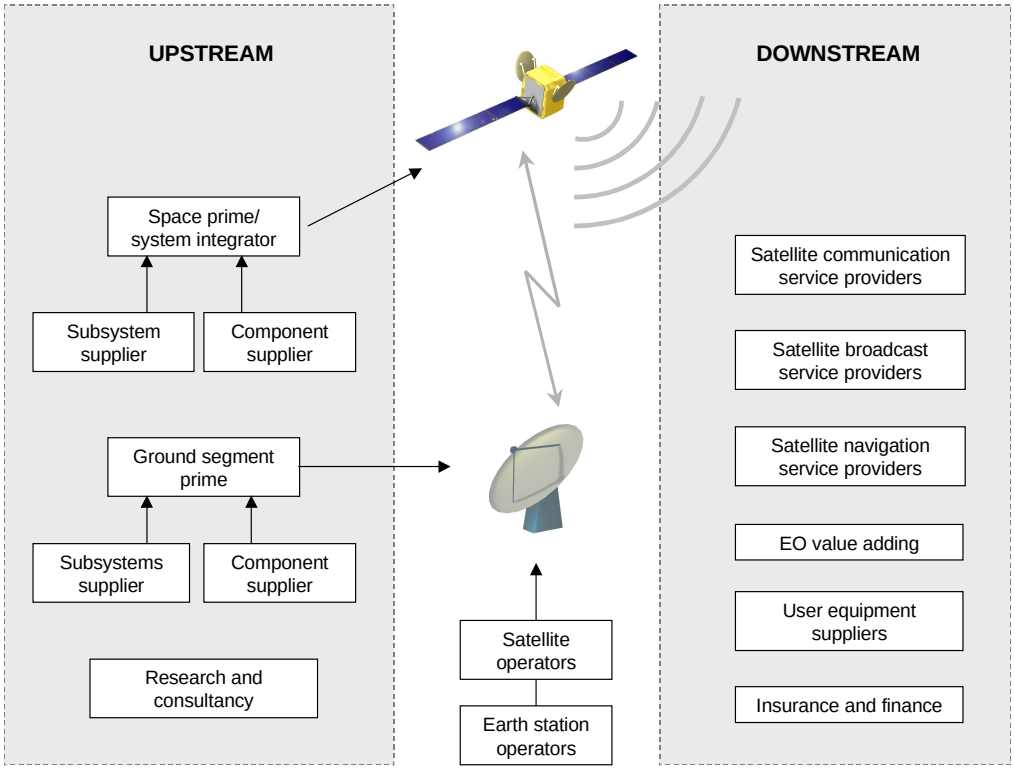
The space industry consists of companies who provide the technology (the upstream sector), as well as companies that exploit the technology (the downstream sector). The distinction between the upstream and the downstream segment is not always completely clear, for that there could be companies whose activities could be included in both the upstream and downstream. However, as a general rule, we could define the upstream segment as the "Provision of Technology", and the downstream as the "Exploitation of Technology". For instance, the satellite navigation would include an upstream activity (which would be the actual satellite and the ground technology that transmits and processes data), and a downstream activity that would include the manufacturing of the navigation device, as well as the provision of the service to the end user.

Upstream companies include those involved in the space segment prime and their suppliers, as well as those companies involved in ground segment prime and subsystems and components. Companies who provide support products and services and research and consultancy to these companies are also included in the upstream definition.

[2] The closest standard industrial classification (SIC (2003) code) to space in ONS statistics is 35.30: Manufacture of aircraft and spacecraft.

The downstream sector includes the parts of those companies involved in satellite broadcasting (for example, Inmedia Communications Ltd), satellite communications (for example, cable and wireless), and satellite navigation (for example, TrafficMaster). Organisations involved in earth observation (for example, Met Office) and equipment and support product and service providers also form part of the definition of the downstream segment (see Figure 3-1).

Figure 3-1, Definition of the UK space industry



Source: Size and health of the UK space industry 2008 (BNSC)

To put the UK space industry in a global context, the global space industry employs over a million people and findings from 'The World Space Report 2008' show that world turnover generated from commercial services and government programs reached £104 billion in 2007, with an upstream turnover of £26 billion, and £78 billion downstream, which gives the UK a world market share of approximately 6% (3.2% market share for the upstream, and 6.5% for the downstream).

3.3 Approach to measuring the impact of the space industry

There are many channels through which the UK space industry makes a contribution to the UK economy. This contribution includes the following standard economic impacts:

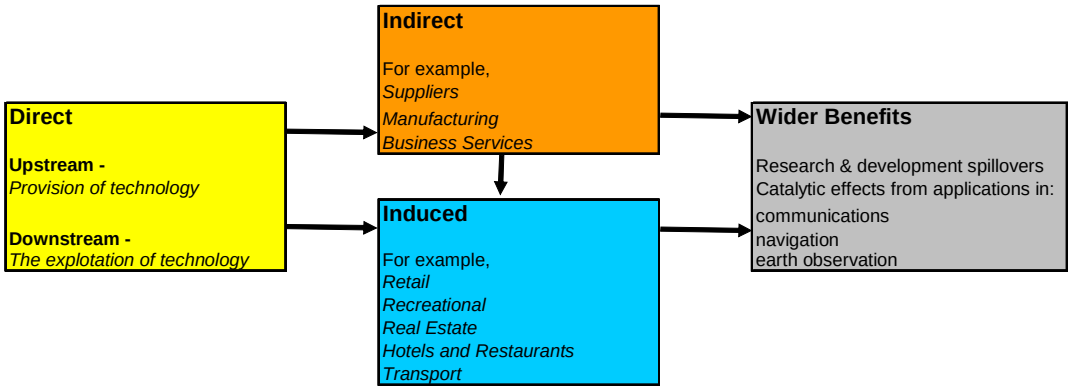
- **Direct impacts** – employment and activity in the UK space industry itself. As discussed above, this covers the upstream (provision of technology) by UK companies as well as the exploitation of the technology by UK based downstream companies.
- **Indirect impacts** – employment and activity supported down the supply chain to the UK space industry, as a result of UK space companies purchasing goods and services from UK suppliers. This includes, for example, jobs supported by the manufacture of computers sold to space companies; by the manufacture of metals used in satellite equipment; business expenditure in

hotels, restaurants etc; and a wide variety of activity in the business services sector (legal, accountancy, IT etc).

- **Induced impacts** – employment and activity supported by those directly or indirectly employed in the UK space industry spending their incomes on goods and services in the wider UK economy. This helps to support jobs in the industries that supply these purchases, and includes jobs in retail outlets, companies producing consumer goods and in a range of service industries.

But there also are a number of additional **economic catalytic impacts ('spillovers')** which result from the benefits that government, consumers, society and other industries derive from the existence of the space industry. These partly reflect the wider use of technology and applications developed through the R&D undertaken by the space industry. But the use of space derived services and data also facilitates the development of a range of products and services that would not be possible without the use of satellite technology and also facilitates the more efficient use of the UK's economic infrastructure and resources, helping to improve productivity (Figure 3-2).

Figure 3-2, The impact of the UK space industry

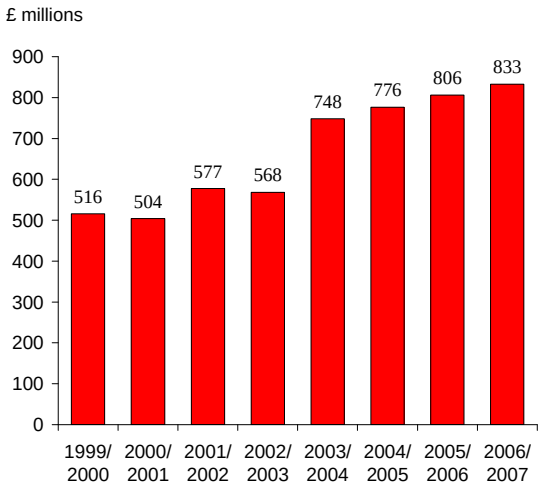


Source: Oxford Economics

3.4 Upstream

The upstream space industry contributed £547 million directly to UK GDP in 2006/07, from a turnover of £833 million. The industry has grown rapidly in recent years: turnover has increased by an average of 7% a year in real terms since 1999/2000. This growth is nearly three times faster than the UK economy as a whole (see Figure 3-3). Productivity growth has been the key factor behind this performance with gross value added per employee growing at nearly 4% a year in real terms during this period.

Figure 3-3, Upstream space industry turnover, 2006/7



Source: Size and health of the UK space industry 2008 (BNSC) / Oxford Economics

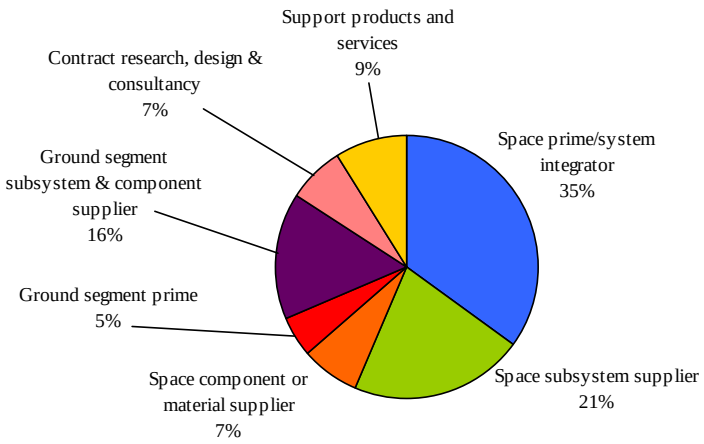
The largest segment in the upstream industry is space prime, which includes companies such as EADS Astrium and SSTL, and accounts for 35% of upstream turnover, down from 52% in 2004/2005.

Although this fall in turnover in space prime has been partly compensated by an increase in turnover by the space subsystem supplier (21% of upstream turnover, up from 15% in 2004/2005), and space component and material suppliers (up from 5% in 2004/5 to 7% in 2006/7), the upstream space sub-segment (prime, subsystem suppliers, and components) has reduced its share from 72% to 64% of the upstream turnover. This may indicate a change in the nature of business in UK, with a growing importance in the provision of payload subsystems rather than complete spacecraft.

Other major components of the upstream industry include (see Figure 3-4):

- Ground segment prime, that accounts for 5% of upstream turnover, up from 4% in 2004/05).
- Ground subsystem & component supplier, that makes up 15% of upstream turnover, up from 12% in 2004/05)
- Contract research & design consultancy, that accounts for 7% of upstream turnover, (7% in 2004/05).
- Upstream support & others, that accounts for 9% of upstream turnover, up from 3% in 2004/05.

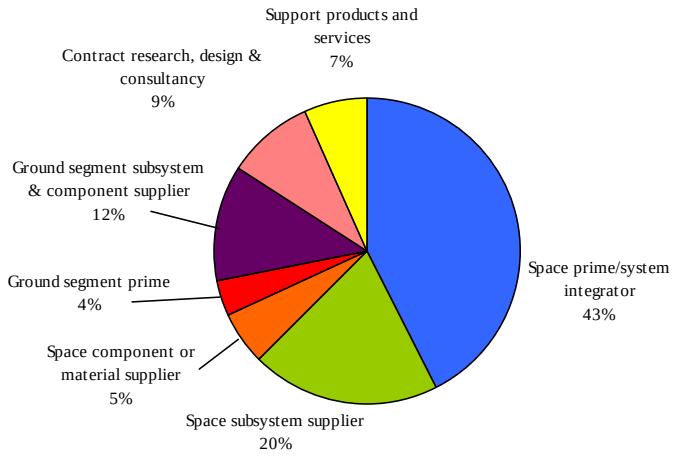
Figure 3-4, Upstream space industry turnover, 2006/7



Source: Size and health of the UK space industry 2008 (BNSC) / Oxford Economics

The upstream space industry now employs around 5,850 workers up from just over 4,700 in 1999/00. Of these around 2,500 are in the space prime sector, 1,200 in the subsystem supplier, and 300 in the component or material supplier. The ground segment and subsystem supplier employ around 950 persons in total, whereas contract research and consultancy services employ around 500 people, and support products and services around 400 (see Figure 3-5).

