

# Innovation and the city

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## ABSTRACT

*Innovation is an increasingly globalised phenomenon but the highest rates of visible innovation are found in and around cities. This paper explores the 'urban factors' that support innovative activity, focusing on English cities. Agglomeration economies can help explain both cities' resilience and the characteristics of urban markets, assets, networks and institutions that help innovation to take place. A high-level explanatory framework is set out, using the concepts of 'urban hubs' and 'local links' to draw together these ideas. The framework is then explored using five case studies from the UK and abroad. The findings suggest a number of different 'innovation trajectories' for different city types. Innovation policymakers should pay more attention to improving urban infrastructure, skills and critical mass, and should devolve strategy-making towards pan-regional and sub-regional actors.*

**Keywords:** innovation, cities, fashion, ICT, automotive, biotechnology

## INTRODUCTION

The literature on the increasingly globalised nature of innovation is enormous, particularly that dealing with multinational corporations and global trade. However, less work has been done on the spatial aspects of innovation, which is an important dimension of the globalisation process. This is because innovation activities, personnel and expenditure tend to be geographically concentrated or clustered. It is also because certain geographical areas tend to be associated with significant levels of innovation activity and success, such as Silicon Valley for semiconductors, London for hedge funds, or Paris for fashion.

Cities provide an ideal environment for innovation as they offer proximity, density and variety. However, some cities are more innovative than others, and policymakers have long been concerned with finding out why. Unpacking this problem requires considerable effort. Cities are complex systems and they exist in the context of diverse regions, nations and international relationships. Moreover, cities themselves rarely innovate – they are hosts for innovation by people, firms and organisations. This means that cities often support innovation indirectly and that some of the most important things they do are not thought of as innovation policy at all. This

article presents an initial consideration and analysis of which particular urban features, processes or assets may be important in enabling, sustaining and promoting innovation.

The paper draws on a 12-month research project carried out in 2007 focusing on cities in the UK and Germany. The paper uses the term 'city' to mean the spatial area that comprises a functional urban economy. In the UK, the title 'city' has no statistical or technical definition – it is a title conferred on a settlement by a royal charter. This paper therefore focuses on the 'economic city' – functional urban economies of scale – and uses statistics from the largest 56 functional urban economies in England. When we refer to 'cities' in this paper, we mean a large urban area, based on a functional urban economy.

## INNOVATION IN UK CITIES

In England, several measures of innovation suggest that the highest rates of 'visible innovation' are found in and around cities. Analysis of European Patent Office data for 1999 to 2001 shows that 67 per cent of EPO patent applications came from the 56 largest cities in England, and that 43 per cent of these applications came from just 10 cities (DCLG-SOCD).

Patent applications are only one measure of innovation; they are poor at capturing process innovations and are biased towards manufacturing industries (NESTA, 2006) and science-based fields. However, the strong urban focus of innovation holds true when broader types of innovation are included, such as those recorded by the Community Innovation Survey (CIS) which provides data for a range of types of innovation, including organisational, service and process innovations as well as product innovation, and data on the employment of scientists and researchers. The Fourth European Community Innovation Survey (CIS) provides an estimate of the proportion of all firms which are 'innovation active', actively innovating by developing or improving new products and processes, implementing new organisational forms or adopting and adapting existing ideas and

innovations for their own use. The CIS reveals that a number of England's cities have high rates of innovation-active firms, compared to the English average (Department for Communities and Local Government, 2006). A more recent analysis of this data by Simmie et al. (2008) shows that the cities with the highest rates of innovation-active firms tend to be small yet internally and externally well networked cities. It may therefore not be size that is essential to city innovation.

Cities generally seem to offer the specialised, knowledge-based labour markets that help to enable and drive innovation. Employment data for England, for example, show that in 2005, 81 per cent of knowledge-intensive business services employment was located in cities. Additionally, 90 per cent of England's knowledge workers (an aggregate including firms in engineering-based manufacturing, manufacturing, knowledge-intensive services and creative industries) worked in cities in 2005.

## Innovation is uneven between UK cities

Not all cities are equally innovative, however. Large variations in the rates of innovation between cities can be seen when using the measure of patent applications. Cambridge, for example, registered 81 patent applications per 10,000 adults between 1999 and 2001, whereas Blackpool registered just two. Table 1 presents the top five highest and lowest innovation performers when patents per 10,000 inhabitants are the measure. A similar picture emerges from other indicators of innovation activity. Tables 2 and 3 show which English cities are the most and least innovative in terms of developing new products and processes – illustrating widely differing performance between cities.

