LLAKES
CENTRE FOR LEARNING AND LIFE CHANCES IN KNOWLEDGE ECONOMIES AND SOCIETIES

IOE LONDON
Leading education and social research
Institute of Education University of London

Rethinking industrial policy design in the UK: foreign ideas and lessons, home-grown programmes and initiatives

Geoff Mason and Max Nathan

LLAKES Research Paper 48

Centre for Learning and Life Chances in Knowledge Economies and Societies

LLAKES is an ESRC-funded Research Centre - grant reference ES/J019135/1.

To request printed copies of this paper or other LLAKES Research Papers,
please contact the LLAKES Centre - llakescentre@ioe.ac.uk.

To view this and other LLAKES Research Papers online, please visit www.llakes.org.

Rethinking industrial policy design in the UK: foreign ideas and lessons, home-grown programmes and initiatives

Geoff Mason and Max Nathan

National Institute of Economic and Social Research, London; and Centre for Learning and Life Chances in Knowledge Economies and Societies (LLAKES), Institute of Education, University of London

List of Contents

Tables

Abstract

There is now renewed interest in the UK in the potentially beneficial economic effects of industrial policy, that is, government policies designed to influence the structure of output and employment. Much public discussion and debate on this subject emphasises the lessons that can be learned from other countries which have proved in recent decades to be more successful in terms of innovation and the commercialisation of the results of research and innovation. However, there are no guarantees that particular industrial policies that have worked well in different times and countries will enjoy similar success in the future, even in those same countries, let alone in other places. Furthermore, in the UK as in other countries, product and labour markets and socioeconomic institutions have their own deeply rooted characteristics that need to be taken into consideration in the design and development of industrial policies and programmes.

In this paper we argue that new efforts to design effective industrial policies in the UK need to be informed, not just by foreign examples, but by past experience of what has worked well and what has worked badly in terms of previous industrial policy endeavours in the UK. We examine these issues by focussing specifically on programmes and initiatives that have sought to improve UK innovation performance by fostering knowledge transfer flows and research collaboration between firms in particular sectors and between firms and universities, and by promoting the development of industrial clusters. We identify examples of both successful and unsuccessful UK policy borrowing from other countries and varying degrees of success in home-grown policies and programmes.

A key constraint on industrial policy design in the UK is the relatively low level of research and innovation activity by UK-based firms (as compared with firms in many other countries that the UK is urged to emulate). This has contributed to failed efforts to develop a UK equivalent of the US Small Business Innovation Research programme and also imposes limits on any attempts to scale up relatively successful home-grown programmes such as Knowledge Transfer Partnerships. In order to try and increase the proportion of UK firms which engage in innovation, priority needs to be given to policies which target firms that are currently not undertaking innovative activity but which face commercial pressures to start doing so.

We identify some key mechanisms which may help in this process, all of them with implications for the delivery of industrial policy at sub-national level:

First, firms with innovative potential but little or no prior track record in innovation will need external advice and support if they are to stand a chance of breaking into supply-chains in innovation-intensive sectors such as automotive, aerospace and renewable energy. Well-funded regional agencies would be best placed to identify firms with such potential and help broker relationships between these firms and Research and Technology Organisations (including the new Catapult centres) and universities, with the aim of helping firms fill gaps in their skills and knowledge and develop links with lead contractors in supply-chains.

Second, it is notable from evaluation evidence that many recipients of government R&D grants subsequently found it easier to obtain finance from banks and other sources, suggesting that prior awards of R&D grants serve as endorsements of the firms concerned so far as lenders are concerned. This process depends on the detailed scrutiny that business applicants receive when applying for government R&D grants and adds to the case for a regionally-based Business Bank to provide SMEs with relationship banking services rather than process credit requests through a computerised scoring procedure. The aim would be for business lenders to base their responses to credit requests on a deep understanding of different firms' commercial prospects, especially innovative SMEs.

Third, our review of the evidence on the performance of cluster policies suggests that successful clusters of high-performing firms in particular sectors tend to develop organically through the decisions of firms and individuals and the interactions between them. Rather than provide support for cluster development of this kind, industrial policy initiatives seeking to foster innovation and growth in specific regions should give more attention to the benefits and costs of agglomeration and the evidence of what makes some cities and their surrounding regions more productive than others. 'Agglomeration policies' should aim at increasing the benefits of urban location (for example, by improving skills and infrastructure) while reducing some of its costs (eg, congestion).

1. Introduction[1]

From the early 1980s until the mid-2000s, the concept of 'industrial policy' – specifically referring to government policies designed to influence the structure of output and employment – was largely excluded from serious consideration in the UK. Under both Conservative and Labour administrations during this period, UK policy-makers turned against industrial policies which sought to rectify 'market failures' by channelling government assistance to selected sectors and firms to help improve their innovation and growth performance. This outlook reflected concerns that attempts to 'pick winners' are not only unlikely to be cost-effective but may also interfere with market-induced restructuring of output and employment. Instead, the UK joined with many other OECD member states in shifting attention towards 'horizontal' approaches to industrial policy which focus on framework conditions conducive to improved competitiveness in a wide range of sectors (eg, freeing up markets and increased support for university-based research and for skills development) (OECD, 2009).

However, since the mid-2000s, new counter-arguments to the abandonment of sector-focussed initiatives have emerged. For example, Rodrik (2004) suggests that market failures such as imperfect information leading to under-investment in innovation can be addressed by 'strategic collaboration between the private sector and the government with the aim of uncovering where the most significant obstacles to restructuring lie and what type of interventions are most likely to remove them' (2004: 3). Aiginger (2007) notes that even horizontal policies have different effects on sectors which vary, for example, in terms of their involvement in innovation and utilisation of skills.

[1] We are grateful for support for this project from the Economic and Social Research Council (ESRC) Centre for Research on Learning and Life Chances in Knowledge Economies and Societies (LLAKES), ESRC grant reference RES-594-28-0001. The ESRC is not responsible for views expressed in this paper. We are grateful to NIESR and LLAKES colleagues for helpful comments on previous drafts of this paper. Responsibility for any remaining errors is ours alone.
This work makes use of data from the Community Innovation Survey which were supplied by the Secure Data Service at the UK Data Archive. The data are Crown Copyright and reproduced with the permission of the controller of HMSO and Queen's Printer for Scotland. The use of the data in this work does not imply the endorsement of ONS or the Secure Data Service at the UK Data Archive in relation to the interpretation or analysis of the data. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

Thus in designing industrial policy there is a now a greater readiness to consider a mix of horizontal and sectoral approaches. Aiginger and Sieber (2006) argue that, at a time of globalisation and economic crisis, European Union member states can benefit from horizontal policies being complemented by sector-specific strategies, which they dub a 'matrix' approach. Aghion (2012) also highlights the 2008 financial crisis as a factor inducing many policy-makers to rethink their approach to industrial policy, along with the apparent success of China's pro-active approach to the development of selected industries.

In the UK this renewed interest in sector-focussed strategies is reflected in a 2012 statement by the Secretary of State for Business, Innovation and Skills, Vince Cable, which announced plans for government actions intended to develop collaborative strategic partnerships with 'key sectors' and support emerging new technologies with growth potential as well as boosting workforce skills, introducing a more strategic approach to government procurement and improving access to finance for small and medium-sized enterprises (SMEs).[2]

In a supporting analytical paper, BIS (2012) argued that government policies are likely to be more effective if they take due account of sector-specific characteristics (for example, the sources of competitive advantage and the tradability of outputs and inputs) and the fact that businesses often organise themselves in terms of sectors in order to address particular issues and problems. In addition, some government policies (for example, in procurement and regulatory areas) inevitably affect some sectors more than others, while some sectors may be better placed than others to help achieve broadly defined policy objectives such as mitigating climate change.[3]

---

[2] Vince Cable, Speech at Imperial College, 11 September 2012, 'Industrial Strategy – Cable outlines vision for future of British industry', https://www.gov.uk/government/speeches/industrial-strategy-cable-outlines-vision-for-future-of-british-industry [accessed 8.7.2014]

[3] Specifically, BIS (2012) proposes that the bulk of government support should be directed to the following sectors which are identified as having good prospects for increasing innovation, productivity and employment in the future and facilitating growth in other sectors which use their products:

- Advanced manufacturing (such as aerospace, automotive and pharmaceuticals manufacturing)
- Knowledge-intensive traded services (such as professional and business services)
- 'Enabling sectors' which strongly affect performance across the wider economy (such as energy and construction)

These sectors are very broadly defined and details of which particular activities within these sectors will be given priority are only starting to emerge. For example, Willetts (2013) announced new

In addition, support for industrial clusters remains high on policy-makers' agendas. Economic activity is unevenly distributed, and many sectors exhibit substantial concentration. Cluster policies along the lines suggested by Porter (1990, 2000) have not generally been successful – see Martin and Sunley (2003) and Duranton (2011) for two overviews of the evidence. However, the UK government has kept the cluster policy concept alive (Foord, 2013) as indeed has the US government (Yu and Jackson, 2011).

One feature of the public discussion and debate regarding industrial policy in the UK is the emphasis on apparent lessons that can be learned from other countries which have proved in recent decades to be more successful than the UK in terms of innovation and, especially, in commercialising the results of research and innovation. Thus, for example, it is often suggested that the UK has much to learn from foreign organisations involved in bridging the gap between university-based research and business innovation such as the Fraunhofer Gesellschaft in Germany and the TNO **(**Organisation for Applied Scientific Research) in the Netherlands (Mina, Connell and Hughes, 2009; Hauser, 2010; House of Commons Science and Technology Committee, 2011). Similarly, Dyson (2010) and Mazzucato (2011) argue that the UK should strive to emulate US models of using public procurement to stimulate innovation by SMEs. In a wide-ranging review of innovation policy, the National Endowment for Science, Technology and the Arts (NESTA) notes that public investment in innovation in the UK is proportionately much smaller than in other countries such as the US, France, Germany and South Korea and holds up the US as a positive example of 'lavish investment in science and technology, mission-related health and defence funding, state-backed investment programmes and pro-business procurement policies' (NESTA, 2012:43).

However, there are good reasons for caution in advocating that the UK follow other countries' policies in striving for greater success in innovation and commercialisation of new discoveries. For a start, some perceived foreign strengths may not be as great or wide-ranging as they are sometimes portrayed. And even if particular industrial

---

government investment in science capital in support of 'eight great technologies' which are likely to have applications in a range of sectors: energy-efficient computing, satellites, robotics, synthetic biology, regenerative medicine, agricultural technologies, new advanced materials and energy storage.

policies have worked well in different times and countries in the past, there is no guarantee that they will enjoy similar success in the future in those same countries, let alone in other places. As in other countries, product and labour markets and socioeconomic institutions in the UK have their own deeply rooted characteristics which need to be taken into consideration in the design and development of sector-based policies and programmes.

