


# Competing on knowledge

The UK's Global Innovation Challenge



Opening up innovation  
Mastering higher-order innovation  
Developing innovation networks  
Making the most of international firms in the UK

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# About AIM

The Advanced Institute of Management Research (AIM) develops UK-based world-class management research. AIM seeks to identify ways to enhance the competitiveness of the UK economy and its infrastructure through research into management and organisational performance in both the private and public sectors.

## **AIM consists of:**

- Over 250 AIM Fellows and Scholars – all leading academics in their fields...
- Working in cooperation with leading international academics and specialists as well as UK policymakers and business leaders...
- Undertaking a wide range of collaborative research projects on management...
- Disseminating ideas and shared learning through publications, reports, workshops and events...
- Fostering new ways of working more effectively with managers and policymakers...
- To enhance UK competitiveness and productivity.

## **AIM's Objectives**

Our mission is to significantly increase the contribution of and future capacity for world class UK management research.

Our more specific objectives are to:

- Conduct research that will identify actions to enhance the UK's international competitiveness
- Raise the quality and international standing of UK research on management
- Expand the size and capacity of the active UK research base on management
- Engage with practitioners and other users of research within and beyond the UK as co-producers of knowledge about management

## **Current AIM research projects focus on:**

### **UK productivity and performance for the 21st century**

*How can UK policymakers evaluate and address concerns surrounding the UK's performance in relation to other countries?*

National productivity has been the concern of economists, government policymakers, and corporate decision-makers for some time. Further research by scholars from a range of disciplines is bringing new voices to the debates about how the productivity gap can be measured, and what the UK can do to improve the effectiveness of UK industry and its supporting public services.

### **Sustaining innovation to achieve competitive advantage and high quality public services**

*How can UK managers capture the benefits of innovation while meeting other demands of a competitive and social environment?*

Innovation is a key source of competitive advantage and public value through new strategies, products, services and organisational processes. The UK has outstanding exemplars of innovative private and public sector organisations and is investing significantly in its science and skills base to underpin future innovative capacity.

### **Adapting promising practices to enhance performance across varied organisational contexts**

*How can UK managers disseminate their experience whilst learning from others?*

Improved management practices are identified as important for enhancing productivity and performance. The main focus is on how evidence behind good or promising practices can be systematically assessed, creatively adapted, successfully implemented and knowledge diffused to other organisations that will benefit.

## Executive Review

In recent years, 'innovate or die' has become a cliché. Yet, as is usually the case with over-used phrases, it contains a substantial nugget of truth. Innovation is essential to business health and wealth – both for individual firms and national economies. In particular, innovation is linked to superior competitiveness and productivity.

Traditionally, the UK has been regarded as good at invention – with many inventions and scientific breakthroughs emanating from within these shores. But the fact is that for many years the UK economy has underperformed in terms of innovation. Research shows that Denmark, Finland, France, Germany, Japan, Singapore, South Korea, Sweden, Switzerland and the US all spend more than the UK on R&D as a percentage of GDP.<sup>1</sup> The Competitiveness Index, produced by the World Economic Forum, ranks the UK 6th on a more general measure of innovativeness.

Part of AIM's remit, when it was originally funded, was to consider the UK's innovation performance. This led to research projects looking at innovation from a number of different perspectives and at different levels of activity. In particular, AIM researchers tried to understand the UK's innovation performance within the context of a changing business world.

This Briefing draws on AIM's research to date. Taken together this research offers a glimpse of innovation in an increasingly globalised world. AIM's work suggests that the way forward for the UK lies in:

**Opening up innovation:** innovation involving collaboration across organisations and national borders is increasingly important. The UK is well placed to take advantage of increasing cross-border collaboration, as it already has one of the highest levels of international flows of investment. But in other areas, such as collaboration between universities and the private sector, or with India and China, the UK has further to go. To make progress here, the UK has to build even further on existing efforts to encourage international collaboration.

**Mastering higher-order innovation:** a better understanding of the different forms of innovation – especially higher order innovations, including management innovations – is essential to raising the UK's innovation game. We need fresh ways of looking at innovation in order to move up the value chain. In particular, UK firms need to adopt smarter innovation practices, leading to novel business models and better ways of working.

**Developing innovation networks:** to capitalise on its strong science base, the UK should develop innovation networks around its leading research centres which would become innovation hubs. These innovation networks should also reach beyond the UK. In this way, the UK could position itself at the centre of a global innovation web. UK firms already invest heavily in R&D in other countries, especially the US. Rather than worrying about this practice, policymakers should recognise the important role it plays in technology transfer and knowledge spillovers into the UK.

**Making the most of international firms in the UK:** foreign multinationals own large parts of the UK economy (40 percent of private sector companies); and the trend towards foreign ownership is continuing. Concerns have been raised about the 'hollowing out' of the UK economy, especially the ability of these foreign-controlled businesses to be innovative and entrepreneurial. AIM research suggests this concern is unfounded. There is evidence that foreign-owned companies are at least as innovative as locally-owned companies. There is also evidence that UK firms can use the local presence of foreign firms to learn from their superior technology.

From this research we draw implications for policy and practice, and the ways they complement each other.

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# Glossary of terms

**Steady state innovation:** (also called lower order innovation) involves relatively incremental innovations in products or processes. So, for example, the formulation of a product is altered slightly to create the new and improved version, or a process is streamlined to enhance efficiency, but the fundamental approach and technology remains unchanged.

**Discontinuous innovation:** involves a fundamental change in the approach or technology. Every now and then a disruptive event occurs that changes markets, industries, and even societies. A good example is the advent of the internet. Such world changing events give rise to a wave of discontinuous innovation across many industries. This has a destabilising – or disruptive – effect for established firms. (Together with management innovation, discontinuous innovation constitutes higher order innovation, which can be a source of lasting competitive advantage.)

**Ambidextrous organisations:** organisations that simultaneously cope with steady state and discontinuous innovation.

**Management innovation:** A management innovation is a marked departure from traditional management principles, processes and practices, or a departure from traditional management principles or organisational forms that significantly alters the way the work of management is performed. In the 1920s, for example, General Motors' invention of the divisionalised organisation helped it overtake Ford to become the world's leading automotive company. In the 1930s, Procter & Gamble's development of brand management made it the dominant force in consumer goods markets. Toyota's work on employee based problem solving in the 1970s helped revolutionise manufacturing.

**Open innovation:** the idea that the innovation process has shifted from a closed process within firms to an open process drawing on many sources of knowledge. In his Open Innovation study, Harvard professor Henry Chesborough notes that firms can access vital knowledge from outside sources including customers, suppliers, universities, national laboratories and research centres, consortia, consultants and start-up firms.

**Technology spillover:** When a firm invests in R&D the knowledge that it generates can often be used by other firms, either for free or at low cost. This 'spillover', or what economists call an 'externality', means that individual firms do not value the R&D investment as much as society as a whole does, so they are likely to underinvest.