There is a clear correlation between innovation and economic performance in cities. In the UK, cities such as Cambridge, Oxford and Reading have high-performing economies and their strong innovation profiles are one of the features that help to explain that performance.

**TABLE 1: TOP AND BOTTOM FIVE INNOVATION PERFORMERS ON PATENTS PER 10,000; 2001**

Top 5 performers	Bottom 5 performers
1. Cambridge (81)	1. Grimsby (2)
2. Oxford (50)	2. Blackpool (2)
3. Birkenhead (35)	3. Sunderland (3)
4. Swindon (35)	4. Luton (3)
5. Reading (31)	5. Doncaster (3)
England average = 13.7 per 10,000	

Source: DCLG (2006), Community Innovation Survey

**TABLE 2: PERCENTAGE OF FIRMS INTRODUCING PROCESS INNOVATIONS; 1998–2000**

Top 5 performers	Bottom 5 performers
1. Northampton (31 per cent)	1. Wakefield (6 per cent)
2. Coventry (30 per cent)	2. Grimsby (10 per cent)
3. Crawley (29 per cent)	3. Gloucester (11 per cent)
4. Oxford (27 per cent)	4. Southend (11 per cent)
5. Chatham (26 per cent)	5. Liverpool (12 per cent)
England average = 17.9 per cent	

Source: DCLG (2006), Community Innovation Survey

**TABLE 3: PER CENT OF FIRMS INTRODUCING PRODUCT INNOVATIONS; 1998–2000**

Top 5 performers	Bottom 5 performers
1. Cambridge (40 per cent)	1. Doncaster (7 per cent)
2. Aldershot (38 per cent)	2. Stoke (8 per cent)
3. Coventry (35 per cent)	3. Grimsby (10 per cent)
4. Derby (32 per cent)	4. Wakefield (4 per cent)
5. Bradford (30 per cent)	5. Wigan (13 per cent)
England average = 22 per cent	

Source: DCLG (2006), Community Innovation Survey

Cities have very different economic structures, physical assets, governance, labour markets, and other strengths and weaknesses. Some cities, such as Blackpool in the north west of the UK, a traditional holiday resort, do not have the types of economic activities or labour markets which tend to provide the basis for innovation. Industrial structure may explain these differences – but what other factors are at work in explaining the differences in innovation performance between cities?

This paper presents an initial consideration of this question and uses evidence from both five case studies researched in 2007 and existing studies and sources of data to answer it.

## INNOVATION IN CITIES: FIVE CASE STUDIES

### Overview of the case study cities and sectors

During 2007, a research project was completed which examined existing literature and secondary evidence about which city characteristics and processes contribute to shaping and driving innovation. Within each city, a sectoral economic specialism was examined. The cities and sectors were:

- Dundee (Life sciences)
- London (Fashion)
- Coventry (Auto-engineering and design)
- Reading (ICT)
- Dortmund (Life sciences and micro-technology)

The case studies were designed for breadth: the aim was to explore as wide a range of cities and innovative sectors as possible. A brief overview of each city is provided in the remainder of this section. Section 4 draws out the key findings from the case study evidence and on that basis suggest that there are five main components of an urban innovation system: firms, markets, assets, institutions, and networks. It is how these are working that determines the degree of innovation in the surrounding urban area.

### Dundee and life sciences

With a population of 146,000 in 2006, Dundee is Scotland's fourth largest city, behind Glasgow, Edinburgh and Aberdeen. Dundee's life sciences sector has grown around the University of Dundee's leading international life sciences research. It has developed from a centre of purely scientific and research expertise into an industry with 350 businesses with between 2,700 and 2,900 employees in total. Between 1993 and 2003, 22 of the research team leaders at the Uni-

versity of Dundee's School of Life Sciences were in the top one per cent of most quoted scientists in their field and in the areas of biology, biochemistry and genetics the Dundee was either the first or the second most cited university in Europe, ahead of Cambridge, Oxford and University College, London.

A significant reason for the emergence of Dundee as a world leader in the life sciences field has been the leadership of one person, Professor Sir Phillip Cohen, who played a pivotal role in orchestrating large-scale investments in the university's facilities by bringing and holding together complex alliances of public and private sector actors. The result has been the creation of a series of state-of-the-art research centres, including the £13m Wellcome Trust Biocentre completed in 1997 and the £21m James Black Centre opened in 2005. Cohen has also been instrumental in nurturing and attracting world-class scientific talent, and in securing public and private sector financing for research.