In particular, industrial policy design in the UK needs to confront a level of research and innovation activity which appears to be markedly lower than in many other countries that the UK is urged to emulate. First, comparisons of research and development (R&D) spending suggest that business spending on R&D in the UK (expressed as a proportion of value added in industry) has been falling since the 1990s and is now substantially lower than in countries such as the US, France, Japan, Sweden and Denmark (Hughes and Mina, 2012).[4] Second, the UK compares unfavourably with these countries in respect of a more broadly-defined set of innovation-related investments (including intangible assets such as software and firm-specific human capital as well as machinery and equipment) (ibid). Third, in line with the comparisons of aggregate R&D spending, there is evidence that the proportions of UK-based firms which may be classified as 'innovators' are lower than in leading competitor nations such as Germany, France and the US (Abramovsky, Harrison and Simpson, 2004; Cosh, Hughes and Lester, 2006).

Comparatively low levels of investment in innovation in the UK in recent years contrast with heavy investment in buildings and property prior to the onset of financial crisis in 2008 (NESTA, 2012) and appear to reflect underlying incentive structures in the same way as relatively weak demand for skills -- which can be attributed to the profitable business opportunities available in many low-skill low-innovation product and service areas in the UK (Mason, 2011). Given comparatively low levels of business investment in innovation, UK industrial policy faces real difficulties – seemingly greater than in many other advanced industrial countries – in

[4] This assessment applies even after adjustments are made for inter-country differences in industrial structure to allow for the fact that different industries have different propensities to engage in formal R&D (Hughes and Mina, 2012). It is worth noting that, by international standards, research-intensive UK-owned multinational firms carry out a relatively high share of their R&D spending in foreign locations. However, this is more than offset by the relatively high share of UK-based R&D spending which is carried out by subsidiaries of foreign-owned multinational firms (ibid).

trying to stimulate companies that have never previously engaged in innovation to start doing so.

Given these and other challenging features of the UK innovation landscape, it is arguably all the more important to ensure that new efforts at sector-focussed industrial policy are informed, not just by foreign examples, but by past experience of what has worked well and what has worked badly in terms of previous industrial policy endeavours in the UK. Accordingly, in this paper we review existing research and evaluation evidence on the success or otherwise of some past and present UK industrial policies. Rather than attempt to cover all aspects of industrial policy, we focus in depth on two key aspects of innovation performance, namely, knowledge generation and transfer, and the commercialisation of research discoveries. We also critically examine the evidence on policy-makers' efforts to support industrial clusters. We suggest that, only with this kind of analysis, can sound decisions be made about what foreign ideas and lessons (if any) can be usefully applied in the UK market and institutional context.

The paper is ordered as follows: Section 2 assesses policies and programmes designed to enhance the commercialisation of new products and technologies. Section 3 focusses on policies and programmes aimed at increasing knowledge exchange and transfer, relationship-building between firms and other organisations and the development of firms' capacity to make effective use of knowledge generated outside each firm. Section 4 examines how programmes and initiatives can best be delivered at sub-national level and considers evidence on the impact of government policies designed to promote the geographical clustering of firms in particular sectors. In the light of these analyses, Section 5 summarises our main findings regarding the success or failure of past efforts by UK governments to learn from industrial policy programmes in other countries. We then discuss how industrial policy design could be improved to help build on areas of relative strength in the UK economy and address areas of weakness such as the limited availability of finance for innovative firms (especially SMEs).

2. Improving commercialisation of new products and technologies

2.1 Knowledge transfer between universities and businesses

Over the last 20 years UK government documents on science, engineering and technology policy have repeatedly argued for the importance of supporting innovation networks and recognised the fact established by much research on innovation that productive knowledge transfer between universities and firms is invariably two-way rather than one-way in nature. In 1993 a White Paper published by the Department for Trade and Industry stated:

> "The Government welcomes [proposals to increase] ….the two-way flow of industrial technology and skilled people behind the [academic] science and engineering base and industry; partnerships between the science and engineering base; core research underpinning product and process development; and industrially relevant postgraduate training"
> DTI (1993), *Realising our Potential: A Strategy for Science, Engineering and Technology*, White Paper, Cmnd 2250. London: HMSO, p14

Similar points can be found in White Papers published 15 and 18 years later by different governments:

> "Enabled and accelerated by new technologies, innovation is becoming more open. Organisations are increasingly reaching outside their walls to find ideas – to universities, other companies, suppliers and even competitors. Users are also increasingly innovating independently or in collaboration with businesses or in the co-creation of public services. Government policy needs to recognise these new sources of innovation and, in particular, develop new instruments that drive demand for innovation as well as its supply".
> DIUS (2008), *Innovation Nation*, White Paper, Cm 7345. London: The Stationery Office, p4

> "We know that competition is important in driving the quality of research and business innovation. However, there is overwhelming evidence to show that multi-partner collaborations can add more than the sum of their parts. That's why some funding encourages and supports collaboration, both between researchers and with business**….**We will continue to look for other ways to encourage more relationships between universities and business".
> BIS (2011), Innovation and Research Strategy for Growth, White Paper, Cm 8239, London: The Stationery Office, p3

A useful overview of university-business interactions in the UK is provided by the annual Higher Education, Business and Community Interactions (HE-BCI) survey which gathers information on the different types of income which universities earn through external interactions. Table 2.1 shows how universities differ in their main sources of external income according to how much each university can be classified as ‘research-active’. In this table collaborative research refers to research projects which involve both public funding and business funding. Contract research refers to research contracts between universities, firms and other organisations which are arranged independently of public funding.

Table 2.1: Average income per academic professional in UK universities, 2008, analysed by Research Assessment Exercise (RAE) Group

	RAE Group			
	1	**2**	**3**	**Total**
	Average income per academic professional (£ per year)			
Income-generating activity				
Collaborative research involving both public funding and funding from business	6854	5940	1829	4997
Contract research	10700	6687	1494	6114
Consultancy contracts	1614	2935	2032	2399
Facilities and equipment-related services	691	1029	278	748
Continuing professional development (CPD) courses and Continuing Education (CE)	2374	3252	4748	3477
Intellectual Property (IP) income	650	316	124	335
Number of universities: n =	*12*	*54*	*59*	*125*

Sources:
Income: Higher Education, Business and Community Interactions Survey (HE-BCI); Academic professional employment: Higher Education Statistics Agency (HESA).

As expected, average collaborative and contract research income per academic professional is highest in universities ranked as Group 1 on the basis of their scores in the 2008 Research Assessment Exercise (RAE). [5] However, for Group 2 universities, research contracts of both kinds are also very substantial sources of income. In the case of reported consultancy income per academic professional, both Group 2 and Group 3 universities do better than Group 1 universities but for Group 2 universities (as for those in Group 1), reported consultancy income is much less important than income from research contracts with business partners. [6] The single largest source of

[5] See Mason, 2014, Annex A for a full listing of universities by research group based on the RAE 2008.
[6] Caution is needed in interpreting these differences between different types of university on reported consultancy income since, in more research-intensive universities, professors may be allowed to undertake private consultancy activities which are not picked up in the HE-BCI survey.

income for Group 3 universities is from provision of training and continuing professional development (CPD) courses. It is notable that, for all three groups of universities, income from research and consultancy contracts with businesses greatly exceeds income received from sale of Intellectual Property (IP) products such as patents, technology licenses and software.

Growth over time in many forms of university-business interaction reflects a much higher level of university responsiveness to income-earning opportunities than existed prior to the 1990s (Kitson et al, 2009). However, the firms involved in these interactions still constitute only a small minority of all UK firms. In the Community Innovation Survey (CIS) covering the period 2008-10, about 10% of UK firms said that university information sources contributed to their innovation activities but only 3% of firms said that these information sources were of high or medium importance. About 4% of firms reported formal involvement in innovation partnerships with universities.[7]

The limited number of innovation partnerships between firms and universities has contributed to concerns about the UK's comparative failure to take commercial advantage of new knowledge generated in the academic science base. Successive UK governments have sought with varying degrees of enthusiasm to learn from foreign examples of how to improve commercialisation of new products and technologies. Here we examine some of these efforts to learn from foreign examples under two main headings: (1) the use of public procurement to support business innovation; and (2) the role of organisations which seek to intermediate between firms and universities in support of commercialisation objectives.

[7] Own estimates derived from analysis of CIS data held by the UK Data Service (see Footnote 1 for further details). Equivalent results from the last CIS carried out before the 2008-09 recession, covering the 2006-08 period show higher levels of firm involvement with universities: about 15% of firms said that university information sources contributed to their innovation activities during this period (with 4% saying that university information sources were of high or medium importance. About 6% reported formal involvement in innovation partnerships with universities. BIS (2013) points out that CIS results for 2006-08 are not directly comparable with those for 2008-10 due to changes in sampling procedures and survey design; however, they conclude that 'it seems safe to say that there was a fall of several percentage points in the number of innovation active firms over the period' (BIS: 2013: 7)

2.2 Public procurement and business innovation

As major purchasers of goods and services, governments are often seen as well placed to support innovation by playing the role of 'advanced' or 'demanding' customers, requiring or encouraging their suppliers to meet technological challenges of different kinds (Edler and Georghiou, 2007; Aschhoff and Sofkaa, 2009; see Uyarra and Flanagan, 2009, for a contrasting view).

US government expenditures on research and innovation in defence- and health-related areas provide an early example of this kind of procurement contributing to the development of new products and services, not just by providing a market for such products in their early phases but also by enforcing high standards and encouraging competition among suppliers (Geroski, 1990). The concerted nature of US policies of these kinds included bringing firms, universities and other organisations involved in innovation together in a number of different ways and has been likened to a 'hidden developmental state' in action (Block, 2008).

One particular example of US procurement policy aimed at fostering innovation is the Small Business Innovation Research (SBIR) programme under which 2.5% of several US federal agencies' external research budgets has, since 1982, been made available to innovative SMEs through competitive tenders. SBIR evaluations point to considerable success in stimulating the commercialisation of new products and technologies and the future growth of SMEs participating in the programme (Lerner, 1999; Audretsch et al, 2002).

In 2001 the UK government made a first effort to emulate the US SBIR by setting up a counterpart programme, namely, the Small Business Research Initiative (SBRI). This met with very little success due to non-participation by many government departments and a failure to ensure that contracts were provided for technology development rather than for other services provided by SMEs (Connell and Probert, 2010). In 2006 a new version of the UK SBRI programme was re-launched under the wing of the Technology Strategy Board (TSB) which is a public body reporting to the Department for Business, Innovation and Skills. The new SBRI now appears to be working more effectively than its predecessor but is still operating on a very small scale by US standards (Holland, 2009; Bound and Puttick, 2010).

Although the new SBRI is not explicitly aimed at SMEs, TSB guidance states that 'it is expected that SBRI opportunities will be particularly attractive for SMEs'. [8] Successful applicants are typically awarded a short-term Phase 1 contract (typically up to £100,000) to explore the feasibility of proposed solutions to problems identified by government departments. If this work proves successful, they may then become eligible for further Phase 2 contracts (up to £1 mn) to develop working prototypes of their products. This process is expected to lead to eventual commercialisation with the assisted firms competing for public sector contracts as well as seeking private market opportunities.

