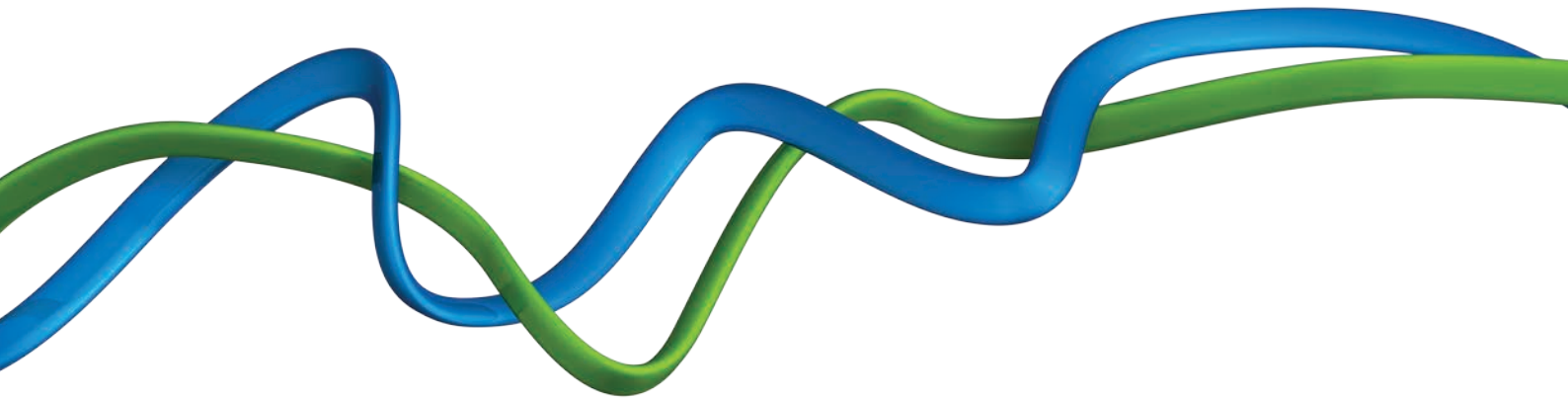
ROYAL ACADEMY OF ENGINEERING

Investing in **Innovation**



BETWEEN 2000 AND 2008, INNOVATION ACCOUNTED FOR **51% OF PRODUCTIVITY GROWTH**

INNOVATE UK'S SCHEMES RETURN AN AVERAGE OF **£6 GVA TO THE ECONOMY** FOR EVERY £1 INVESTED

THE **UK HAS THE LOWEST LEVELS OF GOVERNMENT FINANCED INVESTMENT IN R&D**, AS A % OF GDP, OF THE G7 COUNTRIES

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Summary

Innovation is the process by which new ideas generate economic and social value. It is instrumental in delivering the economic and productivity gains associated with investment in research and offers a key route to developing new tools and approaches for tackling major societal challenges and improving quality of life.

Government has a pivotal role to play in stimulating innovation. While innovation offers many potential benefits at the level of an individual firm, government support is often essential to encourage companies to engage in innovation. This is because innovation is an inherently risky process with an uncertain outcome, the benefits may only materialise over very long timescales and the innovator often accrues only a small proportion of the overall benefit generated. By creating a conducive policy environment, using procurement intelligently and providing targeted direct support, the public sector can be highly effective at enticing the private sector to invest in innovation.

Other countries' governments have increasingly embraced these arguments, prioritising investment in innovation and the creation of policy frameworks that encourage others to invest in innovation. In the context of this growing international competition, if the UK is perceived as offering a less attractive location for innovation activities, there is a high risk that companies will choose to make their knowledge-based investments elsewhere. It is certain that innovation will happen irrespective of the UK's policies – what is at risk is our ability to drive and benefit from it.

The case for continued investment in our research base as a means of fuelling future prosperity is compelling and has been widely articulated. However, this is necessary but not sufficient to safeguard our ability to compete globally: a concomitant focus on our innovation investment and performance is essential to ensure that we benefit from the potential in our research base. A clear and robust commitment to targeted, coherent and stable support – both direct and indirect – is essential if the government is to meet its ambition to tackle the UK's productivity challenge and secure our position as one of the richest economies in the world.

Innovation is a crucial contributor to growth and productivity. It also provides the means of developing new tools and approaches to tackle major societal challenges.

The public sector has a key role to play in enticing private sector investment and encouraging innovation in priority or high-potential areas, through direct investment, smarter procurement and creating an enabling environment.

This approach has been adopted by many, if not all, of our competitors. They will not stop innovating if we reduce our innovation investments.

The UK has many innovation assets; the challenge for government is to ensure that there is an overarching vision and a coherent, stable and strategic policy framework that enables these to act effectively in concert over the long term.

Introduction

The UK has a world-leading research base that provides an excellent source of new ideas and discoveries. Through innovation, these discoveries can result in advances in our economy, social and cultural well-being and health. Without a strong innovation system, the UK would struggle to reap the returns from both its own investments in research and development (R&D) and the investments made by others, jeopardising economic growth, much-needed increases in productivity and the creation of high-value jobs. The rest of the world is in agreement; the consensus is that the capability and capacity to innovate is the way to prosper in the 21st century. At a time of severe pressures on public finances and growing global competition, this paper sets out the case for investing in innovation to secure our future growth.

THE CONSENSUS IS THAT THE CAPABILITY AND CAPACITY TO INNOVATE IS THE WAY TO PROSPER IN THE 21ST CENTURY

What is innovation?

Innovation is the process by which ideas are converted into value – in the form of new and improved products, services and approaches. It often draws on R&D and may involve commercialisation, but it is not synonymous with either. While technology is a common source of innovation, innovation can also derive from developments in design, business models and mechanisms of service delivery. Innovation is an iterative, non-linear process and there is frequently a complex interplay, including multiple feedback loops, between the actors involved.*

Innovation has improved our lives immeasurably and will continue to do so. Examples of its impacts abound: it underpins advances in all aspects of healthcare; is helping to deliver cheaper, quieter and more efficient air travel; and has enabled the introduction of social media and the accompanying explosion of new services and ways of interacting, to name but three instances where innovation has had widespread consequences.