## 1

## Introduction

Since the 1980s, the UK economy has undergone a dramatic transformation. Huge swathes of industry have been stripped out of the public sector and privatised. Trade union power has diminished; and previously protected industries have been deregulated. As a result, the UK is among the most market-oriented and business friendly economies in the world.<sup>2</sup>

These changes have successfully encouraged growth in the UK. Yet, a puzzle remains: research consistently shows that, despite the improvements, the UK economy continues to under-perform relative to other developed nations on many key measures. National productivity and prosperity have improved in absolute terms, but still obstinately lag those of direct rivals, especially the US.<sup>3</sup>

The market reforms of the 1980s stimulated growth but were insufficient to close the productivity gap with other developed nations. Moreover, the world has now moved on. The rise of India and China and other lower cost economies means that competing on cost is no longer a viable strategy for firms in the UK. Indeed, with the increasing commitment by those countries to R&D investment and to education and training, the basis of international competition has shifted firmly to *knowledge*.

### Competing on knowledge

AIM research suggests that one of the main drivers of differences in productivity is differences in knowledge – both in terms of individual skills and competencies, and in terms of the knowledge-based capabilities of firms. To succeed in future, the UK needs to shift away from competing on cost to competing on added value – especially its knowledge base.<sup>4</sup>

This is a strategy that suits a more advanced economy. For example, the US has benefited greatly from exploiting its knowledge base in high tech industries. A similar challenge now faces the UK. This places critical importance on innovation, especially the ability to harness the UK's science base in areas where it is strong.

Every year, the UK spends £21 billion<sup>5</sup> on creating new knowledge – via the science system in universities, research institutes, and companies. This forms part of an estimated £600 billion spent by OECD countries around the world, involving some 3 million researchers.

Here the news is positive. Evidence suggests that the UK is good at producing scientific knowledge: it is ranked second in the world for academic citations, for example, with an impressive 8.10 percent world share<sup>6</sup>; and the UK also ranks fifth in the world for PhDs produced per unit HERD (Higher Education R&D Spend), while the US is ranked twelfth.<sup>7</sup>

Yet despite its impressive performance in this area, the UK lags behind other developed economies in converting new ideas into commercial applications. With the exception of a few sectors such as pharmaceuticals, we have not been effective at capturing and leveraging our know-how.<sup>8</sup> This is true both in terms of creating new products and services, and improving processes and practices.

Anecdotal evidence supports this view. Famous examples include the body scanner developed by EMI, and pioneering work on the world's first computer at the British war time code breaking centre Bletchley Park – both of which drew on the UK's science base but were commercialised outside the UK. Similarly, British managers have been criticised for their failure to adopt the latest management practices.<sup>9</sup>

### The innovation challenge

The challenge now facing the UK is not simply to create more knowledge, but to capture it in ways that have a positive economic and social impact. Primarily, this means converting our knowledge base into economic value – through commercial innovation. But it also means recognising the changing nature of the global knowledge economy.

Attention is shifting from knowledge creation to knowledge *flows* – with the implication that trading knowledge may become as important in the 21st century as trading physical goods was in previous centuries. This requires the UK's innovation infrastructure to become more effective at identifying and capturing useful know-how, rather than letting it slip through our hands.

To achieve this goal, policy and practice need to work together: the government needs to provide the appropriate infrastructure, and to ensure that firms are facing the right incentives to commercialise innovation; and firms need to be better attuned to developing and exploiting new ideas. Other key players in the policy landscape – for example, trade and business associations, major supply chain ‘owners’ and regional development agencies, also have a vital role to play in meeting that challenge.

So how can the UK make that leap? AIM research indicates four factors will be critical in the future:

### **Opening up innovation**

In an increasingly competitive world, no single organisation has all the answers. In future, innovation involving collaboration across organisations and national borders will play a critical role in competitive positioning. A growing number of firms, including BT in the UK, Lego in Denmark and Procter & Gamble in the US, have begun to emphasise this approach. The UK has one of the most open innovation systems in the world in terms of cross-border flows, but more needs to be done to encourage collaboration between businesses and universities, for example. The UK’s strong science base offers enormous opportunities. UK firms, research centres and universities are also well placed to collaborate with upcoming countries such as India and China. It is vital that these opportunities are grasped.

### **Mastering higher-order innovations**

There is an important distinction between the run-of-the-mill innovations in products and processes that all firms engage in, and the higher order forms of innovation – such as business model innovation, discontinuous innovation and management innovation – that very few have mastered. UK firms need to find ways of understanding and managing these different forms of innovation.

Many organisations around the world are currently experimenting with new innovation practices. There is a great opportunity for UK firms to learn from and adopt new practice in this area to develop more sustainable sources of advantage.

### **Developing innovation networks**

The UK’s science base could be better harnessed by developing innovation networks around the top research centres and universities. Importantly, such networks are not only about stimulating high tech start-ups but also about providing the space within which a variety of knowledge exchange activities can occur to support existing businesses. Clearly much effort has already gone into this, but as innovation opens up the importance of networks will grow. Global innovation networks can also support knowledge transfer – but they depend critically on brokers and gatekeepers to enable the flow. UK firms already use their R&D investment in other countries, especially the US, as an important way to access new technology and import know-how into the UK. International links will be increasingly important to create networks that span the globe, including the rapidly developing economies of Brazil, Russia, India and China (BRIC).

### **Making the most of international firms in the UK**

Large parts of the UK economy are owned by foreign multinationals, and the trend towards foreign ownership is continuing. This has prompted concerns about the ‘hollowing out’ of the UK economy and the ability of foreign-controlled businesses to be innovative and entrepreneurial. AIM research suggests this concern is not well-founded: there is evidence that foreign-owned companies are at least as innovative as locally-owned companies, and there are a number of clear strategies open to managers of foreign-owned business who want to chart their own destiny.

“The answer is not running away from globalisation. It’s investing in innovation, design and training to help our skilled workforces provide an unanswerable argument for continued investment in the UK.”

The Rt. Hon. Alistair Darling MP, Speech at 2007 Lord Mayor’s Trade and Industry Dinner, Mansion House

## 2 Opening up innovation

Innovation was traditionally viewed by large companies as a closed process. Whether it was innovation involving the source code for a new software product, the formula for a new drug, or the designs for a radically different motor car, the watchwords were caution and secrecy. With large financial investments and future profits at stake, commercial innovation, in particular, typically occurred behind closed doors.

This made sense in a world where competitive advantage was seen to reside in proprietary R&D, protected by patents and intellectual property law. Consequently, the exchange of ideas remained in-house. Over the last decade, however, this situation has started to change. One major catalyst has been the success of the open source software movement, which openly publishes the source code for new software projects on the internet. Open source collaboration can, and does, work. For example, the Linux computer operating system, invented by Linus Torvalds and developed through the open source model, now offers an alternative to Microsoft's Windows OS (Operating System).