Figure 3-5, Upstream space industry employment, 2006/7



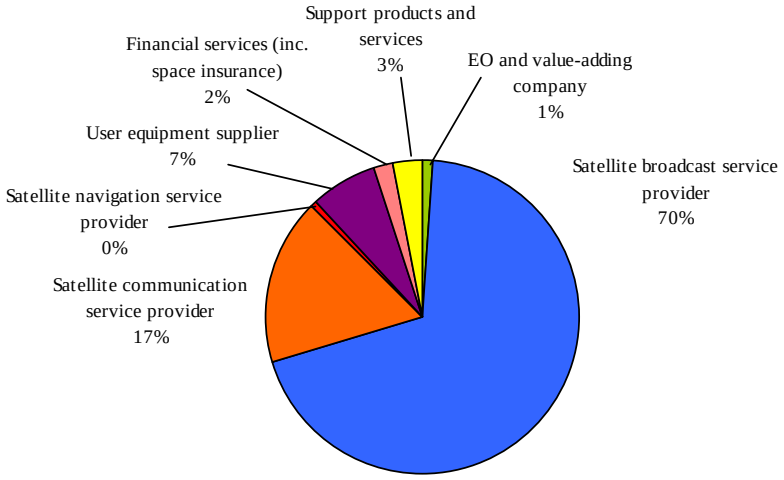
Source: Size and health of the UK space industry 2008 (BNSC) / Oxford Economics

3.5 Downstream

The downstream space industry contributed £2,213 million directly to UK GDP in 2006/7, from turnover of £5,080 million. Of this by far the largest component, with £3,474 million turnover, are satellite broadcast service providers. But there is also substantial activity in a range of other downstream segments, for example, satellite communications, satellite navigation, earth observation,

user equipment suppliers, support products are services and financial services (see Figure 3-6). Many companies are involved in downstream space and they include for example; BSKYB, Cable and Wireless, TrafficMaster, Norwich Union and the Met Office.

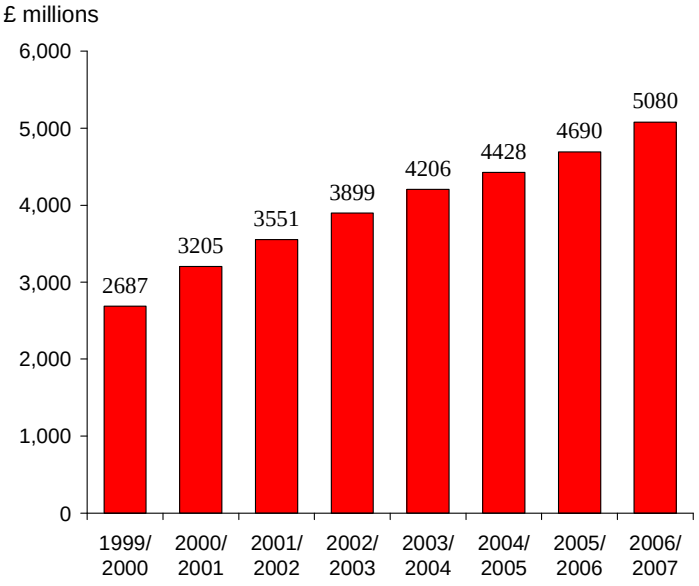
Figure 3-6, Downstream space industry turnover 2004/5



Source: Size and health of the UK space industry 2008 (BNSC) / Oxford Economics

The downstream space sector has grown at an even faster rate than the upstream sector with turnover increasing by an average of almost 10% a year in real terms since 1999/00 (see Figure 3-7). On this basis, the downstream space industry has grown more than three times the rate of the UK economy as a whole.

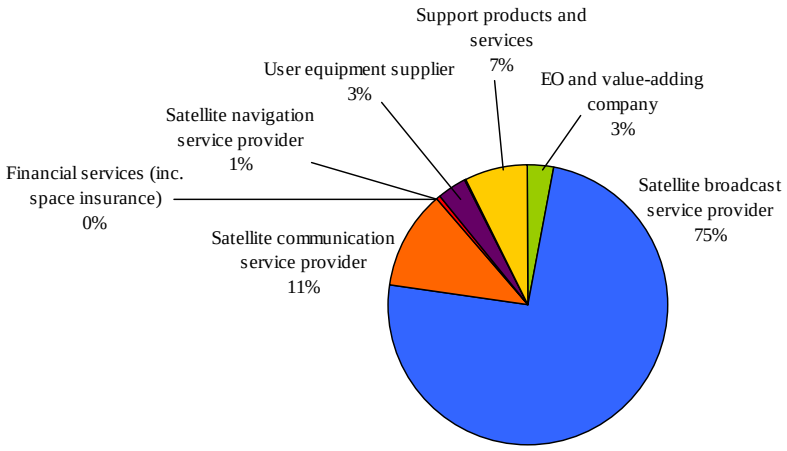
Figure 3-7, Downstream space industry turnover



Source: Size and health of the UK space industry 2008 (BNSC) / Oxford Economics

Although productivity has been the driving force behind growth in the downstream sector -with productivity per employee growing at 5% a year since 1999/00, employment has also grown strongly (at 4% per year) during that period, contributing to the doubling of the sector in 7 years. The downstream space industry now employs around 13,250 workers. Of these around 9,700 work for satellite broadcast service providers and around 1,500 for both satellite communication service providers. Support products and services almost employ 1,000 people, whereas earth observation and user equipment suppliers employ around 500 people each (see Figure 3-8).

Figure 3-8, Downstream space industry employment



Source: Size and health of the UK space industry 2008 (BNSC) / Oxford Economics

3.6 Linkages between upstream and downstream

The presence of the upstream industry in the UK is likely to have stimulated benefits to the downstream sector that would not otherwise have materialised. Examples of the how the benefits from the presence of a UK upstream industry will flow to the downstream are:

- Improved information – this could include:
    - technical knowledge and expertise that flows to downstream providers allowing them to identity, develop and market new services
    - reduced risk in developing downstream services
    - information and knowledge base in funders – improving the City's and public sector funders ability to assess projects resulting in a better allocation of capital and improved "export" capacity in the City
- Scope – bigger and better downstream projects ensuring that economies of scale are captured
- Collaboration – brings together entities from upstream and downstream sectors to realise projects that neither could develop individually, nor which could be developed via collaboration between UK based downstream companies and non-UK upstream companies (trust, culture, familiarity, key staff interaction, co-location)
- Human capital – development of skills in downstream via the movement of people between the upstream and downstream sectors, development of a critical mass of skills in the labour market that enable downstream activities to occur
- Early adoption – upstream activity allows downstream industry to adopt new techniques / services early which in turn influences the competitive offering / productivity of other sectors.

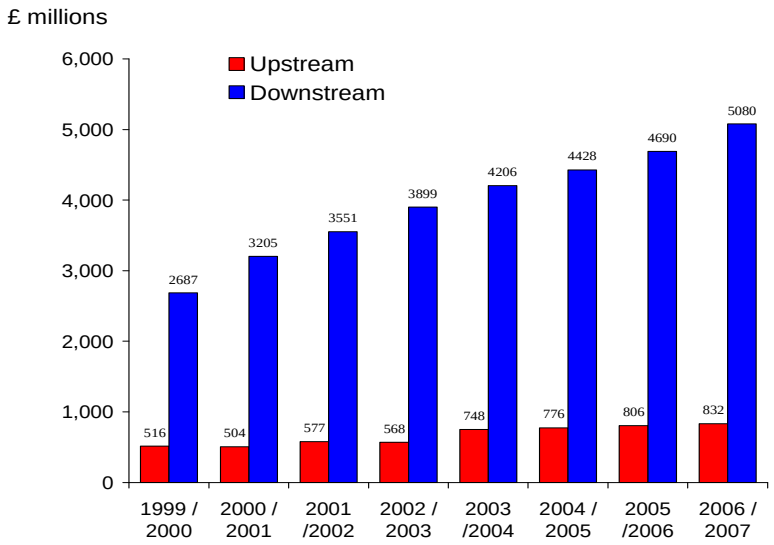
- Closeness – geographic co-location and similarity in technological approach (across and up and down the supply chain) are thought to encourage spillovers from R&D spend – presence of upstream investment in the UK increases the likelihood that these spillovers will be captured by UK entities –in downstream services, as well as elsewhere in manufacturing and in other upstream activities.
- Competitive position of UK universities and higher education institutions – cutting edge upstream activities helps maintain the science base and the ability of related university departments to compete for staff, (international) students and research contracts.
- Business start up rate – creates opportunities for new service and upstream providers.

3.7 Total Space Industry

The UK space industry had a turnover of £5.9 billion in 2006/7, having grown at an annual rate of above 9% a year since 1999/2000 (7% for the upstream and almost 10% for the downstream).

In terms of GDP, the Space industry directly contributed £2.8 billion to UK GDP in 2006/7 (Figure 3-9). This means the UK space industry is comparable in size with the film industry, or the radio and television production and broadcasting and larger than the market research industry, or software publishing and even call centre activities[3].

Figure 3-9, Evolution of UK Space Industry turnover

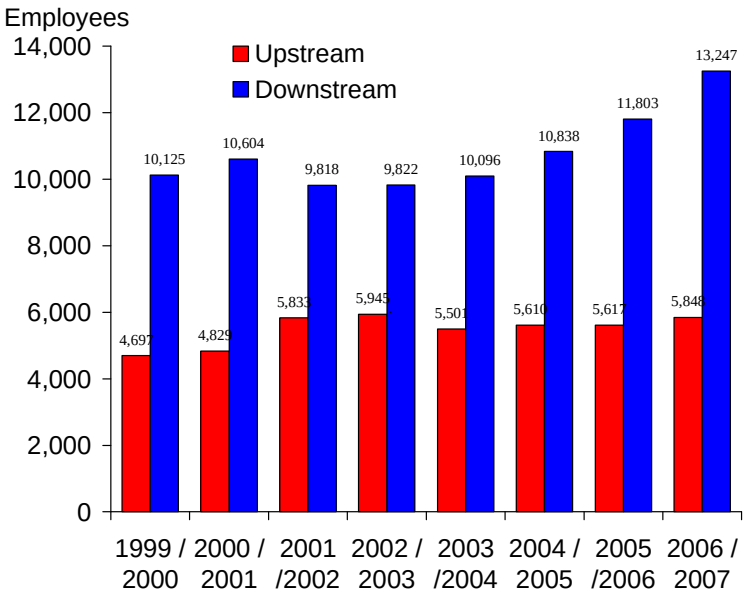


Source: Size and health of the UK space industry 2008 (BNSC) / Oxford Economics

In terms of employment, in total the UK space industry employed directly more than 19,000 people in 2006/07, up from less than 15,000 in 1999/2000, having grown at an annual rate of 3.7% a year during the last 7 years (Figure 3-10)

[3] Source: ONS, based on standard industrial classification (SIC 2003) code definitions

Figure 3-10, Evolution of UK Space Industry employment



Source: Size and health of the UK space industry 2008 (BNSC) / Oxford Economics

3.8 Productivity in the space industry

Productivity growth and highly productive industries are crucial to the UK economy.

"…high value added, high tech, high skilled, science-driven products and services are the key to wealth creation in the future" Gordon Brown

Industries that are highly productive generate more economic activity per worker for the economy and hence raise living standards. Productivity in the upstream space industry is £93,500 per worker, which is more than two and a half times higher than the Figure for the UK economy as a whole (£35,300). Productivity in the downstream space industry, which makes up the bulk of the industry, is even higher, nearly five times more than the economy average, at £167,000 per worker.