Moreover, many of the grand challenges of our age – including climate change, sustainable resource management, global poverty and international terrorism – simply cannot be addressed without innovation. Closer to home, government itself needs to innovate, as well as adopt innovations generated elsewhere, in order to meet ambitious policy objectives and provide more efficient, effective and resilient public services.

Innovation delivers significant economic benefits. Approximately half the UK's productivity growth in the eight years leading up to the 2008 financial crisis was attributable to innovation and there are clear benefits at the firm level.[1] Innovative businesses grow twice as fast as non-innovators,[2] are less likely to fail,[3] fare better during periods of economic turmoil,[4] and influence how innovative their high-growth neighbours are.[5] Without innovation, economies and firms stagnate and become increasingly unable to compete with those that do invest in, deliver and adopt innovation.[6]

* The OECD's Oslo manual offers the following definition: An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations. The minimum requirement for an innovation is that the product, process or marketing method or organisational method must be new (or significantly improved) to the firm.

The role for public support for innovation

In view of the private benefit derived from much innovation, the question has been posed: what is the role for the public sector in supporting innovation? This section highlights some of the main reasons that governments choose to support innovation.

The benefits of innovation are shared, so the risk should be too

A key driver of the requirement for public support is the fact that the original innovators often accrue a relatively modest proportion of the aggregate benefit associated with an innovation. For an individual company, funding innovation is inherently risky because the outcome is uncertain and, even if an innovation proves successful, it is rarely clear at the outset who the main beneficiaries will be. Furthermore, the benefits may be delivered over longer time horizons than those the company uses to guide its investment decisions and, crucially, there are significant 'spillover' effects which mean that innovations can create substantial value for other businesses that adopt or adapt the innovation, as well as for society at large.

See: Optical fibre research case study ■
Departure planning information case study ■
Surrey Space Centre case study ■

Public sector investment can entice private sector investment

A substantial body of evidence has shown that public investment in R&D 'crowds-in' private investment, with a recent report concluding that an extra £1 of public R&D funding gives rise to an increase in private funding of between £1.13 and £1.60.[7] The vast majority of Innovate UK grants are accompanied by co-investment by the recipient or other funders and returns from Innovate UK schemes show substantial leverage, with an average of £6 returned to the economy in gross value added (GVA) for every £1 invested.[8] Firms receiving significant support from government have large and statistically significant results on all measures of innovation activity and output, and receiving a public sector grant doubles a company's spending on innovation.[9]

Fiscal measures are widely used to incentivise private investment in R&D as a means of stimulating innovation. Government analysis of the impact of R&D tax credits, for example, indicates that up to £3 of spending on R&D is stimulated for each £1 of tax forgone, with companies stating that these tax credits have contributed to an increase in R&D overall.[10] Over 15,000 companies claim around £1.4 bn in R&D tax credits each year;[11] in 2012–13, the SME scheme accounted for over 80% of these claims by number and 44% by value.[12]

Direct support can deliver productivity gains and improve market effectiveness

While government can, understandably, be reluctant to provide support in the form of direct grants or subsidies to companies, they can be extremely valuable tools for bridging the 'valley of death' between the development of a prototype and a product or service that is commercially viable, as well as in other circumstances where private enterprise is reticent to invest in innovation, for example due to particularly high R&D costs. It can be in government's interest to provide direct support for innovations associated with emerging, potentially disruptive, technologies, since that support can be crucial for both enabling the UK to secure an early foothold in a potentially important future market and preventing UK companies from losing their competitive advantage if other countries take a lead. Recent literature suggests that direct support provides positive returns to governments, with productivity gains resulting both from product and from process innovations.[13]

Collaboration with the public sector enhances the impact of innovation support

Collaboration further enhances the benefits associated with public support: firms that receive a grant for innovation are more successful in terms of outputs than peers that do not receive such support but their success is increased if there is an element of cooperation with the public sector, whether via universities, public sector research establishments (PSREs) or government agencies.[14] Public funding can be essential for seeding pre-competitive R&D collaborations across sectors in areas where innovation can deliver broadly-based benefits.[15]

See: VIEWS project case study

Providing a long-term strategic framework can give others the confidence to invest

One of the most significant roles of government in stimulating innovation is in articulating a clear vision and establishing an accompanying stable and coherent policy framework. A long-term, consistent policy framework can be as important as the specifics of the policies in place – the evidence demonstrates that a lack of policy stability can substantially undermine the effectiveness of otherwise favourable policies.[16]

Smart public procurement can promote innovation and deliver better value

Procurement is also a critical mechanism through which government can promote innovation, as illustrated by the highly successful US Small Business Innovation Research (SBIR) initiative (see Figure 1: *Country spotlight*). In addition to accelerating the process by which key technologies – including highly disruptive ones – can reach market readiness and promoting innovation among SMEs, smart procurement can deliver better value for the public sector.

See: BBC Micro case study

Public support can stimulate innovative solutions to societal challenges

Public support for innovation plays an important role in addressing societal and policy challenges, such as responding to demographic change, delivering sustainable, secure and affordable energy supplies and improving the efficiency of the NHS. In these cases, government can signal the importance of the potential future market and incentivise investment by the private sector, as well as directly supporting the development of promising technologies or approaches. This also applies where the public sector itself needs innovation to improve its performance or to support the delivery of public services.

See: Mastodon C case study
Cobalt Light Systems case study

Government can create an enabling environment and infrastructure

The wider investment and regulatory context can have a major impact on the ability of the UK to reap the benefits of its investments in research and innovation. Regulations and standards can act as either brakes on growth or drivers of innovation: government's task is to ensure that it uses these policy levers to enhance competitiveness. Government also has a role in supporting the development and maintenance of infrastructure, such as specialist facilities that can be used across sectors or centres where universities and industry can come together to undertake innovation activities (see *The UK's innovation assets*).