Preliminary assessments suggest that recent SBRI grants have helped government departments to develop new relationships with previously unfamiliar UK-based suppliers, for example, in areas of healthcare and house building technology (Bound and Puttick, 2010). This progress has been facilitated by the TSB playing an active role in 'matching' government departments to SBRI grant applicants through its Knowledge Transfer Networks, in which some 70,000 firms participate in on-line networking. Many of the successful applicants have benefited not just from the initial 100% grants for development contracts but from the way in which such 'endorsements' from government departments have helped with subsequent fund-raising from private investors (ibid).[9]

As a result of these initial successes, the TSB now expects the value of SBRI contracts to rise from £40 mn in 2012-13 to over £100 mn in 2013-14 and £200 mn in 2014-15.[10] The ability to achieve growth on this scale while maintaining quality will depend heavily on whether government departments can adjust their commissioning

---

[8] https://www.innovateuk.org/-/sbri [accessed 8.7.2014]

[9] Note that it is beyond the scope of this paper to attempt to evaluate the quality of evaluation evidence in detail. A number of the evaluation studies referred to in Sections 2-4 focus on process – policy design and implementation – rather than trying to identify the causal impacts of the policy (on, say, firm births or levels of innovative activity). One of the main forward tasks for policymakers is to commission more impact evaluations of existing policies and programmes.

[10] https://www.innovateuk.org/-/sbri [accessed 8.7.2014]

practices quickly enough to fit in with the programme's objectives. Expert evidence presented to a recent House of Lords Select Committee hearing suggests that this kind of adjustment cannot be taken for granted unless there is strong Treasury support for the process and unless better means of coordination between central and local government are found.[11]

As with other government programmes designed to support innovation, the question will also arise as to whether there are sufficient UK firms (particularly SMEs) with innovation potential to allow the SBRI to be scaled up in this way. In 2010 Phase 1 SBRI funding was awarded to about 16% of applicant companies which is a similar success rate to applicants to the SBIR programme in the US (Bound and Puttick, 2010). However, the US programme is operating on a proportionately much larger scale than in the UK. Therefore, the UK's ability to meet the quality challenge inherent in scaling up SBRI may depend on the success of other programmes in expanding the number of firms with innovative capacity (discussed below in Section 3).

The difficulties which have been encountered in UK efforts to emulate the US SBIR model highlight the problems involved in policy borrowing from one country to another. We now go on to consider a different area of industrial policy – how to improve the commercialisation of research results generated in the academic science base – in which UK efforts to learn from foreign policy practices appear to have better chances of success.

2.3 Intermediating between firms and universities in support of commercialisation objectives

As in many countries, there are a number of organisations in the UK that help to bridge the gap between the academic knowledge base (universities and independent research institutes) and firms which might be able to make use of academic research results in bringing new products and services to market. Several dozen of these organisations – known as RTOs (Research and Technology Organisations) – work

[11] House of Lords Select Committee on Science and Technology Inquiry on Public Procurement, 11 January 2011.

with university-based researchers and with businesses to encourage and support commercial development of research discoveries. These RTOs are estimated to undertake about a third of all UK-based extramural expenditure on R&D by UK firms (Oxford Economics, 2008).

Many RTOs play a catalysing role in helping firms to gain access to knowledge generated beyond their own boundaries and find solutions to problems which arise in the course of new product development. In a survey of RTO clients, large proportions said that they could not have achieved the same innovation results if they had worked solely in-house or had sought to develop their own relationships with universities. RTO services are particularly important to SMEs, which lack the resources that larger R&D-intensive organisations can devote to external knowledge sourcing (ibid).

However, it has long been understood that RTOs in the UK are at a disadvantage compared to similar intermediary organisations in several other countries because of their lack of core government funding (Rothwell and Dodgson, 1993; Mason and Wagner, 1999; EARTO, 2007). Although many RTOs have won publicly-funded research grants over the years, these have typically been time-limited and RTOs have been forced to develop strategies for surviving in commercial markets for R&D-related services. For many this has contributed to pressure to engage in short-term consultancy activities, with potential negative effects on their strategic research capability and on their ability to stay in touch with developments in the academic science base (Arnold et al, 2010).

By contrast, the Fraunhofer institutes in Germany receive about one third of their budget as core funding and sizeable proportions of core funding are also made available to intermediating research and technology organisations in other countries such as the Netherlands Organisation for Applied Scientific Research (TNO), the Technical Research Centre of Finland (VTT) and the Electronics and Telecommunications Research Institute (ETRI) in South Korea. This core funding has been found to provide critical support for these organisations to engage in strategic research projects of medium- to long-term duration; develop in-house competences which enable them to search more widely for knowledge of potential use to their customers; and to purchase and maintain large-scale facilities and specialised equipment (EARTO, 2007; Arnold et al, 2010).

This evidence was reviewed in the Hauser (2010) report on technology and innovation in the UK, which recommended that selected organisations involved with commercialisation of new ideas and knowledge should be provided with approximately one-third core funding which should not be time-limited. In a welcome example of continuity in UK industrial policy, this recommendation was accepted by the previous Labour government and has now been implemented by the Coalition government with the recent establishment of seven 'Catapult' centres. These centres have an assurance of one-third funding through core grants and a brief to focus on 'late-stage late-stage research and development – transforming "high potential" ideas into new products and services to generate economic growth'.[12]

The Catapults are built around selected technology and innovation centres in the following technology areas which the government regards as strategically important and with a large global market potential:

- High value manufacturing
- Cell therapy
- Offshore renewable energy
- Satellite applications
- Connected digital economy
- Future cities
- Transport systems

To varying degrees the selected Catapult centres are already engaged in commercialisation through existing relationships between RTOs, firms and university departments. For example, the High Value Manufacturing Catapult comprises seven different centres in five regions of the country which are already working closely with universities and with firms from a number of different sectors such as aerospace, automotive, rail and electronics manufacturing. The Offshore Renewable Energy

[12] https://www.innovateuk.org/-/catapult-centres [accessed 8.7.2014]

Catapult will build on established links with firms and universities in Scotland, North East England and several other regions. Other Catapults such as those for Cell Therapy and Satellite Applications are currently based in single locations where clusters of organisations involved in the same technology area have developed. [13]

In the light of the evidence reported above, the assurance of core funding for the Catapult centres represents a useful example of learning from foreign examples which should enable the home-grown RTOs and university research centres on which they are based to achieve a higher level of performance in helping UK-based firms to make use of new knowledge generated through research in bringing new products and services to market. However, it will still be important for the Catapults to be operated in ways that take account of specific UK problems such as the relatively small proportion of innovative firms in most sectors and regional imbalances in research and innovation. We now turn in Section 3 to examination of home-grown policies and programmes that may help to increase the number of innovative firms. Later in Section 4.1 we discuss the balance between national and regional priorities in respect of the delivery of industrial policy.

[13] https://www.innovateuk.org/-/catapult-centres [accessed 8.7.2014]

3. Supporting collaborative research, knowledge exchange and network formation

3.1 Encouraging higher levels of innovative activity

Numerous UK government programmes and initiatives over the years have sought to encourage knowledge transfer and network building between firms and universities, and between firms themselves. This emphasis on knowledge transmission derives in large part from the pace of technological change in recent decades and the growth of 'open innovation', referring to the efforts of many firms to look beyond their own boundaries for economically useful knowledge (Chesborough, 2003; Von Hippel, 2005). By design many of these programmes address the specific British problem of relatively low levels of innovative activity by providing channels and mechanisms by which firms can step up their involvement in innovation. This is particularly true of programmes targeted at SMEs.

Here we focus on three programmes of particular interest, namely, Collaborative Research and Development (CRD), Knowledge Transfer Partnerships (KTPs) and the Higher Education Innovation Fund (HEIF). Both CRD and KTP are among the programmes administered through the Technology Strategy Board (TSB).[14] A breakdown of TSB spending on technology grants in 2011-12 is shown in Table 3.1. In total it dispensed just over £350 million in that year of which approximately 70% went to private sector firms, 20% went to universities and not-for-profit private organisations and the remaining 1% went to public sector recipients.[15]

Collaborative Research and Development (CRD) programmes are co-funded through government Research Councils as well as the TSB and are designed to encourage businesses and university-based researchers to work together on innovative projects in areas of science and technology that are deemed by policy-makers to be high-priority. As shown earlier in Table 2.1, collaborative research of this kind is heavily concentrated among research-intensive universities. A recent evaluation of CRD programmes identified positive outcomes for the majority of participating firms, for

[14] As discussed later in this section, HEIF is funded by the Higher Education Funding Council for England.
[15] Technology Strategy Board, Annual Report and Accounts, 2011-12, p55.

example, in improving technical knowledge and understanding, new product and process development, increasing employment and entering new markets. These firms comprised a mix of multinationals, large UK-based firms and SMEs (PACEC, 2011).

Table 3.1: Technology grants awarded by Technology Strategy Board, 2011-12

	Gross grants (including co-funding)	**% of total**
	£000	
Thematic interventions (including Collaborative R&D)		
Energy	25702	9
Sustainability	2699	1
Built environment	7153	2
Food supply	4072	1
Transport	28251	9
Space	3991	1
Healthcare	15315	5
High value manufacturing	19708	7
Digital services	15764	5
Advanced materials	6710	2
Biosciences	3958	1
Electronics, photonics and electrical systems	9605	3
Information and communications technology	6635	2
Development	1472	0.5
Sub-total	**151035**	**50**
Responsive interventions		
Small Business Research Initiative (SBRI)	3204	1
European Union	2715	1
Grant for Research & Development (GRD)	20277	7
Knowledge Transfer Networks (KTNs)	17926	6
Knowledge Transfer Partnerships (KTPs)	26889	9
Catapult Centres	42413	14
Micro Nano Technology Centres	2009	1
Non-core projects	35356	12
Sub-total	**150789**	**50**
TOTAL GRANT EXPENDITURE	**301824**	**100**

Source: Technology Strategy Board, Annual Report and Accounts, 2011-12.

R&D support of this kind plays a critical role in supporting relationships between universities and firms which already possess many of the capabilities required for innovation and for managing projects involving external partners. A survey of CRD participants in projects approved between 2004-09 found that nearly all of them already had some employees who engaged in R&D (PACEC, 2011). Thus CRD contrasts sharply with Knowledge Transfer Partnerships (KTPs) which are specifically aimed at encouraging hitherto less innovative firms to engage with universities as sources of useful knowledge and facilities.

KTPs began operating in 2003 as a direct successor to the Teaching Company Scheme (TCS) which dated back to 1975. Their key aim is to support the employment of science, engineering and business management graduates and postgraduates in firms, primarily SMEs, which need to build up their innovation capability and in many cases may have never previously employed graduates or postgraduates. This support is initially provided through TSB Advisers which help to bring firms together with 'knowledge base partners' (usually universities but also including independent research organisations) to develop KTP project proposals. Then, if proposals are successful, KTP grants contribute to the costs of employing graduates and postgraduates (termed 'Associates') in firms while projects are in progress and to the continued involvement of academic supervisors throughout each project.