By way of comparison, the Extraction industry has a higher productivity figure, and the Production and Distribution of electricity has a slightly higher figure to the space industry as a whole, but lower than the downstream space industry. Productivity in Financial Intermediation or Computed and Related Activities have lower productivity to the upstream space industry (Figure 3-11).

Figure 3-11, Labour productivity in the space industry (2006/07)

Sector	Value added per worker (£'000s) 2006 prices
Extraction	337.4
Space (downstream)	167
Production and Distribution of Electricity	146.7

Space (total)	145.5
Telecommunications	113.8
Pharmaceuticals	112
Renting of Machinery	97.1
Financial Intermediation	95.5
Space (upstream)	93.5
Computer and Related Activities	85.1
Advertising	74.9
Aerospace	71.4
Legal Activities	70.4
Research and Development Activities	62.7
Air Transport	46
Motor vehicles	42.5
Public admin & defence	33.4
Health	25.6
Post	24.8
Education	20.4
Distribution	16.7
Manufacturing (total)	51.5
Whole economy	35.3

Source: ONS, Oxford Economics

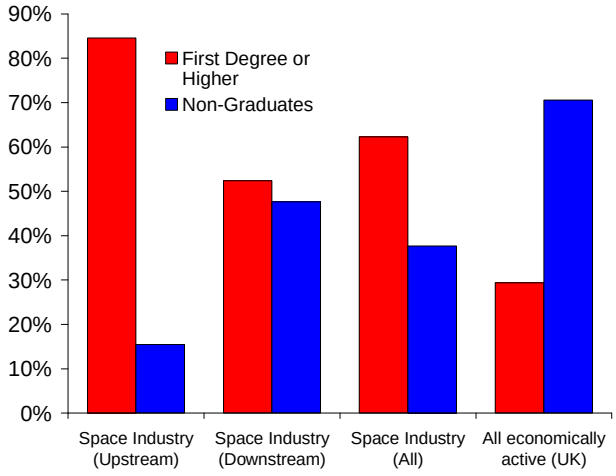
Not only is the space industry a highly productive industry but productivity per employee has also seen considerable growth. According to Size and Health data productivity has grown on average by 5% a year since 1999/00, although it has been flat over the last 3 years, following years of high growth (see Figure 3-12). This is almost three times the rate of productivity growth experienced by the UK economy as a whole. This growth rate is also considerable above that seen in other highly productive industries such as Business Services (1%), Extraction (-5%) or Electricity Supply and Distribution (1.5).

Figure 3-12, Labour productivity in the space industry (GVA / employee)

Source: Size and health of the UK space industry 2008 (BNSC) / Oxford Economics

This high productivity is partly due to the fact that the Space Industry employs a highly qualified labour force. In the upstream space industry, 84% of all employees hold a first degree or higher, whereas in the downstream, Oxford Economics estimates that this figure is around 52%. This brings the average for the space industry to 62% of all employees holding a First degree or higher, significantly above the UK average for all people economically active (29%) – Figure 3-13.

Figure 3-13, Qualifications in the Space Industry



Source: Size and health of the UK space industry 2008 (BNSC), ONS, Oxford Economics

Box 3-1, Productivity and government policy

"Productivity is the most crucial factor in securing long-term growth in living standards. UK productivity has been consistently lower than that of our major competitors - France, Germany and the US - with whom we have a persistent productivity gap of at least 20%."

Indeed the first stated PSA Target (a joint target with HM Treasury) is to Demonstrate progress by 2006 on the Government's long term objective of raising the rate of UK productivity growth over the economic cycle, improving competitiveness and narrowing the productivity gap with the US, France and Germany.

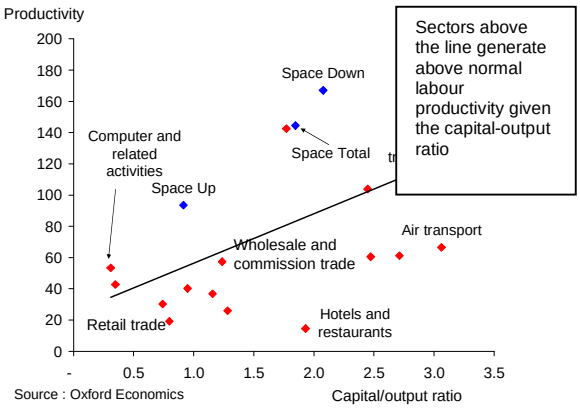
"The DTI drives our ambition of 'prosperity for all' by working to create the best environment for business success in the UK. We help people and companies become more productive by promoting enterprise, innovation and creativity."

Source: DTI, "The Strategy"

Part of the explanation for higher productivity in the UK space industry is the relative capital intensity of the industry. As seen in Figures 3-14 and 3-15, there is a positive[4] relationship between labour productivity and capital intensity. However, the space industry (both upstream and downstream) generates higher productivity than many of the other industries that have similar levels of capital intensity. This distinction is important, giving that a sector that is highly productive relative to its capital intensity, frees up resources to be invested in the rest of the economy, and can raise its level of output with smaller investments than in more capital intensive industries (that is, it has a higher rate of return to capital).

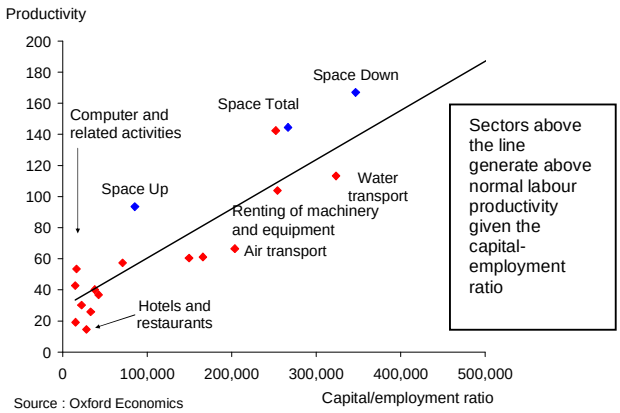
This suggests that the UK space industry is a highly skilled sector and efficient in its use of both labour and capital, and has a very high Total Factor Productivity (TFP), which is key to long term economic growth –TFP will be discussed further in Chapter 4.

Figure 3-14, Labour productivity and capital output ratios (2007)



Source : Oxford Economics

Figure 3-15, Labour productivity and capital employment ratios (2007)



Source : Oxford Economics

3.9 Indirect and induced effects

The space industry has a wider impact on the UK economy than simply the activity and jobs in those companies directly part of the industry. Both upstream and downstream companies source goods and services from companies outside the space industry thereby generating activity in the rest of the UK economy.

These industries themselves will in turn source goods and services from suppliers and so on. This multiplier effect is known as the 'indirect effect' of the space industry. Account also needs to be taken for the economic activity supported by the spending of people who work in the space industry and its supply chain, the 'induced effect'. The multiplier impacts depend upon the extent of linkages between sectors.

The employment multiplier for the UK space industry is estimated to be around 3.6[5]. This means that for every 10 jobs directly supported by the UK space industry, another 26 in total are supported indirectly in the supply chain and from the induced spending of those directly or indirectly employed by the UK space industry. This employment multiplier is higher than most other industries reflecting the very high productivity of those employed in the space industry. For the downstream space industry, which is the largest segment, this multiplier is even higher, of more than 4.2. This means that, for every 10 jobs created in the downstream space industry, 32 additional jobs are supported elsewhere in the economy.

In total, including direct and multiplier (indirect and induced) impacts, we estimate that the UK space industry supported around 68,000 jobs in the UK with a value added contribution to GDP in the region of £5.6 billion. This is just under 0.5% of UK GDP in 2007.

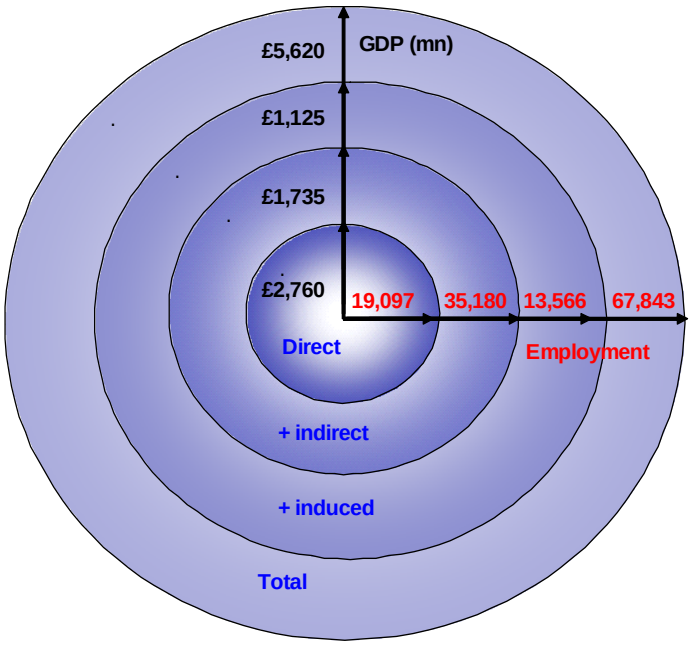
This impact is comprised of:

- **Direct** employment in the UK space industry of around 19,100 jobs in 2006/07, and contributed value added of £2,760 million to GDP in the UK economy.
- **Multiplier** employment in other industries of around 48,700 jobs supported through purchases of goods and services by companies in the space industry, and from employment supported by employees in the space industry (whether direct or indirect) using their income to purchase goods and services for their own consumption. The value added contribution to GDP from these supported jobs is estimated to be a further £2,860 million in 2006/07 (see figure 3-17).

Indirect jobs supported include those in the retail sector, employment in the financial and business services sector, or the workers required to manufacture equipment. Induced are likely to include jobs in retail and a range of service industries.

[5] In the terminology this is a "Type II" multiplier and in formula terms is equal to (direct impact + indirect impact + induced impact) / direct impact. The number of dependent jobs in the supply chain are computed by assessing how many workers would be required in the supply chain to produce the amount of goods and services demanded by the space industry. To calculate the number of jobs supported through the induced impact, we model the additional effect on domestic demand in the UK economy that salaries generate through consumer spending. This is then converted into jobs using average productivity across the economy.

Figure 3-17, Total upstream and downstream including indirect and induced effects



Source: Oxford Economics

3.10 Contribution to Regional Development

The regional breakdown of the space industry turnover, is presented in figure 3-18.

Figure 3-18, Regional Breakdown of Space Industry Turnover

Region	Turnover (£ 000s)	% of UK Total
North East	1,402	0%
North West	3,883	0%
Yorkshire	93	0%
East Midlands	103,632	2%
West Midlands	10,193	0%
Eastern	870,107	15%
London	394,299	7%
South East	4,466,736	76%
South West	54,333	1%
Wales	0	0%
Scotland	6,546	0%
Northern Ireland	778	0%
UK	**5,912,000**	**100%**

Source: Size and health of the UK space industry 2008 (BNSC), ONS, Oxford Economics

Space Industry is concentrated in the South East of England, with 75% of turnover, and to a lesser extent, the East of England, with 15% of turnover. However, and as it is explained in the previous section, the Space Industry purchases goods and services from companies located in other regions of the UK (indirect effects), adding to employment and GDP in these economies. Additionally,

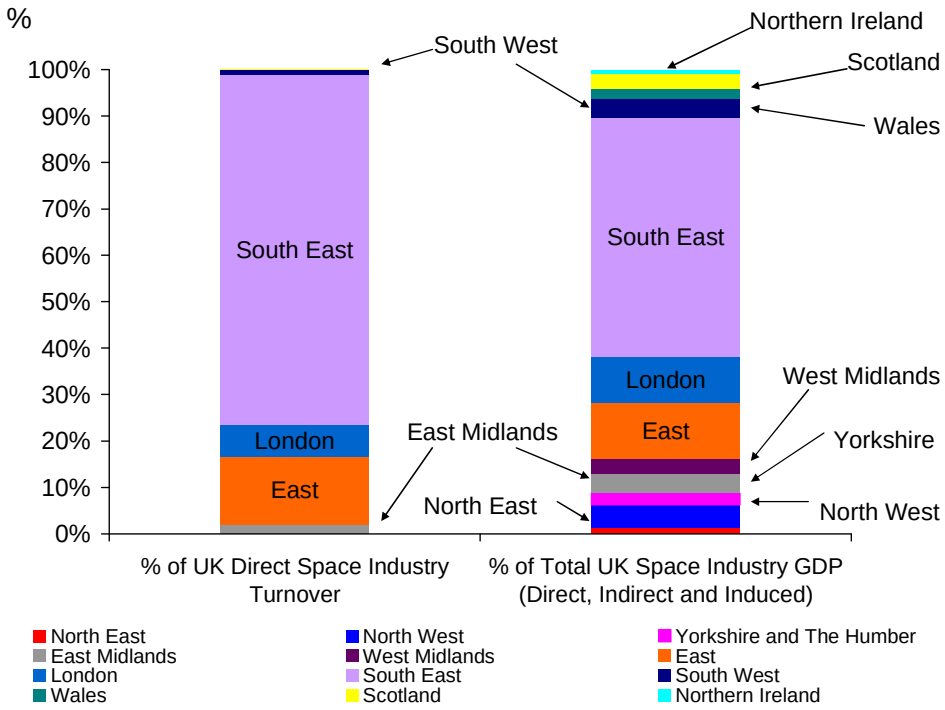
employees in both the space industry and its supply chain, purchase additional goods and services from the local economy (induced effects), so that the contribution of the Space Industry to regional development is much greater than the regional breakdown of direct space turnover may suggest.