See: Plaxica case study

Government support is essential for skills development

Human capital, in the form of an adequate supply of skilled people and appropriate managerial and organisational practices, is a vital input to innovation.[17] For example, sectors with high concentrations of graduate engineers report higher than average levels of innovation activity and innovation-related income, as well as higher levels of labour productivity; engineering-based manufacturing, the broad sector with the highest concentration of engineering skills, reports the highest percentage of firms that are 'innovation active' at circa 60%.[18]

Timely *adoption* of externally-generated innovation can be one of the most important ways of driving up productivity within firms and, therefore, the economy as a whole. In order to adopt innovation, companies need to have 'absorptive capacity': the ability to recognise the value of new, external information, assimilate it and apply it to commercial ends.[19] This relies heavily on the availability of people with the right skills and experience. Indeed, implementing an innovation generated outside a company often entails some degree of innovation to ensure that the original innovation is successfully applied within the company context.

Government has an essential part to play in supporting the development of absorptive capacity. It must ensure that the education system produces a sufficient quantity and quality of graduates and apprentices to populate the future workforce and, while companies clearly need to take much of the responsibility for ongoing training and organisational development, government can use policy levers and co-investment to encourage this.

Figure 1 – Country spotlight

Countries were selected to demonstrate the diversity of approaches to innovation, expenditure on R&D, and innovation rankings.

United Kingdom

GERD as % of GDP, 2013

GII: **2nd** | GCI: **9th** | EIUS: **7th**

Innovate UK, established in 2007 as the Technology Strategy Board, is the UK's innovation agency and in 2014/15 had a budget of £615.9m. Its aim is to fund, support and connect innovative businesses to accelerate sustainable economic growth, which it does through a number of different mechanisms.

Finland

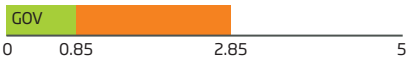
GERD as % of GDP, 2013

GII: **4th** | GCI: **4th** | EIUS: **3rd**

Finland has a well-regarded innovation funding agency, Tekes, which in 2013 had an annual budget equivalent to 0.29% of Finland's GDP. Tekes funds approximately 1,500 business R&D projects and 600 public research projects a year and increases the exports, and patent and license applications of the SMEs it works with.

Germany

GERD as % of GDP, 2013



GII: **13th** | GCI: **5th** | EIUS: **4th**

Germany's Fraunhofer-Gesellschaft is Europe's largest application-orientated research organisation comprising 66 institutes throughout Germany and employing nearly 24,000 people. It has an annual research budget in excess of €2bn. The success of the Fraunhofer-Gesellschaft has resulted in a number of international subsidiaries being established.

Republic of Korea

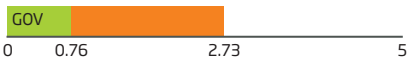
GERD as % of GDP, 2013

GII: **16th** | GCI: **26th**

The Republic of Korea has embedded R&D and innovation strategies throughout its governmental activities, including the Third Korean Science and Technology Basic Plan, launched in 2013; the Korea Institute for Advancement of Technology (KIAT); the Korea Institute of Energy Technology Evaluation and Planning (KETEP); and the Ministry of Trade, Industry and Energy (MOTIE).

United States

GERD as % of GDP, 2013

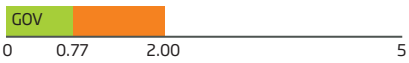


GII: **6th** | GCI: **3rd**

The Small Business Innovation Research (SBIR) programme, introduced by the US government in 1982, demonstrates the power of public procurement. SBIR is a highly successful and competitive programme that, through government investment and procurement, encourages domestic small businesses that have the potential for commercialisation to engage in federal R&D.

Singapore

GERD as % of GDP, 2012



GII: **7th** | GCI: **2nd**

Singapore's investment in human capital has contributed to its tremendous economic growth via R&D and innovation. The Agency for Science, Technology and Research (A* STAR) has successfully recruited top international scientists to the country; meanwhile, the country has heavily invested in improving the country's education and talent pipeline.

