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Study of the impact of the Intermediate Research and Technology Sector on the UK economy

Oxford Economics

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ANNEX 1: European Definition of a Research Organisation

Key Points

- **The Intermediate Research and Technology Sector is positioned between academia and corporate and governmental end-users of technology.** It comprises a range of companies and organisations whose activities bridge gaps in the process of converting research outcomes into innovation and new technologies for use in business, industry and government.
- **Intermediate Sector companies have special and unique characteristics.** They are independent, market responsive and have the single objective of providing access to the R&D needed to maintain UK competitiveness, sales and profits.
- **The Sector is highly productive; each worker produces around 50% more GDP per person than on average across the whole economy.** The Intermediate Sector is estimated to have directly employed around 22,000 employees in 2006. Of these 60% are qualified to at least degree level compared to 23% for the economy as a whole making this one of the most highly skilled workforces in the country.
- **It helps to raise productivity in other UK based companies** through the significant research and development (R&D) it undertakes. The Sector is estimated to have undertaken R&D worth of the order of £400 million in 2006 – a third of the total extramural expenditure on R&D in the UK by UK firms.
- **It currently contributes at least £3 billion per annum to UK GDP and supports over 60,000 jobs according to our calculations,** based on the direct, multiplier and current R&D spillover effects.
- **The wider catalytic contribution the Sector makes to the UK economy as a whole is far greater and extends to many tens of billions of pounds.** By providing firms with access to a network of other organisations and a greater breadth and depth of research than they could undertake in-house, the Intermediate Sector enhances the benefits these firms receive from the R&D they commission. Furthermore, this leverage generates additional benefits to society through increased R&D spillovers. Nearly 60% of respondents to our survey agreed that the work they had undertaken with the Intermediate Sector had given them access to networks that they would not have found otherwise.
- **The research undertaken in the UK would not be commercially exploited to the same extent without the Intermediate Sector.** Our interviews indicated that among clients of the Intermediate Sector there is a strong recognition of the distinction between academic research and the ‘problem solution’ work which the Intermediate Sector provides - 80% of clients strongly agreed that they could not have achieved the same results by just working in-house or with a university.
- **The Sector plays a crucial role in correcting for market failures, providing ‘one-to-many’ channels for spreading innovation to business and industry.** Without its work many companies would not be able to exploit technological advances cost effectively in the marketplace, as the cost and risk of acquiring the necessary expertise unaided is frequently too high to contemplate for individual companies. In many instances, the Intermediate Sector offers the necessary resources on a cost and risk sharing, industry wide, open innovation basis.
- **Its clients include many governmental organisations, providing ‘many-to-one’ channels to government from a wide range of business and industrial communities.** The Sector’s work thereby helps government to achieve policy and procurement objectives, improve efficiency of public services and inform policy making.
- **The Intermediate Sector has a vital role to play in ‘The Race to the Top’ as presented in Lord Sainsbury’s 2007 Review of UK Innovation. This role is acknowledged in the principal economies that compete with the UK and it should be specifically recognised in this country. In view of the extremely important contribution the Sector makes to UK prosperity, its work should be supported by Government.** The market failures discussed in this report provide a rationale for this support. Without such recognition and support the UK’s exploitation of its science and technology will suffer. AIRTO’s recommendations are summarised below, followed by the main body of our impact study report.

Summary of AIRTO recommendations - Public sector funding and the Intermediate Sector

- In line with the recognition that government needs to adopt the Open Innovation business model (ref: Minister for Science and Innovation 13 November 2007) we believe that the role of the Intermediate Sector should be seen as a strategic component in the resource base that delivers exploitation of scientific and technological advances to UK business and a key player in building the competitiveness of UK industry.
- The Sector includes specialists and managers in networking, knowledge transfer and early stage applied research and development. However, they are not distinguished by government from the rest of industry and must therefore, like manufacturing and service industry, fund a sizeable proportion of their own costs of collaboration and participation in public sector innovation support projects. For an organisation in the Intermediate Sector the cost of participation cannot be covered from sales derived from subsequent product exploitation, creating a significant barrier to participation in such programmes and lost opportunities for the UK.
- Another issue for organisations in the Intermediate Sector is the fact that many potential Intermediate Sector partners cannot operate on equal terms with their public sector counterparts. This causes duplication of effort rather than fostering collaborative enterprise.
- In contrast, in European Programmes many of the UK's Intermediate Sector players are increasingly perceived as part of an important strategic European asset and are recognized accordingly in the terms offered to them for participation in these programmes. The working definition for such a research organisation is in Annex 1. The UK needs to adopt a similar approach in order to maximize leverage from its scientific and technological advances and deploy its resources to greatest efficiency.
- The Sainsbury Review of Science and Innovation¹ (October 2007) identified that successful innovation is a product of interaction between demand and supply. In view of the key role which the Intermediate Sector plays in increasing the rate of adoption of technological innovation in the UK, we recommend that the Intermediate Sector should be able to bid into those Public Sector funds which are earmarked for proof of concept/technology commercialisation such as HEIF, PSRE and by Research Councils. Forming strong business partnerships with the science base at the earliest opportunity will expedite the pull through from basic research.
- Finally, we recommend that AIRTO works with Government to identify and recognise the respective roles that all the players in the science and innovation community undertake.

¹ http://www.hm-treasury.gov.uk/media/5/E/sainsbury_review051007.pdf

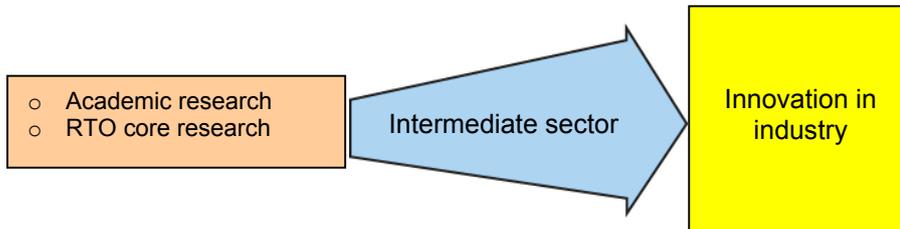
1. Executive Summary

The Intermediate Sector is positioned between academia and corporate & governmental end-users of technology

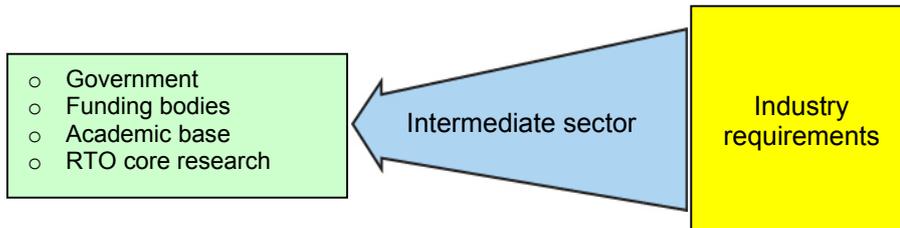
- The Intermediate Research and Technology Sector is positioned between academia and corporate and governmental end-users of technology. It comprises a range of companies and organisations whose activities are aimed at enhancing the development of new technologies and increasing the rate of adoption of technological innovation.
- Box 1-1 describes the position of the Intermediate Sector in the UK economy. In this diagram, where readiness level 1 represents basic science research and readiness level 9 full production, the Intermediate Sector mainly encompasses levels 4, 5, and 6 – helping to enable industry to translate research into production. Research and Technology Organisations (RTOs) are typically part of the Intermediate Sector, as are independent laboratories, innovation centres and some university enterprise units.
- Intermediate Sector companies have a number of special and unique characteristics. In particular, they are independent, market responsive and have a single objective of providing industry access to R&D to enhance sales and profits. The independence of the Intermediate Sector enables it to draw on a network of research providers. This not only ensures the best solutions for clients, but also boosts the impact R&D has on the rest of the economy by enhancing the spillover effects. In our interviews with clients of the Intermediate Sector nearly 60% of respondents agreed with the statement that the work they had undertaken with the Intermediate Sector had given them access to networks that they would not have found otherwise.
- Another key characteristic of the Intermediate Sector is its permanence. The knowledge and expertise of the Sector is embedded in each company rather than a particular academic who might, at some point, move to an overseas university or change academic interests. Furthermore, as these networks of knowledge are embedded in the UK's economic infrastructure they become permanent – often much less likely to relocate abroad than, for example, a manufacturing plant.
- Our interviews indicated that there is a strong recognition among clients of the Intermediate Sector of the distinction between the 'problem solution' work provided by the Intermediate Sector and academic research. Indeed, nearly 80% of businesses we interviewed for this study strongly agreed that they could not have achieved the same results working in-house or with a university - highlighting the crucial role the Intermediate Sector has in innovation by transferring knowledge into commercial applications.

Box 1-1: The role of the Intermediate Sector in technical innovation

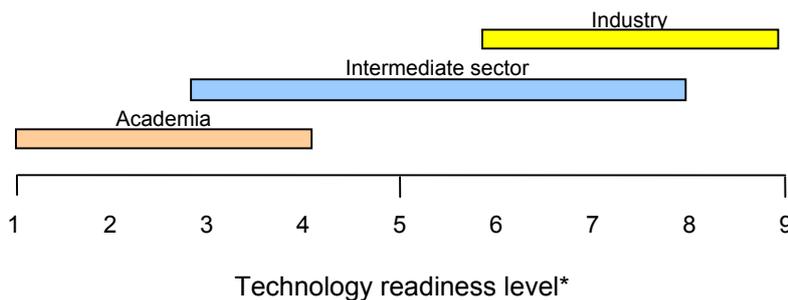
Technology driven - amplifying the take up of technology



Market driven - channelling needs and perspectives



Technology development - bridging between academia and industry



* Based on NASA Technology Readiness Levels - see

www.hq.nasa.gov/office/codeq/trl/trl.pdf

1. Basic principles observed and reported.
2. Technology concept or application formulated.
3. Proof of concept and outline design.
4. Demonstration in laboratory environment.
5. Demonstration in relevant environment.
6. Prototype demonstration in relevant environment.
7. Prototype demonstration in operational environment.
8. Pilot production.
9. Full production.

The intermediate Sector is a substantial employer of highly skilled workers... and now directly employs 22,000 workers...

- The Intermediate Research and Technology Sector is estimated to have directly employed around 22,000 employees in 2006. Of these 60% are qualified to at least degree level compared to 23% for the economy as a whole.
- This highly skilled labour force means that the Intermediate Sector is a highly productive industry; each worker produces around 50% more GDP per person than on average across the whole economy. These skilled workers move to new jobs in other sectors at a staff turnover rate comparable to that across the whole economy.

...directly contributing around £1.2 billion a year to GDP

- On a turnover of £2.2 billion, the Intermediate Sector directly contributed around £1.2 billion to UK GDP in 2006. This means that the Intermediate Sector contributed nearly as much to GDP as, for example, the 'manufacture of medical and surgical equipment' industry.

In total the Intermediate Sector supports 62,000 jobs and contributes £2.4 billion a year to GDP

- The Intermediate Sector helps to support a total of 62,000 jobs allowing for those directly employed and for the multiplier effects.
- Moreover, taking into account direct, indirect and induced impacts the Intermediate Sector contributes £2.4 billion a year to UK GDP, around 0.2% of UK GDP.

The Intermediate Sector also boosts UK productivity through the R&D it undertakes...

- A key element of the impact of the Intermediate Sector on overall UK productivity reflects the large amount of research and development (R&D) it undertakes, which is estimated to have been of the order of £400 million in 2006. This means that the Intermediate Sector is responsible for a third of all private sector extramural R&D investment in the UK by UK private sector firms.
- The technological advances that come about as a result of R&D undertaken by the Intermediate Sector 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 manufacturing sector generating a social return of around 50% - every £100 million invested in R&D leads to a reoccurring increase in GDP of £50 million a year in the long run.
- On this basis, we estimate that the Intermediate Sector helps to generate £0.7 billion a year of GDP in the UK due to the spillover effects of the R&D it undertakes, on top of its £2.4 billion of direct and multiplier impacts. So, we calculate that the Intermediate Sector overall currently contributes at least £3 billion a year to UK GDP.

The Intermediate Sector is much more than a collection of research institutes...

- Companies in the Intermediate Sector facilitate the exploitation of R&D more effectively and enhance the spillover effects that result from that R&D, as well as undertaking vital work in areas such as testing & certification and national & international standards.

...it enhances the spillover effects of R&D...

- The Intermediate Sector offers open innovation solutions to firms. These benefit individual firms as they gain access to a network of organisations and a greater breadth and depth of research than they could replicate in-house. There are also gains to society from enhanced R&D spillovers as other firms gain access through the Intermediate Sector to the expertise and research undertaken by a broader group of organisations. For example, the access to networks provided by TWI enabled Airbus to exchange technology with the wind energy and marine sectors.
- Open innovation also helps raise the skills of staff. They learn from a wider pool of knowledge which not only benefits their company, but also other companies as staff move along the supply chain or to competitors.
- Nearly 70% of the Intermediate Sector's clients that we interviewed agreed that working with the Sector had helped to raise the skills of their staff. For example, UK Trade and Investment saw staff skills improve when they worked with Pera on a programme designed at getting multinational companies to invest in more R&D in the UK.

...facilitates the exploitation of R&D...

- Some of the research undertaken in the UK would not be commercially exploited to the same extent without the Intermediate Sector. It fills a crucial role between academia and industry by enabling the transfer of 'raw' knowledge from academic research into a 'problem solution' that can be well understood by all levels of management within industry. For example, Ultra Electronics worked with QinetiQ on the development of a system to link the electronic components in a vehicle using considerably less wire; the technology has spread to the wider markets of commercial vehicles and to the military area.