Oxford Economics estimates, based on the supply chain of the space industry, reveal that whereas 75% of direct space turnover is concentrated in the South East, around 51% of the total (direct, indirect and induced) GDP generated by the space industry is in the South East. In terms of employment, whereas the South East is home to 75% of the direct jobs generated in the space industry, only accounts for 39% of the employees when the indirect and induced effects are taken into account (see figure 3-18).

On the other hand, regions such as the North West, whose share on the direct GDP and employment of the space industry is only 0.06%, accounts for 5% of the GDP and 8% of the jobs generated by the industry, when indirect and induced effects are taken into account. This is so, because although little direct space industry activity is located in the region, available data suggests that some suppliers are likely to be, and so the space industry contributes indirectly to the local economy (see figure 3-19).

These regional estimates have been complied using aggregate ONS statistics which suggest the location of potential suppliers rather than actual purchasing patterns, and therefore should only be seen as an indicative sum of the likely spread of the Space Industry's supply chain. Survey work on actual space company purchasing patterns would be required to produce definite answers.

Figure 3-19, Regional Space Industry Turnover and GDP contribution



Source: Size and health of the UK space industry 2008 (BNSC), ONS, Oxford Economics

The total share of employment is greater than the total share in GDP for some regions, because certain regions may have a higher concentration of labour intensive industries, so that suppliers located there generate a higher number of jobs for every unit of GDP (figure 3-20).

Figure 3-20, Regional Breakdown of Industry Turnover

	GDP (£ millions)						Employment				
	Direct	As a % of UK Direct	Indirect	Induced	Total	As % of UK Total	Direct	Indirect	Induced	Total	As % of UK Total
North East	1	**0%**	52	13	**66**	**1%**	4	1,063	160	1,227	**2%**
North West	2	**0%**	225	57	**283**	**5%**	14	4,556	684	5,254	**8%**
Yorkshire and The Humber	0	**0%**	113	28	**141**	**3%**	0	2,289	340	2,629	**4%**
East Midlands	58	**2%**	136	48	**242**	**4%**	399	2,765	586	3,749	**6%**
West Midlands	5	**0%**	133	34	**172**	**3%**	34	2,690	415	3,139	**5%**
East	410	**15%**	137	137	**684**	**12%**	2,835	2,780	1,649	7,264	**11%**
London	172	**7%**	274	112	**558**	**10%**	1,192	5,560	1,348	8,099	**12%**
South East	2,081	**76%**	227	577	**2,887**	**51%**	14,399	4,608	6,967	25,974	**38%**
South West	28	**1%**	161	47	**237**	**4%**	196	3,268	571	4,035	**6%**
Wales	0	**0%**	90	22	**112**	**2%**	0	1,820	270	2,090	**3%**
Scotland	3	**0%**	151	38	**192**	**3%**	21	3,055	463	3,539	**5%**
Northern Ireland	0	**0%**	36	9	**45**	**1%**	3	727	112	842	**1%**
United Kingdom	**2,760**	**100%**	**1,735**	**1,125**	**5,620**	**100%**	**19,097**	**35,180**	**13,566**	**67,843**	**100%**

Source: Size and health of the UK space industry 2008 (BNSC), ONS, Oxford Economics

3.11 Support for SMEs

The space industry is composed, to a great extent, of Small and Medium Enterprises (SMEs). Adjusting turnover figures by turnover per employee, it is estimated that 71% of the companies are composed of less than 3 employees (at an average turnover per employee of £311,000 for 2006/7). The corresponding figure for the UK manufacturing sector is 47%, whereas for the UK business sector is 53% (figure 3-20).

Figure 3-21, Proportion of companies by number of employees, 2006.

	Space Industry	UK Manufacturing	UK all sectors
Less than 3 employees	71%	47%	53%
3-30 employees	17%	42%	41%
30-300 employees	9%	10%	6%
300 + employees	4%	1%	0%
Total	100%	100%	100%

Source:Size and health of the UK space industry 2008 (BNSC), ONS, Oxford Economics

In additon, the space industry supports a substantial number of SMEs through its value chain.

3.12 Conclusions

The UK space industry makes a substantial direct contribution to UK GDP and employment. Turnover and GDP in the space industry has grown substantially faster than the economy average since the millennium. The space industry is one of the most productive sectors in the UK economy. It has a highly skilled work force and has high productivity even allowing for its capital intensity.

The total contribution of the UK space industry, including direct and multiplier impacts, is estimated to be around 68,000 jobs with a value added contribution to GDP in the region of £ 5.6 billion. The presence of an upstream space industry in the UK is likely to provide benefits to the downstream sector in the UK that would not be achieved to the same extent through the purchases of satellite services from abroad.

The UK space industry supports other industry through its purchases of goods and services. But the links it has with the rest of the UK economy go far further than this. Research and development undertaken by the space industry helps raise productivity across the economy and consumers and society benefit from the application of space related technologies in ways not captured in the analysis in this chapter. These issues are explored further in the following chapters.

4 Wider effects of the space industry on the UK economy – R&D spillovers

Key Points

- The space industry is a highly R&D-intensive sector, investing 4.7% of its GVA, compared to a UK average of 1.8%. It invested around £131 million in R&D overall in 2006/07, of which £69 million was in the upstream sector and £62 million was in the downstream sector. The upstream space industry is seven times more R&D intensive than the UK economy as a whole.
- Three quarters of the R&D investment undertaken by the space industry is funded by companies in the sector. The remaining quarter is externally funded by Government, ESA, EC and commercial customers. External funding for R&D is important given the inherent risks associated with investment in the development of space technologies. The proportion of R&D which is externally funded has reduced significantly since 2004/05, when it was estimated to be around 50%.
- The upstream industry has made considerable efforts to increase its R&D spending intensity, but lack of access to external funding may result in the industry losing its long-term competitiveness to other countries, having negative consequences for its long-term growth prospects.
- The technological advances that come about as a result of R&D investment in the space industry can be transferred into other sectors in the form of 'spillover' effects. Previous research by Oxford Economics suggests that such spillover effects are very large, with R&D investment by the aerospace sector generating spillovers of around 70% - i.e. every £100 million invested in R&D in the sector leads to an increase in GDP of £70 million in other sectors in the longer term.
- The large spillover effects from R&D over and above the private returns to the company undertaking the R&D make a strong case for Government intervention and support.
- On this basis, we estimate that the space industry helps to generate a contribution of almost £900 million to GDP in the UK due to the spillover effects of its R&D, on top of its £5.6 billion of direct and multiplier impacts.
- The application of space derived services and data further contributes to the UK economy by facilitating the provision of a wide range of services to business and consumers, and by enabling the UK's economic infrastructure to be used more efficiently.

4.1 Introduction

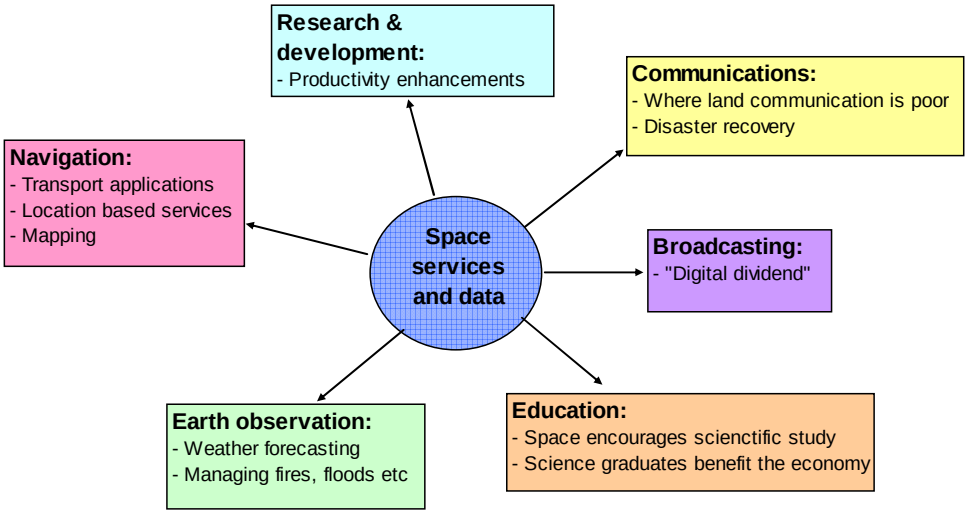
The contribution of the space industry to the UK economy is much wider than the direct and multiplier impacts discussed in chapter 3. In particular, there are a number of catalytic or spillover impacts whereby the space industry helps to facilitate improved supply-side performance of the UK economy, creating capabilities and enhancing productivity across the wider economy. These catalytic impacts include:

- The transfer of knowledge and technological advances that result from the substantial R&D investment undertaken by the space industry.
- Facilitating the development of a wide range of new services that either could not be offered in the absence of space derived services and data or only at significantly higher cost, enhancing both consumer choice and helping UK companies to operate more efficiently.
- Enabling the UK's economic infrastructure to be used more effectively.

The catalytic impacts are summarised in Figure 4.1. In this chapter, we consider the wider economic impact of the R&D investment by the space industry. In the next chapter we focus on the catalytic

impacts of the space industry by considering four key applications of space derived services and data – communications, navigation, Earth observation and broadcasting. Finally, we consider the benefits that result from the inspiration space provides for science education.

Figure 4-1, Examples of R&D spillovers and catalytic effects of the space industry



4.2 Research and development (R&D) investment by the UK space industry

The UK space industry is a substantial investor in research and development (R&D). Overall R&D investment in the space industry (upstream and downstream) was £131 million in 2006/07, equivalent to 2.2% of turnover, or about 4.7% of its GVA – compared with a UK average of 1.8% of GDP devoted to R&D investment.

Of this R&D, around three quarters (£98 million) was funded from companies own resources, with the remaining quarter funded primarily by external sources including Government, ESA, EC and commercial – external funding for R&D is important given the inherent risks associated with investment in the development of space technologies-.

There has been, however, a drop in the level of R&D investment since 2004/05. In the upstream segment, self-funded R&D has almost doubled from £21 million to £41 million in 2006/07; however, this has not been enough to compensate for the large fall in the amount of externally funded R&D (£98 million in 2004/05 to £29 million in 2006/07), so that the total amount of R&D has decreased from £120 million to £69 million (figure 4-2).