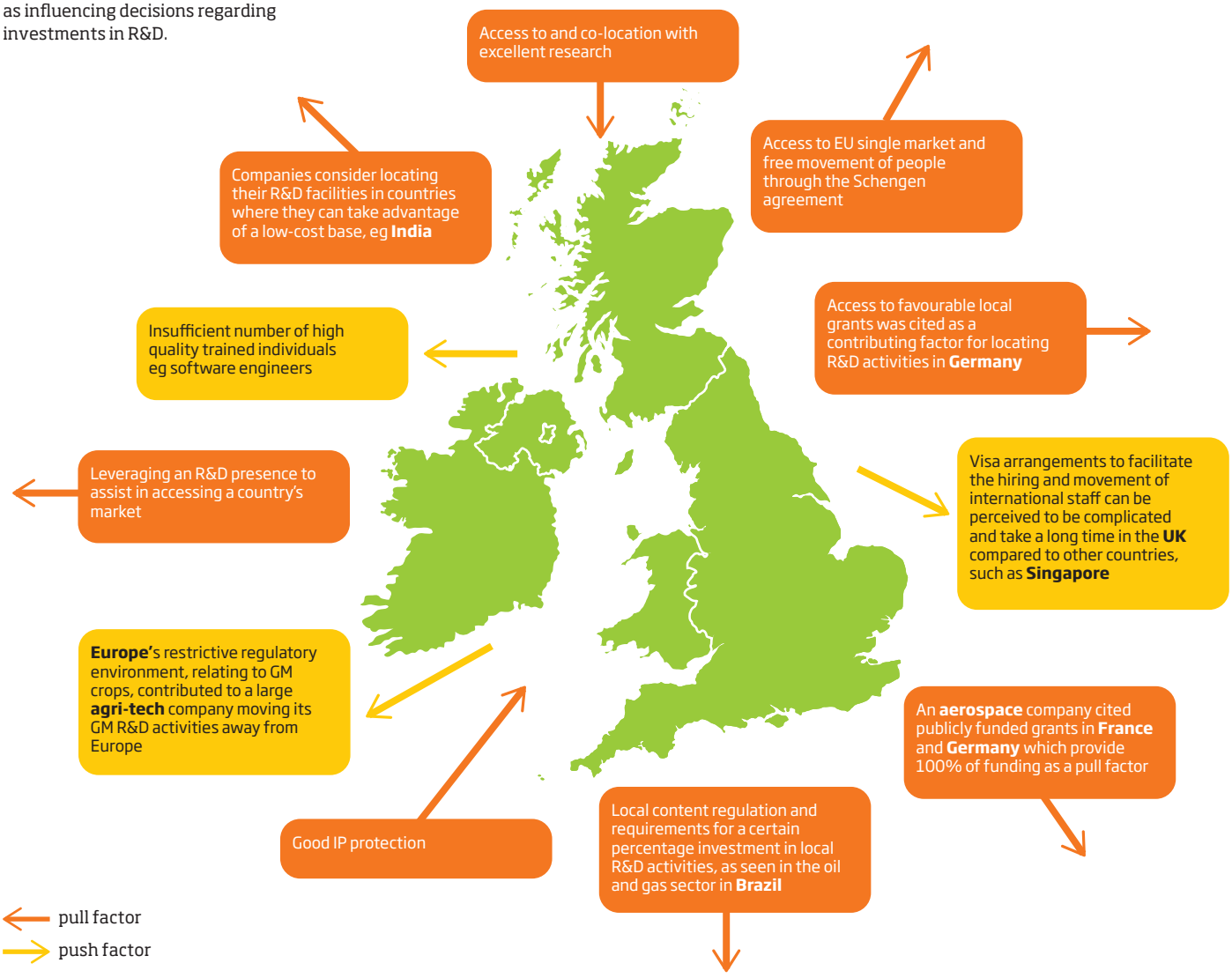
Global Innovation Index 2014 (GII) ranked 143 countries; Global Competitiveness Index 2014 (GCI) ranked 144 countries, EC Innovation Union Scoreboard 2015 (EIUS) ranked 28 EU member states. All GERD data is taken from the OECD Main Science and Technology indicators (See http://stats.oecd.org/, accessed 9 September 2015), except for the UK values which are taken from the Office of National Statistics (ONS), 2013. GERD refers to gross expenditure on R&D, green indicates government expenditure on R&D. Further analysis of the GERD data shows that the UK has the lowest levels of government financed investment in R&D, as a % of GDP, of the G7 countries, (where values for 2013 were not available, those from 2012 were used).

Global competition

The arguments for public support for innovation have been widely accepted by the UK's global competitors. As a result, the UK faces stiff competition for talent and investment. Indeed, many countries, including China, Germany, Singapore and Finland, are attempting to strengthen their position in the global innovation race by launching aggressive strategies targeted at boosting their innovation performance. With the continual reshaping of global supply chains, the changing location of skilled individuals and improvements in communications, most companies, including those established in the UK, have to make global decisions about where to situate high-value activities. In this highly competitive and internationalised environment, the role of government in providing an assertive, effective and long-term commitment to innovation is more important than ever (see Figures 1 and 2: *Country spotlight* and *Global investment decision factors*).

Figure 2 – Global investment decision factors

Examples of factors cited by companies as influencing decisions regarding investments in R&D.

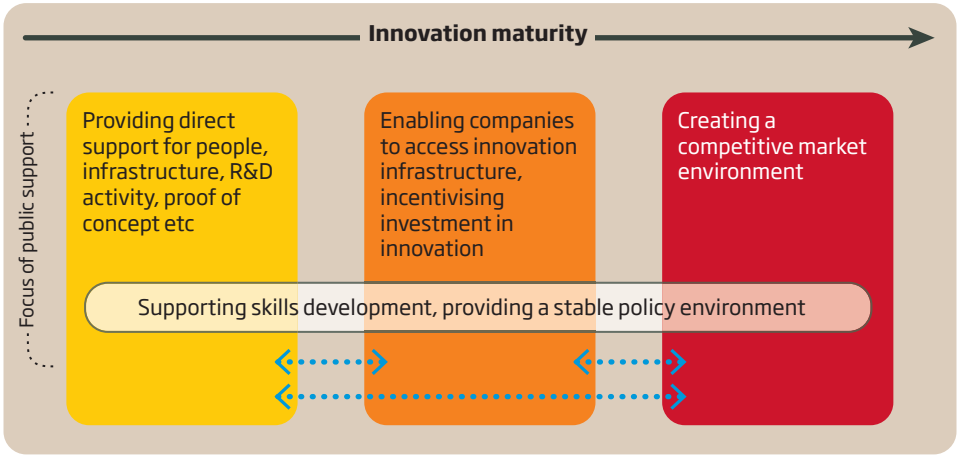


Public support needs to be sensitive to stage of innovation and type of innovator

Figure 3: *Innovation and support stages* summarises the key roles of the public sector in supporting and stimulating innovation at different stages of maturity – as with any schematic, it presents a heavily simplified perspective. The type of public support that is needed may also vary according to the size and maturity of the company undertaking innovation. For start-ups and spin-outs, access to finance and capacity development are often key and the *Dowling Review* highlights the challenges faced by SMEs in navigating the system of public support. Public support can also be used very effectively to encourage large companies to stimulate the capacity and appetite for innovation in the SMEs in their supply chains.

Figure 3 – Innovation and support stages

The nature of public support tends to vary according to the maturity of the innovation. Select examples are highlighted in the figure.



PUBLIC SUPPORT CAN ENCOURAGE LARGE COMPANIES TO PROMOTE INNOVATION IN THEIR SUPPLY CHAINS

DIRECT SUPPORT FOR INNOVATION PROVIDES POSITIVE RETURNS TO GOVERNMENTS

The state of innovation in the UK

There is no simple way to measure a country's innovation performance but the UK consistently ranks within the top 10 in most international league tables.[20] Figure 4: *UK innovation profile* highlights some of the most commonly cited strengths and weaknesses of the UK's innovation system. Indicators relating to the UK's research base and universities are the most consistently highly ranked across all of the innovation league tables. While these undoubtedly provide the UK with a comparative advantage as a knowledge-based economy, a strong research base does not reflect *innovation* performance per se and will not deliver the benefits associated with innovation if other aspects of the innovation system are weak.