Both KTPs (and before it TCS) have received largely positive evaluations over the years. In 2002 SQW (2002a) found that technology or knowledge transferred through employment of TCS Associates was new to 38% of the company partners concerned while another 45% said that company knowledge had been increased by participation in TCS. This had contributed to improvements in technical understanding and skills and firms' ability to manage innovation processes. However, only four in ten participants thought that their commercial objectives had been met. A later evaluation of KTPs also found room for improvement in their impact on business performance but still identified 'significant' positive effects of KTPs on sales and employment (Regeneris, 2010). This evaluation noted additional benefits in the form of enhanced innovation capacity, increased involvement in business networks and spillover effects on suppliers to participating firms.

Evaluations of how much schemes such as KTPs contribute directly to business performance need to take account of the fact that innovation is inherently risky and cannot always be expected to pay off in commercial terms or, if it does pay off, to do so on similar timescales in different firms (Coad and Rao, 2008). In this context it may be thought more important to assess whether KTPs simply help firms to enhance their innovation capabilities or to develop such capabilities for the first time, and to have lasting effects on firm behaviour in the process, and the evaluation evidence suggesting success by these criteria is strong (Regeneris, 2010; Ternouth et al, 2012).

Another key feature of KTPs is that many of them involve universities which are not highly ranked in terms of academic research outputs (Wilson, 2012) but nonetheless are equipped to play a useful role in assisting hitherto non-innovative firms to gain access to existing knowledge. Ternouth et al (2012) report no significant differences between Russell Group universities and post-1992 universities in their estimated effects on the success of KTP projects. Thus as well as helping to increase the proportion of innovative firms in the economy, KTPs also help to widen the breadth and diversity of university involvements with firms on innovation projects.

Operating in a very different way to KTPs, the Higher Education Innovation Fund (HEIF) also plays a role in stimulating university relationships with firms which have limited prior track records in innovation as well as with firms which are already active in innovation. This fund developed out of Higher Education Funding Council for England (HEFCE) support for 'third stream funding' designed to encourage universities to engage with business, public sector and the wider community (in addition to HEFCE's two main streams of funding for teaching and research). HEIF is estimated to contribute about 35-55% of the income reported by HE institutions to the HE-BCI survey shown in Table 3.1 above (Galsworthy and Knee, 2007).

The key mechanisms by which HEIF has helped universities to generate more income from interactions with firms have been employment of more staff dedicated to knowledge exchange activities (for example, in technology transfer offices), providing funds to buy out academics' time so they can participate in contract research of different kinds and providing funding for 'seed' and 'proof of concept' projects which enable preliminary investigation of the feasibility of ideas for commercialising research results (PACEC/CBR, 2009).

Evaluation studies suggest that HEIF has had positive impacts on the number and diversity of business customers for university services and has provided assistance for many firms, especially SMEs, with product innovation, training and marketing (SQW, 2002b; PACEC/CBR, 2009). HEIF has also contributed to university support for start-up firms through mechanisms such as business incubators (Robertson and Kitagawa, 2011). As with KTPs, a sizeable proportion of these relationships are with firms in universities' own regions and the greater emphasis on working with SMEs comes mainly from less research-active universities. This presents a strong contrast with the more research-active universities' preferences for engaging with large firms. However, in spite of these developments, PACEC/CBR report only 'modest change in culture among academics' in relation to third stream activities (2009:8). Many academics still see lack of time as a significant barrier to engaging with business customers.

3.2 Additional support for knowledge acquisition and innovation in SMEs

UK governments have also developed schemes designed to support innovation and external knowledge sourcing by SMEs that do not necessarily require collaboration with university-based researchers. These include the SMART scheme for provision of R&D grants to SMEs and the Feasibility Studies Programme (FSP).

The latest version of SMART was introduced in 2012 to replace the Grant for Research and Development (GRD) scheme that used to be run by the former Regional Development Agencies.[16] Its main stated aim is to assist SMEs to undertake R&D in 'strategically important areas of science, engineering and technology'.[17] It offers three different types of grant designed to help firms establish the commercial viability of projects ('proof of market') or the technical feasibility and commercial potential of new technologies, products or processes ('proof of concept'), or to undertake the development of prototypes for innovative products or services. In its GRD incarnation this scheme also specified an aim 'to increase the proportion of firms that innovate' (PACEC, 2009: vi) and this aim is still implicit in TSB descriptions of SMART.

A formal evaluation of GRD in 2009 found that it had helped many potentially innovative SMEs to overcome funding gaps that would have hindered their ability to undertake R&D projects (PACEC, 2009). In addition, award of GRD grants had often

[16] The choice of name SMART (originally referring to Small firms' Merit Award for Research and Technology) reinstated the name of a similar scheme that GRD had itself replaced in 2003.
[17] http://www.innovateuk.org/deliveringinnovation/smart.ashx [accessed 8.7.2014]

helped these firms to obtain funding from private investors at a later stage. A large majority of supported projects had met their technical objectives and added to the innovative capabilities of firms. For the same reasons as described above in relation to KTPs, direct effects on firms' commercial performance were harder to identify but these were expected to develop over time in many cases (ibid). Although partnerships with universities were not a formal requirement of the scheme, almost half of participating firms said that GRD awards had contributed to them collaborating more often with universities and/or independent research and technology organisations (ibid).

The Feasibility Studies Programme (FSP) is also aimed primarily at SMEs and awards grants for firms to carry out exploratory studies on the technical feasibility of ideas for new products and processes. The grants are expected to serve as stepping stones to further R&D in the same areas (perhaps through the CRD programme) or to help bring new products to market. FSP started in 2008 and currently oversees about £2 million per year of grants to competition winners. In contrast to GRD/SMART, competitions for FSP grants tend to be closely targeted on specified priority areas of technology (for example, in 2013, complex high-value formulated products in areas such as pharmaceuticals, chemicals and food). Perhaps because of this very precise targeting, a recent evaluation of FSP found that award winners tended to be firms that were already active innovators and often specialised in R&D services (WECD, 2013).

This evaluation compared FSP award-winners with unsuccessful applicants and found that FSP awards had contributed substantially to new product development, skills and knowledge acquisition, employment growth and collaboration with universities and other external partners. Like GRD/SMART, these awards had not only helped to finance R&D projects which in many cases would not otherwise have gone ahead but had also helped a sizeable proportion of the firms involved to secure additional finance from other sources (ibid). Thus the evaluation process involved in choosing winners in formal competitions for publicly-funded R&D grants seems to fill a gap in the resources devoted to such evaluation by other providers of business finance (see Section 5 below for further discussion of this point).

3.3 Scaling up existing knowledge transfer and network building programmes

A common thread in the UK programmes discussed in this section is a recognition by government of the need for stepping stones of differing kinds for many firms (especially SMEs) to make progress in innovation. These stepping stones include financial support for the very early stages of innovation projects and encouragement for efforts to plug gaps in knowledge at firm level through collaboration with external partners. Thus home-grown UK programmes of this kind seem well suited to tackling the specific UK problem of the relatively small proportion of firms with a track record in innovation.

Far from seeking to emulate foreign examples of programmes designed to improve knowledge transmission and network building, a greater priority seems to be to try and operate the most successful UK programmes on a larger scale. Information on the scope for scaling-up can be gleaned in part from data on the numbers of firms that applied for but did not succeed in winning grants for different programmes. For example, Ternouth et al (2012) note that the grant approval rates for CRD (20% of submitted proposals) and GRD/SMART (10%) are much lower than for KTPs (80%). This suggests that there is only limited scope for expanding KTPs. However, the approval rate for KTPs conceals a very different filtering process for that programme in which most applications only go ahead after detailed discussions between firms and external agencies such as university departments and technology transfer offices (ibid). Ternouth et al (2012) cite examples of outreach activity by agencies of this kind which suggest that about 2% of all businesses, *when approached*, may recognise some degree of opportunity or potential for a KTP application to proceed.

Further research of different kinds – both quantitative and qualitative -- would be useful to explore the scope for existing programmes supporting research, innovation and knowledge exchange to be scaled up. In some cases it has been suggested that increases in the number of participating firms could be achieved if the design and administration of programmes were improved. For example, Regeneris (2010) suggests that, for the number of KTPs to be increased, it would be helpful to reduce the length and administrative burdens of the application process and the inflexibility of KTP Associate training requirements. However, even with such improvements, it seems likely that the low proportion of firms with innovation capacity, or the potential to develop such capacity, would continue to be an important limiting factor.

In addition to observing grant approval rates, information on the quality of previous failed applications is needed to assess the potential volume of firms which might be capable of benefiting from government-funded programmes designed to support knowledge transfer and the development of innovative capacity within firms. For example, PACEC (2009) suggests that unsuccessful applicants to GRD were often rejected because the projects they had bid for were not deemed to be sufficiently innovative. An alternative perspective could be to say that, just by having sought to win grant awards for innovative activity, the firms concerned were possibly demonstrating awareness of their need to move away from existing products and ways of doing things. Thus such firms might be receptive to advice and encouragement from external advisers about how best to proceed.

Put another way, it could be fruitful for innovation support policies to target firms which are currently not engaged in innovative activity at all but which face commercial pressures to start doing so. Many such firms may find it hard to embark on this path without external advice and support. This raises the question of how best, if at all, government can cost-effectively increase the provision of such advice and support. In the past considerable resources have been devoted to local and regional efforts to provide business services of this kind on the grounds that candidate firms for these services are best identified through local knowledge and contacts. We now go on to discuss this sub-national dimension to industrial policy in some detail.

4. Regions, clusters and place-based policies

4.1 Expanding innovation and commercialisation: the regional dimension

As noted in Section 2, it is important for research and technology organisations such as the new Catapults to be operated in ways that take account of spatial imbalances in research and innovation activity. In their present form, the Catapults vary widely in the breadth of their geographical coverage. Some of the constituent organisations have developed networks of partners in different locations and indeed received much of their initial funding from regional agencies under the last government. But some other Catapults are based on organisations which, so far, are located in single regions. Thus, if industrial policy and the public resources that go with it are now to be more heavily concentrated on selected technologies and sectors, it is essential to think afresh about how to take account of different spatial needs and characteristics in delivering that policy.

This matters particularly if a central aim of policy is to increase the proportions of firms which engage in innovation and commercialisation since many firms which currently lack innovation capacity but have the potential to develop it (and especially SMEs in this category) can often only be identified and assisted by universities, RTOs and publicly-funded agencies in their own areas. This is partly because local knowledge and contacts are needed for firms with this potential to be identified but also because firms that are relatively new to seeking knowledge and technical support from external sources often turn first to universities and RTOs in their own areas (Mason, 2014). As discussed in Section 3, it is a strength of home-grown programmes such as Knowledge Transfer Partnerships and the Higher Education Innovation Fund that they facilitate many such within-regional relationships.

Since the Coalition government came to power, the nine former Regional Development Agencies (RDAs) in England have been replaced by 39 Local Enterprise Partnerships (LEPs), with substantially smaller resources than were available to RDAs.[18] More continuity in regional agency structure and funding levels has been retained in Scotland through its development agency Scottish Enterprise.