The open source approach is now being applied not only to the development of software but to an increasingly wide range of products. Increasingly, firms are adopting the collaborative principles of what is called open innovation. As the head of innovation at the US consumer goods company Procter & Gamble recently explained: "We have a broad programme we call 'connect and develop.' In the academic world, they call it 'open innovation.' We want to connect internally – move technologies and ideas across our business units internally – but we also want to connect externally. This has been a real source of innovation for us."<sup>10</sup> Open innovation at P&G now accounts for 35 percent of the company's total innovations – and millions of dollars in revenue.

### Knowledge exchange

The potential of the internet as a knowledge resource is huge. In 2001, for example, the pharmaceuticals company Eli Lilly and Company, set up InnoCentive as a match making tool, connecting those with scientific problems with those being able to offer solutions. Its stated aim is to: "use the power of the internet to create and enhance open-source scientific research and development." There are now multiple sites

offering a brokering service, linking needs and means to create a global market-place for ideas – in the process providing a rich source of early warning signals. InnoCentive CEO Darrel Carroll explained: "Lilly hires a large number of extremely talented scientists from around the world, but like every company in its position, it can never hire all the scientists it needs. No company can."

Another increasingly common strategy involves companies seeing users not as passive consumers of innovations, but rather as active players in the process. Their ideas and insights can provide the starting point for very new directions and create new markets, products and services. For example, the Danish toy company Lego has set up the Lego Factory website. Users can design their own model online and then have the ready-to-assemble set sent to them (<http://factory.lego.com/>). The site is an effective way to capture ideas from its most advanced users which can then be incorporated into mainstream products.

A collaborative approach is now used for everything from T-shirts and surfboards through to complex aerodynamic shapes and engineering products. And a growing set of tools, such as rapid prototyping, simulation and computer-aided design, helps users interact with professional designers.

Of course, innovation is not confined to manufactured products. It also encompasses the huge range of service activities in both public and private sectors. Service businesses may not have a formal R&D department but they do undertake research and development activities in order to deliver a stream of innovations. Importantly, the knowledge sets with which they work involve a much higher level of user insight and experience – and thus their continuing competitiveness, especially in those sectors which are internationally traded, will depend on taking an open approach to innovation.

### Exhibit 1: Open for innovation – UK plc abroad

R&D by UK plc has grown faster than R&D within the UK. In 2000 alone, for example, UK firms invested \$5 billion in R&D in the US. This was equivalent to 28 percent of all R&D undertaken in the UK. For French firms the equivalent number (R&D undertaken in the US relative to total R&D undertaken within France) was 10 percent. For Germany, the equivalent figure was 16 percent.

### Foreign firms in the UK

At the same time, foreign firms account for a large proportion of R&D undertaken within the UK. The table below shows the percentage of all R&D in the UK paid for by foreign firms.<sup>11</sup> In fact, AIM research shows that foreign multinationals perform around one-third of all R&D carried out in the UK, with US-owned multinationals accounting for more than half of this. Indeed, US owned multinationals account for an increasing proportion, rising from 13 percent of all UK R&D in 1999 to 25 percent in 2003. The next largest country by ownership is France, with French multinationals accounting for 8 percent of all UK R&D in 2003.<sup>12</sup> The table below shows details by industry.

Table: Proportion of UK R&D performed by multinationals, 2000

R&D product group	R&D (£bn)	Domestic firms	Multinational firms	
			UK	Foreign
Pharmaceuticals and Chemicals	3.42	16%	52%	32%
Mechanical Engineering and Electrical Machinery	2.36	16%	36%	48%
Transport equipment and Aerospace	1.85	10%	52%	38%
Other manufacturing	1.08	42%	38%	21%
Services	2.25	39%	43%	17%

### Opening minds

Underpinning the move to open innovation is a growing recognition that no single country or organisation can corner the market in new ideas. The effect of open innovation is a fundamental change in the way that organisations create value. It involves a willingness to seek out leading edge research wherever it occurs, and an acceptance that home grown knowledge is less proprietary than was once the case. This favours the UK, which already has one of the most open innovation systems in the world.

UK firms, for example, are big investors in R&D overseas, especially in the US (see box above). In the past this has been viewed negatively, with calls for UK firms to invest their R&D budgets within the UK. But in the context of a global innovation system, investing in R&D outside the UK offers important benefits in terms of technology transfer and importing leading edge ideas.

Similarly, the fact that R&D carried out by foreign owned multinationals represents almost a third of all R&D in the UK suggests that the UK is a good innovation system to invest in. This also points to the openness of the UK's innovation infrastructure.

At the level of the UK economy as a whole, AIM research<sup>13</sup> has shown that the large scale market liberalisation undertaken as part of EU integration, and other pro-competitive reforms, has had a positive effect on innovative activity and economic performance. More open markets encourage firms to innovate in order to 'escape competition'.

At the level of the individual firm, AIM research<sup>14</sup> has examined the strategic choices firms make to develop and commercialise new product ideas. This research emphasises the importance of gaining access to external sources of ideas, but it also shows that such external 'sourcing' works best when done in combination with a less proprietary attitude to knowledge protection. Open innovation relies on trust and reciprocity between partners. Unless a firm changes its mindset to reflect the need for such values, the necessary knowledge exchanges will not occur.

In terms of the UK science base, there is more to be done to encourage collaboration among firms and across academic institutions. AIM research<sup>15</sup> shows that the UK's share of internationally co-authored papers (an indication of scientific collaboration) with newcomer countries is relatively high, but well below US and Japanese levels.

When it comes to collaboration with China and India, in particular, the trend from 1988 is downwards. In terms of collaboration with China, for example, the UK has been overtaken by Germany and the group formed of South Korea, Taiwan and Singapore. Collaboration with India shows a similar pattern to China, but with a more pronounced drop of the UK's share.

Another AIM study<sup>16</sup> focuses on the commercial outputs from research-council funded projects. Projects that lead to spin-off

companies, licensing, patenting or consulting activities are more likely to arise in higher-reputation universities (in terms of RAE ranking) with technology transfer units; they are also more likely to be led by less experienced and more junior faculty. This study highlights the difficulty of trying to steer established research-oriented faculty towards commercial projects, and underlines the importance of developing a broader range of outlooks and capabilities among researchers if the twin objectives of high-quality research and commercial outcomes are to be obtained.

### **Exhibit 2: Open innovation – the biotech industry**

The biotechnology industry highlights the value of networking across organisational borders. Biotech companies translate scientific discoveries into commercial technologies and new medical products. To do this they need, among other things: large amounts of capital to fund costly research; assistance with management and clinical trials; and later on, experience with the regulatory approval process, manufacturing, marketing, distribution, and sales.

The technological and scientific knowledge required to stay on top of such a field is diverse. The industry is complex and changing rapidly. Many new areas of science are converging or have become inextricably intertwined – from genetics, biochemistry, cell biology, general medicine, computer science, even to physics and optical sciences. Modern biotechnology is a set of technologies relevant to a wide range of disciplines and industries.