There is a widely-held perception that other countries have been more effective at extracting economic value from ideas generated by the UK knowledge base than the UK has been itself.[21] Although quantitative evidence to support this argument is hard to find, there is no question that there are numerous instances where this has been the case – from breakthrough technologies such as liquid crystal displays and plastic electronics delivering substantial profits to foreign-owned firms, to the more recent exploitation of the UK's vibrant creative sector by foreign intermediaries.[22]

Exploitation of UK-generated knowledge and insights by foreign firms should be welcomed, especially where those firms have UK-based development and manufacturing operations. Nevertheless, it is essential that the UK possesses the ability to capture value both from its own investments in research and from research undertaken overseas. Up to 90% of innovation in advanced economies is estimated to be based on technology transfer from foreign countries so it is a source of concern that the UK is not considered to be particularly effective at adapting innovation from overseas.[23]

UK support needs to be simplified

There is a strong advantage in public support being kept as simple as possible to minimise unintended barriers to access, as well as inefficiency. The *Dowling Review* highlights the current complexity faced by businesses wishing to access public support for collaborative research activities with universities in the UK. There has been recent discussion of the possibility of moving from supporting innovation in companies by grants to loans – while this may seem to offer a better return on public investment, careful consideration needs to be given to whether the additional complexity created as a result of any move would deter companies, especially SMEs, from applying, as well as subsequent investment in those businesses by other investors. Experience with knowledge exchange activities in universities has also drawn attention to the distorting effect that can arise when there is an expectation that innovation will deliver a near-term return on investment to the funder, reinforcing the risk that a change in innovation support for companies from grants to loans could result in unintended and undesirable consequences.

Investment levels

Investment in R&D is an important input factor for innovation performance, although it needs to be considered in the context of the outputs delivered. By now it is a well-known fact the UK invests less in R&D as a percentage of GDP than many of its peer nations. Many developed nations, including Japan, Korea, the United States, Germany, the UK and France responded to the 2008 economic crisis by increasing their R&D investments. The UK was the only one of these countries whose R&D budget was lower in 2010 than in 2007.[24] Several emerging economies are increasing their R&D investment levels at an even faster rate than many developed countries.[25]

Figure 4 – UK innovation profile

The UK's relative strengths and weaknesses in relation to innovation, as assessed following an analysis of the UK's status in international indexes. This is not intended to be an exhaustive or quantitative analysis.

Another notable feature of the UK landscape is the fact that business enterprise R&D (BERD) is highly concentrated: almost 60% of BERD is performed in just five sectors,[26] and, 28% of all BERD is undertaken by ten businesses.[27] This reinforces the importance of ensuring the UK continues to offer a competitive environment for investing in innovation – if even a small number of these companies decided to reduce their R&D investments in the UK it could have damaging consequences for jobs, supply chains and the wider innovation ecosystem.

Investment in intangible assets is seen as another indicator of relevance to innovation performance and is sometimes used as a proxy for private sector funding for innovation.[28] This covers a broad range of investments that firms make in design, organisational improvement, training and skills development, advertising and market research. Only a subset of intangible assets relate directly to innovation and BIS has estimated that the UK fares well in the investments it makes in this subset, which it refers to as 'private sector financed non-R&D innovation': in 2011, the UK invested 4.8% of GDP, behind the US (6.1%) but ahead of France (4.2%), Finland (3.4%) and Germany (3.3%).[29] Drawing conclusions on countries' innovation investment performance is, however, not simple due to the lack of comparable data sets and approaches to assessment.

International investment

The UK attracts high levels of R&D investment from foreign companies, with 20% of the UK's R&D investment coming from overseas in 2012, compared to 4% for Germany and the United States and 1% for China.[30] This situation has both advantages and disadvantages. Companies investing in and siting their R&D activities here benefits the UK economy through the creation of jobs and resource consumption, and there is evidence that this foreign direct investment (FDI) can boost the productivity of domestic companies, for example through exposure to new knowledge, networks and capabilities.[31] However, the high levels of FDI may also mask underinvestment by UK businesses and render the UK especially sensitive to changes in international capital flows.

See: Procter & Gamble case study

The increasing global awareness of the importance of innovation means the UK is no longer just competing with the developed economies for inward investment; in recent years some technology-intensive multinational corporations have sited R&D facilities in emerging economies with seemingly successful results.

SMEs

The UK scores poorly in international comparisons for product and process innovation by SMEs, as well as marketing and organisational innovations.[32] This matters because SMEs make up 99.9% of all businesses in the UK, yet in 2013 accounted for only 3.6% of BERD.[33] The *Dowling Review* identifies the need to consolidate and strengthen local support for SMEs to enable them to better engage with the excellence in the UK's research base.[34] Local Enterprise Partnerships have a key role to play here but their capacity for, and approach to, innovation support is highly variable. In view of the focus on innovation within Horizon 2020, and the historically poor performance of UK SMEs in accessing European funding, a concerted effort to strengthen national support structures for SMEs could yield significant dividends. There is also ample scope for the UK to utilise public procurement more effectively to stimulate innovation among SMEs – the UK Small Business Research Initiative is perceived as being far less successful than its US equivalent, the SBIR.[35]

Skills

As already outlined, an appropriately skilled workforce is a pre-requisite for innovation, so it is worrying that the UK achieves relatively weak scores on a range of indicators associated with the quality and uptake of education in general and the science, technology, engineering and mathematics (STEM) pipeline in particular. Consistent with this, 39% of UK firms in a recent survey reported difficulty recruiting candidates with STEM skills critical to innovation.[36] It will not be possible to boost, or even maintain, the UK's innovation performance without addressing these deficiencies in the talent pipeline.