[18] http://www.publications.parliament.uk/pa/cm201213/cmselect/cmbis/598/598we22.htm [accessed 8.7.2014]

Some insight into the impact of different regional characteristics and institutions on innovation and commercialisation can be gleaned from focussing on efforts to build up the participation of UK-based firms in supply-chains for leading multinational firms of both UK and foreign origin.

For example, in the automotive industry, UK-based suppliers are estimated to provide about 36% of total purchases of UK-based original equipment manufacturers (OEMs) in that industry (Holweg et al, 2011). In recent years UK suppliers have lost market share due to competitive weaknesses in unit costs, accreditation, processing capabilities, quality and logistics. Furthermore, many UK suppliers are apparently not well placed to participate in the development of low-carbon technologies for future generations of vehicles, partly because 'they are neither asked to participate, nor do they feel that within their own firm they are at the forefront of development' (Holweg et al, 2011:32).

One approach to addressing such problems, as in the past, is to seek to attract foreign investors with greater technological competences to locate in the UK (SMMT, 2010). However, this still begs the question of whether foreign firms locating in the UK will feel able to make extensive use of UK-based suppliers for their own purchases of components and sub-systems. Many of the weaknesses identified in UK-based suppliers can only be addressed through the development of innovation capacity within those firms, through both the implementation of existing knowledge and technologies and participation in the generation of relevant new knowledge.

In automotive product areas – and indeed in other sectors such as aerospace – some of the technology and innovation centres which form part of Catapults already provide collaborative environments for relatively inexperienced suppliers (including SMEs) to engage with OEMs and Tier I contractors in product design and development activities and to become familiar with the requirements for participation in their supply chains.[19] But the extent to which these activities can be extended beyond the Catapults' base areas depends greatly on the resources available to sub-national agencies and institutions. In the case of the automotive supply-chain, new resources have recently been made available for local economic development through the

[19] See for example http://www.the-mtc.org/ (Manufacturing Technology Centre, Coventry) [accessed 8.7.2014];and http://nccuk.com (National Composites Centre, Bristol) [accessed 8.7.2014]

Regional Growth Fund.[20] But experience in other sectors such as offshore wind energy suggests that support for innovation across England may be hampered by comparison with the greater resources and institutional continuity of regional development in Scotland.

The growth of the renewable energy industry – in particular, the ongoing and planned future construction of offshore windfarms around the UK coast – has raised hopes that some slow-growing low-productivity regions will be able to benefit from the development of new supply-chains. The potential opportunities are most obvious in installation, operation and sea-going maintenance services which necessarily have to be carried out in the areas where windfarms are located. But the sheer size of many of the components which new offshore windfarms will require suggests that at least some manufacturing work will also need to take place near to windfarm locations.

In order for UK-based suppliers to take advantage of these opportunities, many of them will have to plug gaps in their existing skills and knowledge. In general, firms seeking to break into renewable energy supply-chains cannot expect to work to straightforward blueprints provided by their customers. Rather, they are likely to have to be able to innovate and deliver new products that meet specific performance requirements agreed with their customers (Mason, 2014). In these circumstances regional agencies can play a key role in bringing prospective supply-chain entrants together with universities and RTOs, including those involved in Catapults, that might be able to help fill gaps in firms' technical knowledge and enhance their links with turbine manufacturers and lead contractors. Another role for such agencies is to assist firms in this position to gain access to government and EU funding streams which provide support for innovation.

In the case of renewable energy supply-chain development, the Engineering Technology Partnership (ETP) in Scotland, supported by Scottish Enterprise, has enabled the specialist knowledge of hundreds of academic researchers to be pooled and made available to firms in energy sectors in different parts of Scotland. In different parts of England some universities have found ways to support firms seeking to break into energy supply-chains using alternative sources of funding such as HEIF

[20] https://www.gov.uk/understanding-the-regional-growth-fund [accessed 8.7.2014]

(Mason, 2014). However, as yet the relatively poorly-resourced LEPs are not well placed to contribute to this activity or to help extend the spatial coverage of Catapults.

Thus if the new efforts to improve commercialisation of new knowledge and innovations in the UK are to assist in supply-chain development and contribute to economic performance in other ways, there may be an important role for well-resourced regional agencies to help broker relationships between universities, RTOs and firms and for additional funding streams to be made available to support these relationships, particularly in their early stages. Although the former RDA system in England was criticised for lack of coordination at a national level, the establishment of the Catapults with their national remits provides an opportunity to improve spatial coordination in their particular areas of technology. But rather than address such coordination needs in a piecemeal way, the future design of industrial policy and its sub-national application needs to take account of both theoretical arguments for place-based policies and the empirical evidence on the performance to date of such policies.

4.2 Rationales for place-based industrial policies

There are two linked, but distinct, rationales for an active place-based focus in industrial policy. The first and simplest rationale derives from the industrial policy literature. As set out in Section 2, if some economic activities are characterised by high levels of knowledge and/or co-ordination externalities, policymakers may want to intervene to raise the level of those activities. If externalities are localised, there will be additional welfare gains from the physical clustering of economic activity. There is then a case for *some* intervention to promote and develop co-location (Harrison 2011).

The second, more complex case derives from urban economists and economic geographers, who point to the role of agglomeration economies in influencing the productivity of firms and workers (Krugman 1991; Combes, Duranton and Overman, 2005; Overman and Leunig 2008). Duranton and Puga (2004) characterise these production and consumption-side advantages as ‘matching’, ‘sharing’ and ‘learning’ economies. For example, on the production side of the economy, cities tend to be characterised by large, diverse pools of workers and by similar pools of firms. This feature of urban areas should in theory allow individual workers to ‘match’ to the job that best suits them, and similarly, for firms to recruit the optimal workforce for their given production function. Large urban populations also allow the 'shared' provision of important infrastructure, such as public transport systems, which would be harder to sustain in less dense environments. Perhaps most importantly for industrial strategy, urban environments seem to facilitate both the generation and flow of ideas between economic actors, so that workers and firms in cities 'learn' from each other over time (Jacobs 1969; Duranton and Puga 2001; De La Roca and Puga 2012; Glaeser 2011). Localised learning of this kind occurs at both individual and collective levels and, in so doing, has the potential to contribute to many different kinds of innovation (James, Guile and Unwin, 2011).

At the same time as agglomeration economies influence growth, cities also produce *dis*economies such as congestion and pollution, which may influence firms, workers and households to locate outside urban areas. Cities also enable some anti-social activities, for example by providing agglomeration economies for criminal activity (Glaeser and Sacerdote 1999). As cities grow, therefore, their size and set of activities is influenced by the balance of these centrifugal and centripetal forces (Fujita, Krugman and Venables, 1999).

Long-term urban development is characterised by feedback loops and path-dependence, so that existing agglomerations often have first mover advantage (Krugman and Obstfeld 2003; Martin and Sunley 2006). Conversely, technological and other shocks tend to lead to 'production jumps' from higher to lower cost regions (Venables 2006). New firm entry also has implications for overall urban performance. Increased competition in urban markets tends to weed out weaker firms, raising the average productivity of those remaining (Melitz and Ottaviano 2008; Combes et al, 2012). Entry may also directly raise productivity if it leads to innovation by surviving incumbents (Aghion, Blundell et al, 2009).

Most economists argue that place-based economic development policies are welfare sub-optimal, since promoting development in one place simply displaces it from another (Glaeser and Gottlieb 2008). However, the productivity-enhancing roles of urban areas provide a strong in-principle rationale for area-based components to industrial policy, and potentially for fully area-based interventions. If agglomeration economies are strongly non-linear and/or dynamic, gains in areas 'treated' with industrial policies may outweigh losses in non-treated areas (Kline 2010; Moretti 2010; Kline and Moretti 2012). Specifically, threshold effects in given locations/sectors suggest that in principle, place-based investments can generate self-sustaining returns beyond a certain point.

4.3 Cluster policies

In addition to using regional agencies to help improve firms' innovative performance in low-productivity areas, governments may also seek to raise aggregate growth rates by focusing interventions on firms in high-productivity areas. This may take the form of encouraging firms in the same or related sectors to cluster together in selected product and technology areas.

In the UK a number of factors have led to current interest in cluster policies, over and above the re-awakening of interest in industrial policy. First, national industrial and innovation policies will clearly tend to affect some places more than others, whether or not there is an explicit spatial dimension to policy (Uyarra and Flanagan 2009). Many sectors exhibit physical clustering, especially those where agglomeration offers substantial productivity gains. Horizontal policies are thus likely to affect the largest numbers of firms in urban areas. The Coalition's national industrial strategy recognises this, and stresses that sectoral partnerships need to be sensitive to the spatial footprint of those sectors (BIS, 2012).

Second, successive UK governments have taken an interest in specific existing clusters, partly reflecting the influence of Michael Porter (discussed below). The last Labour administration developed a Porter-influenced cluster strategy (Department of Trade and Industry 2001), followed by a 'Science Cities' programme aimed at building clusters around high-tech activities in Manchester, Bristol, York and other locations (BBC 2005). The current Coalition government has taken a very active interest in the digital economy cluster around Old St roundabout in East London, also known as Silicon Roundabout (Nathan, Vandore et al. 2012; Foord 2013). Launching the 'Tech City' strategy in 2010, the Prime Minister set out an ambition to:

> *… bring together the creativity and energy of Shoreditch and the incredible possibilities of the Olympic Park to help make East London one of the world's great technology centres.* (Cameron, 2010).

Third, and more broadly, the European Union is embedding 'smart specialisation' into regional policy, and this includes a strong cluster component. Smart specialisation will involve 'integrated, place-based economic transformation agendas' that require 'each region building on its own strengths' (Foray et al, 2012). From 2014 it will be compulsory for any region accepting EU Structural Funds to have such a strategy in place (European Commission 2011).

Porter (1990; 1996; 2000; 2003) defines clusters loosely as 'geographically concentrated sets of linked firms in the same or closely related sectors'. Drawing on his well-known 'Diamond' model, he argues that while clusters arise for historic or geographic reasons, they go on to drive economic development by enhancing the 'micro-economic business environment'. Specifically, clusters help increase productivity and innovation, stimulate firm entry and promote entrepreneurship (Porter 2000). Rather than conventional industrial policies, which he argues may be captured by sectoral interests, Porter proposes re-orientating national interventions around cluster mapping and upgrading. Promoting 'deep' and 'established' clusters should be the priority, as these are likely to succeed, and thus contribute to national objectives. There is also a strong emphasis on developing local networks, supply chains and joint ventures over international links.

Cluster policies, especially those associated with Porter, have been widely criticised by academic economists and geographers – in particular, see key pieces by Martin and Sunley (2003) and Duranton (2011). These critiques raise a number of important objections to cluster-based industrial policies: 'Porterian' clusters are defined too loosely to be useful, with no obvious limits to their geographic or sectoral scope; the Diamond model is too simplistic, and does not take into account negative feedback between the elements of the diamond; it also misses some fundamental drivers such as firm and worker mobility. In both cases, urban economics (UE) and new economic geography (NEG) models provide clearer foundational concepts and more robust modelling of cause-effect relations. Overall, Duranton (ibid) argues that successful clusters grow organically through the decisions of firms and individuals, and the interactions between them. As implied by UE/NEG perspectives, clusters are fundamentally the *outcome* of these decisions and interactions – not what drives them.