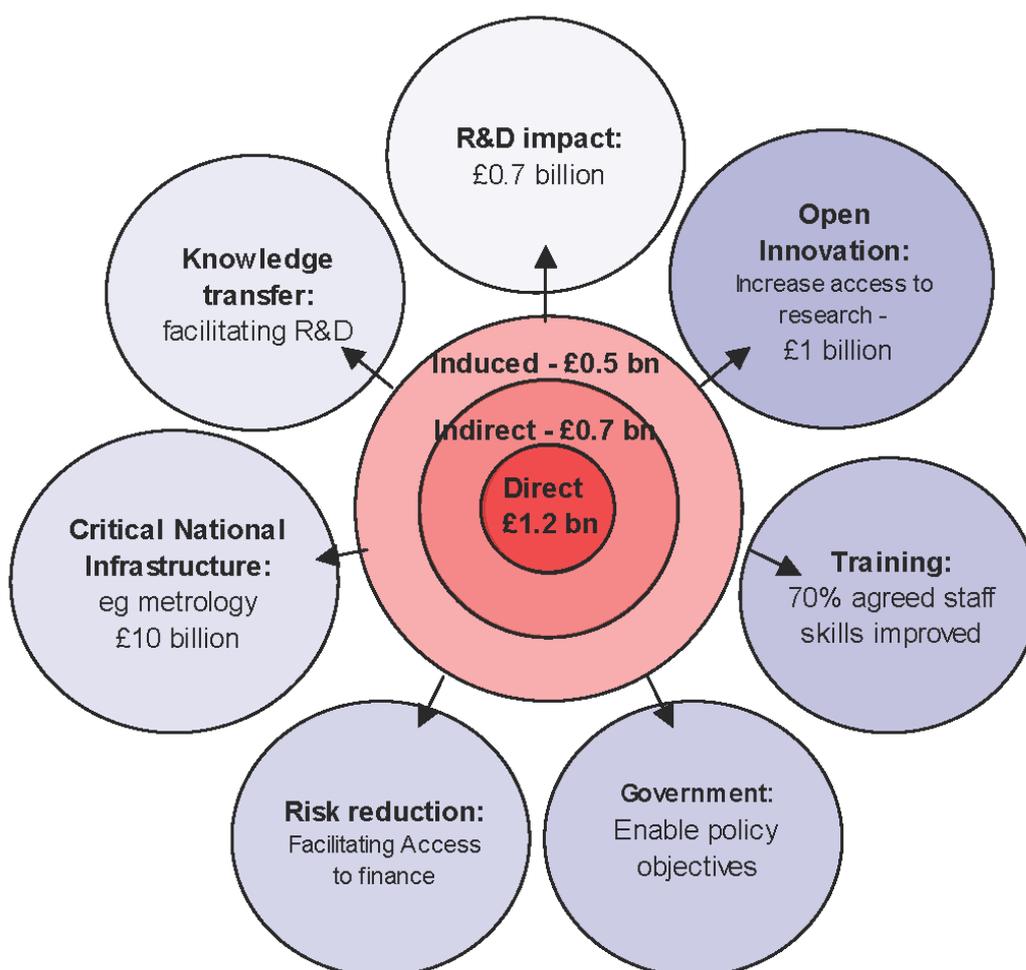
...helps government meet policy objectives...

- The work of the Intermediate Sector also helps government deliver policy objectives. For example, Campden & Chorleywood Food Research Association's work with the Department for Environment, Food and Rural Affairs (DEFRA), which sought technology based solutions in the food industry targeted at reducing carbon emissions, made a significant contribution to government environmental targets.
- Similarly, NAMTEC's work with Yorkshire Forward, in the field of advance engineering and materials, contributed to regional government policy objectives by creating jobs in South Yorkshire – an area that has seen significant job losses from the historic decline of the UK's steel industry.

...and makes markets work more effectively

- The Intermediate Sector plays a crucial role in providing independent expert advice that helps bridge the information gap that can prevent viable R&D projects from getting access to finance.
- Metrology is one specific example of work by members of the Intermediate Sector that helps to correct for market failures. Estimates suggest that the quality of the measurement system in the UK as a whole delivers a significant positive impact to the economy equivalent to 0.8% of GDP² - ie £10 billion per annum in terms of GDP in today's prices.
- Given the substantial contribution the Intermediate Sector makes to the UK economy and the vital role it plays in the UK's economic infrastructure (summarised in Figure 1-1) it is vital for government to recognise and support its work.

Figure 1-1: The overall contribution of the Intermediate Sector



² Review of the Rationale for and Economic Benefit of the UK National Measurement System – PA Consulting (1999)

2. Introduction

The Association of Independent Research and Technology Organisations (AIRTO) commissioned Oxford Economics³ to undertake an independent study to assess the impact the Intermediate Research and Technology Sector (the “Intermediate Sector”) has on the UK economy.

In 2003, Professor Michael Porter (a leading authority on the competitiveness and economic development of nations) published a review of the competitiveness of the UK economy sponsored by the Department of Trade and Industry (DTI) and Economic and Social Research Council (ESRC)⁴. One of its conclusions was that the UK’s competitiveness was hindered by low productivity (relative to other industrialized nations), in part at least due to low rates of innovation. He commented: “Current levels of UK innovation are insufficient to drive UK productivity growth and close the UK productivity gap versus key competitors”. And similarly, “To achieve higher prosperity, UK companies will need to upgrade their productivity by competing on more unique and more innovative products and services”.

Porter argued that the UK’s failure to innovate is not related to the strength of its science base. The Office of Science and Technology (2004), for example, claims that “we are probably strongest overall in the natural sciences, and on many indicators are second only to the USA”⁵. The problem lies in the UK’s ability to commercialise scientific discoveries and knowledge. Also, the UK lags behind other nations in its ability to protect the intellectual property of the innovations it does make; its patent rate is low.

Concerned by the UK’s low innovation rate, the Chancellor commissioned the Lambert Review⁶ to investigate the interactions between higher education institutions (HEIs) and business. Lambert found: “dozens of companies in a wide variety of sectors which have gained significant economic advantages by working with universities to develop new ideas and innovations”. This in turn helped the companies involved broaden their range of goods or services, open new markets or increase their market share.

But the Lambert Review also found there are many impediments to the successful collaboration between academia and business. It concluded: “In many ways, businesses and universities do not make easy bedfellows. They have different values and different missions. They work on different time scales towards different objectives under different management systems. Building a culture that allows the two to come together in a creative fashion requires considerable commitment from both sides, and an infrastructure that can sustain the relationship.”

The Intermediate Sector comprises a range of companies and organisations whose activities are aimed at enhancing the development of new technologies and increasing the rate of technological innovation. In its position between, and independent of, both academia and corporate and governmental end-users of

³ www.oxfordeconomics.com

⁴ Source: DTI/Professor M.E. Porter & C.H.M. Ketels (Institute of Strategy and Competitiveness, Harvard Business School), 2003, *UK Competitiveness: Moving to the Next Stage*, DTI Economics Paper No. 3

⁵ Source: Office of Science and Technology (2004), ‘PSA target metrics for the UK research base’, DTI, October

⁶ Source: HM Treasury (2003), ‘Lambert review of business-university collaboration: Final report’, HMSO, December.

technology, the sector plays a crucial role in encouraging, enabling and realising the benefits of innovation in the UK.

2.1. The channels of economic impact

This report describes the Intermediate Sector and analyses the ways in which its work contributes to the prosperity of the UK economy. There are many channels through which the Intermediate Sector makes a contribution to the UK economy including the following standard economic impacts:

- **Direct impacts** – employment and activity in the Intermediate Sector itself.
- **Indirect impacts** – employment and activity supported down the supply chain to the Intermediate Sector, as a result of the Sector's purchasing of goods and services from UK suppliers. This includes, for example, jobs supported through the demand for IT equipment, advertising, higher education, and a wide variety of activities in the business and financial services sector (legal, accountancy, IT services etc).
- **Induced impacts** – employment and activity supported by those directly or indirectly employed in the Intermediate Sector 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.

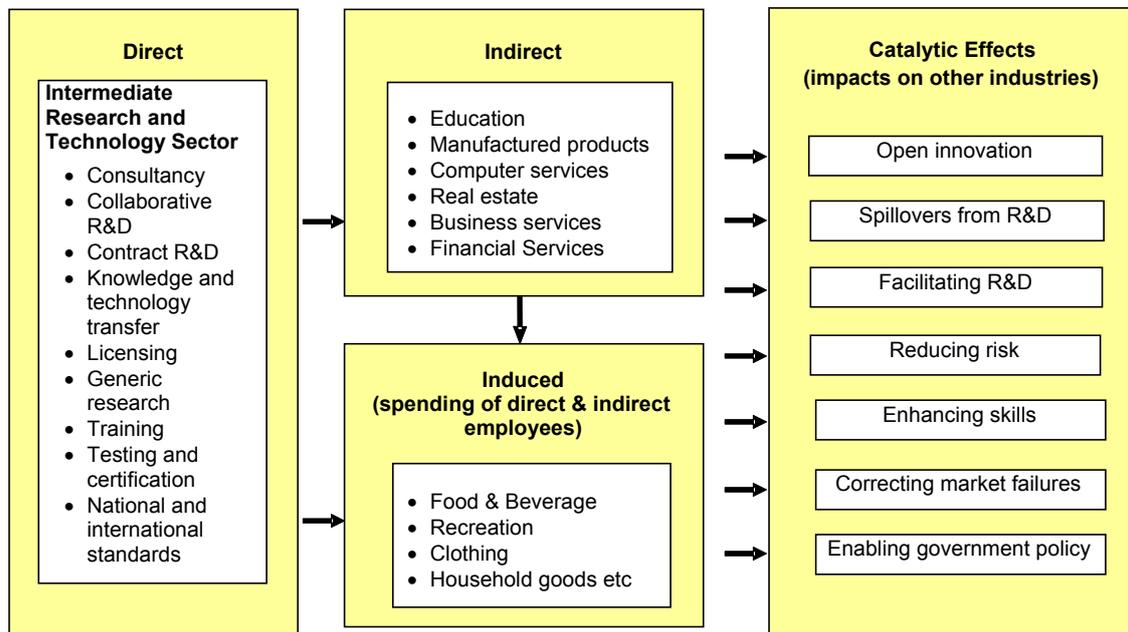
But there are also a number of additional economic catalytic impacts ('spillovers') which result from the activity of the Intermediate Sector, for example:

- **Spillover impacts from the research and development (R&D) undertaken by the sector.**
- **Facilitating the exploitation of R&D.**
- **Helping government achieve policy and procurement objectives.**
- **Making markets work more effectively.**

In these ways, the Intermediate Sector helps to overcome market failures that result in too little R&D being undertaken in the UK and the strength of our science base not being exploited to its full commercial potential.

The economic value of the direct, indirect and induced effects is related to the total revenues of the Intermediate Sector, while the catalytic impacts are 'spillover' benefits for other industries, consumers and the economy more generally (as shown in Figure 2-1).

Figure 2-1: The Intermediate Sector and its economic impacts



2.2. Approach to the study

In order to inform this study we have:

- Undertaken a survey of AIRTO members in order to gather financial, employment and R&D statistics.
- Gathered Companies House records in order to estimate the contribution to UK GDP made by Intermediate Sector companies who are not members of AIRTO.
- Undertaken a series of structured interviews with clients of the Intermediate Sector. These interviews enabled us to further establish the ways in which the Intermediate Sector contributes to the performance of the UK economy.

These data have been used in conjunction with Oxford's macro and sectoral models of the UK economy.

2.3. Report structure

The rest of this report is structured as follows:

- Chapter 3 discusses the role of the Intermediate Sector.
- Chapter 4 quantifies the direct, indirect and induced contribution that the Intermediate Sector makes to the UK economy.
- Chapter 5 quantifies the contribution the research and development undertaken by organisations in the Intermediate Sector makes to the UK economy.

- Chapter 6 discusses the other wider benefits of the Intermediate Sector.
- Chapter 7 provides a summary of the contribution made by the Intermediate Sector to the UK economy.

3. The role of the Intermediate Research and Technology Sector

Key Points

- The UK has a world leading science base, but lags many other developed countries in terms of productivity. This is, in part, due to low rates of innovation.
- The Intermediate Sector is positioned between academia and business – it helps translate ‘raw’ research into ‘problem solutions’ for business that can be understood by all levels of management.
- The Association of Independent Research and Technology Organisations (AIRTO) is a membership organisation for companies that are part of the Intermediate Sector. While not all companies in the Intermediate Sector are members it does represent a substantial proportion.

3.1. Introduction

This chapter defines the Intermediate Sector and explores the role it plays in the UK’s economic infrastructure (see annex 1 for European Definition of a Research Organisation). The chapter also introduces the Association of Independent Research and Technology Organisations (AIRTO).

3.2. The Intermediate Research and Technology Sector

3.2.1. Definition of the Intermediate Sector

The key characteristics that define organisations in the Intermediate Sector are that their business purpose is knowledge-transfer; they are independent to trade with any company or deal with any academic institution.

Members of the Intermediate Sector are commissioned by their clients to undertake a range of different types of work. The main areas of activity can be classified as follows:

- Consultancy.
- Collaborative research and development.
- Contract research and development.
- Knowledge and technology transfer.
- Licensing technology and spinning out companies.
- Generic research.

- Training.
- Testing and certification.
- National and international standards.

Box 3-1: A sample of companies that are part of the Intermediate Sector

BMT Group - BMT is an international design, engineering and risk management consultancy, working principally in the defence, energy and environment, marine risk and insurance, maritime transport and ports and logistics sectors. BMT invests significantly in research. Its customers are served through a network of international subsidiary companies. The assets are held in beneficial ownership for its staff.

Campden & Chorleywood Food Research Association (CCFRA) - CCFRA provides research, process and product innovation and development, analysis and testing, consultancy, auditing, scheduled and tailored training, publishing and information services for the food, drink, and allied industries. Expertise covers manufacturing technologies, food processing (heating, chilling, freezing), aseptic technology, microwave heating, milling, baking and extrusion technology, cereal science, process control and instrumentation, product development, food packaging, hygiene and sanitation, raw material technology, database/modelling, knowledge-based systems (expert systems), quality and safety management, consumer research and market insights, training course development, information provision, and food and environment law. Analysis and testing encompass microbiology, chemistry, biochemistry and molecular biology, sensory evaluation and laboratory and process equipment. CCFRA has a subsidiary company in Budapest, Hungary.

National Physical Laboratory (NPL) - NPL is the UK's national standard laboratory. It develops, maintains and disseminates national measurement standards for physical quantities such as mass, length, time, temperature, voltage, force and pressure, and many others. It also undertakes underpinning research on engineering materials and information technology. The Laboratory explores and implements ways in which good measurement practice can contribute to UK competitiveness and compliance, and is being developed as an internationally respected measurement services provider.

Pera Group - Pera is an international group of companies specialising in innovation strategy, helping companies to unlock the potential within their products and markets by exploiting technological and operational change. It provides a unique platform of information, research and development, technology innovation and management and technical services, and through this breadth of skills gains a unique understanding of business needs. The broad approach encompasses complete support through concept design to full scale manufacturing ability. Customers range from small businesses to multi-national corporations and government departments. Pera also manages many business support and innovation stimulation programmes for UK Regional Development Agencies, national government and UKTI, and for other European national governments.

Thames Innovation Centre (TIC) - TIC is a business support organisation, home to Think Big and Business Solutions teams that facilitate the commercialisation of innovation and technology within start-ups and small to medium size firms, as well as business support and access to finance. The teams work

north and south of the Thames, in seven London boroughs, including Hackney, Tower Hamlets, Newham, Havering, Barking & Dagenham, Bexley and Greenwich. The TIC affords local companies the opportunity to forge links with entrepreneurs, universities and colleges, economic development agencies and R&D organisations. The Centre also provides flexible workspace, from state-of-the-art hotdesks and offices to workshops, on an 'easy in, easy out' basis, along with on-site support and business advice. The TIC also operates an Enterprise programme which supports any kind of start up.