Research-based businesses have developed and grown alongside the university, which feeds the cluster's development through patents, spinouts and licences. Firms can choose to locate elsewhere after being spun out but there are important economic reasons why they stay. In particular, many firms need access to the expensive facilities housed at the university and they all benefit from the steady stream of expert researchers that Dundee University produces.

### **London's designer fashion industry**

London is the capital city of the UK and is located in the south east of England, with a population of 8.7 million in 2005. London has a highly successful range of creative industries – including publishing, music, theatre, film, television and designer fashion industry.

Directly employing 4,400 in Fashion Design in 2005 (Greater London Authority Economics, 2007), London has one of the most thriving, dynamic fashion industries in the world. Innovation in London's designer fashion sector draws heavily on London's scale, diversity of demand

and cultural dynamism, as well as the complex system of informal networks that are enabled by the co-location of businesses and workers.

In London, the fashion scene has a distinct character shaped over decades. There are clear links between fashion, art, design and music; and more broadly, between fashion and different aspects of pop culture in general. Sub-cultures feed each other with creative ideas and innovations. Designers need to be in London to be part of this, and remain at the leading edge of cultural trends. Strong local networks are important for enabling designers to hook into London's various cultural scenes and they also act as a crucial source of knowledge, ideas and business opportunities.

### **Coventry's auto-engineering and design sector**

Coventry is located in the West Midlands region of England, situated east of the city of Birmingham. With a population of 305,000 in 2005, Coventry was once well known for heavy engineering. After 30 years of industrial restructuring, Coventry has now developed a reputation for innovative, high-value automotive design, a sector which employs between 500 businesses and 30,000 people.

This sector covers a broad spectrum of activities across the full life cycle of road vehicles – from initial concept design through to production, use and end of life (re-use, recycling and vehicle disposal). By global standards, the sector remains small, and the city only provides a small share of innovations in the international market but the auto sector is nevertheless amongst the leaders in many areas of its field, including fuel cell development and safety engineering.

The city's engineering legacy is an important part of the explanation for why the current cluster is located in Coventry. The city's history as a 'motor town' means that businesses are still able to find the products and services needed to make a complete vehicle within a 10-mile radius. And the long history of sectoral specialisation in the city has meant that there is a critical mass of

highly skilled workers and component manufacturers with the necessary knowledge and experience to support a competitive cluster.

### **Reading and Thames Valley's ICT industry**

Reading, situated 30 miles west of London, and the neighbouring Thames Valley are often referred to as the nearest thing that the UK has to Silicon Valley. The population of the Thames Valley and Reading areas combined is 410,000. Reading performs outstandingly well on available innovation indicators – ranking in the top five cities in the UK on patents per 10,000 residents, on the percentage of firms introducing product innovations and the percentage of firms introducing process innovations. Between 1995 and 2005, the city added 43,000 net new jobs, with high growth in knowledge-based service sectors, particularly ICT and finance.

The region's information and communications technology (ICT) industry has been a major driver of its success. This case study shows how the region's range of urban assets – including strong national and international transport connections, the availability of land, and the presence of a large skilled labour force – combine to support innovation and growth.

Innovation occurs in diverse ways in the area's ICT sector. Innovative products can be procured from external providers, both internationally and locally, or be developed in-house from local facilities or overseas R&D labs. The region includes large national and international ICT firms which act as originators and users of innovation as well as small, innovative technology companies. And these are complemented by major research facilities, universities and other research institutions. All interact in a complex network of local and international connections.

### **Dortmund's life sciences and microtechnology industry**

Dortmund, one of the biggest cities in Germany, is located in the Westphalia region and has a pop-

ulation of 589,000 people. It lies on the north-west edge of the Ruhr area, bordering Sauerland to the south-west and Münsterland to the north. It is well connected by road, rail, water and air. Dortmund is the largest city in Westphalia and the Ruhr Metropolitan Region. The city has experienced significant economic change in recent years. A former industrial powerhouse, its core coal, steel and beer industries had guaranteed economic prosperity until the 1960s. Following the decline of these sectors, Germany's 'steel city' has transformed itself into a thriving modern city, hence its growing European reputation as an innovative

Dortmund's emerging cluster of life sciences and micro-technology businesses demonstrates how strong public sector leadership and partnership working across stakeholder groups can successfully drive forward cluster development processes. The micro-technology cluster has around 40 companies, together employing more than 2,000 people. The life sciences sector is smaller and consists of around 20 businesses from the fields of biomedicine, medical technology and biotechnology, all of which have close ties to the area's universities and many research institutes.