These objections imply that Porter-style 'cluster policy' is very hard to implement successfully. Internationally, the empirical evidence tends to support this. A comprehensive recent quantitative review by van der Linde (2003) of 773 cluster interventions around the world found that government interventions were more likely to be associated with 'weak' or 'uncompetitive' clusters than with competitive clusters, where they were the least important associated factor. An international mixed-methods survey of high-tech regions by Bresnahan and Gambardella (2004) also pours cold water on Porter-style cluster programmes, emphasising instead the importance of local and national cultural/historical/institutional conditions, as well as a wider set of developmental actions, including encouraging entrepreneurship, subsidising early stage finance, developing workforce skills and building firms' managerial capacity. A wave of more recent studies (Martin, Mayer and Mayneris, 2011; Yu and Jackson 2011; Huber 2012) also find little empirical support for cluster-based approaches. One exception is Falck et al (2010) who conclude that the 1990s 'High Tech Offensive' in Bavaria raised the region's levels of innovative activity and generated some additional sales for firms – but at the huge cost of €1.35bn.

The UK-specific cluster evaluation literature is less well developed than one might expect. Van der Linde (ibid) includes 141 UK clusters in his meta-study. Simmie (2004) reports the findings of a major firm-level survey across five European city-regions (London, Amsterdam, Paris, Milan and Stuttgart). Asking about determinants of innovation and clustering, the survey suggests that matching and sharing economies provide an important source of competitive advantage for firms in larger cities. By contrast, local knowledge spillovers and networks were less important than relations with clients and collaborators, often on a national and international scale. However, for firms in smaller cities local links were salient. McDonald et al (2007) use data from the DTI's cluster study to test associations between cluster features and area economic performance across the UK. They find inconsistent results with only some established or deep clusters linked to employment growth. Cluster 'performance' varies between sectors, with established manufacturing clusters faring worse than more recent media, IT and biotech-orientated clusters. They also find no evidence that local supply chains are important for competitiveness, against Porter's emphasis on local actions.

Nathan (2011), Nathan et al (2012) and Foord (2013) provide some early evaluations of the current 'Tech City' strategy. While policy-making is still in the early stages, four issues stand out. First, the definition of the cluster is elastic – as the quote above suggests. Policymakers would like 'Tech City' to stretch from its Old Street core to the Olympic site, five miles away and currently an area with very little tech activity (although this may change in years to come, as the iCity development comes on stream). Second, the current policy mix has some internal tensions, most notably between programmes designed to encourage local entrepreneurship (incentives for early stage finance, networks, shared workspaces) and programmes designed to encourage inward investment. The evidence is that while some forms of foreign direct investment may result in gains to indigenous firms (for instance, via knowledge spillovers or providing complementary products/services), new firm entry may also displace incumbents (Markusen and Venables 1999; Javorcik 2004; Meyer and Sinani 2009). Third, and in turn, there may be unintended distributional effects. *Overall*, encouraging entry may be innovation-enhancing, if stronger incumbents are forced to innovate in order to compete (Aghion, Blundell et al. 2009). But this can come at the expense of other policy goals, such as building domestic advantage (that is, growing UK-based firms' market share).

4.4 Cluster policies versus agglomeration policies

An important lesson from these debates is that clusters tend to develop through a combination of factors, including chance, and evolve in a fashion analogous to organic systems – limiting the potential for policy interventions. For example, US studies of the development of Silicon Valley, Hollywood and more recently, the biotech industry, emphasise the interaction of history, local conditions and culture, key institutions and individual leaders, as well as unintended effects of other decisions (Zucker, Darby and Brewer, 1998; Markoff, 2005; Scott, 2005). In the case of Silicon Valley, for instance, Bay Area universities, individual scientists and academic entrepreneurs, the area's military history, climate and counter-culture all played enabling roles, as did national defence spending (Saxenian, 1994; Markoff, 2005; Block and Keller, 2009).

Nathan and Overman (2013) discuss a 'second wave' of cluster thinking, which tries to explain these trajectories. It highlights the dynamic emergence, growth and decline of clusters and draws on both the ideas of Jane Jacobs (1969) and concepts from evolutionary economics (Nelson and Winter 1982). As set out in overviews by Martin and Sunley (2010; 2011), the focus is on area-level processes that mark phases in cluster development, for example, an area's industry mix evolving or 'branching' from one path to another, or an external shock that creates a process of lock-in or decline.

In the light of evidence that successful clusters grow organically through the decisions of firms and individuals, and the interactions between them, rather than as the result of government policy interventions, it seems likely that industrial policy initiatives seeking to assist innovation and growth could usefully comprise a mix of horizontal policies and sector-focussed policies - but not putting too much emphasis on single sectors in particular regions as is implied by cluster-based approaches. In this context, industrial policy design should also give more attention to the benefits/costs of agglomeration and the evidence of what makes some cities and their surrounding regions more productive than others. 'Agglomeration policies' should aim at increasing the benefits of urban location (for example, by improving skills and infrastructure) while reducing some of its costs (eg, congestion). At the same time particular attention should be paid at city-region level to improving advice and support for firms that are currently not undertaking innovative activity but which face commercial pressures to start doing so. The aim for government would be to assist firms in a range of sectors and city-regions to develop their innovative capacity, not to focus on particular sectoral clusters.

5. Summary and assessment

There is now renewed interest in the UK in the potentially beneficial economic effects of industrial policy, that is, government policies designed to influence the structure of output and employment. Much public discussion and debate on this subject emphasises the lessons that can be learned from other countries which have proved in recent decades to be more successful in terms of innovation and the commercialisation of the results of research and innovation.

However, there are no guarantees that particular industrial policies that have worked well in different times and countries will enjoy similar success in the future, even in those same countries, let alone in other places. Furthermore, in the UK as in other countries, product and labour markets and socioeconomic institutions have their own deeply rooted characteristics that need to be taken into consideration in the design and development of industrial policies and programmes.

In particular, industrial policy design in the UK needs to confront a level of research and innovation activity that appears to be markedly lower than in many other countries that the UK is urged to emulate. Hence in this paper we have argued that a key aim for industrial policy in the UK must be to increase the proportion of firms with the capacity to engage in research and innovation. Since a great deal of public resources have already been invested in innovation and business support programmes of different kinds, it is important to ensure that new efforts to design effective industrial policies are informed, not just by foreign examples, but by past experience of what has worked well and what has worked badly in terms of previous industrial policy endeavours in the UK.

We have examined these issues by focussing specifically on policies and programmes that have sought to improve UK innovation performance by fostering knowledge transfer flows and research collaboration between firms in particular sectors and between firms and universities, and by promoting the development of industrial clusters. We have identified examples of both successful and unsuccessful policy borrowing from other countries and varying degrees of success in home-grown policies and programmes. The reasons for this variation in outcomes are instructive, highlighting key features of the UK innovation landscape.

Positive learning from other countries

In 2010 the Hauser (2010) report on technology and innovation in the UK reviewed international evidence on the ways in which Research and Technology Organisations (RTOs) involved with commercialisation of new ideas and knowledge generated in universities benefited from having a sizeable proportion of core funding which was not time-limited. This core funding has been found to provide critical support for RTOs to engage in strategic research projects of medium- to long-term duration; develop in-house competences which enable them to search more widely for knowledge of potential use to their customers; and to purchase and maintain large-scale facilities and specialised equipment. The Hauser report recommended that selected RTOs should be provided with approximately one-third core funding.

In a welcome example of continuity in UK industrial policy, this recommendation was accepted by the previous Labour government and has now been implemented by the Coalition government with the recent establishment of seven ‘Catapult’ centres. These centres will be built around RTOs and other organisations specialising in technology areas which the government regards as strategically important and having a large global market potential. The Catapults will have an assurance of one-third funding through core grants and a brief to focus on ‘late-stage’ research and development, facilitating the development of new ideas into marketable products and services. Because this policy borrowing has been based on a careful reading of international and UK evidence on the way that RTOs operate in different countries, it is expected to reduce the pressure on participating RTOs to engage in short-term consultancy activities and should enhance their ability to work with university-based researchers and with businesses to speed up commercial development of research discoveries.

Failures in foreign policy borrowing

In other areas of industrial policy, such as public procurement in support of innovation, the UK has made little progress through its own efforts and hence the attractions of programmes based on foreign models are clear. However, continued UK efforts to emulate the Small Business Innovation Research (SBIR) programme in the

US have met with little success to date. Under this programme 2.5% of several US federal agencies' external research budgets has, since 1982, been made available to innovative SMEs (small and medium-sized enterprises) through competitive tenders. SBIR evaluations point to considerable success in stimulating the commercialisation of new products and technologies in the US and the future growth of SMEs participating in the programme.

In 2001 the UK government made a first effort to emulate the US SBIR by setting up a counterpart programme, namely, the Small Business Research Initiative (SBRI). This met with very little success due to inertia in government departments and a failure to ensure that contracts were provided for technology development rather than for other services provided by SMEs. A re-launched version of the UK SBRI now appears to be working more effectively but is still operating on a very small scale by US standards. There is reason to doubt that the UK currently has sufficient SMEs with innovation potential to allow the SBRI to be scaled up to the same level (proportionately) as has been achieved in the US.

Home-grown successes in fostering innovation

Greater success has been achieved by UK programmes which have been specifically designed to address areas of weakness in the innovation capacity of UK firms, especially SMEs. Examples include Collaborative Research and Development (CRD), SMART (formerly Grants for Research and Development), Knowledge Transfer Partnerships (KTPs) and the Higher Education Innovation Fund (HEIF). Our review of existing research and evaluation evidence on the performance of these programmes suggests that, in combination, they have worked well on three fronts:

(1) supporting collaboration between research-intensive businesses and research-active university departments on innovative projects in areas of science and technology that are deemed by policy-makers to be high-priority – with positive outcomes for the majority of participating firms, for example, in improving technical knowledge and understanding, new product and process development, increasing employment and entering new markets;

(2) encouraging hitherto less innovative firms (many of them SMEs) to engage with universities as sources of useful knowledge and facilities – with many of these

firms acquiring new technology and knowledge as a result as well as greater ability to manage innovation processes. Some of these programmes have also succeeded in catalysing partnerships between firms and less research-active universities which have a key role (especially at regional level) in helping firms to acquire existing knowledge and develop innovation-related skills;

(3) channelling support towards firms for research and innovation projects (not necessarily involving universities) which they would have struggled to finance without receiving publicly-funded grants.

Given these positive outcomes, the big challenge for UK policy-makers is how to operate these programmes on a larger scale given that a relatively high proportion of UK firms (by international standards) do not currently engage in innovative activity and are poorly equipped to do so.

Home-grown success in cluster development (but not because of government intervention)

Successive UK governments have attempted to promote the development of clusters of firms in related product and service areas which are believed to help increase productivity and innovation, stimulate firm entry and promote entrepreneurship. However, there is increasing evidence that successful clusters grow organically through the decisions of firms and individuals, and the interactions between them, rather than as the result of government policy interventions. Indeed, empirical evidence from several countries (including the UK) suggests that government interventions are more likely to be associated with 'weak' or 'uncompetitive' clusters than with competitive clusters. In this context the main role for government seems to be primarily supportive in nature, seeking to reduce impediments to cluster growth where firms in related industries are already choosing to locate near each other.