As all the necessary skills and organisational capabilities needed to compete in the industry are not readily available under one roof, biotech firms enter into a wide array of alliances to gain access to different competencies and knowledge. These alliances may be with larger pharmaceutical companies, for example, that provide a set of organisational capabilities that biotech firms are lacking, or they may be with research institutes and other specialised firms to stay abreast of the latest technological and market opportunities. Ultimately, however, success in the biotech industry depends on a firm's ability to access knowledge and skills located beyond its organisational boundaries. Without access to the appropriate network partners and the skills to manage the process of networking a biotech firm would be unable to compete and survive.<sup>17</sup>

### **Exhibit 3: Open innovation at BT**

Telecommunications company BT has a long history of technological innovations with a total worldwide portfolio of 7,700 patents and applications. Deregulation, convergence and fierce competition made BT rethink its research and development (R&D) strategy by 'innovating the way it innovates', in the words of BT's group chief technology officer, Matt Bross.

Bross believed that the company's innovation efforts had to be more commercially – rather than technologically – driven, with the entire research portfolio structured around business needs. With that purpose in mind, BT adopted an open innovation model based mainly on two pillars.

First, BT is actively managing its patent portfolio (e.g. licensing, and spinning out new businesses) through NVP Brightstar, a firm that specialises in taking technology projects out of BT as new ventures. Second, BT is moving towards a model where it leverages the power and speed of external partners to accelerate the creation of new services. Bross reorganised BT's R&D function to enhance its ability to identify, understand, select from, and connect to the wealth of available external knowledge. In November 2006, BT had scouting units in Silicon Valley, China and Japan, with the objective of identifying global sources of innovation (product, service, process, social) and seeding them into the lines of business.

# 3 Mastering higher-order innovation

Critical to improving the UK's innovation performance is a better understanding of different types of innovation. For many firms, innovation is seen as applying narrowly to new product development or technological progress; but this is an unduly constraining point of view that restricts a firm's ability to generate new sources of competitive advantage.

Think of the different forms of innovation in a stack. At the bottom are relatively incremental innovations in products or processes. So, for example, the formulation of a product is altered slightly to create the new and improved version, or a process is streamlined to enhance efficiency, but the fundamental approach and technology remains unchanged. These are the lower-order forms of innovation, also called 'steady state' innovation. They are important, but because everyone is doing them, and can copy each other's advances fairly quickly, they are never a lasting source of advantage.

At the top of the stack are the higher-order forms of innovation that can have a dramatic impact on a firm's competitiveness if they are effective. One of AIM's key contributions is to examine the nature of these higher-order innovations, and the managerial challenges they present.<sup>18</sup>

Specifically, the research looked at two higher order forms of innovation: discontinuous innovation and management innovation.<sup>19</sup>

## Discontinuous innovation

Every now and then a disruptive event occurs that changes markets, industries, and even societies. A good example is the advent of the internet. Such world changing events give rise to a wave of discontinuous innovation across many industries. This has a destabilising – or disruptive – effect for established firms.

Successful well-managed companies thrive in mature markets by focusing on doing what they do just a little bit better (steady state innovation). Consequently, when a disruptive event comes along – such as new technology or a regulatory change – the successful company is often blindsided. It is just not very good at the 'doing it different' type of innovation. The very attributes that make it successful in stable conditions hinder its ability to detect or exploit the change.

AIM research confirms that the ability to manage innovation well during steady state periods and the types of routines employed can actually hinder a company's ability to deal with innovation during discontinuous change. The consequences of failing to take advantage of such disruptive change are often severe. Eastman Kodak, for example, struggled to cope with a shift to digital photography. Digital Equipment Corporation (DEC) lost its way when the Mini computer was superseded by the Personal computer, and the company was ultimately sold to Compaq.

## Navigating disruptive change

So how can established firms cope with – and thrive on – disruptive change? AIM research examined this issue from several different perspectives.

One AIM study focused on the need for firms to adopt 'smarter innovation practices'.<sup>20</sup> Steady-state innovation practices are fine for equilibrium conditions or non-complex environments, but they break down when used to try and deal with high unpredictability ('the edge of chaos'). In fact, the approaches needed to cope with these two different types of conditions are different in almost every respect (see exhibit 4).

Through a detailed study of organisations such as BT, the BBC, Lego, and P&G, the research suggests a number of broad findings:

- First, not all firms 'get it' as far as discontinuous innovation is concerned. Many still work inside a comfort zone, defining the 'box' which they pretend to want to get out of. But actually the decision and resource allocation structures limit the exploration space – and leave the firm vulnerable to new entrants rewriting the business model or opening up completely new markets created by radical technological shifts.

**Disruptive forces**

Sectors that currently face disruptive change include:

- Pharmaceutical firms, where the dominant model of high (15-20 percent of turnover) investment in R&D linked to the quest for blockbuster drugs is giving way to uncertainty about new technological direction (the bio-pharma challenge). This involves 'low end' disruption from generic drugs; future market growth in low income countries; and new business models around total healthcare services rather than product delivery.
- Telecoms firms, where a combination of technologies around VOIP (Voice over Internet Protocol), convergence within ICT, and market fragmentation challenges service and delivery models.
- Medical devices producers facing shifts like pharmaceuticals from product development to service delivery.
- Engineering companies facing challenges around new business models which involve offering 'total' solutions based on a wide range of services wrapped around a core product. Rolls Royce, for example, now derives over 50% of its revenue from the services surrounding its aero engines.
- Digital media and entertainment companies are in a sector that is fragmenting rapidly with the emergence of web 2.0. The boundaries between consumers and creators are disappearing – contrast YouTube with a traditional TV firm. Recent data suggests that YouTube has 100 million viewings per day, with 65,000 new videos being uploaded every day.

**Exhibit 4**

<b>Type 1 Innovation organisation for steady state</b>	<b>Type 2 Innovation organisation for discontinuous conditions</b>
Operates within a mental framework based on a clear and accepted set of rules of the game	No clear rules – these emerge over time High tolerance for ambiguity
Strategies path dependent	Path independent, emergent, probe and learn
Clear selection environment	Fuzzy, emergent selection environment
Selection and resource allocation linked to clear trajectories and criteria for fit	Risk taking, multiple parallel bets, tolerance of (fast) failure
Operating routines refined and stable	Operating patterns emergent and 'fuzzy'
Strong ties and knowledge flows along clear channels	Weak ties and peripheral vision important

- Second, UK firms need to develop new mechanisms to help let go of the past, reframe the present and explore multiple rather than single futures. This requires them to find new ways to encourage (or at least tolerate) challenges to the industry orthodoxy – including the views held by senior management (see Exhibit 5). The danger otherwise is that any radical alternative vision of the future will be killed by the corporate immune system. There is an important role here for input from outsiders coming in with a different frame of reference.
- Third, firms need access to 'gatekeepers': science partners such as universities, consultants and trade associations, which provide expertise and act as neutral knowledge brokers across the network. By collaborating with those at the forefront of new technologies, firms can better identify disruptive change and, crucially, use that knowledge to create commercial applications.