### **LEARNING FROM THE CASE STUDIES AND EVIDENCE: THE URBAN INNOVATION SYSTEM**

Drawing existing theory and the case study evidence together, we suggest that there are two main ways to explain why firms' location in cities may help the innovation process. One explanation relates to a city's scale, such as the size of its markets, and its asset base. Another explanation relates to how cities facilitate proximity, networking and knowledge exchange. Respectively, we have dubbed these explanatory frameworks 'urban hubs' and 'local links'.

There are two specific components within 'urban hubs': markets and assets. Within 'local links', there are also two components: institutions and networks. Working across 'urban hubs'

and ‘local links’ are firms, the key actors in innovation in cities. These concepts are represented diagrammatically in Figure 1. The next sections demonstrate how these concepts help explain the innovation process in cities, using our highly diverse case study cities and other examples to illustrate the argument.

### ‘Urban hubs’: the asset base and markets

A number of urban innovation theorists (notably Jacobs 1969) put forward the view that it is cities’ market size and asset base that are critical to supporting higher levels of innovative activity. We call this the ‘urban hubs’ approach. The urban hubs model draws heavily on the notion of ‘urbanisation economies’. This view postulates that it is the scale and choice of suppliers, work-

ers and customers found in urban economies that help firms innovate as businesses in cities can select the optimal mix of suppliers and workers to meet specific customer needs. This ‘pick and mix economy’ of major cities such as London helps explain the concentration of innovative firms in and around the capital (Simmie 2004).

In terms of *assets*, good transport infrastructure and services deliver that accessibility and proximity that are essential for market access and doing business. Proximity was found to be important for innovation in all the case study cities and sectors. The concentration of skills, firms and institutions within cities also facilitated easy access for firms. Most sectors and their innovating firms required a maximum of one hour’s travel time to suppliers, markets and skills, or to an international transport hub. In Coventry, Dundee and Lon-