Figure 4-2, R&D funding in 2004/05 and 2006/07

R&D Intensity, Upstream Segment	R&D Investment (£m)	R&D / Turnover	Self funded (£m)	Externally funded (£m)
2004-05	120	14.1%	21	98
2006-07	69	8.3%	41	29

Source: Size and health of the UK space industry 2008 (BNSC), Oxford Economics

A sustained fall in R&D will have negative consequences in the long-term, which may have not materialized yet given that the initial return in to R&D in the space industry usually occurs within 3 to 5 years from the initial investment. The upstream industry has made considerable efforts to increase its R&D spending intensity, but lack of access to external funding may result in the industry losing its long-term competitiveness to other countries, having negative consequences for its long-term growth prospects.

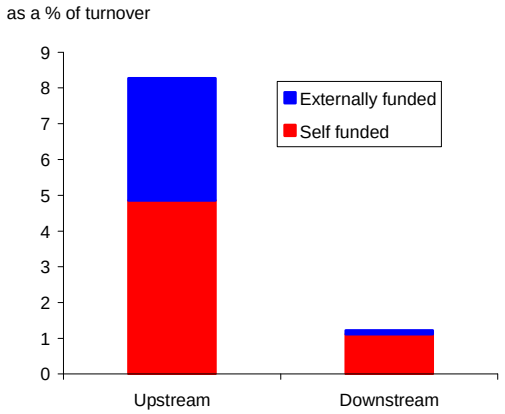
Given that social returns to R&D are larger than private returns to R&D, companies will not invest as much as it would be socially optimal unless there is Government support, since they will only take into account their private return when making R&D investment decisions.

The upstream space sector invested £69 million in R&D in 2006/07, 8.3% of turnover, or 12.6% of their GVA. More than half of it (59%, or £41 million) was funded from their own resources, equivalent to 4.9% of turnover. This implies that the upstream space sector is seven times more R&D intensive than the economy as a whole.

R&D investment in the downstream space sector was £62 million in 2006/07, 1.2% of turnover, or 2.8% of their GVA. Of this, the vast majority (91%) was funded from the companies own resources (figure 4-2), accounting to more than £56 million.

In addition to the R&D undertaken by the space industry, due to the nature of the business, a substantial amount of money is also spent on non-reoccurring costs such as product development and tailoring products for individual clients. This spending has been excluded from the R&D analysis.

Figure 4-2, R&D spending as a % of turnover



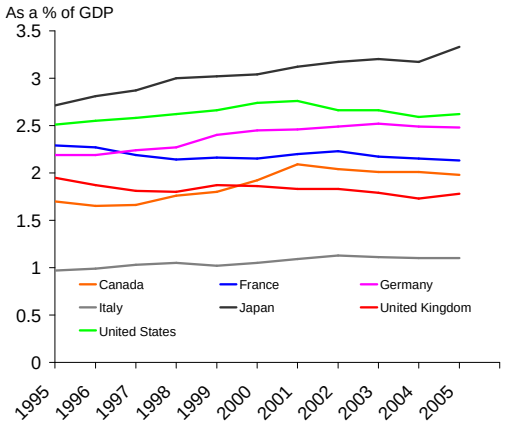
Source: Size and health of the UK space industry 2008 (BNSC), Oxford Economics

Overall, the UK space industry invested 4.7 % of its value added (i.e. its GDP contribution) in R&D in 2006 /07. This means that the space industry is almost three times more R&D intensive than the UK economy as a whole (1.74% of GDP in 2006[6]).

As figure 4.3 shows, UK R&D investment has been falling in recent years. As a result, investment in R&D in the UK is much lower as a share of GDP than in, for example, the US, Japan, Germany and France, such that only Italy has a lower R&D investment than the UK among the G7 countries (figure 4-3). R&D intensity in a number of the key emerging economies is increasing and in some cases already exceeded the levels in Italy and fast approaching those of the UK (figure 4-4).

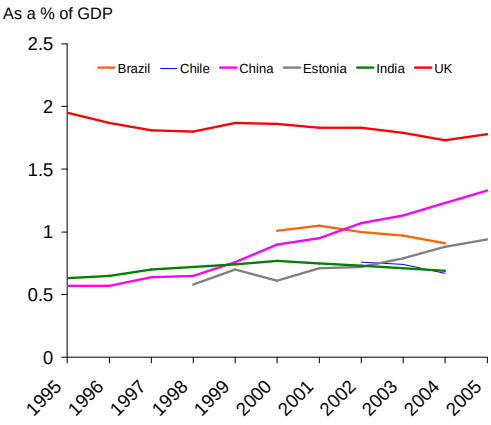
[6] ONS

Figure 4-3, R&D spending in the G7



Source: OECD, Oxford Economics

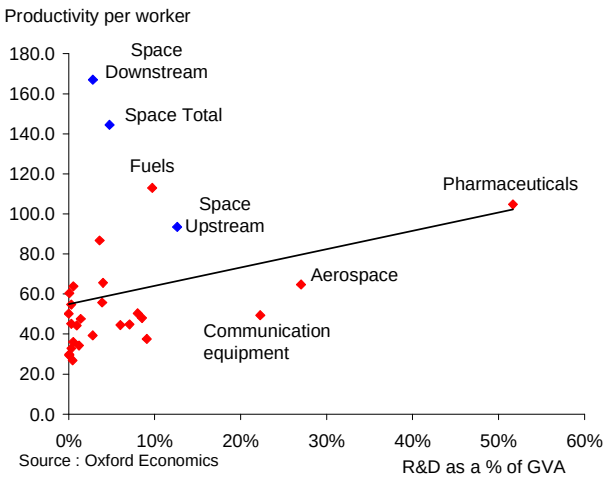
Figure 4-4, R&D spending in the UK and emerging economies



Source: OECD, Oxford Economics

Increased R&D spending raises productivity in the long term, both within the sector and in the rest of the economy, which is the key to long-term, sustainable economic growth. Those sectors that are more R&D intensive tend to have a higher productivity. However, although there is a positive relationship, comparisons between sectors cannot be drawn directly, given that there are other factors that may affect productivity, such as the capital. The space industry is among the UK's most R&D intensive sectors (figure 4-4).

Figure 4-4, R&D spending and productivity by sector in the UK



Source : Oxford Economics

4.3 The wider benefits of R&D investment

R&D investment enhances the productivity performance of the firm or sector that undertakes it. But not all of the returns to R&D spending are 'private' – i.e., captured by the firm or sector that makes the investment. Some of the technological advances and innovations that come from R&D *spill over* into other firms and sectors, boosting their productivity as well. Academic studies and previous research by Oxford Economics suggest that the 'spillover benefits' of R&D can be very large, with R&D investment generating a social return of around 50%-100% - i.e. every £100 million invested in R&D leads to an increase in GDP of £50-100 million in the long run (see figure 4.5).

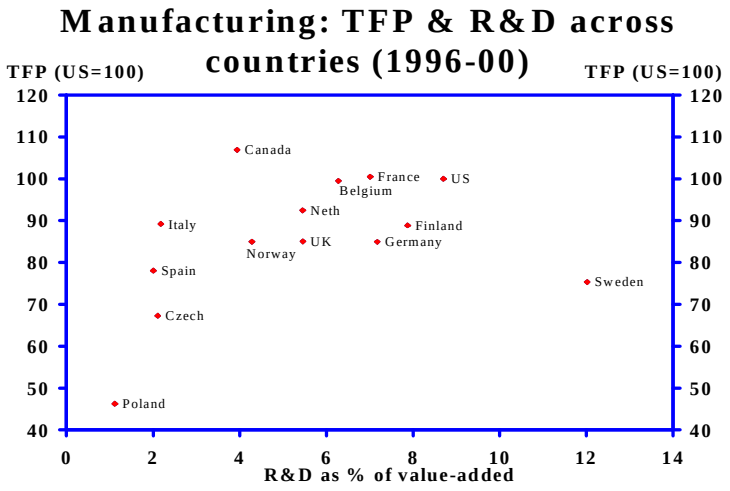
Figure 4-5, Estimates of returns to R&D

Author (year)	Estimated private rate of return (%)	Estimated social rate of return (%)
Nadiri (1993)	20-30	50
Mansfield (1977)	25	56
Terleckyj (1974)	29	48-78
Sveikauskas (1981)	10-25	50
Goto-Suzuki (1989)	26	80
Bernstein & Nadiri (1988)	9-27	10-160
Scherer (1984)	29-43	64-147
Bernstein & Nadiri (1991)	14-28	20-110
Average	25	70

Source: DTI 'Prosperity for all'

Figure 4.6 illustrates the spillover benefits that result from R&D investment. It shows the general relationship between R&D investment and underlying productivity performance in the manufacturing sector, as measured by total factor productivity[7]. Countries that are close to the top of the league in terms of high manufacturing productivity (e.g. the US, France and Belgium) tend also to be close to the top of the league in terms of total manufacturing R&D spending as a proportion of GDP; countries near the bottom of the productivity league (e.g. the Czech Republic, Poland and Spain) tend to be near the bottom of the R&D league table as well.

Figure 4-6, R&D spending and total factor productivity



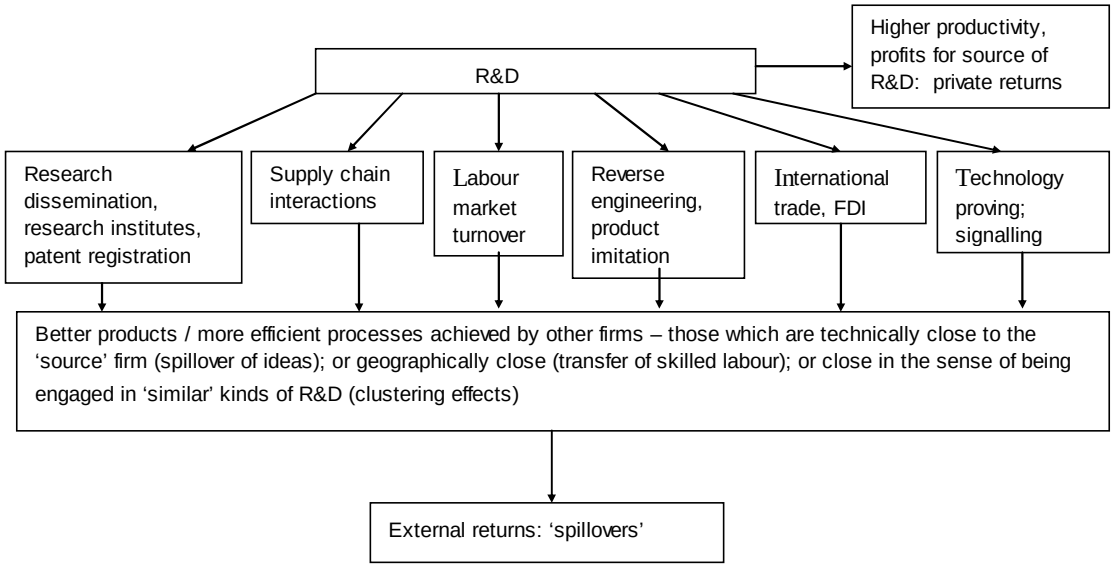
Source: ONS, Eurostat, Oxford Economics

[7] Total factor productivity is a measure of the efficiency with which the inputs to the production process – labour, capital and material inputs – are combined to create output.

The benefits of R&D investment by one sector spill over to the wider economy in a number of ways. For example, it may be through knowledge sharing or imitation; it may occur as new techniques and products are passed onto the next stage of the production process; or it may happen as workers move from one company to another. Figure 4.7 summarises the channels by which R&D spillovers may occur.

The large social returns from R&D over and above the private returns to the company undertaking the R&D make a strong case for Government intervention and support. Without such intervention the socially optimum level of R&D will not be achieved.