3.2.2. The role of the Intermediate Sector

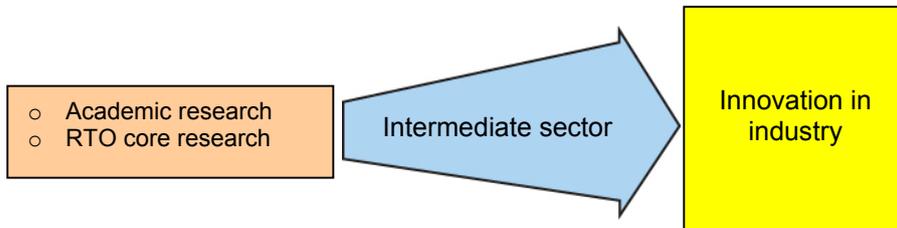
The Intermediate Sector is positioned between academia and corporate and governmental end-users of technology. It comprises a range of companies and organisations whose activities are aimed at enhancing the development of new technologies and increasing the rate of technological innovation. Box 3-2 illustrates schematically the relationship between academia, the Intermediate Sector and industry.

In this role in the UK's economic infrastructure, the Intermediate Sector is crucial in enabling the UK economy to realise the full benefits of the early stage research undertaken in academia. Without the Intermediate Sector industry may employ additional resources to link directly with academia. However, there are often cultural differences, noted by Lambert in his review of business-university collaboration⁷ – “In many ways, businesses and universities do not make easy bedfellows. They have different values and different missions. They work on different time scales towards different objectives under different management systems”. Furthermore, with this relationship there would be no impetus for helping new industries to emerge. If instead academia were to employ resources to link with business then they would need to be extensive in order to be able to “speak the language” of the different research requirements across all the market sectors in which industry operates. The Intermediate Sector, however, overcomes these issues by being independent of both academia and business, encompassing a broad range of market sectors and by operating in a commercial environment.

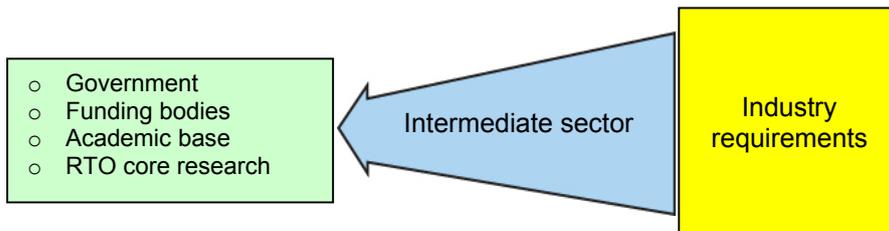
⁷ http://www.hm-treasury.gov.uk/media/9/0/lambert_review_final_450.pdf

Box 3-2: The role of the Intermediate Sector in technical innovation

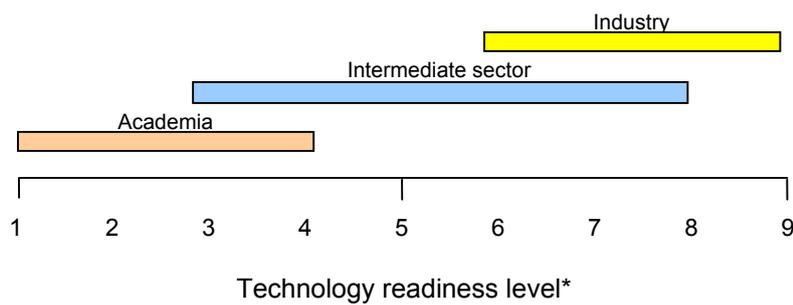
Technology driven - amplifying the take up of technology



Market driven - channelling needs and perspectives



Technology development - bridging between academia and industry



* Based on NASA Technology Readiness Levels - see

www.hq.nasa.gov/office/codeq/trl/trl.pdf

1. Basic principles observed and reported.
2. Technology concept or application formulated.
3. Proof of concept and outline design.
4. Demonstration in laboratory environment.
5. Demonstration in relevant environment.
6. Prototype demonstration in relevant environment.
7. Prototype demonstration in operational environment.
8. Pilot production.
9. Full production.

The key roles of the Intermediate Sector are:

- Translating academic research into solutions to meet business needs. The output from the academic community is often early stage research which apart from a minority of sectors (eg pharmaceuticals) does not translate readily into industrial practice.
- Supplying research directly relevant to the needs of business. Organisations that are part of the Intermediate Sector work on the supply side, undertaking research, process and product development and testing, which can be close to academia or could be further down the development line, undertaking training and consultancy services on the adoption of new technology or improved processes.
- Ensuring businesses' research demands are met. The Intermediate Sector also works with the demand side commissioning and co-ordinating research on behalf of end-users.
- Assisting businesses - often small firms - that do not have sufficient research expertise or contacts with academia.
- Bringing together inputs from several disciplines and a number of experts with which the client is not totally familiar.

Each of these categories of work has a good mix of private and public funding from a wide variety of sources. Public funding is important to the Intermediate Sector in order to keep research open, independent and with a vision horizon for emerging markets in the twenty first century. Given the positioning of the Intermediate Sector between academia and industry, securing public funding does present challenges for the Intermediate Sector.

3.2.3. Association of Independent Research and Technology Organisations (AIRTO)

AIRTO is a network of independent research and technology organisations. Its mission is to influence industry, universities and government to work together to drive forward the UK's adoption of innovation, new technologies and technological applications to achieve enhanced competitiveness, economic performance and socio-economic benefit. AIRTO members also undertake best practice, networking together to improve their own business performance.

AIRTO currently has 34 member organisations including research associations, laboratories, university enterprise offices, innovation centres and companies. They undertake consultancy, applied research, design, technology development, value-added knowledge transfer, technology transfer, early-stage investment in commercial exploitation, information management, skills provision and training, materials and product evaluation and the provision of leading-edge test facilities and services. AIRTO members work across a diverse range of industries (eg food manufacturing, defence, transport equipment). The case studies in Chapters 5 and 6 set out some examples of the sectors in which AIRTO operates.

The AIRTO community is independent of government. But its members serve the public sector in a variety of capacities. In particular, they participate in a number of the government's initiatives to foster collaboration between academia and business and foster innovation more generally.

Box 3-3: Members of AIRTO

Aircraft Research Association Limited	The Motor Insurance Repair Research Centre
BMT Group Limited	NAMTEC (National Metals Technology Centre)
BRE Group	The National Computing Centre Limited
Brewing Research International	National Physical Laboratory
BSRIA Ltd	Nexia Solutions Ltd
Campden & Chorleywood Food Research Association	Pera Group
CERAM Research Ltd	The Paint Research Association
City University - Centre for Innovation and Knowledge Transfer	QinetiQ Group plc
Cocoa Research UK Ltd	SATRA Technology Centre
CIRIA	SCI
E-Synergy Ltd	Smithers Rapra Technology Limited
FIRA International Ltd	Thames Innovation Centre Ltd
HR Wallingford Group Ltd	The Scotch Whisky Research Institute
ITRI Limited	The Smith Institute
Leatherhead Food International	TRADA Technology Limited
LGC	TWI Ltd
MIRA Ltd	University of Surrey

4. The economic contribution of the Intermediate Research and Technology Sector

Key Points

- The Intermediate Sector is estimated to have directly employed around 22,000 workers in 2006.
- On a turnover of £1.9 billion, the Intermediate Sector is estimated to have directly contributed around £1.2 billion to UK GDP in 2006 – a similar amount to the ‘manufacture of medical and surgical equipment’ industry.
- Value added per head in the Intermediate Sector is around 50% above the UK average at £55,000 per annum.
- The workforce is well qualified: some 60% are graduates compared with 23% for the economy as a whole.
- The Intermediate Sector helps to support 62,000 jobs in total, allowing for those people employed in companies supplying the Intermediate Sector and for the jobs dependent on the spending of the Sector’s employees.
- In total, the Intermediate Sector contributed around £2.4 billion in 2006 to UK GDP, taking into account direct, indirect and induced impacts.

4.1. Introduction

This chapter discusses the employment and GDP supported in the UK by the Intermediate Sector. The contribution of the Intermediate Sector is presented in terms of direct, indirect and induced impacts.

4.2. The size of the Intermediate Research and Technology Sector

It is difficult to measure the size of the Intermediate Sector using official statistics. There is no single or group of Standard Industrial Classification (SIC) codes that comprehensively matches the activities undertaken by organisations considered to be part of the Intermediate Sector. The closest-matching SIC codes are:

7310: Research and development on natural sciences & engineering.

7430: Technical testing and analysis.

However, closer inspection of all the companies defined under these SIC codes reveals that many could not be strictly classified as being part of the Intermediate Sector. Equally, we cannot solely rely on the community of AIRTO members to totally define the Intermediate Sector, although the membership of

AIRTO does cover a substantial part of the Intermediate Sector. We estimate that it accounts for over 50% of the Intermediate Sector's direct UK GDP contribution.

In order to capture as many relevant organisations as possible in our analysis, we have added to the list of AIRTO members a selection of other organisations that report full accounts at Companies House and classify their activities as either part of SIC code 7310 or 7430. This selection was decided through consultation with AIRTO members as to which of these organisations had the characteristics that would define them as part of the Intermediate Sector. It should be noted that, whilst we believe this is the most robust definition possible for our analysis, by defining the Intermediate Sector in this way we have almost certainly under-estimated its true size by excluding very small companies and also those that may have been defined under different SIC codes.

4.3. The direct economic impact of the Intermediate Sector

4.3.1. GDP impact

The standard method for calculating the direct contribution of an industry or a company to GDP is to measure its so-called value added – that is, to calculate the difference between the industry's total pre-tax revenue and its total bought-in costs (ie costs excluding wages and salaries) adjusted for any changes in stocks.

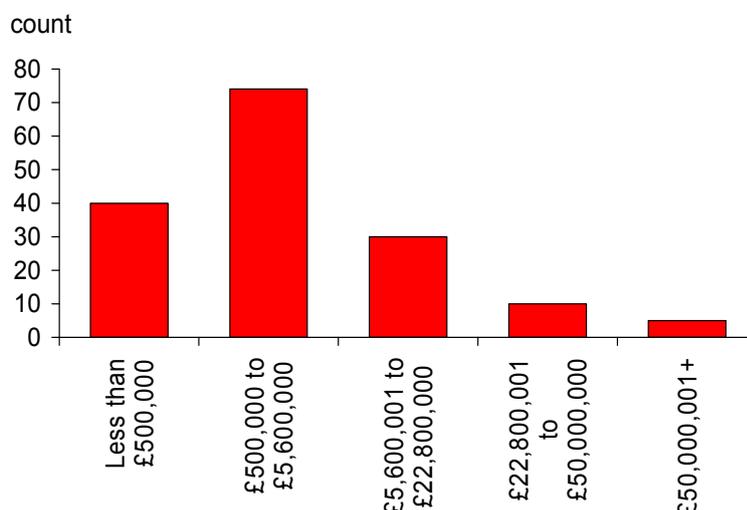
In order to estimate the GDP contribution of the Intermediate Sector we have used data from Company's House on turnover, expenditure on goods and services, wages and salaries and pre tax profits for a total of 172 organisations (see section 4.2 for further details). We have supplemented this with a detailed survey of AIRTO members which enables us to estimate, for example, the percentage of sales made by overseas subsidiaries.

On this basis, we estimate that on a turnover of £1.9 billion, the Intermediate Sector contributed around £1.2 billion to UK GDP in 2006⁸. This means that the Intermediate Sector directly contributed nearly as much to GDP as, for example, the 'manufacture of medical and surgical equipment' industry.

Of the 172 organisations we have been able to identify as belonging to the Intermediate Sector, a quarter have a turnover of less than £500,000 per year and over 70% would be defined as a small company by Department for Business Enterprise & Regulatory Reform (BERR). A further 19% would be defined as a medium sized company (turnover of less than £22.8 million), whilst just 3% have a turnover of greater than £50 million (Figure 4-1).

⁸ Accounts data often does not cover the period January to December, and when this is the case we have used the data that matches this period most closely.

Figure 4-1: Turnover in the Intermediate Sector 2006 estimate



Source : Oxford Economics

4.3.2. Employment Impact

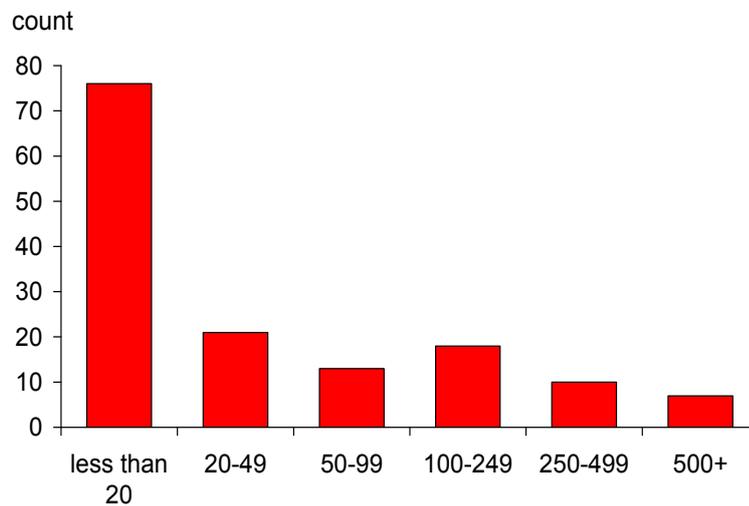
The Intermediate Sector now employs around 22,000 workers, many of whom are highly qualified scientists and engineers. The mean level of employment per organisation is 143 whilst the mode is 18 highlighting the skew in the distribution of the size of companies caused by a few much larger organisations. In terms of employment, BERR defines a medium sized company as one employing less than 250 people and a small company as one employing less than 50. Based on this employment definition, two-thirds of organisations in the Intermediate Sector can be considered small and a further 21% as medium-sized (Figure 4-2). For manufacturing as a whole, 93% of businesses would be considered as small and a further 5% medium sized⁹ - implying the Intermediate Sector has a significantly higher proportion of medium sized firms than the manufacturing sector in the UK.

The rate of staff turnover for the Intermediate Sector can be estimated by using the closest applicable SIC code and data from the Labour Force Survey¹⁰ (LFS 2007q2). These data suggest that employees of the Intermediate Sector tend to move to other sectors of the economy at a very similar rate to that seen in other industries in the UK. For example, based on the 2007 quarter 2 LFS data turnover for the Sector is estimated to be just below 10 percent, a figure similar to that of, for example, the computer software consultancy sector.