Delivering industrial policy at sub-national level

In order to try and increase the proportion of UK firms which engage in innovation, priority needs to be given to policies which target firms that are currently not undertaking innovative activity but which face commercial pressures to start doing so. Many such firms may find it hard to embark on this path without external advice and support and it seems likely that well-funded regional agencies would be best placed to identify firms which would benefit from these services.

In this context a key aim for the Catapults should be to help more UK-based firms to acquire the skills and knowledge that they need to break into supply-chains in innovation-intensive sectors such as automotive, aerospace and renewable energy. However, regional advisers may be needed to help broker relationships between prospective supply-chain entrants and Catapults, other RTOs and universities, with the aim of helping firms to fill gaps in technical knowledge and develop links with lead contractors in supply-chains.

Rather than provide support for regional clusters of high-performing firms in particular sectors, our review of the evidence on the performance of cluster policies suggests that industrial policy initiatives seeking to assist innovation and growth could usefully comprise a mix of horizontal policies and sector-focussed policies - but not putting too much emphasis on single sectors in particular regions. In this context, industrial policy design should give more attention to the benefits/costs of agglomeration and the evidence of what makes some cities and their surrounding regions more productive than others. 'Agglomeration policies' should aim at increasing the benefits of urban location (for example, by improving skills and infrastructure) while reducing some of its costs (eg, congestion). Particular attention should be paid at city-regional levels to improving advice and support across a range of sectors for firms that are seeking to develop their innovative capacity.

Finance for innovative firms

One striking feature of existing successful programmes supporting innovation and commercialisation of research findings is the role that they play in plugging gaps in the finance available to innovative firms, especially SMEs. The existence of such gaps partly reflects the reduced availability of bank loans and higher costs of credit for SMEs in general since the 2008-09 recession (Armstrong et al, 2013) but it also reflects the fact that innovation-related credit requests are particularly resource-intensive for lenders to assess. It is notable from evaluation evidence that many recipients of government R&D grants subsequently found it easier to obtain finance from banks and other sources, suggesting that prior awards of R&D grants serve as endorsements of the firms concerned so far as lenders are concerned.

This process depends on the detailed scrutiny that business applicants receive when applying for government R&D grants and adds to the case for a regionally-based Business Bank – as proposed, for example, by Heseltine (2012) – to provide SMEs with relationship banking services rather than process credit requests through a computerised scoring procedure. The aim would be for business lenders to base their responses to credit requests on a deep understanding of different firms' commercial prospects, especially innovative SMEs (Mazzucato, 2012).

Among other things this approach to business lending could help ensure that finance is available when needed for the small number of rapidly-growing firms or 'gazelles' which make disproportionate contributions to innovation and to employment growth in the UK (Mason, Bishop and Robinson, 2009). Although such firms cannot usually be identified in advance of periods of rapid growth, it should be possible for a new Business Bank to identify them once they have started growing and to help reduce financial constraints which might hinder their further growth. By contrast with previous failed efforts by policy-makers to 'pick winners' in advance, singling out fast-growing firms for support in this way could develop into a welcome new method of identifying and supporting 'winners in progress'.

References

Abramowsky, L., Harrison, L. and Simpson, H. (2004) ‘Increasing innovative activity in the UK? Where now for government support for innovation and technology transfer?’ Briefing Note N. 53, London: Institute for Fiscal Studies

Aghion, P. (2012) ‘Growth policy and the state: Implications for the design of a European growth package’.. Submission to LSE Growth Commission, London (10 June 2012)

Aghion, P., Blundell, R., Griffith, R., Howitt, P. and Prantl, S. (2009) ‘The Effects of Entry on Incumbent Innovation and Productivity’, *Review of Economics and Statistics*, 91 (1), 20-32

Aiginger, K. (2007) ‘Industrial policy: A dying breed or a re-emerging phoenix?’, *Journal of Industry, Competition and Trade*, 7: 297-323

Aiginger, K. and Sieber, S. (2006) ‘The matrix approach to industrial policy’, *International Review of Applied Economics*, 20 (5): 573-603

Armstrong, A., Davis, E.P., Liadze, I. and Rienzo, C. (2013) *Evaluating Changes in Bank Lending to UK SMEs Over 2001-12 – Ongoing Tight Credit?* London: Report to Department of Business, Innovation and Skills

Arnold, E., Clark, J. and Javorka, Z. (2010), *Impacts of European RTOs: A Study of Social and Economic Impacts of Research and Technology Organisations*. Report to European Association of Research and Technology Organisations (EARTO). Brighton: Technopolis Ltd

Aschhoff, B. and Sofkaa, W. (2009) ‘Innovation on demand: Can public procurement drive market success of innovations?’, *Research Policy*, 38 (2009): 1235-1247

Audretsch, D., Link, A. and Scott, J. (2002) ‘Public/private technology partnerships: evaluating SBIR-supported research’, *Research Policy*, 31(1): 145-158

BBC (2005) ‘UK to invest long-term in science’. Retrieved 1 May 2013, from http://news.bbc.co.uk/1/hi/sci/tech/4061755.stm

BIS (2012) *Industrial Strategy: UK Sector Analysis*. BIS Economics Paper No. 18, London: Department for Business, Innovation and Skills

BIS (2013) *First Findings from the UK Innovation Survey 2011 (Revised)*. London: Department for Business, Innovation and Skills

Block, F. (2008) ‘Swimming against the current: the rise of a hidden developmental state in the United States’, *Politics and Society*, 36 (2): 169-206

Block, F. and Keller, M. (2009) ‘Where do innovations come from? Transformations in the US economy’, 1970-2006, *Socio-Economic Review*, 7: 459-483

Bound, K. and Puttick, R. (2010) *Buying Power? Is the Small Business Research Initiative for procuring R&D driving innovation in the UK?* BP/55, London: National Endowment for Science, Technology and the Arts (NESTA)

Bresnahan, T. and Gambardella, A. (Eds.). (2004) *Building High-Tech Clusters*. Cambridge: CUP

Cameron, D. (2010). *East End Tech City speech*. Retrieved 8.7.2014 from www.number10.gov.uk/news/east-end-tech-city-speech/

Chesborough, H. (2003) *Open Inovation: The New Imperative for Creating and Profiting from Technology*. Cambridge, MA: Harvard Business School Press

Coad, A. and Rao, R. (2008), Innovation and firm growth in high-tech sectors: a quantile regression approach, *Research Policy*, 37: 633-648

Combes, P.-P., Duranton, G., Gobillon, L., Puga, D. and Roux, S. (2012) *The Productivity Advantages of Large Cities: Distinguishing Agglomeration from Firm Selection*. Bonn: IZA

Combes, P.-P., Duranton, G. and Overman, H. (2005) 'Agglomeration and the Adjustment of the Spatial Economy', *Papers in Regional Science*, 84 (3), 311-349

Connell, D. and Probert, J. (2010) *Exploding the Myths of UK Innovation Policy: How 'Soft Companies' and R&D Contracts for Customers Drive the Growth of the Hi-Tech Economy*, Cambridge: Centre for Business Research

Cosh, A., Hughes, A. and Lester, R. (2006) *UK plc: Just how innovative are we? Findings from the Cambridge-MIT Institute International Innovation Benchmarking Project.*, Cambridge: The Cambridge-MIT Institute

De La Roca, J. and Puga, D. (2012) *Learning by Working in Big Cities.* Discussion Paper 9243. London: Centre for Economic Policy Research

Department of Trade and Industry (2001) *Business Clusters in the UK - A First Assessment*. London: DTI

Duranton, G. (2011) 'California Dreamin': The feeble case for cluster policies', *Review of Economic Analysis*, 3 (1), 3-45

Duranton, G. and Puga, D. (2001) 'Nursery Cities: Urban Diversity, Process Innovation and the Life Cycle of Products', *American Economic Review*, 91 (5), 1454-1477

Duranton, G. and Puga, D. (2004) 'Micro-Foundations of Urban Agglomeration Economies', in J. V. Henderson and J.-F. Thisse (Eds.), *Handbook of regional and urban economics 4* (pp. 2063-2117). The Hague: Elsevier

Dyson, J. (2010) 'Making the UK the Leading High Tech Exporter in Europe'. Retrieved 8.7.2014 from: http://media.dyson.com/images_resize_sites/inside_dyson/assets/UK/downloads/IngeniousBritain.PDF

EARTO (2007) *Research and Technology Organisations in the Evolving European Research Area*. Brussels: European Association of Research and Technology Organisations (EARTO)

Edler, J. and Georghiou, L. (2007) 'Public procurement and innovation – Resurrecting the demand side', *Research Policy*, 36 (2007): 949-963

European Commission (2011) *Cohesion Policy 2014-2020: Investing in growth and jobs*. Brussels: European Commission

Falck, O., Heblich, S. and Kipar, S. (2010) 'Industrial innovation: Direct evidence from a cluster-oriented policy', *Regional Science and Urban Economics*, 40 (6), 574-582

Foord, J. (2013) 'The new boomtown? Creative city to Tech City in East London', *Cities*, 33 (August): 51-60

Foray, D., Goddard, J., Beldarrain, X. G., Landabaso, M., McCann, P., Morgan, K., Nauwelaers, C. and Ortega-Argilés, R. (2012) *Guide to Research and Innovation Strategies for Smart Specialisation (RIS3)*. Brussels: DG Regio

Fujita, M., Krugman, P. and Venables, A. J. (1999) *The Spatial Economy: Cities, Regionsand International Trade*. Cambridge, MA: MIT Press

Galsworthy, J. and Knee, P. (2007) *Higher Education Innovation Fund Impact Survey (Study C)* Report to Higher Education Funding Council for England (HEFCE). Amersham: Quotec Ltd

Geroski, P. (1990) 'Innovation, Technological Opportunity and Market Structure', *Oxford Economic Papers*, 42(3): 586-602

Glaeser, E. (2011) *The Triumph of the City*. London: Pan Macmillan

Glaeser, E. and Gottlieb, J. D. (2008) 'The Economics of Place-Making Policies', *Brookings Papers on Economic Activity*, 2008 (1), 155-239

Glaeser, E. and Sacerdote, B. (1999) 'Why Is There More Crime in Cities?' *Journal of Political Economy*, 107(S6), S225-S258

Harrison, A. (2011) *Industrial Policy: Why, What and How?* Paper presented at the IGC Growth Week

Hauser, H. (2010) *The Current and Future Role of Technology and Innovation Centres in the UK*. London: Department for Business, Innovation and Skills

Heseltine, M. (2012) *No Stone Unturned: In Pursuit of Growth*. London: Department for Business, Innovation and Skills

Holland, C. (2009) *Peer Review of Small Business Research Initiative (SBRI) – UK.* Report to INNO-Partnering Forum. Brussels: European Commission Enterprise and Industry.