Manufacturing and services

Manufacturing accounts for around 10% of GVA and 15% of business investment in the UK, but it has high levels of innovation and delivers 44% of exports, making a crucial contribution to UK competitiveness.[37]

Since services dominate the UK economy, adequate support for non-product innovation is essential.[38] Innovation can play a crucial role in raising productivity in services – the IT revolution, for example, had a transformational role in the retail sector. Recent data suggest that service innovation is also becoming increasingly important for manufacturing, with the proportion of manufacturing firms engaging in service innovation rising from 17% in 2014 to 40% in 2015.[39]

Innovation is changing the future profile of employment and it has been argued that the impact of technologies such as autonomous systems and artificial intelligence will be particularly strong on service sector jobs.[40] If the UK is a passive recipient of the impacts of innovation, rather than a leader in developing and adopting innovation, it will be unable to harness the opportunity provided by innovation and risks being outcompeted in the sectors and roles that currently underpin its economy.

Investment environment

The UK's investment environment for innovation and entrepreneurship has both strengths and weaknesses. The Enterprise Investment Scheme (EIS) and Seed Enterprise Investment Scheme (SEIS) have helped to make the UK one of the most favourable environments for angel investing. However, a lack of access to debt financing for SMEs remains a concern and the shortage of long-term, patient capital has been identified by many experts as a barrier to the ability of UK companies to innovate, especially the smaller companies which tend to account for much of the UK's innovative activity.[41]

Strategy

One of the essential ingredients for a successful innovation system is a clear strategy underpinned by a stable and coherent policy framework. Unfortunately, for many years this was not a feature of the UK landscape.[42] The introduction of the UK's modern industrial strategy represented an important step forward and was warmly welcomed across a range of industrial sectors and the research and innovation communities. While changing circumstances and governments may result in different policy priorities, the value of stability and continuity for giving business and others the confidence to make investments over the long term should not be underestimated. At this time of austerity, it is more important than ever that the government commits to an industrial approach that builds on the progress made to date towards an overarching vision and policy framework.

The UK's innovation assets

As highlighted above, the UK benefits from a variety of institutions, policies and features that collectively comprise its innovation assets. These include its world-class research base and universities, a strong intellectual property rights (IPR) system, a favourable environment for angel investment in early-stage entrepreneurial companies and R&D and manufacturing bases for many leading international firms.[43]

There have also been several important developments in the UK innovation infrastructure in recent years, not least the emergence of Innovate UK as a significant force. Innovate UK oversees the Catapult Centre network which offers facilities and expertise to enable businesses and researchers to collaboratively solve key problems and develop new products and services on a commercial scale.[44] Returns from the more established Catapults are already being seen, with the High Value Manufacturing (HVM) Catapult generating net benefits of £15 from £1 of core public funding.[45] Catapults are also making valuable contributions through providing an infrastructure for sector-based innovation, as illustrated in a number of the case studies. In addition, Innovate UK collaborates with the UK's Research Councils to support innovation through the highly-regarded Catalyst programmes.

Public sector research establishments, such as the National Physical Laboratory (NPL), National Nuclear Laboratory and the Met Office constitute another category of innovation asset, providing access to specialist expertise, skills and facilities for businesses and other users. A recent survey of NPL's user base found that 63% of users introduced a new or improved product during the period they worked with NPL and received direct financial benefits worth £634m a year.[46]

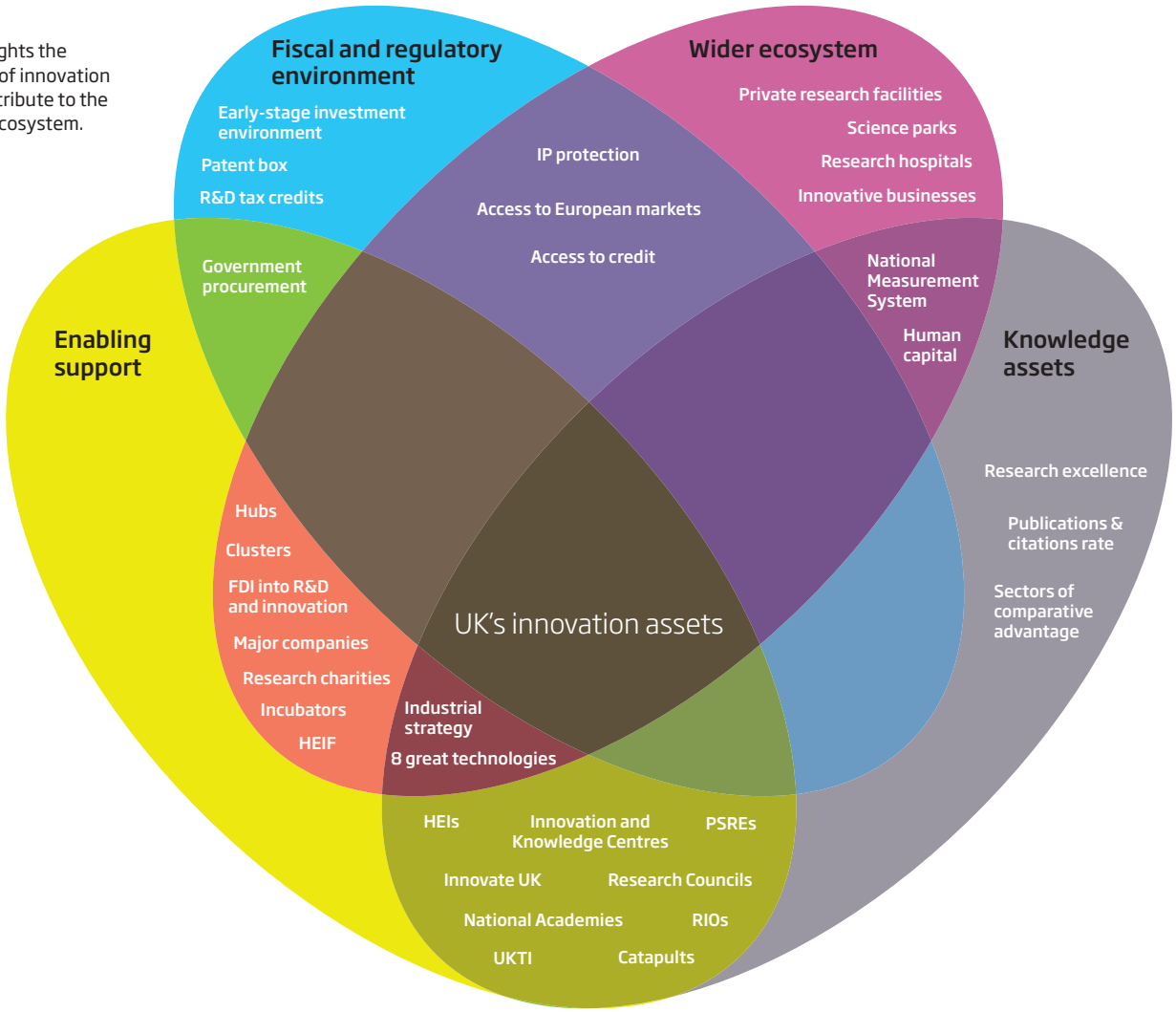
PSREs and Catapults are both research and innovation organisations (RIOs): non-profit organisations that perform research and innovation support as their main activity, whose existence depends on a significant degree of public funding, and whose work serves a public policy purpose. They are complemented by an earlier generation of non-profit organisations and previously privatised government laboratories working more extensively now in the private sector (RTOs). Collectively, RIOs and RTOs are estimated to account directly for £3.7bn per annum in GVA – or £7.6bn if indirect and induced impacts are included – and represent an important innovation asset for the UK, helping to maximise the leverage achieved on direct public investment in innovation.[47]