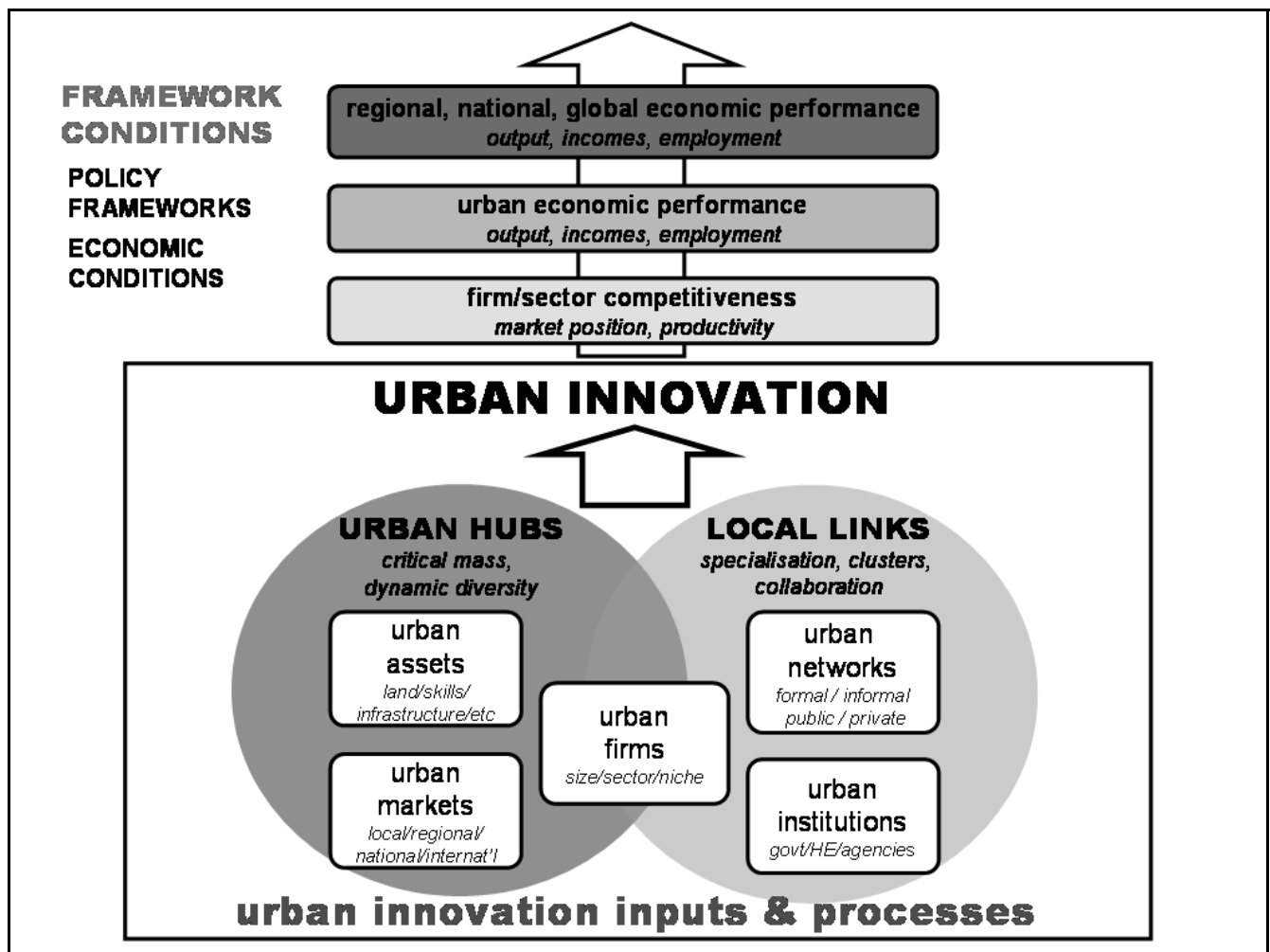


FIGURE 1: CONCEPT FOR AN URBAN INNOVATION SYSTEM

don, reasonable travel times to universities and colleges were also essential.

The case studies suggest that transport infrastructure was regarded as the major physical asset for facilitating business connections, networks and knowledge transfer. Some sectors had a clear need for real proximity, or 'co-location', as they needed good intra-city transport links. Others needed international connection. One of London's big advantages for fashion designers, for example, is its role as an international transport hub. Designers need to have regular access to international customers and suppliers and they need to attend fashion events elsewhere in the world. London's international transport connections make it an ideal location for businesses that need this kind of regular access.

In Reading and the Thames Valley, the dense transport network allowed large customer bases to be served by leading software companies. The area benefits from close proximity to Heathrow airport, good connections to road networks, and good rail links to London and the rest of the South East. Good local and regional transport networks allow easy, fast, and reliable market access and it has been common for large companies located in the area to do business with other large firms in nearby locations, either in sourcing innovation or in developing new business models. For innovative companies, such as Oracle (based in Reading), which service many corporate clients, location and transport assets are the key. Some 80 per cent of Oracle's customers are located within 45 minutes journey time of their HQ in Reading.

Another key asset for firms is the availability of skilled labour in case study areas. In London, the fashion industry has been able to draw on new talent from the city's fashion colleges or fashion degree courses. Fashion firms also depend on a constant supply of interns to carry out basic functions and supply of these would be drastically reduced were the businesses not located in London. In Coventry, the city's automotive industry left as its legacy a mature skills base across a wide

range of specialisms. This has been maintained and developed by close collaboration between industry and education institutes. In Dundee, life sciences businesses benefited greatly from the continual supply of highly trained scientists from the University of Dundee. The university had implemented effective staff retention policies to retain scientific talent and had shown flexibility in organisational arrangements, allowing academic staff to become involved in commercial ventures. In Reading/Thames Valley, access to a very large labour market (London and the South East) was a major factor in attracting businesses to locate and start up there. This pool of labour also helped to support innovation. In Dortmund, there was a significant supply of graduate skills but the need for more expert skills required labour to be imported from other areas.

Property and physical assets were important for specific sectors and we found examples where property and the built environment have a direct impact on the ability to innovate. In Reading/Thames Valley, major ICT corporations tend to prefer campus-style headquarters and office facilities on well-equipped business parks and feel that the physical layout of the business environment is a potential barrier to achieving high levels of networking and knowledge transfer. In London, the dynamics of the London property market had a significant influence on networks and physical proximity in the fashion design sector. In London, fashion designers required low-cost large premises adjacent to other designers and within reasonable travel times to educational, retail and media sectors. This requirement led to the spatial clustering of fashion designers in cheap premises. As property prices increased in London, our new evidence suggests that this shift in a fundamental aspect of their businesses has forced fashion designers from the centre of the city to lower cost locations. This may well have eroded the benefits derived from the proximity and agglomeration that characterised their original location. Fashion designers were once located in the west end of London, near the fashion

media industry. Then they moved to lower cost premises in East London – in Shoreditch and Dalston. As property costs rise in these locations, many are moving further east or to south east London as their old premises became unaffordable.