Figure 4-7, Channels of diffusion for R&D spillover effects



Source: Oxford Economics

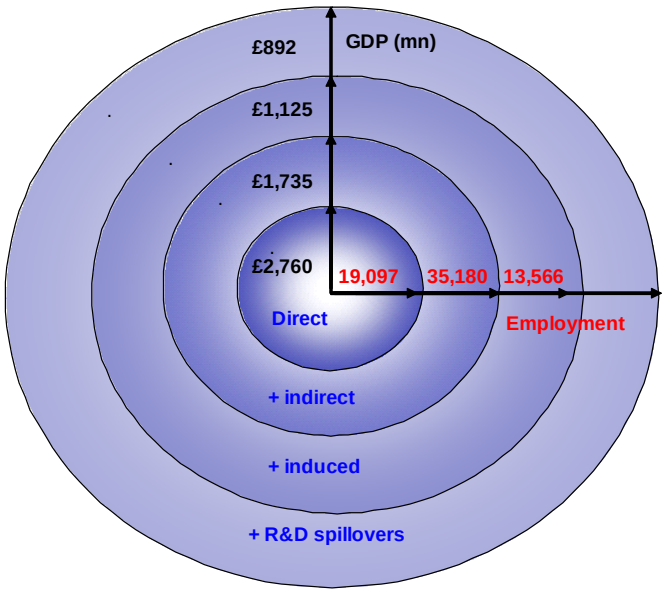
4.4 The spillover effects of R&D investment by the UK space industry

Our estimates of the spillover effects associated with the R&D investment of the UK space sector draw on recent detailed econometric analysis by Oxford Economics8. Using data for 25 European economies plus the US and Canada over a period of two decades, this found that R&D investment in the aerospace sector generates a social return of around 70% - i.e. every £100 million invested in R&D leads to an increase in GDP of £70 million in the long run.

On this basis, we estimate that the space industry helps to generate almost £900 million a year of GDP in the UK due to the spillover effects of its R&D, on top of its £5.6 billion of direct and multiplier impacts (figure 4-8).

[8] Assessing the Economic Impact of Aerospace Research & Development, Oxford Economic Forecasting (2006)

Figure 4-8, Research and development spillover effects



Source: Oxford Economics

4.5 Conclusion

The UK economy lags a number of its international competitors in terms of R&D spending. Overall, the UK space industry invested 5% of its value added (i.e. its GDP contribution) in R&D in 2006/07 compared to less than 2% for the economy as a whole.

The spillover effects from the space industry's R&D make a substantial contribution to UK GDP. On top of the industry's direct and multiplier impacts, we estimate that the UK space industry is contributing at least £900 million a year to GDP. Additionally, there are a range of further catalytic impacts resulting from the use of space derived services and data in a wide range of applications.

5 Catalytic impacts from the space industry

Key Points

The application of space derived services and data further contributes to the UK economy by facilitating the provision of a wide range of services to business and consumers. It is difficult to acurately quantify the value of all the additional benefits, but several examples include:

Communications

- Satellite communications are already integral to a number of users and in particular those operating in communication poor parts of the world.
- Much of the UK oil and gas exploration industry occurs in areas where there is no alternative to satellite communication. The industry spent around £600 million on exploration and appraisal overseas in 2006, a significant proportion of which would utilise satellite based services.
- Satellite communication is already a key aspect of the operational control of aircraft, with its importance growing over time, and in deep-sea shipping, allowing for important operational efficiencies.
- International aid agencies – both public and private – would find it much more difficult to deliver relief if satellite communications were not available to them. The UK provided nearly £1.1bn in emergency relief in 2006 – and even relatively modest operational and efficiency gains from the availability of mobile satellite communications have a significant value.
- There is increasing pressure on businesses to offer guarantees of business and service continuity even if an event closes systems and facilitates.

Navigation

- Use of satellite navigation in road vehicles will bring benefits in terms of reduced travel time, reduced emissions, a reduction in theft and a reduction in accidents. Upper end estimates value these benefits at over £10 billion a year for the UK.
- A National road user charging scheme is estimated by the Department for Transport (DfT) to bring benefits, mostly in terms of time savings, of £10 billion a year. Does this still come across well politically?
- Total UK benefits from the use of GNSS in the aviation industry are estimated at around £1.3bn per year.
- Whilst location-based services (LBS) are in their infancy at present, they are likely to grow substantially, and bring benefits to users.
- Applications of satellite navigation are expected to grow substantially over the next decade. The actual growth that is realised depends amongst other things on the government policy (e.g. on road user charging, investment in Galileo) and consumer preferences.

Earth observation

- Due to the improvements in weather forecasting from use of meteorological data from satellites we estimate the benefit to the UK economy to be in the range £400 to £1000 million.
- Use of satellites applied to mapping has enabled the Ordnance Survey to improve efficiency by up to 50%.
- Environmental protection: Earth observation has become an essential tool for monitoring climate change (such as measuring water levels), emergency responses (by for instance, providing an accurate picture of areas affected by flooding), natural resources (such as sources of pollution), sustainable development (such as applications in agriculture), or

Broadcasting

- Live satellite links enhance the quality and range of news, entertainment and sports programming. Satellite television broadcasts nearly three times as many channels as any other platform. This encourages wider choice, is a stimulus to the creative industries and enhances the functioning of the television broadcasting market.

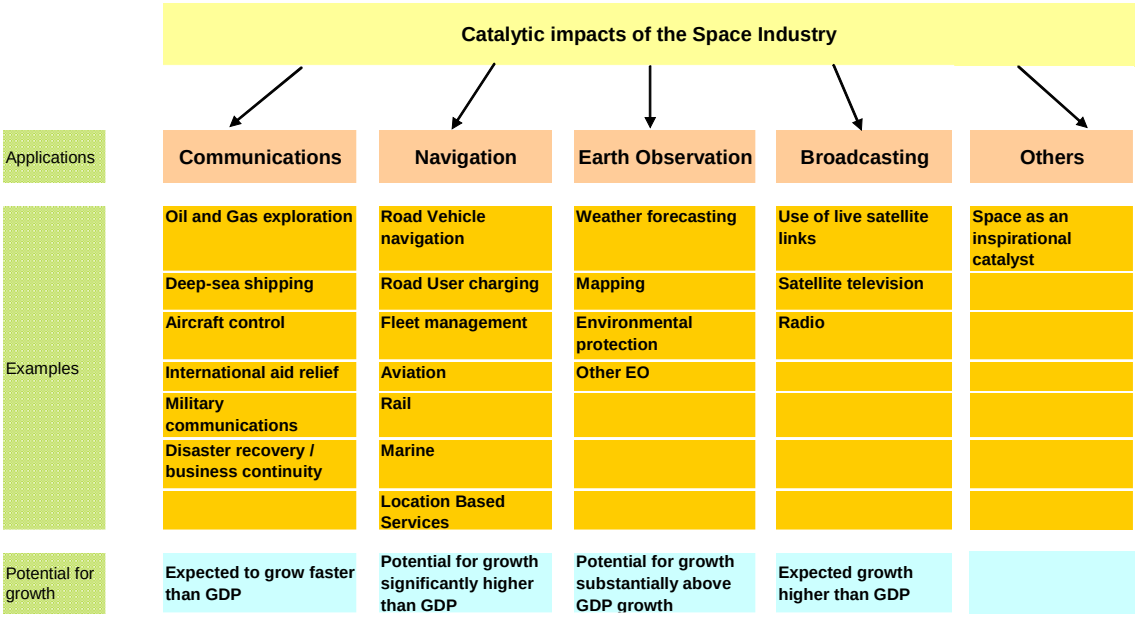
Space as an inspirational catalyst

- Education choices are influenced by space - space was the second (third) most popular factor motivating physics degree (postgraduate) involvement. The additional taxation revenues to the Exchequer over a science graduate's working lifetime compared to non-graduates approximates £130,000-£135,000.

5.1 Introduction

The application of space derived services and data further contributes to the UK economy by facilitating the provision of a wide range of services to business and consumers, and by enabling the UK's economic infrastructure to be used more efficiently. It is not possible to quantify the value of all the additional benefits, but some applications are studied here, to illustrate the potential impact of space applications (figure 5-1). For a more comprehensive discussion on the catalytic impact of the space applications, the reader can refer to our previous 2006 study[9] on the economic contribution of the UK space industry.

Figure 5-1, Examples of catalytic impacts from the Space Industry



5.2 Communications

Communications is integral to the functioning of the economy. The economic impact of spend on communications that uses space is included in Chapter 3. However there are wider economic benefits

[9] "The Case for Space: The Impact of Space Derived Services and Data - Final Report", Oxford Economic Forecasting, November 2006

that are not included in that calculation. These benefits largely flow from activities either enabled or made more efficient because of the availability of communications that use satellites at some stage in their journey. These benefits have potentially big and pervasive impacts on productivity but are extremely hard to measure.

Satellite communications are key where land based communications are poor, so activities that take place away from centres of population and in the developing world are likely beneficiaries of space communications.

One such example is UK companies that undertake oil and gas exploration. The UK offshore industry spent £1.3 billion on exploration expenditure in 2007 in the UK Continental Shelf (UKCS)[10], and it benefits from satellite communications because it is integrated into global communications infrastructure via space. Further, nearly £600 million was spent in 2006 on exploration and appraisal by UK companies[11] overseas – much of which would have been in communication poor parts of the world. In the future satellite communications will grow in importance to the oil and gas exploration industry. Market pressures from expanding energy demand will lead to further growth, with exploration expenditure in the UK in 2007 having more than doubled with respect to 2006[12].

Deep-sea shipping, as another industry that operates in communication poor parts of the world, is crucially reliant of satellite communications. This has many aspects, including operational contact between ship and owners / cargo owners; communication of key information such as weather forecasts; communication possibilities for staff and passengers; management of ship systems – for example the remote control of engines to maintain full efficiency or the downloading of updated charts to enhance safety. More than 90% of world trade, in tonnage terms, is carried by shipping. Satellite communications will grow strongly in importance for deep sea shipping as world trade recovers and starts to grow strongly again.

Satellite communication is already a key aspect of the operational control of aircraft, with its importance growing over time. Communications applications – telephony and internet – for aircraft passengers are in their infancy, but expected to grow rapidly. Once the economy recovers, air travel is expected to grow significantly again and this, coupled with the high anticipated demand for the use of telephony and the internet on aircraft, points to an increase in the importance of satellite communications to the aeronautical industry.

International aid agencies – both public and private – would find it much more difficult to deliver relief if satellite communications were not available to them. Typically these agencies operate in communication poor parts of the world, where any land-line infrastructure may have been compromised by natural disasters or wars. Satellite communication enhances the delivery and targeting of aid.

In total the UK provided nearly £1.1bn in humanitarian assistance in 2006[13] – and even relatively modest operational and efficiency gains from the availability of mobile satellite communications have a significant value. In the future the growth in the use of satellite communications in International aid is likely to be at least as fast as GDP, with the UK being the 2nd largest donor in the world of Humanitarian Assistance after the US.

An efficient, rapid and above all secure communications system is of paramount importance in today's global military operations. There are times when information just has to get through – to the right people, and only the right people, wherever they are, however hostile the environment. Armed forces have highly specific communications requirements, and have become extensive users of satellite technology, which, in comparison to ground-based networks, affords immediate and wide coverage, greater flexibility in terms of power and frequencies, and, critically, almost total freedom from events likely to interfere with terrestrial transmissions.

There is increasing pressure on businesses to offer guarantees of business and service continuity even if an event closes systems and facilitates. For example, the Financial Services Authority expects financial

[10] Oil and Gas UK, 2008 Economic Report
[11] Association of British Independent Oil Exploration Companies
[12] Oil and Gas UK, 2008 Economic Report
[13] www.globalhumanitarianassistance.org, Humanitarian Donor profile, United Kingdom, April 2008.

services firms to have robust plans in place to handle disruption – however large or small - to normal activities. This includes ensuring that "firms and markets can communicate with each other during an emergency, even if some lines of communication are not operational."[14]

5.3 Navigation

There are currently two satellite navigation options - Global Positioning System (GPS) - which was developed by the US department of defense and the European Geostationary Navigation Overlay Service (EGNOS). The EU member states have agreed to develop and operate an independent global satellite positioning system called Galileo, which will offer the prospect of increasing accuracy and availability. There are many possible catalytic effects from the use of satellite navigation, many of which assume complementary use of GPS and Galileo.