⁹ 5% of manufacturing companies employ between 50 and 200 people (data were not available for companies sized between 50 and 250) – source: Annual Business Inquiry, Office for National Statistics (2006)

¹⁰ Source: Office for National Statistics

Figure 4-2: Intermediate Sector employment 2006 estimate



Source : Oxford Economics

4.3.3. Productivity in the Intermediate Sector

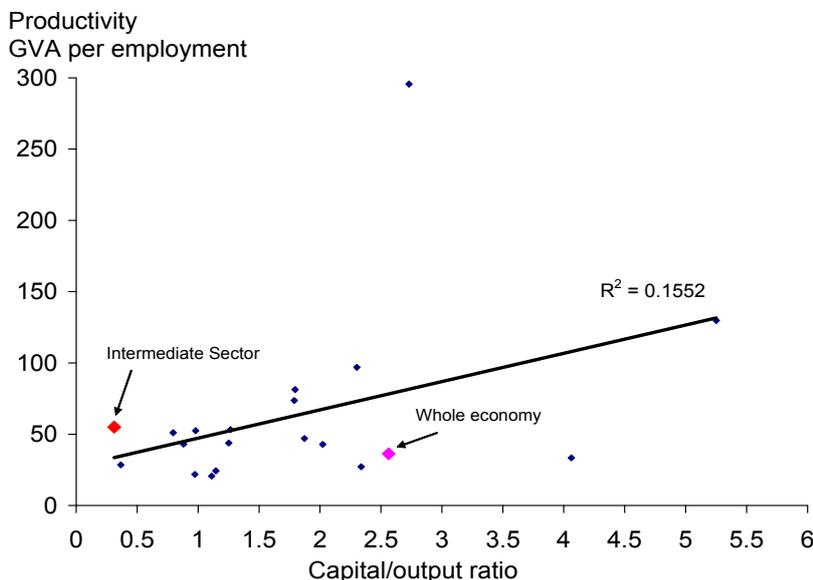
Productivity growth and highly productive industries are crucial to the UK economy. Industries that are highly productive generate more economic activity per worker for the economy and hence raise living standards. Labour productivity in the Intermediate Sector is £55,000 per worker per annum which is around 50% higher than the figure for the UK economy as a whole.

Figure 4-3 plots labour productivity (y-axis) against the capital/output ratio (x-axis) for all major sectors in the UK economy. The data point for the Intermediate Sector is above the line of best fit which indicates that it is highly productive relative to its capital intensity. This suggests that it is a highly skilled sector and efficient in its use of both labour and capital. Indeed, it is estimated that 60% of employees in the Intermediate Sector are qualified to degree level or further¹¹, more than double the corresponding figure (around 23%) for the UK economy as a whole (Figure 4-4).

The statistics show that the Intermediate Sector is a major employer of graduates and helps to train them to be innovators in a commercial environment.

¹¹ Based on most applicable SIC code and AIRTO company data

Figure 4-3: Relationship between productivity and capital intensity



Source : Oxford Economics, ONS

Figure 4-4: Qualifications of the workforce (2007)

Workforce qualifications	
	% with degree or higher
Higher Education	64%
Intermediate Sector	60%
Space	60%
Pharmaceuticals	51%
Banking, finance & insurance etc	37%
Public administration education & health	35%
Energy & water	25%
Other services	24%
Whole economy	23%
Aircraft spacecraft manufacture	22%
Manufacturing	18%
Transport & communication	12%
Agriculture & fishing	11%
Distribution hotels & restaurants	9%
Construction	8%

Source : Labour Force Survey (2007q1), Case for Space, Oxford Economics

4.4. Estimates of the multiplier economic impacts of the Intermediate Sector

The Intermediate Sector has a wider impact on the UK economy than simply the activity and jobs in those companies directly part of the sector. Companies in the Intermediate Sector source goods and services from other companies, 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 Intermediate Sector. In addition, economic activity is supported by the spending of people who work in the Intermediate Sector and its supply chain: the 'induced effect'. These multiplier impacts depend upon the extent of the domestic linkages between sectors.

(a) Indirect impacts

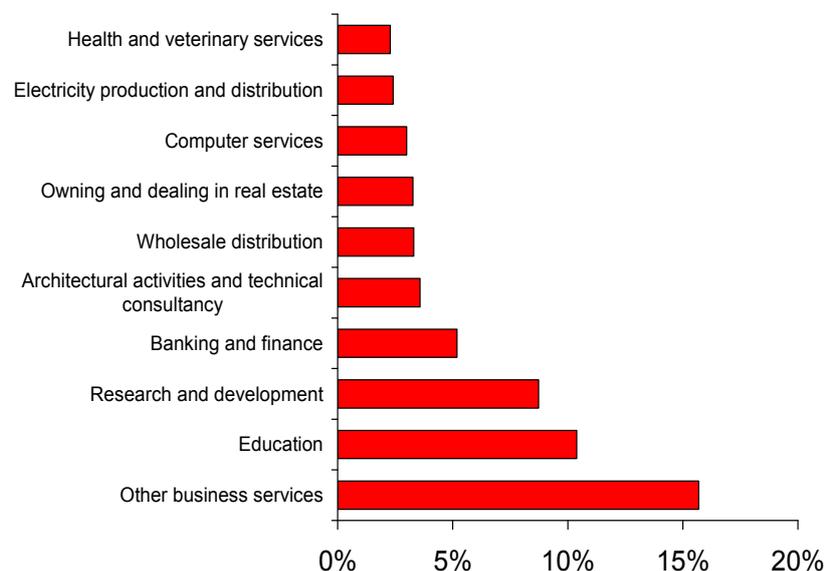
The indirect multiplier for the Intermediate Sector is estimated to be around 1.6. This means that for every £1 million of output generated by the Intermediate Sector, another £0.6 million of output is generated indirectly in its supply chain in the UK. The indirect multiplier value is calculated from the Input-Output Tables prepared by the ONS¹², which provide output multipliers for different Standard Industry Classification (SIC) codes. From these we have used a combination of those most applicable SIC codes to the Intermediate Sector based on the classifications that the companies in the Intermediate Sector are grouped under by the ONS¹³.

Figure 4-5 shows the key UK-based sectors that supply the Intermediate Sector. The largest is the so-called 'other business services', which includes activities such as labour recruitment and industrial cleaning. Other important sectors in the supply chain of the Intermediate Sector include education (eg universities), R&D organisations, and banking & finance. This is in contrast to the supply chain of manufacturing companies. For these firms the main supplying sectors are distribution, banking and finance and a range of material inputs. Education is only a very small part of their supply chain.

¹² UK Analytical Tables – Output multipliers, Source: Office for National Statistics (2000)

¹³ A similar estimate of the multiplier for the Intermediate Sector can be derived from using more up-to-date input-output tables published by the ONS. These tables can not be used directly as they do not identify imports of intermediate consumption by industry separately. However, using other ONS data on imports and assumptions about which sectors are doing the importing, we can generate more up-to-date multiplier estimates. Undertaking this analysis generated a very similar result to the older ONS data – an indirect multiplier of around 1.6.

Figure 4-5: The Intermediate Sector's supply chain



Source : ONS, Oxford Economics

(b) Induced

Estimates based on Oxford Economics' detailed econometric model of the UK economy¹⁴ suggests that the induced multiplier is 1.25 – ie for every £1 million of output generated by the Intermediate Sector and its supply chain a further £0.25 million pounds of output is generated in the economy as workers spend their earnings on other goods and services.

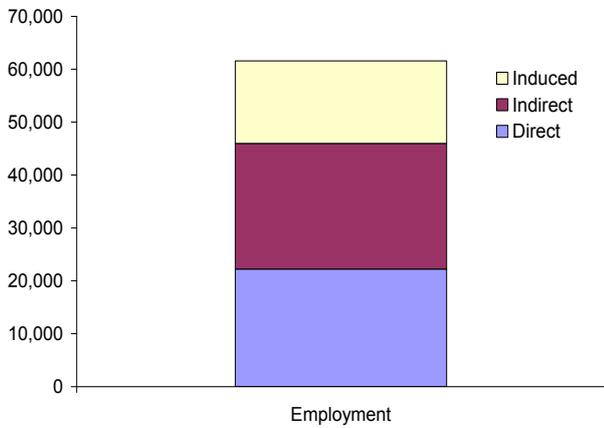
4.5. The contribution of the Intermediate Sector to GDP and employment

Including direct and multiplier (indirect and induced) impacts, we estimate that the Intermediate Sector supported around 62,000 jobs in 2006 with a value added contribution to GDP in the region of £2.4 billion (Figure 4-6). This is equivalent to around 0.2% of UK GDP – a similar amount to the direct contribution of the 'Motion picture and video distribution' industry¹⁵.

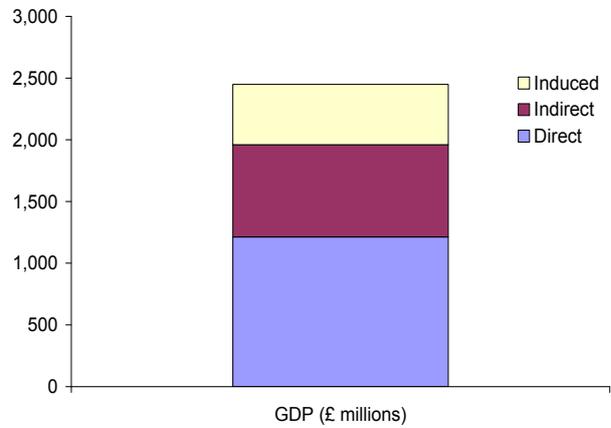
¹⁴ The Oxford Model is widely used. Oxford's clients include international organisations (such as the IMF and World Bank); government departments in the US and Europe (including HM Treasury and the DTI in the UK); central banks around the world; as well as a large number of blue-chip companies in the US, Europe and the UK across the whole industrial spectrum.

¹⁵ Source: Annual Business Inquiry, Office for National Statistics (2006).

Figure 4-6: The direct, indirect and induced contribution of the Intermediate Sector



Source : Oxford Economics



Source : Oxford Economics

4.6. Conclusions

The Intermediate Sector makes a substantial direct contribution to UK GDP and employment. Moreover, it is one of the most highly skilled sectors with labour productivity 50% higher than the economy average despite low levels of capital intensity.

The total contribution of the Intermediate Sector, including direct and multiplier impacts, is estimated to be around 62,000 jobs with a value added contribution to GDP in the region of £2.4 billion. The Intermediate Sector supports other industry through its purchases of goods and services. But the links it has with the rest of the UK economy are far wider than this. Research and development undertaken by the Intermediate Sector helps raise productivity across the economy, and consumers and society benefit from the application of this R&D in ways not captured in the analysis in this chapter. These issues are explored further in the following chapter.

5. Spillovers from research and development

Key Points

- Members of the Intermediate Sector are some of the UK's most R&D-intensive organisations. They undertook around £400 million of R&D in 2006. In order to raise productivity in the UK the government has set an objective of raising R&D to 2.5% of GDP by 2014. This is unlikely to be achieved without support for all key players in technological innovation – universities and the Intermediate Sector. Furthermore, the boost to productivity from the increased R&D will be far greater with the involvement of the Intermediate Sector due to their independence, expertise and market responsiveness.
- The technological advances that come about as a result of R&D undertaken by members of the Intermediate Sector 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 manufacturing sector generating a social return of around 50% - i.e. every £100 million invested in R&D leads to a reoccurring increase in GDP of £50 million per annum in the long run.
- On this basis, we estimate that the Intermediate Sector helps to generate £0.7 billion a year of GDP in the UK due to the spillover effects of the R&D it undertakes, on top of its £2.4 billion of direct and multiplier impacts.
- The large social returns from R&D – which are over and above the private returns to the company undertaking the R&D - make a strong case for government support.

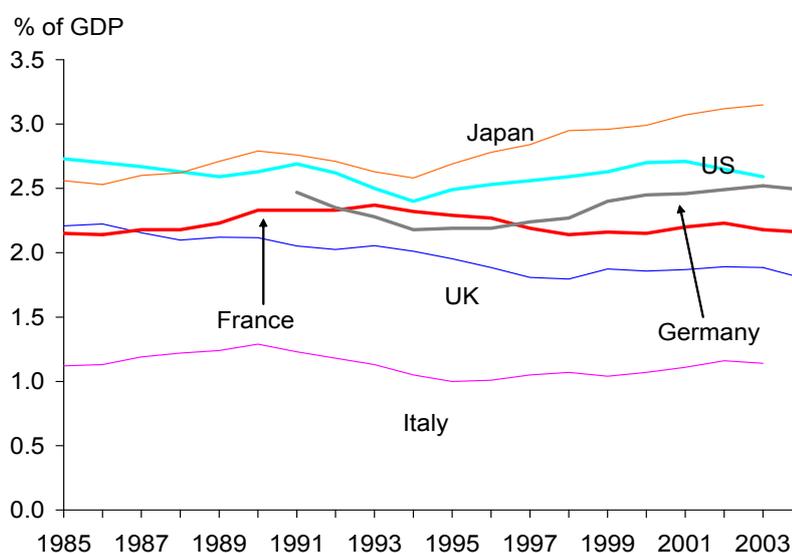
5.1. Introduction

This chapter focuses on one aspect of work undertaken by members of the Intermediate Sector, namely R&D. It examines how this R&D may result in wider benefits to society that cannot be directly captured by the firm investing in the R&D.

5.2. UK R&D expenditure

Figure 5-1 shows that 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, for example, in the US, Japan, Germany and France. And R&D intensity in a number of the key emerging economies is catching up with the UK.

Figure 5-1: R&D spending in the G6



Source : Eurostat and ONS

Enhancing productivity is a key objective for government. One way of doing so is to raise R&D investment¹⁶. The Intermediate Sector plays an important role in meeting this objective.

5.3. The wider benefits of R&D investment

R&D investment enhances the productivity performance of the firm or sector that invests in it. But not all of the returns to R&D spending are 'private' – ie 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% - ie every £100 million invested in R&D leads to an increase in GDP of £50-100 million in the long run (see Figure 5-2).

¹⁶ The current government target is to raise R&D investment to 2.5% of GDP by 2014

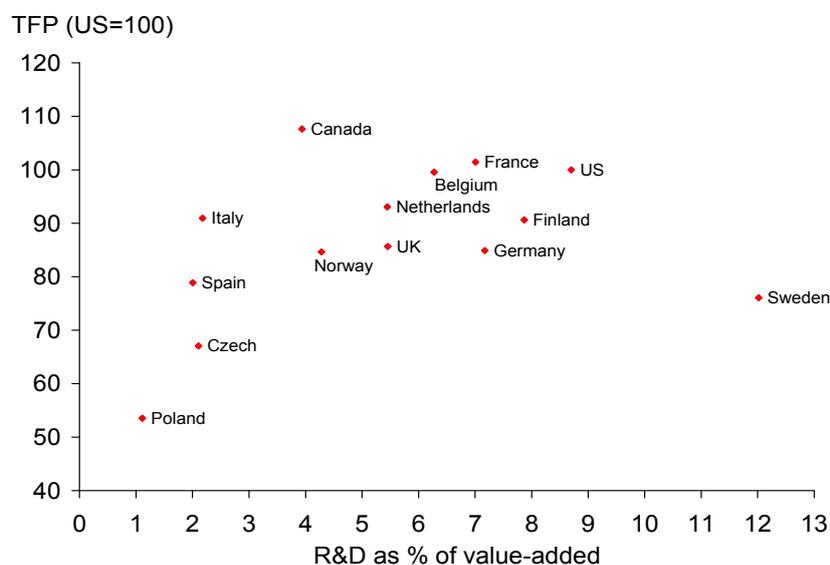
Figure 5-2: Estimates of returns to R&D

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 : <http://www.berr.gov.uk/files/file14768.pdf>

Figure 5-3 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 (TFP). Countries that are close to the top of the league in terms of high manufacturing productivity (eg 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 (eg the Czech Republic, Poland and Spain) tend to be near the bottom of the R&D league table as well.