### **Exhibit 5: Experiments in innovation**

AIM research examined a number of organisations currently experimenting with new innovation practices. The way that the BBC is seeking to get to grips with new digital media and the Web is a good example.

The BBC has a long and illustrious tradition as a producer of broadcast media. In the early 2000s, however, it had to face up to the discontinuous challenges presented by the new digital media environment. A critical question for the organisation was: what is the best approach to deal with this major change in its marketplace? By trying to second guess a massively complex new world through the efforts of a small R&D group? Or by trying to engage a rich variety of players in those emerging spaces via a series of open source experiments?

The Corporation's response was BBC Backstage – a project that sought to do with new media development what the open source community did with LINUX and other software development. The model was deceptively simple – developers were invited to make free use of various elements of the BBC's site (such as live news feeds, weather, TV listings, etc) to integrate and shape innovative applications. The strap line was *'use our stuff to build your stuff'*. As soon as the site was launched, in May 2005, it attracted the interest of hundreds of software developers and led to some high potential product ideas.

Ben Metcalfe one of the programme's founders, summed up the approach: "We want to be seen promoting innovation and creativity on the Internet, and if we can be seen to be doing that, we will be very pleased. In terms of projects coming out of it, if we can see a few examples that offered real value to our end users to build something new, we would be happy with that as well. If someone is doing something really innovative, we would like to invite them into the BBC and see if some of that value can be incorporate into the BBC's core propositions."

One way of getting to grips with this challenge is for firms to learn together, sharing experiences and reflecting on what has and hasn't worked and looking at new ideas and models. This is the basic idea behind the AIM Discontinuous Innovation Laboratory which involves networks of around 50 firms in the UK, Germany and Denmark. (See [www.innovation-lab.org/](http://www.innovation-lab.org/) for details).

Another AIM study focused on the structures firms put in place to handle discontinuous changes in their environment. This research suggests the goal is to become 'ambidextrous'<sup>21</sup> – firms need to be capable of aligning their activities around the needs of the current market, while at the same time being adaptable to new opportunities and challenges as they emerge. In part, this is about changing the culture of the firm so that it encourages people to act in a more entrepreneurial manner when faced with new opportunities; in part it is about building separate units, often called Corporate Venturing units, that provide patient resources and skilled managers needed to get fragile new ventures off the ground. The research<sup>22</sup> shows that most Corporate Venture units fail, but there are also proven ways of beating the odds if you structure and manage the unit carefully (see Exhibit 6: Creating an Ambidextrous Organisation).

But, important questions remain, such as how can firms promote formal and informal networks to ensure the optimal combination of knowledge, talent and investment to support innovation? This is a fertile area for UK firms.

### **Management innovation**

A second key form of higher-order innovation is management innovation – defined as a marked departure from traditional management principles, processes and practices or a departure from customary organisational forms that significantly alters the way the work of management is performed.

Management innovation has the power to transform the way organisations operate. For example, consider how our ability to manage the consistency of manufacturing processes has evolved: from Ford's introduction of the moving assembly line in 1913 and Western Electric's invention of statistical quality control in 1924; through the quality revolution begun by Toyota and other Japanese companies in the period following WWII; and on to more recent innovations such as the ISO quality standard and Motorola's Six Sigma methodology. These advances are as much about innovations in the philosophy and tools by which manufacturing processes are managed as the processes themselves.

### Exhibit 6: Creating an ambidextrous organisation

How firms make innovation happen is one of the most-discussed challenges in the management literature. AIM research<sup>23</sup> evaluated the approaches companies use to become more 'ambidextrous' – both adaptable to future possibilities and aligned around current markets at the same time. Specifically, the research focused on two approaches:

- Corporate venturing
- Building a culture or context in which entrepreneurship and initiative can flourish.

**Corporate venturing:** Corporate venture units exist to nurture and develop start-up businesses for their parent company. Many were established in the late 1990s, during the boom years of the technology bubble. Not only did these operations face all the classic challenges of start-ups – inexperienced management, securing access to funding, attracting customers – they also had to weather a meltdown in the technology sector that left most corporate parents wondering why they had got involved in corporate venturing in the first place.

So how has corporate venturing fared in the post-dotcom world? Is it still a viable and exciting approach to new business development in large corporations? Some venture units have been shut down, but many have survived the downturn and a few new ones have been started up. More interestingly, the survivors have adapted their strategies and organisational models significantly to cope with the more risk-averse business environment we are now living in. AIM research shows that the survivors have:

- Created enough autonomy to make their own investment decisions: rather than allowing corporate management to second-guess their decisions.
- Made good use of external partners, especially venture capitalists who can provide access to new ideas and help them learn how to develop new businesses.
- Ensured top-level support at all times. It takes longer to make a venture unit successful than the typical tenure of a CEO, so it pays to have more than one highly-placed ally.
- Looked for ways of adding value back to the mainstream businesses. For example, by building new ventures that they can benefit from, or that they see as strategically important.

**Building an innovation culture:** The second approach involves firms trying to foster a culture that is supportive of innovation. Specifically, this means wrestling with two diametrically opposed organisational qualities – adaptability and alignment. Adaptability is about focusing on the future. It is the ability to respond to change, to be nimble, to progress. Alignment is about maximising the present, leveraging existing ideas, and exploiting markets.

Organisations that successfully balance the two qualities are called Ambidextrous. The key to success is to empower individuals to make the choices in their day to day work that allow them to find the balance. Car manufacturer Renault and software solutions firm Oracle both rate highly for ambidexterity. They provide some clues about how to create the high-performance organisational context and culture necessary for ambidexterity to exist. They also highlight the fact that there are many paths to ambidexterity.

Renault achieved it by building a performance context around existing social support; Oracle built a performance context first then looked for ways of building support and trust across the organisation. Despite their differences, Renault and Oracle both have a clear and simple set of priorities. Oracle employees emphasised the role of goal setting, individual performance appraisal and risk management as key priorities. With Renault employees, capital allocation, recruiting and vision were important. Selecting focal elements is critical, as they have to fit the needs of the organisation. However, the consistency with which they are applied, and the number of employees impacted, is even more important.

“If you look over a hundred years of industrial history, typically it is management innovation that has allowed organisations to reach new performance thresholds – more than any other kind of innovation,” observes Gary Hamel, co-founder of the Management Innovation Lab (which received seed funding from AIM). “The challenge is to instill management innovation into organisations.”

The trouble is that while many firms have developed established processes for managing the lower-order forms of innovation, few if any have dedicated themselves to the pursuit of management innovation. Instead, when it occurs management innovation is typically ad hoc and serendipitous, rather than systematic and planned.