*Markets* are vital for successful innovation and the research findings demonstrated this again. One of the obvious advantages that cities offer firms is access to markets – both large local markets and larger national and international marketplaces. City-based firms can pick and choose from a wide range of suppliers and sell to a wide range of customers so urban markets and market access play an important role in sustaining innovative activity.

In the case studies, ‘market access’ was repeatedly cited as an important location factor. Local (city) markets are less important to innovative firms, who were found to be more likely to be serving international markets compared to other firms. Our case studies showed that most innovative businesses make use of the ease of local urban connectivity to operate in larger national and global arenas. It was found that innovation in ICT in Reading/Thames Valley, for example, is strongly influenced by the global ICT market. Engineering design in Coventry also serves a global market, and is influenced by changes to that market emanating usually from shifting consumer preferences for fuel efficiency or other design features.

Markets are where ‘supply push’ meets ‘demand pull’. The importance of downstream markets varies. Some of our case study cities and sectors were also characterised by ‘supply push’. In other words, a good supply of innovative goods and services actively shaped markets rather than firms simply responding to customer demand. For example: The key strength of the biotechnology sector in Dundee, for example, was the ability to develop novel products, processes and solutions that realised new market opportunities. The designer fashion sector in London also tended to shape its markets – even in large retail chains,

fashion designers had influence in shaping their market offers.

The Coventry case study, in contrast, provided a clear example of ‘demand pull’ for innovation as smaller engineering businesses were being constantly driven by the need to deliver the requirements of customers further up the supply chain. These businesses needed to be in regular contact with customers so that products could be produced to their specification. A combination of strong local, regional and international demand and customers who know clearly what they want were pulling innovations out from manufacturers in the local market.

London is a good example of the effect of market scale and scope on innovation. The high demand for designer fashion and the size and diversity of the capital’s market means that niche fashion designers have local markets for their goods and can engage with the subcultures, networks or arts communities that help feed their creativity. The designer fashion sector in London operates in very local and global markets. Designers use networks of friends to source staff and achieve small production runs. As firms grow, they make increasing use of textile manufacturers in Eastern Europe and South or East Asia. Some designers also locate in the city to access a small, but influential niche designer fashion consumer market. London’s role as a huge market for fashion is also a major driver for the sector.

### **‘Local links’: the role of networks and institutions**

Some theorists place much greater emphasis on the role in successful innovation of local networks, habits and customs within cities (Piore & Sabel 1984; Porter 1990). Physical proximity allows firms to more easily and frequently establish business and knowledge networks within a given sector or between businesses and public institutions. Proximity encourages knowledge spillovers and helps organisations to collaborate – for example, on new ideas, shared standards, skill requirements, or buying raw materials. Over



time, distinct 'industrial districts' may form where innovation is 'in the air' (Marshall 1920.). Proximity also helps create a shared sense of identity that binds different players together in a community-like social network.

'Local links' are especially important in sectors dominated by small firms and individuals and in sectors where business functions tend to be more disaggregated and involve several organisations, such as designer fashion in London. 'Local links' are less important in sectors dominated by large corporations, such as ICT in the Reading/Thames Valley area. Fashion design appears more dependent on its local milieu and draws inspiration from it and its themes, whereas ICT is more global in outlook, technically oriented and involves many large firms with internalized innovation and development processes.

In reality, cities display both strong and weak local links within different neighbourhoods or districts and the degree of linkage found also depends on the type of industry we are concerned with and how it has developed. A sector in a city with strong 'local links' is one where its firms have dense networks and diverse supply chains. Their industries operate in clusters with strong links to urban institutions. A sector in a city with weak 'local links' has firms with less dense networks and less strong links between firms and institutions.

Urban assets and institutions help business and knowledge *networks* to develop by reinforcing the role of urban markets in encouraging local proximity and over time helping clusters to form. These networks are often said to be essential for firms to develop new ideas, turn these into innovative products and services, and bring them to market. The evidence from our research and elsewhere suggests that formal and informal local networks do indeed matter, especially for high-tech sectors (Orlando and Versa 2006). For example, a number of firms in Reading's ICT sector had spun out of large corporations specifically to develop innovations that serviced the needs of the original 'parent' company. In Dundee and in

Dortmund, firms collaborated regularly over early stage research and development of new drugs and medical technologies. In the fashion industry, informal networks play a crucial role in developing design concepts, with designers firmly embedded into wider cultural and creative networks around the city.