Holweg, M., Tran, Y., Davies, P. and Schramm, S. (2011) *Growing the Automotive Supply Chain: The Road Forward*. Buckingham: PICSIE Books

House of Commons Science and Technology Committee (2011) *Technology and Innovation Centres, Second Report of Session 2010-11*. London: The Stationery Office Ltd

Huber, F. (2012) 'Do clusters really matter for innovation practices in Information Technology? Questioning the significance of technological knowledge spillovers', *Journal of Economic Geography*, 12 (1), 107-126

Hughes, A. and Mina, A. (2012) *The UK R&D Landscape*, London: Council for Industry and Higher Education and UK-Innovation Research Centre (revised edition)

Jacobs, J. (1969) *The Economy of Cities*. London: Vintage

James, L., Guile, D. and Unwin, L. (2011) 'From learning for the knowledge-based economy to learning for growth: re-examining clusters, innovation and qualifications', Research Paper 29. London: Centre for Learning and Life Chances in Knowledge Economies and Societies (LLAKES)

Javorcik, B. S. (2004). 'Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers Through Backward Linkages', *American Economic Review,* 94 (3), 605-627

Kitson, M., Howells, J., Braham, R. and Westlake, S. (2009) *The Connected University: Driving Recovery and Growth in the UK Economy*. London: National Endowment for Science, Technology and the Arts (NESTA)

Kline, P. (2010) 'Place Based Policies, Heterogeneity and Agglomeration', *American Economic Review*, 100 (2), 383-387

Kline, P. and Moretti, E. (2012) *Local Economic Development, Agglomeration Economies and the Big Push: 100 Years of Evidence from the Tennessee Valley Authority*. Berkeley: EMLAB, UC Berkeley

Krugman, P. (1991) *Geography and Trade*. Cambridge, MA: MIT Press

Krugman, P. and Obstfeld, M. (2003) *International Economics: Theory and Policy*. Boston: Addison Weasley

Lerner, J. (1999) 'The government as venture capitalist: the long-run impact of the SBIR Program', *Journal of Business*, 72(3): 285-318

McDonald F., Huang Q., Tsagdis D. and Tuselmann H. (2007) ‘Is There Evidence to Support Porter-type Cluster Policies?’, *Regional Studies* 41 (1): 39-49

Markoff, J. (2005) *What the Dormouse Said: How the Sixties Counterculture Shaped the Personal Computer Industry*. London: Penguin

Markusen, J. and Venables, A. (1999) ‘Foreign Direct Investment as a Catalyst for Industrial Development’, *European Economic Review*, 43 (2), 335-356

Martin, P., Mayer, T. and Mayneris, F. (2011) ‘Public support to clusters: A firm level study of French “Local Productive Systems”’, *Regional Science and Urban Economics*, 41 (2), 108-123

Martin, R. and Sunley, P. (2003). Deconstructing clusters: chaotic concept or policy panacea? *Journal of Economic Geography*, 3 (1), 5-35

Martin, R. and Sunley, P. (2006) ‘Path dependence and regional economic evolution’, *Journal of Economic Geography*, 6 (4), 395-437

Martin, R. and Sunley, P. (2010) ‘The place of path dependence in an evolutionary perspective on the economic landscape’, In R. Boschma and R. Martin (Eds.), *Handbook of Evolutionary Economic Geography* (pp. 62-92). Cheltenham: Edward Elgar

Martin, R. and Sunley, P. (2011) ‘Conceptualizing Cluster Evolution: Beyond the Life Cycle Model?’, *Regional Studies*, 45(10), 1299-1318

Mason, G. (2011) *Product strategies, skills shortages and skill updating needs in England: New evidence from the National Employer Skills Survey, 2009.* Evidence Report 30. London: UK Commission for Employment and Skills

Mason, G. (2014) ‘Innovation and supply-chain development in UK regions: what role can universities play?’ Research Paper (forthcoming), London: Centre for Learning and Life Chances in Knowledge Economies and Societies (LLAKES)

Mason, G., Bishop, K. and Robinson, C. (2009), *Business growth and innovation: the wider impact of rapidly-growing firms in UK city-regions*. Research Report BGI/36. London: National Endowment for Science, Technology and the Arts (NESTA)

Mason, G. and Wagner, K. (1999) ‘Knowledge transfer and innovation in Britain and Germany: “Intermediate institution” models of knowledge transfer under strain?’, *Industry and Innovation*, 6 (1): 85-110

Mazzucato, M. (2011) *The Entrepreneurial State*. London: Demos

Mazzucato, M. (2012), *Rebalancing What? Reforming finance for creative destruction not destructive creation*. London: Policy Network

Melitz, M. and Ottaviano, G. (2008) 'Market Size, Trade and Productivity', *The Review of Economic Studies*, *75*(1), 295-316

Meyer, K. and Sinani, E. (2009) 'When and Where Does Foreign Direct Investment Generate Positive Spillovers? A Meta-Analysis', *Journal of International Business Studies*, 40, 1075–1094

Mina, A., Connell, D. and Hughes, A. (2009) 'Models of technology development in intermediate research organisations', Working Paper No. 396, Centre for Business Research, University of Cambridge

Moretti, E. (2010) 'Local Labor Markets' In O. Ashenfelter and D. Card (Eds.), *Handbook of Labor Economics* (Vol. 4b, pp. 1237-1313). Amsterdam: Elsevier

Nathan, M. (2011) 'East London Tech City: Ideas without a Strategy', *Local Economy*, 26 (3), 197-202

Nathan, M. and Overman, H. (2013) 'Agglomeration, clustersand industrial policy', *Oxford Review of Economic Policy,* 29 (2): 383-404

Nathan, M., Vandore, E. and Whitehead, R. (2012) *A Tale of Tech City: The future of East London's digital economy*. London: Centre for London

Nelson, R. and Winter, S. (1982) *An Evolutionary Theory of Economic Change*. Cambridge, MA: Harvard University Press

NESTA (2012) *Plan I: The Case for Innovation-Led Growth.* London: National Endowment for Science, Technology and the Arts

OECD (2009) 'Global Forum on Competition: Roundtable on competition policy, industrial policy and national champions', DAF/COMP/GF(2009)9 Paris: Organisation for Economic Cooperation and Development

Overman, H. and Leunig, T. (2008) 'Spatial Patterns of Development and the British Housing Market', *Oxford Review of Economic Policy*, 24:1, 59-78

Oxford Economics (2008) *Study of the Impact of the Intermediate Research and Technology Sector on the UK Economy*. Oxford: Report to Association of Association of Independent Research and Technology Organisations (AIRTO)

PACEC (2009) *Evaluation of Grant for Research and Development and SMART*. Final Report to London Development Agency and the Department for Innovation, Universities and Skills, Cambridge: Public and Corporate Economic Consultants

PACEC/CBR (2009) *Evaluation of the Effectiveness and Role of HEFCE/OSI Third Stream Funding*. Report to Higher Education Funding Council for England (HEFCE), Cambridge: Public and Corporate Economic Consultants and Centre for Business Research, University of Cambridge

PACEC (2011) *Evaluation of the Collaborative Research and Development Programmes.* Final Report to Technology Strategy Board, Cambridge: Public and Corporate Economic Consultants

Porter, M.E. (1990) *The Competitive Advantage of Nations*. New York: Free Press

Porter, M. E. (1996) ‚The competitive advantage of the inner city' in R. LeGates and F. Stout (Eds.) *The City Reader* (pp. 274-286). Abingdon: Routledge

Porter, M. E. (2000) 'Location, competitionand economic development: Local clusters in a global economy', *Economic Development Quarterly*, 14 (1), 15-34

Porter, M.E. (2003) 'The Economic Performance of Regions', *Regional Studies*, 37 (6-7), 545-546

Regeneris (2010) *Knowledge Transfer Partnerships Strategic Review*. Report to Technology Strategy Board, Altrincham: Regeneris Consulting Ltd

Robertson, S.L. and Kitagawa, F. (2011) 'University Incubators and Knowledge Mediation Strategies: Policy and Practice in Creating Competitive City Regions', Research Paper 28. London: Centre for Learning and Life Chances in Knowledge Economies and Societies (LLAKES)

Rodrik, D. (2004) 'Industrial policy for the twenty-first century', Discussion Paper No. 4767 London: Centre for Economic Policy Research

Rothwell, R. and Dodgson, M. (1993) 'The contribution which research and technology organisations make to innovation and competitiveness in UK industry', Association of Independent Research and Technology Organisations (AIRTO) Paper 93/1

Saxenian, A. (1994) *Culture and Competition in Silicon Valley and Route 128*. Cambridge: Harvard University Press

Scott, A. (2005) *On Hollywood: The place, the industry*. Oxford: OUP

Simmie, J. (2004) 'Innovation clusters and competitive cities in the UK and Europe' in M. Boddy and M. Parkinson (Eds.) *City Matters*. Bristol: Policy Press

SMMT (2010) *UK automotive supply chain: Input to its future direction and opportunities for growth*. London: Society of Motor Manufacturers and Traders.

SQW (2002a) *Evaluation of TCS: Final Report to the Small Business Servicei.* DTI Evaluation Report Series No.7. London: Department of Trade and Industry.

SQW (2002b) *Interim Evaluation of Knowledge Transfer Programmes Funded by the Office of Science and Technology Through the Science Budget.* Cambridge: SQW Limited

Ternouth, P., Garnier, C., Wood, L. and Forbes, P. (2012) *Key Attributes for Successful Knowledge Transfer Partnerships*. Report to the Technology Strategy Board and Research Councils, London: Council for Industry and Higher Education (CIHE)

Uyarra, E. and Flanagan, K. (2009) ‘Understanding the Innovation Impacts of Public Procurement’, *European Planning Studies*, 18 (1), 123-143.

van der Linde, C. (2003) ‘The demography of clusters - findings from the cluster meta-study’ in J. Broecker, D. Dohse and R. Soltwedel (Eds.), *Innovation Clusters and Interregional Competition*. Berlin: Springer Verlag

Venables, A. (2006) ‘Shifts in Economic Geography and Their Causes’, Discussion Paper 76, Centre for Economic Performance, London School of Economics

Von Hippel, E. (2005) *Democratising Innovation*. Cambridge, MA: MIT Press.

WECD (2013) *TSB Feasibility Studies Programme Evaluation Findings*. Report to Technology Strategy Board. Royal Leamington Spa: Warwick Economics and Development (WECD)

Willetts, D. (2013) *Eight Great Technologies*. London: Policy Exchange

Wilson, T. (2012) *A Review of Business-University Collaboration.* London: Department for Business, Innovation and Skills

Yu, J. and Jackson, R. (2011) ‘Regional Innovation Clusters: A Critical Review’, *Growth and Change*, 42 (2), 111-124

Zucker, L. G., Darby, M. R. and Brewer, M. B. (1998) ‚Intellectual Human Capital and the Birth of U.S. Biotechnology Enterprises’, *American Economic Review*, 88 (1), 290-306

For more information, please contact
llakescentre@ioe.ac.uk
LLAKES Centre
Institute of Education
20 Bedford Way
WC1H 0AL
London
UK