AIM researchers have undertaken three studies that begin to identify some of the key drivers of management innovation. The first study<sup>24</sup> focused on ground-breaking innovations, and the conditions that led to their emergence. Key factors included:

- A questioning, problem-solving culture. Rather than adopt well-proven approaches, individuals in innovative companies sought to develop their own unique solutions.
- Use of analogies from different environments. In order to get outside the ‘box’ of traditional thinking, innovative companies imported ideas from entirely different places. The Danish hearing aid company Oticon, for example, built its innovative ‘spaghetti organisation’ on the principles of the Scouting movement.
- A capacity for low-risk experimentation. Because management innovation is hard to prove in advance, it needs to be tested in low-cost experimental ways. P&G applies its standard testing process, used for new detergents and foods, to its management innovations as well.
- Selective use of external change agents to explore new ideas. Innovative firms make selective use of outsiders such as academics and consultants, who fulfill three roles: providing a source of new ideas and analogies; acting as a sounding board for emerging innovations; and helping to validate what is accomplished.

A second study<sup>25</sup> focused on the conditions under which firms introduce management practices that are ‘new to the firm’ (typically adapted from other settings). This study highlights the importance of a perceived crisis or ‘burning platform’ around which people can be mobilised to seek out new practices, as well as the importance of insights from many different external sources to identify the appropriate solutions.

A third AIM study<sup>26</sup> explored the relationship between management practices and competitiveness. Management practice data was collected from 732 medium sized manufacturing firms in the US, France, Germany and the UK. These measures of managerial practice were linked with firm-level productivity, profitability, sales growth and survival rates. Management practices also display significant cross-country differences with US firms on average better managed than European firms.



## 4 Developing innovation networks

To improve its innovation performance, the UK needs to get better at exploiting its knowledge base, especially its strong science base. AIM research confirms the importance of networks for exploiting know-how; they play a major role in the innovation process. Moreover, a certain type of high-value network is far more effective at sparking innovation. We call these Innovation Networks or i-works<sup>27</sup>. i-works have the following characteristics:

- Highly diverse: network partners are drawn from a wide variety of disciplines and backgrounds and encourage exchange across ideas systems.
- Third party 'gatekeepers': these include science partners such as universities, but also consultants and trade associations, which provide access to expertise and act as knowledge brokers across the network.
- Financial leverage: access to investors – via business angels, venture capital firms and corporate venturing
- spreads the risk of innovation and provides market intelligence.
- Proactively managed: participants regard the network itself as a valuable asset, and actively manage it to reap the innovation benefits.

For firms, access to i-works offers a potent source of new ideas and competitive advantage. Fostering relationships with such networks should be seen by firms as a critical capability.

### Exhibit 7: Case study – the motor sport industry<sup>28</sup>

The motor sport industry is a high value-added and highly innovative business sector. The UK's leading racing car manufacturers are world class centres of research, development and engineering. However, individual firms in the sector do not have the range and depth of capabilities to compete independently in motor sport's dynamic and competitive environment. Industry attention has therefore progressively focused on how networks of collaborating firms can work together to develop new products, improve business processes and reduce costs.

AIM research examined the ways in which firms collaborate as part of wider networks. The research involved gathering data from over 120 firms in the UK and Italian motor sport sectors.

The key findings:

- Closer working relationships between firms facilitate knowledge transfer and learning. These are vital to the collaborative development of innovative new products and also contribute to cost reduction activities.
- There are different degrees of collaboration with more advanced 'partnerships' necessary for the exchange of complex information in higher technology products.
- Network relationships in the UK industry are still often conducted at 'arm's length'. Firms have a significant opportunity to work together more closely to reap the potential benefits of closer relations.
- There has been a proactive strategy on the part of Italy's leading motorsport company to develop a stronger network and to encourage heightened participation and collaboration. This is proving highly successful.
- Along with strengthening existing relationships, firms need to look for new ideas and new opportunities outside their current network in order to remain innovative. This requires a proactive search beyond established industry sources of products, materials and technology.

### **Encouraging clusters**

AIM research also examined the role played by clusters – geographic concentrations of expertise and economic activity – in stimulating innovation.<sup>29</sup>

At their most powerful, clusters – which consist of networks of specialised skills and knowledge – can dominate an entire global industry. The Hollywood film industry and Detroit automotive industry, and the financial district in London's Square Mile are famous examples. But the economic role model in recent years has been the technology cluster of Silicon Valley centred around Stanford University. It has been argued that creating clusters around leading UK research universities could improve the exploitation of the UK's science base.

### **Magnets for R&D**

AIM research investigated the extent to which foreign business R&D activity in the UK was located close to high-quality university research departments. One study<sup>30</sup> compared the concentration of R&D labs with the results of the 2001 Research Assessment Exercise (RAE). The findings show that R&D activity clusters around the more highly rated university research departments.

This is particularly strong in the pharmaceuticals and chemicals sectors. A postcode area with a chemistry department rated 5 or 5\* by the RAE has on average twice as many pharmaceutical R&D labs as an area with no chemistry department. The results are even stronger for foreign-owned labs, consistent with technology sourcing by foreign multinationals.

In some sectors the results are not limited to highly-rated research departments. Postcode areas with a materials science department rated 4 or below have on average more foreign-owned labs in machinery, aerospace and motor vehicles. These results confirm the role of world class centres of research in attracting foreign R&D in some sectors. But they also point to the potential role of more applied research centres. The most pronounced effects were found in pharmaceuticals – where two-way flows of R&D investment and specialisation were observed.

Successful networks or clusters include a wide variety of firms and research centres. AIM research<sup>31</sup> on three UK biotech regions shows how research establishments, manufacturers and a variety of service providers each contribute in different ways to the innovative output of a cluster. It is important that the UK continues to encourage and develop both pure science and the commercial enterprises that bring these ideas to market.

Potentially, clusters are important pillars of UK competitiveness, yet they are still something of an enigma. Theoretically it should be possible to create conditions that encourage cluster development. Yet attempts to foster their formation have had mixed results. AIM research indicates that policy support should be tailored to the specific needs of individual clusters and be designed with the complexity and lifecycle stages of clusters in mind.<sup>32</sup>

### **Learning networks**

Another area where networks can help is in diffusing existing knowledge – essentially reaching the long tail of less experienced firms with knowledge which, whilst not new to the world, is new to them and whose application can enhance productivity. One AIM study has been looking at how such mechanisms can accelerate the take up of innovative practices – for example, in the use of new manufacturing techniques.