Figure 5-3: R&D spending and total factor productivity

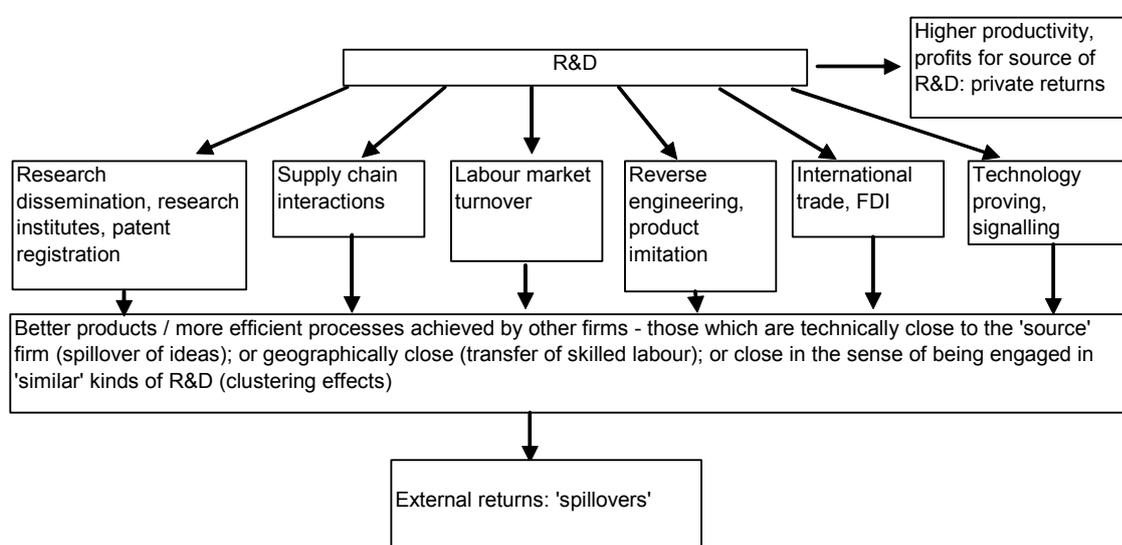


Source : Oxford Economics/Haver Analytics

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 5-4 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 5-4: Channels of diffusion for R&D spillover effects



5.4. Research and development (R&D) investment by the Intermediate Sector

In order to assess the level of R&D undertaken by the Intermediate Sector we undertook a sample survey and asked respondents to classify their activities into various categories. Results from that survey, grossed up using turnover information, indicate that the Intermediate Sector is a substantial investor in research and development (R&D) – collaborative R&D, contract R&D and generic research. The Sector’s overall R&D, undertaken mostly on behalf of private and public sector clients, is estimated to be £400 million in 2006, equivalent to 21% of turnover. On this basis, the R&D undertaken by the Intermediate Sector accounts for 33% of the £1,215 million total extramural expenditure on R&D in the UK by UK businesses. This further underlines the importance of the Intermediate Sector to R&D in the UK.

5.5. The spillover effects of R&D investment by the Intermediate Sector

Our estimates of the spillover effects associated with the R&D undertaken by the Intermediate Sector draw on recent detailed econometric analysis by Oxford Economics¹⁷. Using data for 25 European economies plus the US and Canada over a period of two decades, this found that R&D investment in different manufacturing sectors generates a social return of around 50% depending on the manufacturing sector - ie every £100 million invested in R&D leads to an increase in GDP of £50 million in the long run.

For manufacturing as a whole, total social returns are around 50% pa, with 29% being in the form of spillovers, while the private rate of return is 18%. On this basis, we estimate that the Intermediate Sector helps to generate £0.7 billion a year of GDP in the UK due to the spillover effects of the R&D it undertakes, on top of its £2.4 billion of direct and multiplier impacts (Figure 5-5).

Case Study: Friction Stir Welding (FSW) – An example of R&D “spilling over” into many other sectors

Friction stir welding uses a cylindrical, shouldered tool with a profiled pin that is rotated and slowly plunged into the joint line between two pieces of sheet or plate material. Frictional heat between the wear-resistant welding tool and the work piece causes the metal to soften without reaching the melting point and allows the tool to traverse the weld line. As it does, the plasticized material is extruded around the pin. A solid-phase bond with extremely fine-grain structure is the result. The technology was developed about a dozen years ago by TWI.

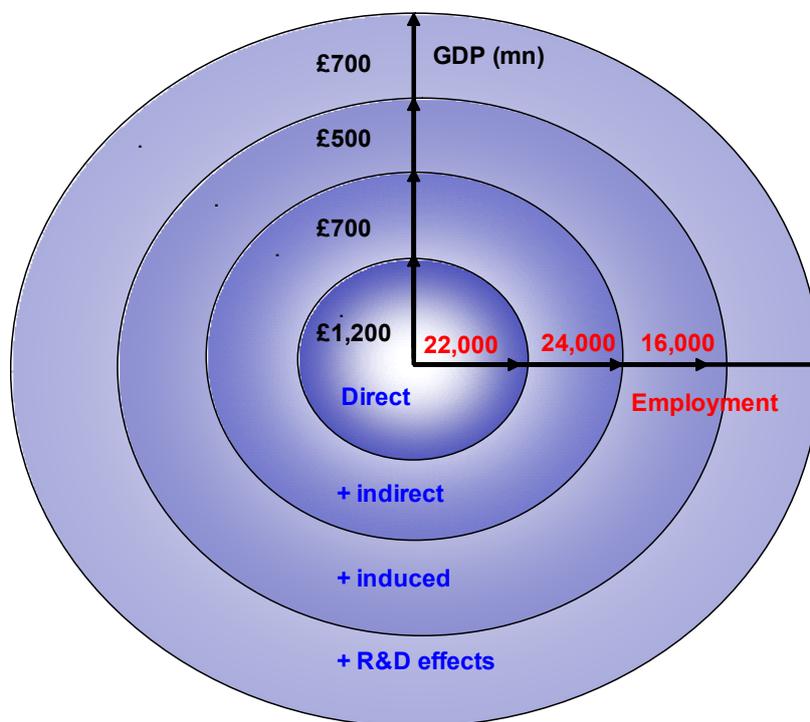
This technology has found numerous applications. It has enabled the manufacture of the Eclipse 500 twinjet at a cost of under \$1 million, a quarter the cost of a comparable small jet aircraft. Use in commercial and private aircraft has also been an area of interest for a number of companies. Boeing and Airbus both have been developing the process for aircraft for a number of years, and Airbus has plans to use the process for skin-to-skin butt welds on various aircraft. Many smaller aircraft manufacturers and components suppliers are also developing FSW for various applications. In the past decade, friction stir welding has been developed for many diverse industries, not only in aerospace, but also in automotive, marine, and nuclear assemblies.

In the coming years, MTS Systems expects the process to become even more widely accepted as manufacturers take advantage of the benefits provided by a simple and robust joining process—welding that really isn't.

Source: A cooler weld - An emerging joining technology lets manufacturers rethink how products fit together (Matt Hanson) Mechanical Engineering, 2003, (March).

¹⁷ Assessing the Economic Impact of Aerospace Research & Development, Oxford Economic Forecasting (2006)

Figure 5-5: Research and development spillover effects¹⁸

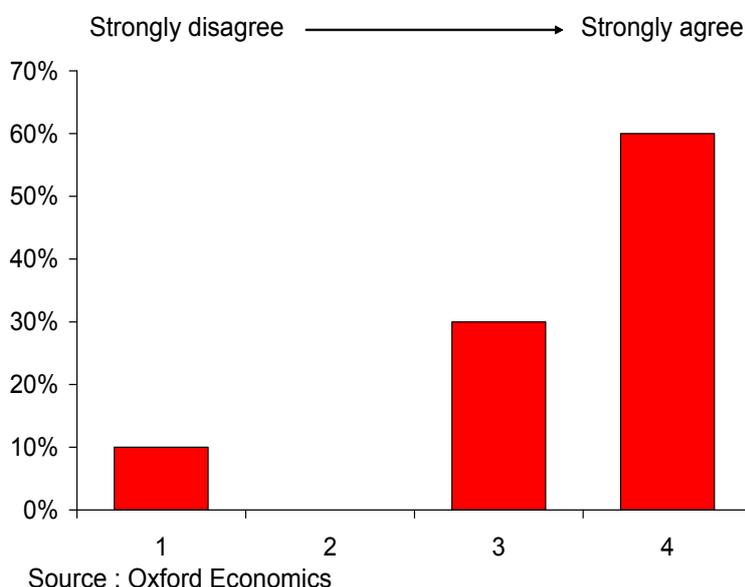


Source: Oxford Economics

Information from our structured interviews with customers of the Intermediate Sector, along with the case studies, provides evidence of the importance of these spillovers from the R&D undertaken by the Intermediate Sector. Nearly 80% of the customers interviewed strongly agreed that there had been internal spillovers from the R&D undertaken to other parts of their business. Nearly 90% of respondents agreed (and 50% strongly agreed) that suppliers or competitors had also benefited from the work (Figure 5-6). For example, TWI's research into the technology behind friction stir welding about a dozen years ago, has applications today in a diverse range of industries such as aerospace, automotive, marine and nuclear assemblies.

¹⁸ No figure is presented for employment supported through the R&D effects as they are estimated to impact on productivity.

Figure 5-6: Our suppliers and/or competitors have benefited from the R&D



Case study: QinetiQ’s work with Ultra Electronics – An example of R&D “spilling over” into other industries

Ultra Electronics is a group of 21 specialist businesses designing, manufacturing and supporting electronic and electromechanical systems, sub-systems and products for defence, security and aerospace applications. It has a turnover of £390 million, 45% in North America and 40% in the UK and it employs about 3,000 people. There are several sites in the UK with vehicle systems being based in Cheltenham. The research spend is about 20% of sales.

The collaborative R&D project with QinetiQ, with whom Ultra have long established links, involved the development of a ‘CANbus’ system to link the electronic components in a vehicle using far less wiring. The technology used in the car industry has spread to commercial vehicles and importantly to the military area.

5.6. Conclusions

The UK economy lags a number of its international competitors in terms of R&D spending. The Intermediate Sector undertook £400 million of R&D in 2006 and therefore plays an important role in raising the UK’s R&D intensity to the government’s target of 2.5% of GDP.

The spillover effect from the R&D undertaken by Intermediate Sector makes a substantial contribution to UK GDP, estimated to be £0.7 billion a year.

However, the catalytic impact of the Intermediate Sector is wider than these spillovers from its R&D

activities. By the nature of the R&D and other work undertaken by the Intermediate Sector there are significant wider benefits:

- **Enhancing the Spillover effects of R&D.**
- **Facilitating the exploitation of R&D.**
- **Helping government achieve policy and procurement objectives.**
- **Making markets work more effectively.**

These issues are explored in greater detail in the next chapter.

6. Wider benefits of the Intermediate Sector on the UK economy

Key Points

- The activities of the Intermediate Sector have a wider impact on UK businesses and government than those effects captured through the multiplier and R&D analysis in the previous chapters.
- The Intermediate Sector offers open innovation solutions to firms. This benefits individual firms as they gain access to a network of organisations and a greater breadth and depth of research than they could hope to replicate in-house. Furthermore, society also benefits as the spillovers from the R&D increase as firms gain access to the expertise and research undertaken by a broader group of organisations.
- A recent study found that increasing accessibility and efficiency in access to research findings would deliver substantial economic benefits. The study suggests that a 5% increase in access would add £1 billion to the UK economy each year.
- Open innovation also helps raise the skills of staff as they learn from a wider pool of knowledge. This in turn benefits both their company and other companies (as staff move along the supply chain or to competitors).
- Nearly 70% of the Intermediate Sector's clients that we interviewed agreed that working with the Sector had helped to raise the skills of their staff. For example, UK Trade and Investment saw staff skills improve when they worked with Pera on a programme designed to encourage multinational companies to invest in more R&D in the UK.
- Much of the research undertaken by UK academics would not be commercially exploited to the same extent without the Intermediate Sector. It fills a crucial role between academia and industry in enabling the transfer of 'raw' knowledge and technology from academic research into a 'problem solution' that can be well understood by all levels of management within industry.
- The Intermediate Sector helps to correct market failures. One particular example is in the field of metrology. In a Department of Trade and Industry study, it was estimated that the quality of the measurement system in the UK as a whole delivered a significant positive economic impact equivalent to 0.8% of GDP.
- The Intermediate Sector also helps to correct the market failures that exist for companies trying to access finance. The independent and expert advice it provides helps to bridge the information gap that can prevent viable projects from getting access to finance.
- The public sector is a significant client of the Intermediate Sector – and the Intermediate Sector's work plays an important role in helping government to achieve its policy objectives.

6.1. Introduction

Spillovers from R&D investment constitute one important element of the catalytic impacts of the Intermediate Sector. But the sector has impacts in a variety of other ways. These include, for example, enhancing the spillovers from R&D, facilitating the exploitation R&D that otherwise would not occur, correcting market failures and enabling government to deliver policies. This chapter discusses these impacts, drawing on the findings from a series of structured interviews with firms and government departments who have commissioned various types of work from the Intermediate Sector in recent years.

6.2. Enhancing the spillover effects of R&D

6.2.1. Open innovation

If the UK is to improve its productivity then it is increasingly important to encourage a much stronger flow of knowledge and technology rather than a focus on generating new knowledge. Firms can directly benefit from using external sources of knowledge, such as academic research. This is particularly true in an environment where the rate of technological change is rapid and increasingly complex.

Open innovation is an important way of encouraging this transfer. The core principal of open innovation as described by Chesbrough¹⁹, is that the drive towards shorter time to market, the globalisation of research and the ease of communications result in companies seeking innovation from a wider range of resources than those within their own corporation (see Figure 6-1). The Intermediate Sector helps companies who have adopted this open innovation approach to prosper by offering access to a huge expanse of knowledge and expertise through the networks the Intermediate Sector has established - "In the highly specialised and uncertain environment, networks allow deeper economic specialization than hierarchies, reduce transaction costs relative to markets and co-ordination costs relative to hierarchies, and provide the most fertile ground for innovation"²⁰.

¹⁹ H Chesbrough Open Innovation. The new Imperative for creating and profiting from technology, Harvard Business School Press, 2003

²⁰ H Linen, T. J. Schienstock, G. (2001): The comparative advantage of networks in economic organisation: efficiency and innovation in highly specialised and uncertain environments in OECD, Innovative Networks. Cooperation in National Innovation Systems.