Most cities have formal and informal networks which help to enable the flow of knowledge between enterprises located in the city. In the case of Dundee, in informal networks, life sciences firms might choose to have a respected academic sit on their board to get their expertise and lend the firm credibility and because they often need to access expert academic knowledge to help them overcome product development problems as they arise. Informal business-to-business links also develop over the exchange of knowledge and ideas on business strategy, as well as over research and product development. Firms talk to one another through workshops and collaborative groups facilitated by the public sector and through existing contact and friendship networks.

The case studies we report here suggest that an urban location helps all firms to develop local supply chains which are both part of the local market for a sector or innovation and the basis for business networks. Supply chain relationships were considered essential to innovation transactions. In most cases, firms also wanted to develop more proactive 'knowledge networks', sharing ideas and collaborating.

Cities are where large public and private *institutions* are located. The most significant types of institution in all our case studies were universities and higher education institutes. Throughout the case studies, universities were a key institution for enabling innovation. They played several roles. One role was the source and main driver of commercial innovation potential, especially evident in Dundee's biotechnology R&D sector where the local university lent credibility and expertise to spin-out enterprises in Dundee's biotechnology R&D sector, with many of Dundee University's scientists holding board positions in biotechnolo-

gy enterprises in the city. Another role was facilitating networks and being a hub for networking, collaboration and knowledge exchange, a role played by Coventry University's engineering and design departments as the key mediator in collaborative innovation between firms. Universities provided collective goods – for Coventry's engineering design sector, the universities of Coventry and Warwick provided an array of research equipment including prototyping technology, virtual conferencing facilities and virtual design studios to facilitate real-time collaborative working across large distances.

Finally, in some cases, universities and other public sector research organisations were the founders of innovation communities, a role most evident in London's designer fashion sector where London's arts colleges (higher education institutes for art and design) drive innovation in the Fashion Design sector. They contribute to innovation in the fashion design sector in three key ways. First, they train designers and professionals. Many of the top designers in London's fashion scene were educated at the London College of Fashion or Central St. Martin's College. Second, arts colleges play a crucial role in helping fashion designers and other arts students build the informal networks on which they depend throughout their careers. Third, for designers, universities also provide a steady stream of cheap or free labour to work in studios.

Local government and development agencies also play important roles in innovation by city firms. As a result of action by the city and province (Land) governments, Dortmund's microsystems technology and life sciences sectors have developed into two of the city's most promising new industries. Through the 'Dortmund Project', the city's mayor has been able to build up a strong vision for change that has attracted considerable support from German Federal and State and European Union funders. The vision is based around the need to develop higher value-added clusters, up-skill the workforce and develop suitable business space to service the needs of

priority businesses. Linked to this vision, the city has been responsible for the development of MST.factory Dortmund, a dedicated micro- and nanotechnology centre of excellence, and the BMZ Dortmund, a competence centre for biotech companies. Both facilities are seen as having contributed substantially to the growth of the science and technology business base.

In Reading and the Thames Valley, the local government and the Regional Development Agency (RDA) similarly played a major part in the ICT sector's growth through the provision of infrastructure and in land preparation for the sites now occupied by ICT firms. Although not directly related to innovation, these efforts helped establish and maintain the area as a desirable business location for ICT companies.

In the case studies, economic development and regeneration agencies played a broad range of roles in enabling and supporting innovation and enterprise. They championed innovative sectors, raising their profile as well as trying to ensure that other public services and policies could help their development. These agencies were heavily involved in property, land and the built environment – developing science and technology parks, and helping innovating sectors with their property needs. They would often situate incubation or advisory facilities alongside science and technology parks. Finally, development agencies helped facilitate and establish networks and they undertook initiatives to ease barriers to growth and development in innovative SMEs, by addressing skills shortages or providing access to finance.

### **Firms: the heart of urban innovation**

Finally, *firms*, as everyone knows, are the key actors in urban innovation. The four components of city advantage mentioned above (assets, markets, institutions and networks) mainly serve to facilitate and enable their successful innovation. Firms use and combine these four components to develop innovations.