The UK's innovation assets offer a clear opportunity to promote the UK as an attractive environment for innovation, but their sheer diversity coupled with the highly decentralised nature of the UK's innovation system, mean that it can be difficult to achieve synergies, or to present a coherent picture to those wishing to access the system. Countries such as Germany have been extremely effective at creating a narrative about their knowledge-based industries and innovation assets, which the UK could usefully learn from.

ONE OF THE ESSENTIAL INGREDIENTS FOR A SUCCESSFUL INNOVATION SYSTEM IS A CLEAR STRATEGY UNDERPINNED BY A STABLE AND COHERENT POLICY FRAMEWORK

Figure 5

This Figure highlights the broad categories of innovation assets which contribute to the UK's innovation ecosystem.



THE UK'S INNOVATION ASSETS OFFER A CLEAR OPPORTUNITY TO PROMOTE THE UK AS AN ATTRACTIVE ENVIRONMENT FOR INNOVATION

Conclusions

Innovation is a crucial contributor to growth and productivity. It also provides the means of developing new tools and approaches to tackle major societal challenges.

The public sector has a key role to play in enticing private sector investment and encouraging innovation in priority or high-potential areas, through direct investment, smarter procurement and creating an enabling environment.

This approach has been adopted by many, if not all, of our competitors. They will not stop innovating if we reduce our innovation investments.

The UK has many innovation assets; the challenge for government is to ensure that there is an overarching vision and a coherent, stable and strategic policy framework that enables these to act effectively in concert over the long term.

Figure 6 – Case studies

These case studies have been selected to highlight the different mechanisms of public support for innovation and the resulting positive outcomes.*

Optical fibre research

Long term sustained funding from EPSRC supports a world-leading research centre of excellence, creating a cluster of optoelectronics companies in the Southampton area and resulting in substantial spillover benefits.

Public Support
- EPSRC
- Innovate UK

Approximately £20m of long-term funding over 20+ years was vital to sustain and develop cluster.

Outcome
- Several major companies created including Fibrecore, SPI Lasers, SENSE, Point Source and Fianium
- Total revenues in excess of £100m
- Created over 500 engineering jobs
- Licensed over 30 key patents

BBC Micro

In 1980 the BBC computer literacy project (CLP) was conceived to make computer programming accessible to everyone. With the support of the Department of Trade and Industry (DTI), the BBC made a direct tender to seven UK computing companies to design and manufacture a UK home computer to support the CLP.

Public Support
- BBC public procurement
- DTI

UK only directed tender essential to future company (Acorn) success.

Outcome
- Direct economic benefits from the increasingly skilled population
- Commercial benefit to companies involved (Acorn)
- Development of chips with very low-power requirements and wide ranging applications
- Led to the creation of one of the UK's most successful technology companies ARM

Surrey Space Centre

Following an initial breakthrough innovation in small satellite technology and sustained funding from EPSRC over 30+ years, Surrey Space Centre has developed into a centre of excellence and contributed to the creation of Surrey Satellite Technology (Ltd).

Public Support
- EPSRC
- Innovate UK

Funding established centre of excellence and sustained pre-commercialisation company development.

Outcome
- Establishment of world-leading Surrey Space Centre of excellence in space engineering; pioneered small low cost satellites
- Employs 80+ researchers
- Creation of a £100m+ p.a. business – Surrey Satellite Technology Ltd (now part of Airbus Defence & Space) which to date has launched 47 space missions and is currently producing the 22 satellites for Galileo, Europe's version of GPS

Procter & Gamble

P&G commits R&D resources in the UK at levels significantly higher than the UK's proportion of P&G's global business, in part due to the UK's unique research climate and world leading expertise.

Public Support
- EPSRC strategic partnership
- £5.3m grant from Regional Growth Fund (RGF)
- Innovate UK

Funding essential to secure overseas investment.

Outcome
- 16 sites around the UK and Ireland
- RGF grant contributed to a combined strategic investment of £14m by a P&G-led consortium to establish a major centre of excellence (CEMENT) based in NE England in cluster around Durham University and the Centre for Process Innovation (CPI), part of the High Value Manufacturing (HVM) Catapult

Departure planning information

The Transport Systems Catapult (TSC) worked with partners to implement real-time departure technology to allow airports to predict more accurately expected arrival times. There was little incentive for the airports to adopt the technology as the benefits are primarily accrued by the airlines not the airports; involvement of the TSC overcame this barrier.

Public Support
- TSC
- Department for Transport

The TSC invested £750,000, which helped to remove the barrier to implementation by transferring the responsibility away from regional airports.