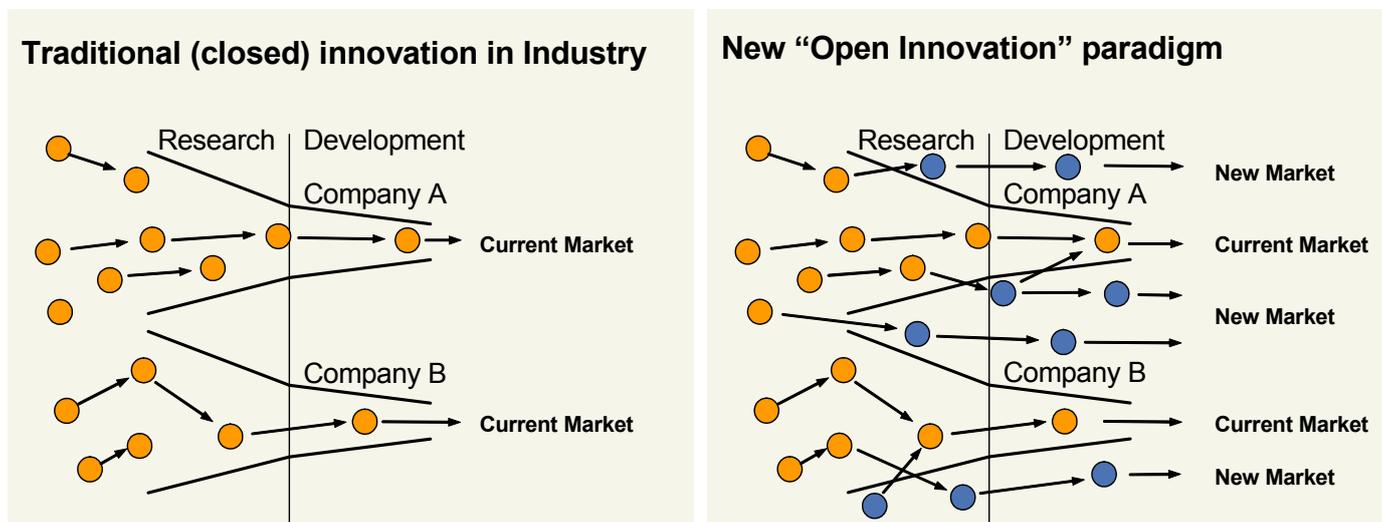
Figure 6-1: Innovation principles

Innovation principles	
Closed innovation principles	Open innovation principles
The smart people in the field work for us.	Not all the smart people in the field work for us. We need to work with smart people inside and outside the company.
To profit from R&D, we must discover it, develop it, and ship it ourselves.	External R&D can create significant value: internal R&D is needed to claim some portion of that value.
If we discover it ourselves, we will get it to the market first.	We don't have to originate the research to profit from it.
The company that gets an innovation to the market first will win.	Building a better business model is better than getting to the market first.
If we create the most and the best ideas in the industry, we will win.	If we make the best use of internal and external ideas, we will win.
We should control our IP, so that our competitors don't profit from our ideas.	We should profit from others' use of our IP, and we should buy others' IP whenever it advances our business model.

source: <http://www.openinnovation.eu/openinnovatie.php>

Figure 6-2 demonstrates the open and closed innovation approached graphically. In an open innovation environment firms will benefit from R&D undertaken in different markets. This may enable them to enhance their existing operations or open up new markets. Box 6-1 explains the importance of open innovation in a modern economy in greater detail.

Figure 6-2: Open innovation



Source: Chesbrough, 2003 (as footnote 19)

The Intermediate Sector is a key facilitator of open innovation. Open innovation will encourage larger spillovers from R&D both across companies and across sectors. These spillovers will, in time, increase the overall value of the R&D - calculated in chapter 5 - to the UK economy. These benefits may be substantial. For example, a recently published study²¹ estimates that if the social returns to R&D are 50% then there would be a reoccurring annual gain of over \$2 US billion (approx £1 billion) from a 5% increase in accessibility and efficiency in access to research findings in the UK.

²¹ The economic impact of enhanced access to research findings – Houghton and Sheetan, CSES Working Paper No. 23 July 2006

Our structured interviews with customers of the Intermediate Sector found a number of examples of projects that gave the customer access to technologies from other sectors and access to networks that they would not have had otherwise. For example, TWI's work with Airbus on the development of a national composites network enabled Airbus to exchange technology with the wind energy and marine sectors. This had spin off benefits across the whole organisation. The project has also been made available to suppliers and to SMEs in the SW Development area (see case study on next page).

More generally, nearly 60% of respondents agreed with the statement that the work they had undertaken with the Intermediate Sector had given them access to networks that they would not have found otherwise (Figure 6-3). Networks are often very durable and are not easy to move from locations. The permanence of the networks will be increasingly important for the UK economy as R&D expenditure in emerging markets expands rapidly in the future.

Box 6-1 Why is open innovation essential for 21st century success?

Firstly, efficiency. Innovation is expensive. Companies are finding it increasingly difficult to justify increasing R&D costs as product revenues decrease due to shorter product lifecycles. Open innovation addresses both these issues as it shares origination costs and also increases potential revenue from new markets - through joint ventures, for example.

Globalisation means greater knowledge is required to compete in more markets. However, in practice, companies are narrowing their knowledge bases in an effort to specialise and focus. Open innovation augments this knowledge. As companies rationalise the numbers of brands they invest in, they hold dormant IP. Open innovation can wake it up.

As companies recognise that their value lies in their brands rather than their ability to invent or manufacture, the 'outsourcing' of innovation becomes as logical as the well-established trend to divest production. Companies are also expressing concern over their ability to meet growing demand fast enough. Open innovation can address invention-to-innovation velocity.

Secondly, no single company knows everything. Useful knowledge has become distributed in universities and web-based communities. No matter how well funded and expert an R&D operation is, it cannot compete with linked-up scientific and user communities. We are witnessing nothing less than the obsolescence of R&D in many industries, but this change provides new ways to create value outside corporate boundaries.

Thirdly, networking is a growing trend. In some sectors of industry there is evidence of new forms of organisational structures emerging, which are reminiscent of social networks like MySpace. A study of the creative industries in Manchester showed that film companies are small, but they have an extensive network of experts to draw upon, across several niche markets. The notion of such 'creation nets' is becoming popular to bring together competencies to engage in collaborative innovation.

Source : <http://www.nesta.org.uk/corporate-open-innovation-if-it-s-so-good-why-isn-t-everyone-doing-it/>

Case study: TWI's work with Airbus – An example of the Intermediate Sector encouraging spillovers from R&D through the networks they provide

Airbus is the aircraft manufacturing subsidiary of EADS, a pan-European aerospace concern with operations in the EC including in the UK. The main focus for Airbus in the UK is on aircraft wings with sites at Filton and Broughton employing about 4,500 people each. Overall employment is in excess of 50,000 at 16 EC sites and turnover last year was over £17 billion.

The project with TWI involved the development of a national composites network. It is a knowledge and technology transfer project with funding of over £20 million from central government, regional agencies and industry. It has been running for over four years. Its first order of relevance is approaching £100 million pa of project work on materials for wings, but it has spin offs across the whole organisation. The project has been also made available to suppliers and to SMEs in the SW area. The work with TWI and the access to the networks that they provide enable Airbus to exchange technology with the wind energy and marine sectors.

Case study: Campden & Chorleywood Food Research Association's work with DEFRA – An example of the Intermediate Sector providing access to networks

DEFRA is the Department for Environment, Food and Rural Affairs. Campden & Chorleywood Food Research Association were involved with technology based solutions in the food industry targeted at reducing carbon emissions. The work discussed was a series of projects on time and temperature indicators to improve the efficiency of the heat treatment of food. The greater the efficiency the less energy is used, reducing costs to the companies and allowing DEFRA to claim energy savings. These projects were run on a 50/50 basis between government and industry with government funding of £200,000. The work with Campden & Chorleywood Food Research Association provided DEFRA with an easy way into a network of food trade organisations.

Case study: The Thames Innovation Centre’s work with Phoenix Product Development Limited to provide access to research expertise

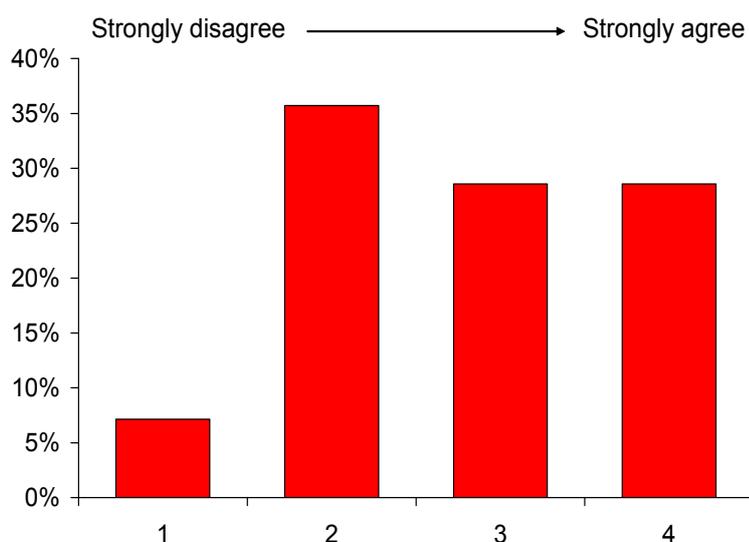
Propelair is a unique patented flushing system that reduces water consumption to 1.5 litres per flush, using 85% less water than the average toilet and 75% less than other “low flush” systems. The core principles of the product have been developed to prototype stage.

The company knew that it had a product that was unique and more efficient than other products currently on the market, but did not have the market research to back this up. In addition, the client was looking to attract investment for research and product development along with increasing contacts within the industry. A key obstacle in obtaining this information was a lack of finances to commission the detailed research required.

Thames Innovation Centre’s (TIC’s) Think Big team met the client following a presentation he was giving and immediately saw the benefits of the product and identified ways in which it could be brought to market. They arranged for six students from Cambridge University to work with Phoenix at no cost to the company. The students were asked to research the sanitary product market; this information has now formed a crucial part in the business plan and the direction of the business.

The TIC’s Think Big team have helped to make the business more attractive to potential investors, have introduced the business to investors, potential suppliers and customers as well as identifying new ways and areas to launch the product.

Figure 6-3: “Working with the Intermediate Sector firm gave us access to a network of organisations which we could not have found otherwise”

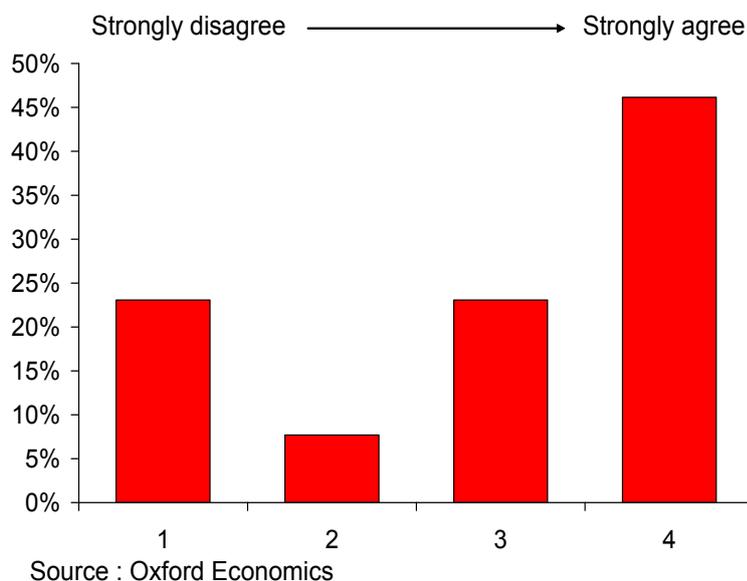


Source : Oxford Economics

6.2.2. Training

The Intermediate Sector also helps to raise the spillover benefits from the R&D they undertake, and other R&D, by enhancing the skills of the staff employed by the companies who commission work from them. This enables the client company to maximise the private returns from the R&D, and also to better exploit potential applications in other areas of the company. More widely other companies may also benefit in due course as staff members move jobs. Nearly 70% of respondents in our survey indicated that the work they had undertaken with the Intermediate Sector had helped to raise the skills of their staff. An example of this is Pera’s work with UK Trade and Investment (UKTI) on a programme designed to encourage multinational companies to do more R&D in the UK (see case study on next page). This project helped the staff of UKTI to improve their skills through knowledge sharing and further gains are expected as these UK based staff assist with briefing of UKTI staff based overseas.

Figure 6-4: “Working with the Intermediate Sector has helped increase the skills of our staff”



Case study: Pera's work with UK Trade and Investment – An example of the Intermediate Sector's work increasing the skills of the staff in the companies they work for

UK Trade and Investment (UKTI), the Government organisation that helps UK-based companies succeed in an increasingly global economy, brings together the work of the Foreign & Commonwealth Office (FCO) and the Department for Business, Enterprise and Regulatory Reform (BERR). UKTI has two main responsibilities, helping UK businesses grow overseas and providing practical assistance to international companies establishing and expanding their business in the UK. Pera help to deliver 5 programmes covering the two major areas described above.

(1) A programme designed to encourage multinational companies to do (more) R&D in the UK. Pera have recruited and manage a team of 20 R&D specialists in high tech areas, mostly with international business development experience, to identify multinational companies who could do more research in the UK and to develop compelling propositions to secure the inward investment.

(2) The second program involves a team of 15 Pera specialists in globalisation strategy helping medium sized UK companies access high growth, emerging, overseas markets such as India and China.

(3) Pera also provide a team of 17 Sector Champions - specialists with high-tech sector expertise who support UKTI officials engaged in procuring Foreign Direct Investment in the UK, or in the strategic promotion of key UK sectors to overseas markets.

(4) Through the Global Partnership Programme, Pera find UK partners for innovative overseas companies looking to become established in the UK. Pera provide bespoke research for each partner request.

(5) Through a network of 7 'Dealmakers' provided by Pera, the Global Entrepreneurs Programme attracts overseas entrepreneurs with exceptional potential to establish their next start-up business in the UK.

With particular reference to the first programme of work, the Pera specialists bring real world business experience and leading edge technical knowledge to enhance the UKTI team. This has led to UKTI staff skills improving through knowledge sharing and through increased confidence in developing compelling propositions and sector strategies. Formal and informal briefing of UK and overseas staff by the specialists has also taken place to effect this.

Case Study: Campden & Chorleywood Food Research Association's work with Marks & Spencer – An example of the work of the Intermediate Sector improving standards

Marks and Spencer is a major UK retailer with UK sales of over £8 billion and overseas sales of over £600 million. This project relates to food which accounts for £4 billion or 50% of UK sales and about £200 million or 30% of overseas sales. Marks & Spencer has no manufacturing assets and buys in all its food products. There are over 500 owned stores in the UK and 200 overseas, most of which are franchised. Employment in the totally owned operation is over 75,000 with about half on the food side. They have been clients of Campden & Chorleywood Food Research Association for a number of years on a variety of projects.