Work in South Africa, for example, indicates that collaboration in 'learning networks' significantly enhanced the ability of automotive component manufacturers to absorb and deploy new manufacturing knowledge and catch up with the world frontier in terms of productivity indicators like quality, cost and delivery performance.<sup>33</sup>

Learning networks can be configured in a variety of ways – another option is to organise across supply chains to provide the framework for sharing and transferring learning about innovative practices. A third option is to mobilise at sector level – as has been the case with the Industry Forum approach in the UK automotive sector.<sup>34</sup>

### Building new networks

AIM research<sup>35</sup> also examined the specific strategies firms can use to gain access to new networks of partners, customers and suppliers – especially when faced with disruptive threats of the type discussed earlier. This research makes a critical distinction between the strategies used to identify new partners, and the strategies used to build relationships with partners once they have been identified. It highlights a number of specific approaches that have been successful for such firms as BT, GSK, the BBC, AstraZeneca, and Rio Tinto (see below).

Lessons for managers in creating new networks<sup>36</sup>

- Two distinct activities: *Finding* the right prospective partners; and *Forming* relationships with those prospective partners.
- Where the challenges in finding and forming relationships are relatively low, approach potential new partners directly, and structure the relationship to minimise whatever obstacles separate you.
- Where the challenge is mostly around finding new partners, approach them through boundary spanners or scouts who specialise in such activities, and work hard at building the capability to absorb insights from these partners.
- Where the challenge is mostly around forming new relationships with prospective partners, focus on the higher-order purpose that transcends ideological differences, and try to identify cross-over individuals who can link the different parties.
- Where the challenge involves finding *and* forming new networks, be prepared to work with specialist and independent network-builders to bridge the gap, and look for ways of gradually breaking down barriers to enable the approaches identified above to work.
- Once the new relationships have been formed, to turn them into high-performing networks it is necessary to: keep the network fresh and engaged; build trust and reciprocity across the network; understand your own position in the network; and learn when to 'let go' of old relationships.

Policy can also play an important role in encouraging the establishment and development of networks. AIM Research has explored innovations in design principles and build processes in the construction of luxury yachts. UK based independent design houses have played a major role in these, but the majority of construction takes place elsewhere. The DTI and British Marine Federation have combined to establish the Superyacht UK initiative in order to promote UK producers internationally.<sup>37</sup> The Cox Review<sup>38</sup> identified a key challenge for the UK was in realising the full potential of applying creativity more widely. The example below from the superyacht industry shows how leading edge-creative designers have combined with key actors in a mature 'smoke-stack' industry to help create a new growth area.

#### Exhibit 8: Combining UK creativity and industrial heritage

The UK is home to the majority of the world's leading independent designers for superyachts (luxury ocean-going vessels of 24 metres or more). For a variety of reasons these designs have usually been constructed by European boatyards with Dutch and German competitors leading the way.<sup>39</sup> Recently, however, UK yards have made some inroads into this growing market.

The most promising example has been the collaboration between Devonport Yachts and Andrew Winch Designs.<sup>40</sup> Project 54 is an 82 metre luxury yacht currently being constructed at Royal Devonport dockyard. The yard dates back to 1691 and has been a key site for Royal Navy shipbuilding for centuries. Now owned and run by DML Group it has diversified, building lifeboats and superyachts as well as working on MoD projects.



# 5

## Making the most of international firms in the UK

The challenge of increasing the innovative capacity of the UK is complicated by the fact that approximately 40 percent of companies in the private sector have non-UK based parent companies. Major UK businesses such as Powergen, Thames Water and Nycomed Amersham are fully-owned subsidiaries of foreign multinationals, and entire industry sectors, including car manufacturing and financial services, are dominated by foreign companies.

Foreign ownership has obvious benefits: it provides UK companies with greater access to capital, cutting-edge technology, and new managerial practices. However, foreign ownership comes at a price: a loss of autonomy and influence for senior executives; and a concern that important decisions will not be made in the best interests of the UK economy.

AIM research has addressed these concerns in two very different ways. One study<sup>41</sup> focused on the strategic issues facing subsidiary operations in the UK, with a view to understanding how much influence subsidiary managers have over their own destiny, and the extent to which they are able to drive new ideas and innovation projects. The research confirmed that UK subsidiary managers typically have low degrees of autonomy (compared, for example, to subsidiary managers in Canada or Australia that are further away from their parent company HQs), but also that low autonomy was not necessarily a bad thing. Rather, the key factors that made a difference in terms of upgrading the subsidiary's activities and influence were 'initiative taking' strategies aimed at acting on opportunities in the local market, and 'profile building' strategies aimed at raising awareness back at HQ of what the subsidiary company was good at.

### **Technology sourcing from overseas**

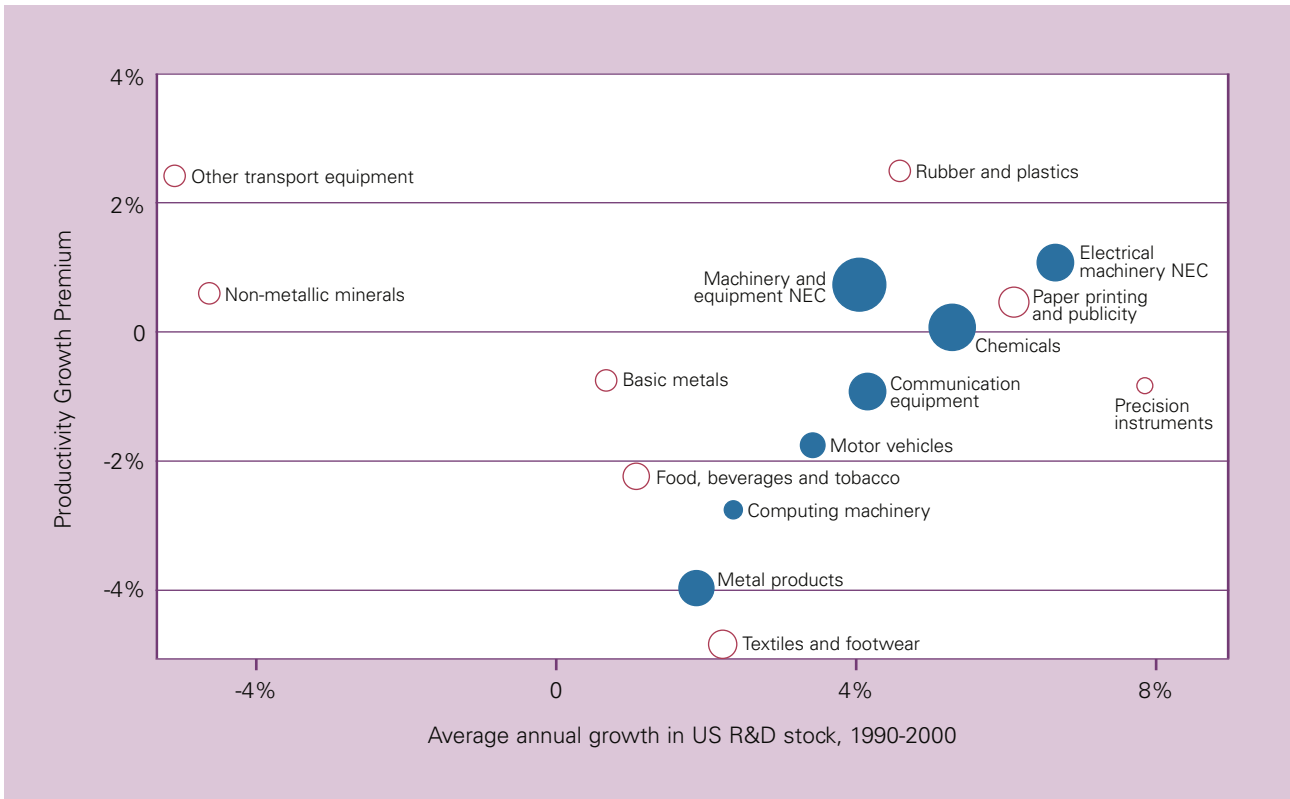
AIM researchers also looked at the benefits of innovation networks that cross national borders for foreign-owned companies. Research<sup>42</sup> examined the effects of UK plc investing in R&D in other countries. In particular, it considered the effects of technology transfer from the US into the UK – often referred to as technology sourcing or 'spillovers'.