Outcome
- Reduced passenger delays, improved airspace efficiency, and a reduction in fuel consumption, noise pollution and carbon emissions in UK airspace
- Potential savings of up to £10m UK-wide over 5 years

Mastodon C

Mastodon C is a small IT company which creates open source tools for quantitative analysis of big data. Partnership with the Connected Digital Economy (CDE) Catapult ensured the creation of Mastodon C's Open Health Platform was viable while involvement with the Open Data Institute (ODI) facilitated partnerships and provided further support and expertise.

Public Support
- ODI
- CDE Catapult

Support established key partnerships.

Outcome
- Creation of the Open Health Data platform and prescribing analytics portal to analyse patterns in health data
- £200m potential savings in GP prescriptions identified to date

* These case studies have been compiled from publicly available information and are not intended to be highly detailed.

Plaxica

Plaxica was created following a breakthrough research discovery at Imperial College London to produce plastics from natural feedstocks. The company was spun out through Imperial Innovations and has received grants from Innovate UK to help test and validate its technology in collaboration with the Centre for Process Innovation (CPI).

Public Support

- EPSRC
- Innovate UK (~£355,00)
- CPI

Funding essential to support company development and upscaling.

Outcome

- CPI assistance led to company relocation to Wilton (Teeside) to upscale and establish new labs and pilot plant
- Over £10m has been raised from investors
- Company now manages two labs and pilot manufacturing plant employing 30 engineers

Cobalt Light Systems

Pioneering research leading to breakthrough invention at STFC Central Laser Facility. Spinout created to commercialise new innovative non-invasive analytical and diagnostic devices.

Public Support

- Research Councils

Funding essential to company creation and product commercialisation.

Outcome

- Successful SME created to produce analyser equipment resulting in liquid scanning device to enable liquids to be carried in hand luggage
- Installed in 65 EU airports
- Won 2014 MacRobert Award for Engineering Innovation

VIEWS Project

Large collaboration bringing together four multinational aerospace companies (GKN, GE, Bombardier, Spirit) with five HVM Catapult centres and four UK universities, to progress and implement the technologies developed by the publicly supported STeM project (Structures Technology Maturity).

Public Support

- Innovate UK
- HVM Catapult

£30m, 27 month project led by GKN has received an £18.8m Innovate UK award. The innovation ecosystem created by the HVM Catapult was critical to enticing private sector industrial collaboration.

Outcome

- Potential to save ~20% of the cost of manufacture and assembly of a typical composite box structure
- Helped to sustain the 12,600 aerospace jobs within the collaboration
- New generation of automated processes and technologies in development
- Expanded UK manufacturing capability, increasing the quality, consistency and speed of production
- Collaboration between competitors within UK sector of comparative advantage

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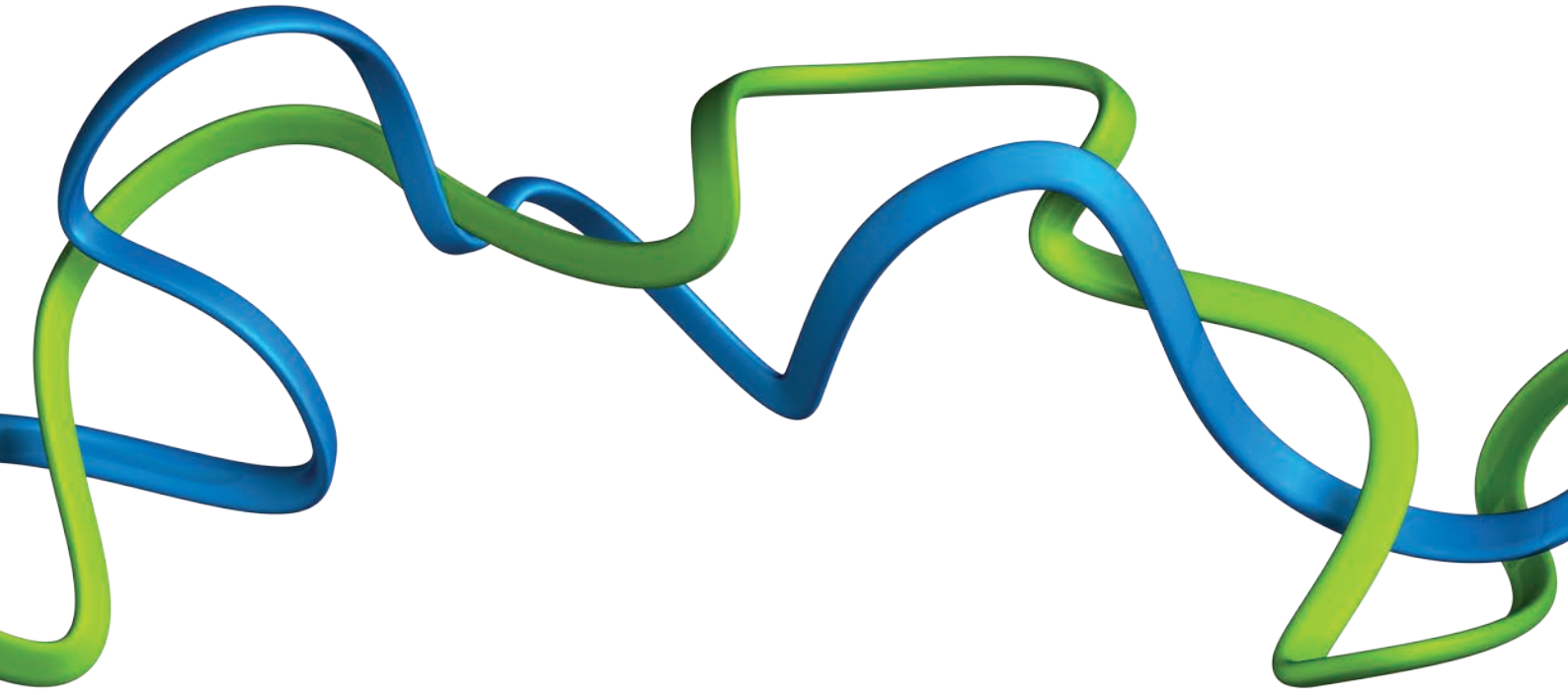

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