Marks & Spencer use a number of different suppliers. Marks & Spencer work with Campden & Chorleywood Food Research Association to get these firms' laboratories working to common standards on both quality and product safety. These external staff can be trained by Campden & Chorleywood Food Research Association. The work by Campden & Chorleywood Food Research Association sets a common standard, increases confidence and reduces risk for Marks & Spencer working with these smaller suppliers.

Case study: NPL's work with manufacturing companies – An example of the intermediate sector's work to help companies develop the skills of their workforce

NPL's training framework is the UK's only independent industry-recognised measurement training programme. It is a set of training modules and assessments that certify an understanding of the principles of measurement.

The aim is to ensure those working on the front line know how to apply the power of measurement to real problems, helping organisations: reduce waste and operational mistakes; take better-informed decisions; and provide career development via a nationally recognised qualification in metrology.

The Director of Manufacturing Engineering at Rolls-Royce has said of the programme: "Rolls-Royce is proud to be part of a programme that is helping to re-establish metrology as a critical element of our value chain process. The programme is enabling the participants to make better manufacturing decisions, and take a more consistent approach to problem solving and process capability improvement. It is also helping to re-energise that questioning culture, so vital to achieving the very best from measurement tools and methods."

6.3. Facilitating the exploitation of R&D

6.3.1. Knowledge and technology transfer

The Intermediate Sector facilitates the commercial exploitation of R&D. It fills a crucial role between academia and industry in enabling the transfer of ‘raw’ knowledge from academic research into a ‘problem solution’ that can be well understood by all levels of management within industry. Knowledge transfer is crucial to improving the innovative performance of the UK.

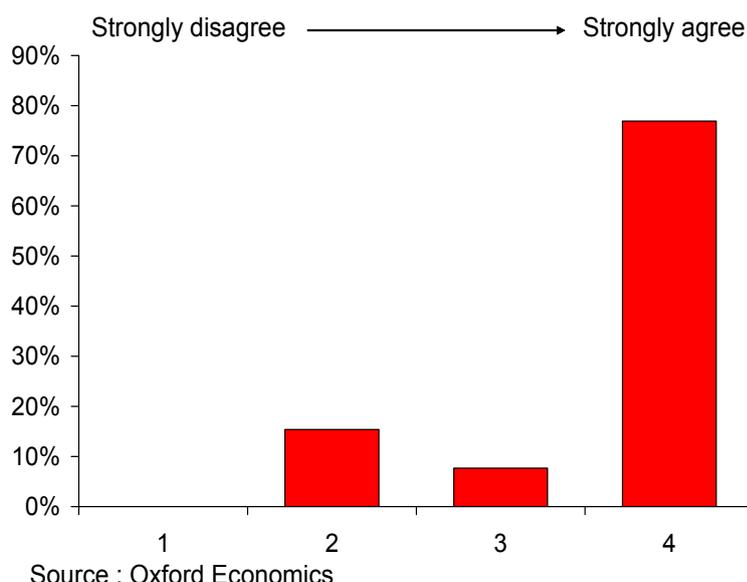
Without the Intermediate Sector the exploitation of R&D would be far lower and the benefits of this R&D to both the company (private returns) and society (social returns) would not be realised in the UK.

In particular:

(a) Firms would not achieve the same results working with academia or in-house.

Figure 6-5 indicates that there is a strong recognition among clients of the Intermediate Sector of the distinction between the ‘problem solution’ work provided by the Intermediate Sector and academic research. Indeed, nearly 80% of businesses we interviewed for this study strongly agreed that they could not have achieved the same results working in-house or with a university - highlighting the crucial role the Intermediate Sector has in innovation by transferring knowledge into commercial applications. The advantages the Intermediate Sector has in this regard are the access to the wide range knowledge they have, their experience in translating research into commercial applications, and their independence.

Figure 6-5: “We could not have achieved the same improvements by working in-house or with a university”



Case study: ASAP calibration services' work with AstraZeneca – an example of where the Intermediate Sector's work could not have been replicated either in-house or by a university

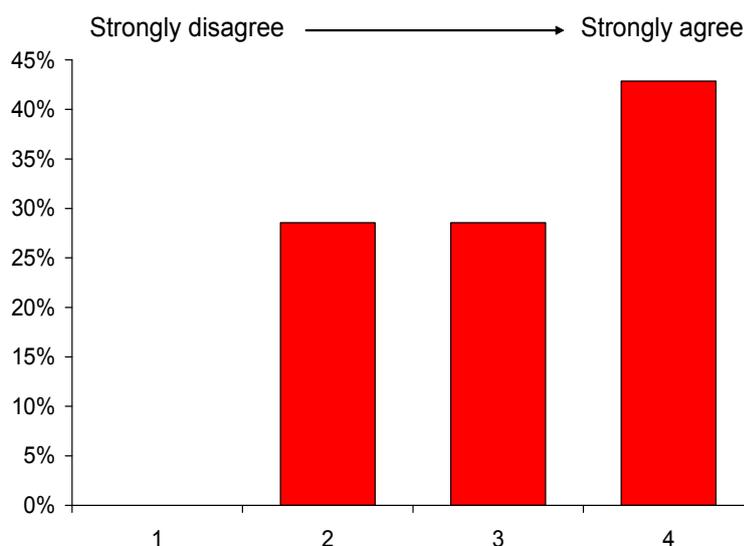
AstraZeneca is a multinational pharmaceutical company, headquartered in the UK with sales of £14bn. UK sales of £850m are only 6% of group sales. However, the UK is a major research and production site with over 20% of total production and over a third of a £2 billion R&D spend. Group employment of 66,000 includes 11,800 UK employees with major facilities in the Macclesfield and Severnside areas.

The project with ASAP calibration services, a subsidiary of QinetiQ, started in 2004, but the relationship has been in place much longer. It was a contract of over £1 million for the calibration and certification of a wide range of instruments used in production and R&D. AstraZeneca strongly agreed that the work could not have been carried out in-house as it was necessary to have an independent organisation, nor could it have been undertaken by a university as they do not have the required range of facilities.

(b) For some work there is not a UK based alternative to the Intermediate Sector

Our interviews revealed that 70% of customers agreed that the project that they commissioned the Intermediate Sector to help with would not have been viable without the Sector's input and 40% strongly agreed with that view (Figure 6-6). For example, TWI's work with Jaguar/Land Rover, which involved joining of stamped panels to the body of the car, could not have been done by a university as they would not have been able to provide adequate technical support. Furthermore, an in-house solution was not considered as it would not be as effective in cost or action (see case study on next page).

Figure 6-6: "The project would not have been viable without the input from the Intermediate Sector"



Source : Oxford Economics

Case study: TWI's work with Jaguar/Land Rover – An example of where there was no viable alternative other than working with the Intermediate Sector

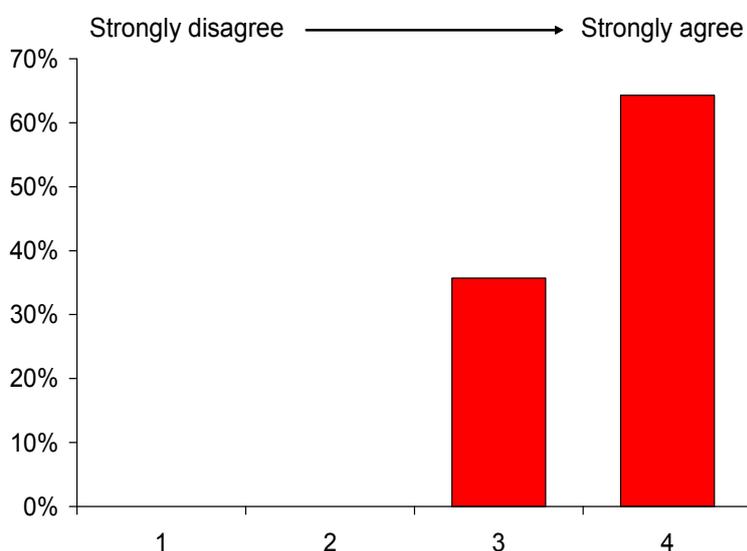
Jaguar/Land Rover are involved in passenger vehicle manufacture in the UK. Although making very different vehicles, Jaguar and Land Rover can share the same production line with a common floor pan. UK employment is in excess of 20,000 at three sites in the Midlands and one on Merseyside. Production last year was 250,000 with about half for export around the world. Turnover was in excess of £5 billion.

The project with TWI involves car assembly in general, and the joining of stamped panels to the body in particular. TWI have been involved in advising on the putting in of the joining facilities and now act as the adviser on all aspects of joining technology, an area in which they believe TWI have the best expertise. All plant operatives have immediate access to TWI if they have queries or problems. The ongoing cost of the support is in the range of £10,000-£20,000 a year but the support impinges across all assembly and affects over £1 billion of sales. Links with TWI have been in place for over 10 years and there has been other involvement in addition to this project. Jaguar/Land Rover believed that whilst a university could have done research they would not have been able to provide adequate technical support. In house was not considered as an option as it would not be as effective in cost or actions. The immediate support provided by TWI was vital.

(c) The results would have been much slower

One of the key benefits from working with the Intermediate Sector is acceleration in the time to bring products to market. This results from the business approach of firms in the Intermediate Sector allied with technical expertise and experience in practical implementation of R&D. This can be seen by considering, for example, the work Campden & Chorleywood Food Research Association has undertaken for Premier Foods in the thermal processing area – assessing the necessary minimum temperature for the processing of different foodstuffs. Premier Foods needed Campden & Chorleywood Food Research Association's in-depth knowledge of thermal processing as they have little in-house capability. Whilst they believed a university could have the technical expertise to undertake the project, they felt that they would have been much slower and would have had poorer implementation (see case study on next page). In our survey all respondents agreed that the work of the Intermediate Sector had helped them achieve results faster and most strongly agreed with this statement (Figure 6-7).

Figure 6-7: “We could not have achieved these results as quickly without the Intermediate Sector firm”



Source : Oxford Economics

Case study: Campden & Chorleywood Food Research Association’s work with Premier Foods – An example of where the Intermediate Sector was able to deliver a far quicker solution

Premier Foods is the largest food company in the UK with turnover of £1 billion in 2006. They have grown rapidly by acquisition and have a very wide ranging set of brands. Current year sales will probably have more than doubled. The headquarters are in St Albans but their 60 sites are country wide eg Long Sutton and Teesside. Raw materials are sourced worldwide but processing is mainly in the UK. There are only limited exports (approximately 5%). They have been clients of Campden & Chorleywood Food Research Association for several years and the relationship has grown as the company has expanded.

Premier Foods have had several projects with Campden & Chorleywood Food Research Association in the thermal processing area. For example, one project involved the development of temperature indicators for processing – assessing the necessary minimum temperature for the processing of different foodstuffs. A major acquisition programme by Premier Foods has resulted in many plants which operated to different temperature processing standards. This project with Campden & Chorleywood Food Research Association attempted some standardisation. Premier Foods needed Campden & Chorleywood Food Research Association’s in-depth knowledge of thermal processing as they have little in-house capability. Whilst they believed a university could have the technical expertise to undertake the project, they felt that it would have been much slower and would have had poorer implementation.

(d) The work may have been taken abroad.

The presence of a strong Intermediate Sector in the UK has enabled business to expand their operations in this country rather than seeking opportunities abroad. Results from our survey show that nearly 60% of respondents strongly agree that the input from the UK Intermediate Sector firm meant that the organisation expanded in the UK rather than abroad (Figure 6-8). For example, QinetiQ's work with IMI Vision on the development of a Tricensor (a small thumb size device inserted into a pipe to measure the characteristics of the product flowing through the pipe) has led to some expansion of the company's UK technical staff which may have occurred abroad instead (see case study in box).

Case Study: QinetiQ's work with IMI Vision – An example of the UK Intermediate Sector encouraging investment in the UK

IMI Vision is a very small unit of IMI with about 40 employees based at Alcester UK. It was set up in 2002 to create value by issuing licences. They expect about £300 million of business over the next 5 years.

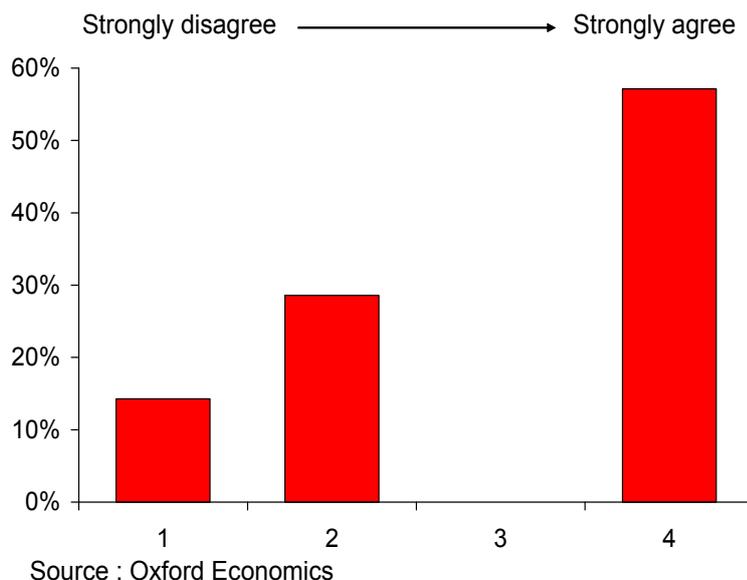
The project started in 2002. It is contract R&D involved with the development of a Tricensor, which is a small thumb size device inserted into a pipe to measure the characteristics of the product flowing through the pipe. The product passes but does not touch the device and the mass, flow, pressure or temperature of liquids or gases can be measured. The project cost has been upwards of £0.5 million and the business is completely dependent on the project. The fact that IMI Vision are working with QinetiQ, after failing to find a US partner, has led to them expanding their technical staff in the UK.

Case study: NPL's work with Agilent - An example of the UK intermediate sector encouraging investment in the UK

Agilent is a US-based electronic measurement business with a turnover in excess of \$5bn per annum. Agilent carries out research and development on test equipment for the telecommunications industry at a site in Scotland. An important reason for Agilent keeping this laboratory in the UK is the low-uncertainty measurement methods and calibrations developed and supplied by NPL.

This has brought significant benefits to the company. For example the Agilent mobile phone handset tester developed in Scotland was only the second product in the history of Agilent to have achieved over \$1bn of sales. The tester was popular because of its outstanding performance.