The use of satellite navigation in road vehicles is growing and is anticipated to be installed in most vehicles in 10 to 15 years time. Satellite navigation brings unique benefits to road users in terms of time saved, reduction in accidents, theft and emissions. This would lead to savings of over £10 billion for UK drivers (both commercial and leisure) and further savings to society from reduced emissions of £0.5 billion. Satellite navigation systems such as eCall that help the emergency services accurately and speedily locate accidents on the roads will help save lives and reduce serious injuries.

Satellite navigation systems that enable stolen vehicles to be tracked and then disabled are estimated to be worth £1.5 billion per year to the UK in the future. Satellite navigation is also used to track down and monitor the transit of heavy vehicles carrying dangerous substances, which could help preventing risks and accidents.

A Department for Transport (DfT) study and other academic studies value the benefits from a National road user charging scheme at between £10 and £12 billion. Any national scheme that would propose to charge on the basis of a combination of time, distance and space would be much more difficult to administer and so would require the use of much more sophisticated technology. The DfT study on the basis of expert advice assumed that technology for such a scheme would not be in place before 2014 and would require amongst other things that the Galileo satellite system was in commercial operation.

There are benefits to fleets over and above the improved navigational facility that a satellite solutions offer. Tracking and monitoring the location of vehicles and goods enables better management of the fleet. Thales reported in our previous study[15] that large fleets can make 5-10% savings on costs by introducing a fleet management system.

There will also be significant benefits from the use of satellite navigation in other forms of transport. In the aviation industry there will be savings amounting to more than £1.3 billion per year, including commercial benefit from reduced delays (£850 million per year), time saved by passengers (£400 per year), and lower emissions (£80 million per year).

In the maritime industry Long Range Identification and Tracking is expected to bring significant benefits to the UK economy, ranging from pilotage, scheduling of logistics and cargo operations, to maritime traffic management[16].

Location-based services (LBS) are applications that leverage the user's physical location to provide an enhanced service or experience, and are likely to be delivered through mobile phones in the future. Some examples of the use of LBS include information (tourist guides, local shops, etc.), security (emergency calls), billing, advertising, permission-based tracking of friends and family (children, the elderly, etc.).

14 http://www.fsa.gov.uk/Pages/Library/Communication/PR/2002/085.shtml
15 "The Case for Space: The Impact of Space Derived Services and Data - Final Report", Oxford Economic Forecasting, November 2006
16 http://www.imo.org/About/mainframe.asp?topic_id=1322&doc_id=

5.4 Earth Observation

Satellites generate a substantial value to the UK economy through their application in the earth observation (EO) field, for which several examples are provided.

The weather affects all aspects of the UK economy from causing delays in transport, to increasing demand for electricity, to loss of life due to unforeseen/unexpected weather patterns. The economic benefits from improved weather forecasts is estimated to be between £1,800 and 3,000 million per year to the UK[17], and somewhere in the range of £400 to £1,000 million per year can be attributed to the improvements brought by satellites. The ability to forecast the weather can help to reduce these negative impacts. Satellites improve the accuracy, scope and timeliness of weather forecasts.

Another industry in which satellites have become integral to in the UK is mapping. During our previous study[18], the Ordnance Survey (OS) revealed that the use of satellites has enabled efficiency gains of around 50%. The OS also expect further gains to come when Galileo becomes operational and they describe themselves as a "great supporter" of the Galileo project.

Finally, satellites in Earth Observation have become a critical tool for environmental protection[19], on issues such as:

- Climate Change: regular water resource monitoring using space-based sources provides a valuable health-check throughout the year enabling risk forecasting and prevention. Global monitoring from space complements land-based monitoring networks, facilitating reliable prediction and timely mitigation of water shortage and other environmental 'tipping points' linked to climate change in different parts of the world.

- Emergency Responses: crisis maps rapidly extracted from satellite imagery provide vital local information – What is the full extent of the flood? Where are the affected settlements? How is the infrastructure affected? These maps are a primary resource for local authorities and the humanitarian services, with timely and relevant information helping them reduce response times and human suffering.

- Natural Resources: Regular updates on water quality status and sources of pollution such as agriculture or urbanisation are derived from remote sensing sources. A range of associated environmental monitoring services provides decision-makers with reliable, up-to-date information ensuring effective intervention and preventative action.

- Sustainable Development: Crop analysis services, derived from Earth observation data, are delivered on a regular basis to local experts. This information enables a clear understanding of vegetation growth and development, and provides key information for establishing sustainable land management.

- Population Dynamics: Satellite Earth Observation is used to observe air quality, or control the level of deforestation, delivering vital status-checks to local authorities on urban growth, enabling implementation of the relevant measures to maintain a healthy environment.

5.5 Broadcasting

Most channels make use of live satellite links in news, entertainment and sports programmes. There is clearly a value to consumers from this although it is difficult to quantify.

Satellite television allows for a greater number of channels to be offered to consumers (BskyB offers three times as many channels as cable operators). The greater number of channels:

17 Based on a 1994 study by the Met Office, which updated to 2006 prices imply benefits in the range £1,862 - £2,878 million per year to the UK
18 "The Case for Space: The Impact of Space Derived Services and Data - Final Report", Oxford Economic Forecasting, November 2006
19 "Increasing our Knowledge of Earth to build a brighter future", Thales-Alenia Space.

- Encourages wider choice;
- Is a stimulus to the creative industries - the direct contribution of the UK film industry to GDP was £1.5 billion in 2006. Satellite television is estimated to have carried £352 million in advertising in the same year;
- Enhances the functioning of the television broadcasting market – this occurs in two ways. Firstly it lowers the cost of entry for any broadcaster wanting to take a channel to air (SKY is required to provide access on a fair, reasonable and non-discriminatory basis) and secondly it increases the sources of demand for programming, which reduces the negotiating strength of the main terrestrial broadcasters.

Satellite may reach locations in the UK that cannot receive terrestrial digital transmissions. Satellite currently provides the only cost effective way of receiving television in these remote regions.

Satellite's share of 'the Digital dividend' - when analogue transmission ceases in 2012, parts of the radio spectrum will be freed for other uses ('the digital dividend'). Expectations are for new mobile services (with high quality video and interactive media), wireless broadband services (with high-speed data and voice services), wider coverage for advanced services in remote and rural areas and additional television channels (including free to air transmission of High Definition channels). A joint DTI and DCMS cost benefit analysis of the digital switchover estimates the net benefits to be worth £1,692 million (if complete by 2012).

Interactive televisions services - satellite television provides a range of interactive services. These include email/messaging, gaming, betting, shopping, banking, travel services and ticket sales. SKY's betting turnover was £44 million in the year to end June 2008 and turnover on other interactive services was £356 million over the same period.

5.6 An inspirational catalyst

Space encourages students to study subjects that have generally been declining in popularity but which are vital to ensuring the UK economy is productive and competitive in the future. Space was the second (third) most popular factor motivating physics degree (postgraduate) involvement.

Science graduates will earn on average over 13% and 16% more during their working lifetimes than graduates in subjects including psychology, biological sciences, linguistics, and history.

It currently costs the state approximately £21,000 to provide education to degree level for the average graduate. However, the value to the state in terms of the tax and national insurance associated with earnings following qualification is approximately £93,000.

Science subjects are expensive subjects to teach when compared with non-laboratory intensive subjects. However, despite the additional costs to the state associated with these laboratory-based subjects, the additional taxation revenues to the Exchequer over a science graduate's working lifetime compared to non-graduates approximates £130,000-£135,000.

The space industry employs proportionally twice as many graduates compared to the economy as a whole. Further to this the space industry encourages the study of science degree and these graduates work in other industries and generate additional revenue for the Exchequer and help the UK be a more productive and competitive economy.

"…high value added, high tech, high skilled, science-driven products and services are the key to wealth creation in the future" *Gordon Brown*

6 Prospects for the UK space industry

Key Points

- Economic activity in the UK space industry is expected to grow strongly over the next decade, although growth forecasts have been revised to reflect the current economic downturn.
- In the short term, the downstream industry may be particularly affected by the current recession, given that, as a provider of final services, it is often reliant on consumer spending, which is forecast to decline by 3% in 2009 and 0.6% in 2010. The upstream industry may to some extent be less affected by the recession if contracts that are already in place are not cancelled, given that they provide intermediate consumption for other companies, and entail investment decisions over longer time-horizons. However, if the recession leads to falls in R&D this may affect the upstream industry in the longer term.
- We present three long-term scenarios, in which the UK space industry grows, in real terms, at 2.8% (low case), 4.8% (central case) and 6.8% (high case) on average per year, until 2020, with a significant proportion coming from productivity improvements.
- The high scenario reflects growth seen in recent years, and assumes that there is a sustained long-term increase in the level of R&D investment, and strong long-term demand for downstream applications.
- The central scenario has been derived based on Size and Health survey data and on productivity forecasts for similar broad economic sectors.
- The low scenario assumes that the current economic downturn will have a severe impact on long term growth rates, and that a sustained fall in R&D spending takes place, negatively affecting the industry's long-term competitiveness.
- The results from the scenario analysis indicate that the UK space industry will directly employ between 22,000 and 30,000 people and contribute between £4,100 and £7,000 million to GDP in 2020.
- Under these assumptions, the UK space industry is estimated to support between 72,800 and 115,000 jobs in total, including direct and multiplier (indirect and induced) impacts, with a value added contribution to GDP of between £8.4 and £14.2 billion in 2020.
- The scenario analysis shows that, with current R&D spending, the UK space industry in 2020 will support a further £1.3 to £2.2 billion of GDP in the UK due to spillover effects of the R&D it will undertake, and potentially much more if external support allows R&D intensity to be increased.

6.1 Introduction

This chapter considers a likely growth path of the UK space industry, both in the short term, and until 2020, and discusses the implications of this growth for the indirect, induced and R&D spillover effects in the future.

6.2 Short-term forecasts

Based on the results of the industry survey conducted by the British National Space Centre[20], 24% of respondents expect an annual growth between 0 and 2.5% over the next two years, whereas 21% expect growth between 2.5 and 5% per annum, and 17% expect growth between 5 and 7.5% a year. However, a sizeable proportion (22%), expect annual growth above 7.5% over the next two years.

[20] BNSC Size and Health survey, 2008.

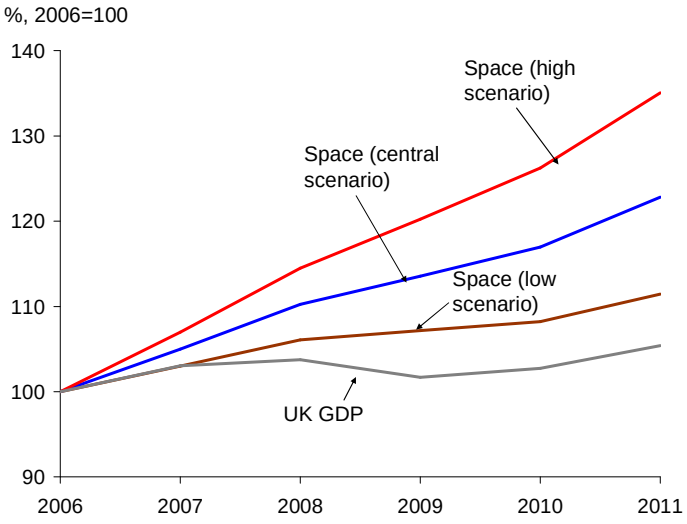
Over the next five-years, half of the respondents expect growth above 10% over the period, with a significant part (29%) expecting growth above 20%. In terms of segments, the upstream is expected to grow slightly faster than the downstream, with 13.5% of respondents reporting expected growth above 25% over the next two years.