UK firms operating abroad access new ideas and technologies and can transmit these back to the UK. Previous research has emphasised the importance of technology sourcing as a method of gaining access to foreign know-how. Firms can tap into leading edge knowledge, for example, by setting up overseas R&D labs close to clusters of innovative activity, and use this knowledge to improve productivity in their home operations.

AIM research<sup>43</sup> examined whether technology sourcing in the US had a beneficial impact on UK firms during the 1990s. The findings suggest that UK firms with R&D activity located in the US benefited more from US R&D spillovers than firms that were not located there.

This is illustrated in the Figure below. It is clear that the productivity premium is larger in those industries where the US had faster R&D growth. The shaded industries are those where the US already had a substantial technological lead over the UK in 1990 and where UK firms had the most to learn. For these 'high gap' sectors, the upward sloping relationship is particularly striking.

This evidence suggests a possible trade off between encouraging the location of R&D activity in the UK and gaining access to cutting edge technologies. This suggests that support for domestic R&D activity is justified by spillover benefits to other UK-based economic activity. But the foreign R&D activity of UK multinationals, especially in the US as the world leader in many areas of technology, is also likely to benefit the UK by increasing the productivity of UK firms.



**Sharing knowledge**

Knowledge flows are clearly important to innovation – especially when they involve technology transfer from one country to another. Another AIM research project looked at how information and know-how flows around organisations. The study compared knowledge sharing in multi-national companies and multi plant firms.

The findings<sup>44</sup> suggest that multinationals are more likely to share information with other parts of the business than comparable multi-plant firms. These information flows are strongly correlated with reported innovation activity. This result supports the idea that knowledge transfer is an important factor in explaining the competitive advantage of multinationals.

Firms that export or, better still, are part of a multinational enterprise tend to have higher productivity than their purely domestic counterparts. Gaining a better understanding of this correlation is a very active area for current research. AIM research suggests that one of the main drivers of differences in productivity is differences in knowledge.

The AIM research looked at several thousand UK firms covering all industries from 1994 through 2000. For each firm the study examined multiple detailed measures of knowledge outputs, knowledge investments, and sources of existing knowledge. The findings indicate that globally engaged firms innovate more. But this is not just because they use more researchers; it is also because they learn more from more suppliers and customers, universities, and other network contacts. The relative importance of knowledge sources also appears to vary with the type of innovation.<sup>45</sup>

There is also evidence<sup>46</sup> that this sort of knowledge brought by multinational firms then spills over to local firms. This suggests that providing incentives to encourage multinationals to come to a host country – for example, by offering subsidies as many countries do – can be an effective strategy. But the research also suggests that the subsidies currently paid are, in some cases at least, too high.

# 6

## Recommendations

### **Embrace open innovation**

Globalisation presents many new challenges. Policies that focus on increasing domestic activity, and particularly encouraging firms to relocate R&D away from international centres of excellence, may come at a cost of isolating these firms from international markets and knowledge systems. In addition, focusing policy on larger firms risks further strengthening the position of large dominant firms.

Changes in the economic environment now favour greater flexibility. It is important to focus on policies that facilitate entry and exit and experimentation, and allow successful entrants to grow and challenge the market position of incumbent firms. The sorts of institutional reforms that matter are complementary policies promoting flexibility: higher education, well functioning financial markets, flexible labour markets that encourage the acquisition of general skills, and greater cooperation between the science base and private sector.

At a national level competition in R&D is not between countries; it is between research teams which operate within and across countries. It is vital therefore to ensure that conditions in the UK are conducive to research teams succeeding here, and to UK firms succeeding in research that is carried out in other parts of the world. The UK Government's anti-protectionist stance is clearly one that helps promote greater international collaboration.

### **Make mastering higher-order innovation a priority**

It is critical that UK firms prepare for discontinuous shifts. Specifically, UK managers need to find ways to:

- Broaden their vision, to look out for possible discontinuities signals. This can be achieved by setting up networks and broadening the scope of research.
- Develop alternative strategic frames. Using different business models to examine discontinuities. For example, Shell has built on its extensive scenario planning experience through a programme called Gamechanger, which seeks to identify forces that will change the rules of the game.
- Extend resource allocation. Being flexible with resource allocation is critical when a firm is experiencing discontinuities.

### **Engage with international innovation networks, including clusters**

AIM research suggests that policymakers should consider a range of measures to stimulate the formation of innovation networks. These include:

- Establishing centres for collaboration in priority areas.
- Fostering the diversity of partners, e.g. actively promoting local SME networking, and pump priming funding for foreign research collaboration.
- Establishing more network intermediaries in universities and colleges.
- Strengthening the role of business angel networks on a local (sub-regional) level.
- Encouraging syndicated investments to improve the quality and the quantity of investment in entrepreneurial firms.

Policies in this area (to develop clusters, but also for innovation in general) need to have a long time frame – decades rather than years. Policy should be consistent and clear in its direction. There have been a lot of changes to policy recently, following various innovation reviews; an important principle in this (as in other) areas is that policy shouldn't change too frequently. Too much change will lead to uncertainty and mean that policy is less effective at encouraging firms to change their behaviour. (Investing in innovation is a long term goal; if firms don't know what future policy will be then they will be less likely to invest.)

Our research also indicates that firms should:

- Proactively manage their networks and networking activities.
- Actively seek out and participate in i-works.

- Collaborate with third parties such as trade associations, consultants and science partners who can act as neutral network brokers.
- Recognise that venture finance networks offer more than just funding.

The first step, however, is for senior managers and policymakers in the UK to realise that networking is a critical capability for UK organisations – and should be managed as such. Companies need to manage knowledge spillover, but they also need to recognise that in the global economy no company can afford to be an island. The failure to develop networking capability is a self-limiting strategy.

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