Figure 6-8: “The input from the Intermediate Sector firm meant we expanded our organisation in the UK rather than abroad”



6.4. Correcting market failure

6.4.1. Reducing risk

When financiers lack the knowledge to fully assess the risks and returns of a certain project then they may be reluctant to provide funding. This is particularly true for firms planning high-tech and innovative projects that have more uncertain futures and in which the firm has a greater understanding of the chances of success than the financiers. In this situation, projects with a good prospect of earning a private return commensurate with the actual risks of the project may not attract funding - private returns may be greater than the private cost of capital, but still not go ahead. The Intermediate Sector plays a crucial role in helping overcome this market failure by providing independent expert advice that can help bridge the information gap that is at the heart of this market failure.

The Intermediate Sector also helps to reduce risk by providing independent expert advice that enables both operators and regulators to have confidence in the safety and robustness of the equipment they are using. For example, TWI's work with Maersk, where they needed an independent specialist assessment of the situation, provided the confidence to Maersk that enabled them to avoid costly modifications to the £15 million dedicated plant (see case study on next page). Campden & Chorleywood Food Research

Association's work to get Marks & Spencer's suppliers firms' laboratories working to common standards on both quality and product safety, increased M&S's confidence and hence reduced the risk they felt when working with their suppliers.

Case study: Pera's work with Piezotag – An example of the work of the Intermediate Sector dealing with market failure

Piezotag is a very small company started in 2004 which has, with the help of Pera, developed a novel automobile tyre warning pressure system. They are seeking to licence the technology rather than manufacture the device themselves. Originally Haswell Tooling Ltd, based in Derbyshire, produced plastic components and tools but went out of business after gearing up for a major contract which was then lost to Eastern Europe. Haswell Moulding Technologies Ltd grew out of this business and with the help of EU funded research developed the product.

US legislation requires new vehicles to be fitted with a low tyre pressure warning light as a safety device. This market is estimated at 20 million units a year. With the help of the EU funded research of about Euros 0.5 million, Pera created a self-powered tyre pressure monitoring safety system using cutting edge ultra low powered micro-electronic sensor technology. The key is that the system is battery-less and hence needs less maintenance. Haswell went to Pera because they were recommended. Pera have been the key R&D operator; they also assembled a consortium of seven other companies in the UK, Germany, Spain, Denmark and Poland to make the innovation achievable. Pera also involved the University of Catalonia in Barcelona. A major tyre manufacturer is involved in the initial development.

Pera has worked with Piezotag on a totally new idea and have developed the product in a top class piece of R&D. Furthermore, Pera have helped to raise the skills of the staff to enable the business to be a success.

Case Study: TWI's work with Maersk and in the oil and gas industry – An example of the work of the Intermediate Sector reducing their client's risk

Maersk Container Industri AS implemented a comprehensive programme of process improvements and testing but needed an independent specialist assessment of the situation. The recommendations made by TWI enabled Maersk to improve the assembly methods and continue volume manufacture with confidence. As a result, costly modifications to the £15 million dedicated plant were not needed.

Dramatic economies, as a direct result of working with TWI on a recent project, were claimed by one of the world's biggest oil and gas companies. Work by TWI established that there was no significant risk of fatigue failure and this helped to eliminate a twenty day planned plant shutdown every two years. It also increased production contribution by £2.5 million a year.

6.4.2. Metrology

Metrology is one specific example of work by members of the Intermediate Sector that helps to correct for

market failures. In a study by PA Consulting²² several examples of how the National Measurement System (NMS) reduces market failure were identified through case studies. These covered a wide spectrum from the provision of broadcast services that cannot be priced, to the reduction of indivisibility failures (where the beneficiaries cannot justify the whole investment) and to support for SMEs.

The National Measurement System (NMS) is the technical and organisational infrastructure which ensures a consistent and internationally recognised basis for measurement in the UK. It has two central objectives:

- To enable individuals and organisations in the UK to make measurements competently and accurately and to demonstrate the validity of such measurements.
- To co-ordinate the UK's measurement system with the measurement systems of other countries.

In the PA Consulting study for the Department of Trade and Industry National Measurement System Policy Unit, it was estimated that measurement in the UK as a whole delivered a significant positive impact to the economy of 0.8% of GDP. Updating this using current GDP data and into today's prices suggests that this now equates to £10 billion per annum in terms of GDP; most of which is either directly or indirectly underpinned and enabled by the NMS. This is a significant return on the approximate £60 million that the NMS currently invests a year in improving measurement in the UK.

The four mechanisms identified in this study through which the NMS impacts the economy are:

- Maintenance of the measurement infrastructure.
- Supporting innovation.
- Enabling fair and safe competition.
- Representation of the UK.

The study also highlighted that the measurement system contributes to a number of other aspects of UK residents' quality of life. For example, an individual is greatly reassured by knowing that the X-ray they must have to help mend a broken arm is done from a calibrated machine so they will not receive damaging excessive irradiation. This individual may also derive peace of mind about X-ray machine calibration even when they have no injury.

The fact metrology makes a large contribution to the UK economy seems to be supported by a more up to date study,²³ undertaken in 2005, that produced estimates of the direct impact on profits for firms working directly with NMS. This survey based approach suggested an impact on just firms' profits of over £700 million.

²² Review of the Rationale for and Economic Benefit of the UK National Measurement System – PA Consulting (1999)

²³ Strategic Review of the UK National Measurement System (2005)

6.5. Enabling government policy

The intermediate Sector works closely with many government departments. In fact, some members of the Intermediate Sector are former government research laboratories (for example, the National Physics Laboratory). In our interviews we spoke to government departments that have commissioned work from the Intermediate Sector in recent years. The Ministry of Defence (MoD) often chooses to work with Intermediate Sector companies as they have innovative ideas, are creative and think of practical ways of tackling problems. The MoD also benefits from the expertise that the Intermediate Sector brings from the knowledge its members have gained from working outside the defence sector. Work with the Intermediate Sector has enabled the MoD to solve problems and to improve military capability. Research has been used for technology upgrades to equipment used in current operations and will also be applied in procurement of capability to meet future military needs. Of key importance to the MoD are cost effective solutions and the provision of research which provides military advantage more quickly than the enemy can develop the threat.

Other examples of the work undertaken by the Intermediate Sector helping government to deliver policy include: the work TWI has been doing with the Welsh Assembly Government (WAG) providing consultancy to Welsh companies in the field of materials technology; NAMTEC's work with Yorkshire Forward helping support jobs in the region through the provision of expert advice in the field of advanced engineering and materials (see case study on next page); and TWI's work with the Highways Agency investigating the collapse of lighting columns.

Within the last European Framework Programme (FP6), for stimulating and supporting technology-based innovation across Europe, there was a special programme aimed at assisting SMEs with good innovative ideas but without sufficient means of in-house R&D. The scheme supported cooperation between groups of, typically, 5 SMEs to develop a cost-sharing programme and to utilise the R&D skills of experienced providers. During FP6 there were 384 of these projects awarded. AIRTO members were selected by SMEs across Europe to help them in a colossal 22% of all projects. This means that nearly 500 SMEs had their innovation made achievable and affordable by the action of the Intermediate Sector in the UK alone. This is an example of open innovation being put into practice for SMEs and not just the big companies. It shows that the Intermediate Sector in the UK is uniquely well regarded in this aspect in Europe.

Case study: NAMTEC's work with Yorkshire Forward– An example of the Intermediate Sector's work with government

Yorkshire Forward is the Regional development agency charged with improving the Yorkshire and Humber economy. The regional economy is worth over £80 billion, the population is over 5 million and there are over 270,000 businesses. The project discussed aims to open up new markets for business by improving access to the knowledge and technology in universities and to boost exports and investment. Much of the latter will come from the region.

South Yorkshire is very dependent on advanced engineering and materials, much of which has developed as the steel industry has shrunk. Yorkshire Forward has set up teams to support this sector with the focus on high tech support. NAMTEC have been involved in a project looking at the surface treatment of metallic components. NAMTEC are the co-ordinators of a program worth £2.35 million over 4 years in which Corus, TWI and the two Sheffield Universities are involved. Much of the research is done at the universities but NAMTEC do the market research, development and application. About 20 companies have been helped 18 months into the period and about 60 may be helped over the 4 years. The project aims at major funding not small seed capital.

Case study: CERAM's work on non-destructive testing – An example of the Intermediate Sector's validation work

CERAM is offering a valuable non-destructive testing (NDT) service to professionals requiring integrity testing for reinforced concrete structures. Utilising the half cell potential electrochemical technique, CERAM experts are able to qualitatively assess the corrosion potential of reinforcing steel used in concrete structures such as bridges and flyovers.

Using copper/copper sulphate electrodes to measure the potential difference between reference points on the concrete grid and the reinforcing steel below, CERAM's experts are able to produce a contoured map of the structure under analysis, highlighting any areas that may need rectifying.

Recently used to excellent effect for a bridge on the M1 motorway, the technique is proving a popular choice. Dr Martin O'Farrell of CERAM commented: "The beauty of the half cell potential method is that it is essentially non-destructive and allows an accurate picture of corrosion potential exhibited by the steel below to be obtained.

"It also takes relatively little time to carry out which, when you're dealing with motorways or busy roads that may need to be closed or restricted during testing work, is important."

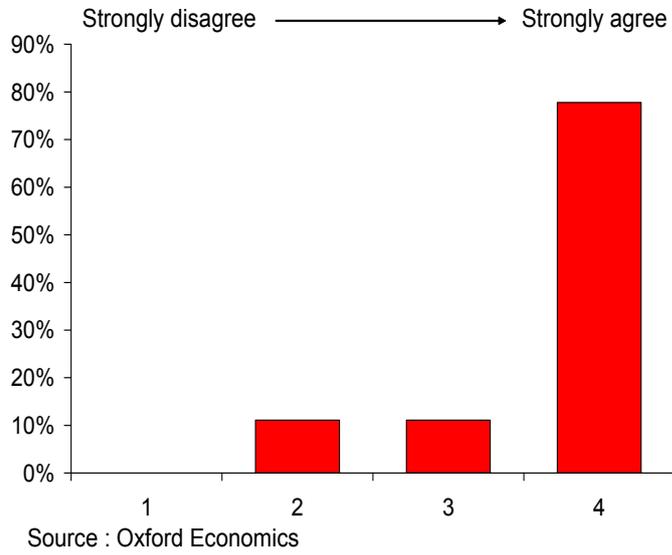
CERAM also offers further validation tests to supplement half cell potential testing, including covermeter surveys and chemical analysis of the samples collected. CERAM's team of engineers and scientists are acknowledged experts in the field of testing individual components, construction materials and full scale structures.

6.6. Conclusions

This chapter has highlighted a number of important ways in which the Intermediate Sector helps to enhance the UK's economic performance that are not captured through analysing the direct, multiplier and R&D spillover impacts discussed in earlier chapters. It is important to note that there are no UK based alternatives to the Intermediate Sector. Without the existence of a strong UK based Intermediate Sector firms may be encouraged to expand their operations abroad to be nearer this type of support infrastructure.

Finally, most customers responding to our survey believed the work they had commissioned from the Intermediate Sector was value for money with over three quarters strongly agreeing with this view (Figure 6-9).

Figure 6-9: “We believe the project was value for money”



7. Conclusions – summary of overall impact

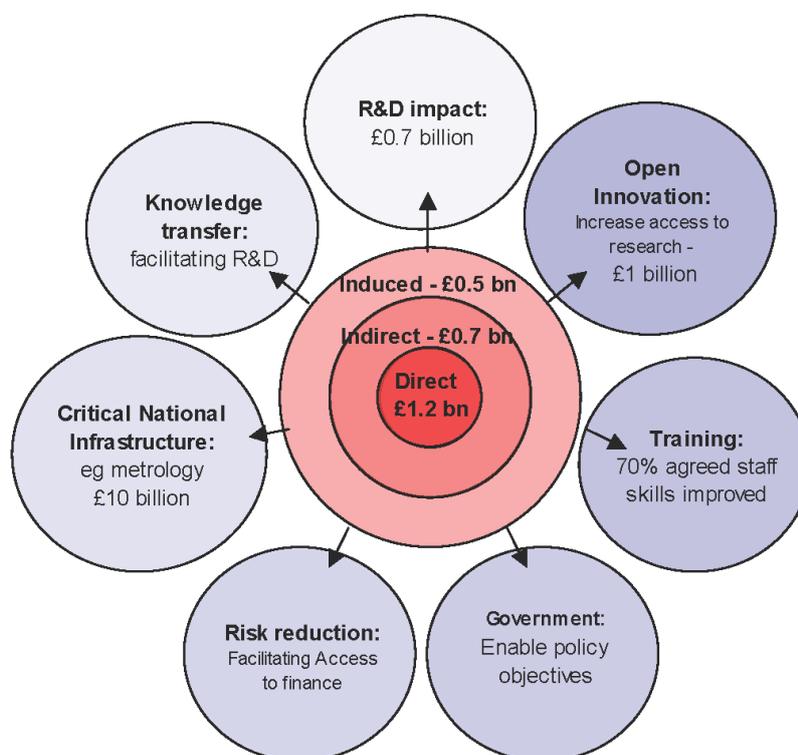
This report sets out the contribution of the Intermediate Sector to the UK economy. Taking into account the direct, indirect and induced impacts, we estimate that the Intermediate Sector in total:

- Supported 62,000 jobs in 2006.
- Contributed directly and through multiplier effects around £2.4 billion to UK GDP in 2006.
- Contributed a further £0.7 billion through the R&D it undertakes.

The overall contribution of the Intermediate Research and Technology Sector industry is far wider. The Intermediate Sector contributes to increasing the spillover effects from R&D, it facilitates the exploitation of R&D that would not otherwise occur, it makes markets operate more efficiently and it enables government to deliver policy and procurement objectives more effectively. Figure 7-1 highlights the ways in which the Intermediate Sector contributes to the UK economy.

It is vital that the role of the Intermediate Sector in the UK’s economic infrastructure is recognised and then supported by the government, given the extremely important contribution that it makes to the UK. The market failures discussed in this report provide a rationale for government support. Without such recognition and support the UK’s exploitation of its science and technology will inevitably suffer.

Figure 7-1: Summary of the GDP contribution of the Intermediate Sector to the UK economy



ANNEX 1

European Definition of a Research Organisation

EARTO²⁴ is the European trade association representing over 350 Research and Technology Organisations (RTOs) from across Europe. The definition of an RTO which they use with the European Commission and other bodies is set out below.

“Research organisation” means an organisation which carries out scientific or technical research and development as its main objective and which either:

- has the status of a non-profit making organisation according to the provisions of the national law under which it is established.

or which:

- by the terms of its statutes, articles of association or equivalent constituent document does not seek to generate a profit for distribution to shareholders or owners.
 - A research organisation may generate a surplus of income over expenditure without prejudice to its non-profit making status provided that the surplus is retained in the research organisation and is employed for the statutory purposes of the research organisation.
 - A research organisation may distribute a surplus of income over expenditure to shareholders or owners without prejudice to its non-profit status provided that the recipient shareholders or owners are exclusively public organisations or research organisations and provided in the case of a research organisation that the distributed surplus is employed for the statutory purposes of the research organisation.

²⁴ www.earto.org