However, it is important to take account of the current economic conditions, which were unexpected at the time of conducting this survey during 2008. On this basis, we have scaled down short-term forecasts for the space industry to reflect this economic climate. The UK economy contracted by 1.5% on the last quarter of 2008 with respect to the previous quarter, and Oxford Economics expects the economy to continue to contract through 2009 before stabilising towards the end of the year as the impact of the monetary and fiscal stimulus feeds through and credit restrictions begin to ease. GDP is expected to fall by 3.2% this year, before growing by 0.4% in 2010, with activity rebounding gradually in 2011 and 2012.

The recession may particularly affect the downstream segment, given that, as a provider of final services, it is often reliant on consumer spending, which is forecast to decline by 3% in 2009 and 0.6% in 2010. The upstream industry may to some extent be less affected by the recession if contracts that are already in place are not cancelled, given that they provide intermediate consumption for other companies, and entail investment decisions over longer time-horizons. However, if the recession leads to falls in R&D this may affect the upstream industry in the longer term.

Overall, the space industry is still expected to grow faster than the UK economy, even under the low scenario (Figure 6-1).

Figure 6-1, Short term growth forecasts for the UK Space industry



Source: Oxford Economics

6.3 Long term forecast

We have produced three scenarios for the expected growth of the UK space industry over the long term (until 2020). Under these scenarios, aggregate turnover grows annually at 2.8% (low scenario), 4.8% (central scenario), and 6.8% (high scenario).

These scenarios have been derived under the following assumptions:

- On the **high scenario**, growth is driven by a sustained increase in the levels of R&D spending, which would allow the UK space industry to continue to increase their productivity on the long term, as well as to remain competitive in the international scene; and by demand for downstream services, particularly satellite navigation (such as location-based services in mobile phones). Given that the amount of self-funded R&D has already increased considerably in the upstream, access to funding is critical for raising R&D intensity in the long-term.

  Under these assumptions, GVA will grow at a slightly lower rate than the last five years (7.6% for the 2001-2006 period) – and lower than for the 1999-2006 period, when the annual growth rate was 9%. Productivity would grow at a similar pace to that during the last 5 years (3.4%), whereas employment would grow at 3.3% a year during the period (see Figure 6-2).

- The **central scenario** has been built based on the expected growth rates reported in the industry survey[21], adjusted to take account of the then unforeseen economic downturn, and using growth forecasts for broad sectors comparable to the UK space industry (such as telecommunications or aerospace).

  Under these assumptions, GVA would grow at 4.8% a year. Productivity growth is forecast to be 2.8%, in line with productivity growth forecasts for comparable sectors (Figure 6-2).

- The **low scenario** assumes that the negative impact of the current economic downturn on the UK space industry will be worse than expected, especially on the demand for downstream services, and on a sustained reduction on the level of R&D spending, which would slow down productivity growth, and would erode competitiveness vis-à-vis international competitors. If access to external funding is not improved, there is a risk that the space industry is no longer able to maintain its R&D intensity over the longer term.

  Under these assumptions, GVA would still grow at a pace slightly higher than the UK economy over the long term (2.8% for the UK space industry and 2.1% for the UK economy). Productivity growth would grow at the same rate as productivity in the UK economy (1.8% a year until 2020). Employment growth has been derived using employment productivity growth forecasts for similar broad economic sectors.

Figure 6-2, Growth scenarios in the UK Space industry

	Average growth rates		
	High	Central	Low
GVA	6.8%	4.8%	2.8%
Productivity	3.4%	2.8%	1.8%
Employment	3.3%	2.0%	1.0%

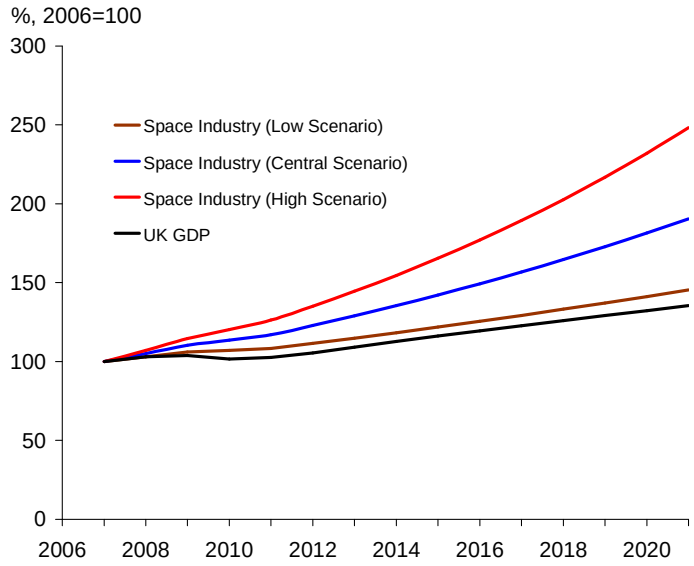
Source: Size and health of the UK space industry 2008 (BNSC), ONS, Oxford Economics

The results of the scenario analysis show that the UK Space industry is expected to be worth between £8,700 and £14,800 million in real terms in 2020 measured by turnover. In terms of GDP, the Space industry is forecast to directly contribute by between £4,100 and £ 7,000 millions to the UK economy.

Over the last five years the space industry has considerably outperformed UK GDP, with the industry growing about three times as fast as the overall economy. Looking forward over the next decade, in our higher growth scenario the UK space industry does even better when compared to UK economy as a whole, but still lower than the growth exhibited during the last 7 years (growth of more than three and a half times the rate of UK GDP), whereas in the central scenario, the UK space industry still grows more than twice as fast as the UK economy. Even in the lower growth scenario the space industry still grows faster than the UK GDP, with an annual growth of 2.8% versus a general growth forecast for the economy of 2.1% a year (Figure 6-3).

[21] Size and Health of the UK space industry 2008.

Figure 6-3, Growth in the UK space industry and GDP (index 2006=100)



Source: Size and health of the UK space industry 2008 (BNSC), ONS, Oxford Economics

The growth rates discussed for these scenarios implies that by 2020 the UK space industry in total, including direct and multiplier (indirect and induced) impacts, will support a substantial number of jobs - in total between 73,000 and 115,000 (Figure 6-4).

It is also estimated to have a significant value added contribution to UK GDP, in the range of £8.4 to £14.2 billion, equivalent to between 0.6 and 0.9% of UK GDP in 2020. This implies that jobs supported in the supply chain of the space industry will be even more significant in the future than at present.

This impact is comprised of:

- **Direct** employment in the UK space industry is forecast to be between 22,000 and 30,000 jobs in 2020, and to contribute value added of between £4,100 and £7,000 million to GDP in the UK economy.
- **Multiplier** employment in other industries of between 51,000 and 85,000 jobs, supported through purchases of goods and services by companies in the space industry, and from employment supported by employees in the space industry (whether direct or indirect) using their income to purchase goods and services for their own consumption. The value added contribution to GDP from these supported jobs is forecasted to be a further £4,200 to £7,200 million in 2020 (see Figure 6-4).

Figure 6-4, Growth in the UK space industry and GDP (index 2006=100)

		Scenarios 2020		
	2006 / 07	High	Central	Low
Direct Impact				
Turnover (£ millions)	5,912	14,820	11,374	8,684
GDP (£ millions)	2,760	7,024	5,390	4,116
Employment	19,097	29,993	25,030	21,998
Indirect Impact				
GDP (£ millions)	1,735	4,374	3,363	2,573
Employment	35,180	62,547	48,109	36,843
Induced Impact				
GDP (£ millions)	1,125	2,849	2,188	1,672
Employment	13,566	22,247	17,483	13,927
Total				
GDP (£ millions)	5,620	14,247	10,941	8,361
Employment	67,843	114,787	90,622	72,768

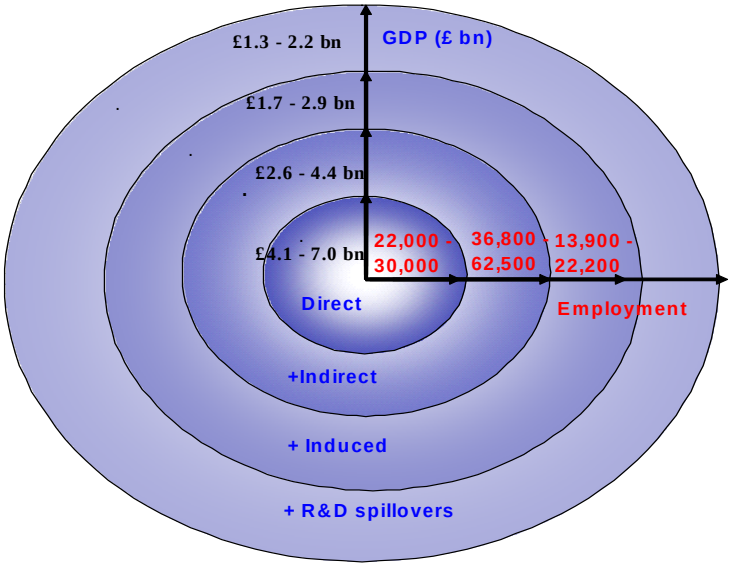
Source: Size and health of the UK space industry 2008 (BNSC), ONS, Oxford Economics

Research and development spending in the UK space industry is expected to be between £200 and £330 million in 2020, if the current R&D intensity with respect to GVA is kept constant over the period. Given this, in 2020 the UK space industry will support a further £1.3 to £2.2 billion of GDP in the UK due to the spillover effects of this R&D[22] , as explained in section 4 (see Figure 6-5).

However, the potential impact can be much larger if R&D spending relative to GVA increases in the future –which relies on funding being available-, because:

- Higher R&D intensity relative to GVA would imply a higher spillover for any level of GVA.
- Higher R&D spending would make more likely that the high case scenario would materialise, so that the effect would be even greater given the higher GVA created by the industry.

Figure 6-5, UK space industry total economic contribution in 2020



Source: Size and health of the UK space industry 2008 (BNSC), ONS, Oxford Economics

[22] We have assumed a constant R&D intensity in the forecast period.

The three scenarios developed here should be seen as indicative and give an estimate of the likely growth path of the UK space industry. Scenarios are presented given the uncertainties surrounding variables which will determine future growth in the industry, such as the level of support for R&D funding, or the level of demand for a number of space related applications that are in their infancy, (for example, location based services delivered through mobile phones).

6.4 Conclusion

The direct contribution to UK GDP from the space industry is expected to grow in significance in the future. In this chapter we have presented three long-term scenarios for expected growth in the UK space industry. Nevertheless, in the short term, the sector is expected to suffer the consequences of the current UK recession, with the downstream segment being potentially more affected.

In the long term, under the high scenario, the UK space industry grows at more than three times the rate of GDP. Under the central scenario, the UK space industry still grows at a rate more than twice that of the UK economy, and even under the lower growth scenario, the growth rate of the industry is still higher than UK GDP in the period to 2020. These scenarios imply the space industry will employ between 22,000 and 30,000 people and directly contribute between £4,100 and £7,000 million to GDP in 2020.

Achieving the higher growth figure depends in particular on the support for R&D funding, (the largest stimulus to which is likely to require increase external R&D funding since industry/internal R&D funding has increased significantly as a proportion of overall R&D in the last 2 years) and on the demand for services from space-derived applications - such as location based services in mobile phones - and the success of UK companies in providing them.

The total contribution of the UK space industry, including direct and multiplier impacts, is estimated to be between 69,000 and 115,000 jobs with a value added contribution to GDP between £8.4 and £14.2 billion. On top of these direct and multiplier impacts, we estimate that the UK space industry will contribute a further £1.3 to £2.2 billion a year to GDP by 2020 from the R&D activity it undertakes, and potentially much more if R&D intensity is raised.

Many of the catalytic impacts resulting from the use of space derived services and data that have been discussed in chapter 5 are likely to be realised (to a great extent) in the future so that the overall contribution of the UK space industry in 2020 could be substantially greater than even under the high growth scenario discussed in this chapter.