In Coventry's auto-engineering and design sector, firms are the key drivers of innovation, with

local supply chain linkages, R&D collaborations and internal processes all act to drive up innovation. In the past, anchor firms such as large automotive manufacturers (including Ford and Peugeot) were critical drivers of innovation. Their position has diminished somewhat now, although they continue to play an important role as they are still engaged in production and act as a source of demand from local businesses for components, and, importantly, contracted out engineering design services. In Coventry's automotive design and engineering sector, companies are continually striving for more effective business practices and internal structures to help drive innovation – including stronger leadership skills, communication, collaboration and financial incentives.

The business base of any city or sector is not uniform. Our case study evidence found that innovation in mature sectors is more embedded in a specific city environment. In Coventry the city's urban assets, institutions and networks tend to be more developed in terms of their ability to support innovation in relation to the auto-engineering and design sector than Dundee's are in relation to younger sectors such as biotechnology. The relevant support institutions seem to take considerable time to develop and Coventry has long been a centre of the automotive industry whereas biotechnology in Dundee is a much more recent creation. More mature sectors tend to support richer and more diverse networks and types of innovation in cities while innovation appears to yield higher economic impacts in terms of economic output and jobs. In Coventry, a range of large and small enterprises is active in a diverse range of market activities. The innovation function in engineering design occurs both within large corporations and in SMEs which have specific design specialisms.

Similarly, the London designer fashion sector is well-established, with clear links between fashion designers, retailers and the larger 'cultural economy'. Innovators tend to be individuals, freelance fashion designers or micro-businesses (typically with under five employees) which serve

the retail industry and independent retailers, although some fashion designers are employed with major retail chains. Compared with Coventry, however, a weakness in the London fashion innovation system is the relative underperformance of a segment of its supply chain, London-based textiles manufacturers. Conversely, innovation in Dortmund and Dundee is dominated by SMEs and is less embedded in the local and regional economy and industrial clusters than in Coventry, Reading/Thames Valley and London. This finding echoes research suggesting that cities with clusters of related businesses tend to drive up innovative activity.

Small and large firms play different but complementary roles in innovation. The case studies show that both large 'anchor firms' and SMEs are potentially important innovators. These findings strengthen existing research showing that firms of different sizes play important, complementary roles in urban innovation. In each of the areas studied, smaller, more specialised firms often supplied innovations to larger businesses further up the supply chain. In Dundee, small businesses set up by scientists often focused on the early stages of research and development of new drugs and technologies before passing these innovations on to larger, multinational pharmaceutical companies located elsewhere. In Reading/Thames Valley, there was collaboration between large firms and SMEs in projects such as Microsoft's Innovation Centre, and through spin-out companies from large ICT firms. The most successful clusters may therefore be born from both large and small players.

## CONCLUSIONS

This paper discusses the spatial nature and distribution of innovation and asks if some of the specific characteristics and processes of cities are particularly helpful in explaining why spatial concentrations of innovation occur. It is explicitly recognised that innovation is uneven between cities and that some cities have more conducive factors for innovation than others.

Cities matter for innovation. The attractiveness of cities – and the reason they continue to grow and prosper – is due to the presence of agglomeration economies, which translate into economic (and social) gains for firms, workers and residents. The concept of agglomeration also helps identify a series of ‘urban factors’ that support innovative activity. Firms are at the heart of the innovation process but urban markets, assets, networks and institutions can all play important roles.

In our model of an urban innovation system, we suggested that there are five main components whose configurations matter: firms, markets, assets, institutions, and networks. *Firms* are the key innovators, and cities support innovation by firms in a number of ways. This report sets out a model of urban innovation, focusing on the role of two interlocking processes, ‘urban hubs’ and ‘local links’. Cities offer access to large *markets*, local and global, and throughout the supply chain. Urban *assets* can be critical in underpinning firms’ innovative activity and competitive performance – particularly big, specialised urban labour markets, transport infrastructure and density of activity. A number of public *institutions* and actors support innovation – notably universities, individual ‘change agents’ and some economic development agencies. Urban proximity and connectivity also help business and knowledge networks to form, increasing the flow of innovative ideas and bringing products to market. Public institutions can help overcome co-ordination problems – by promoting and sustaining *networks*.

This paper introduces two overlapping frameworks for looking at urban innovation systems: ‘urban hubs’ and ‘local links’. Urban hubs explanations emphasise markets and assets; local links approaches focus on institutions and networks.

We have reported the results of five case studies which were undertaken to explore hubs and links in action, across a range of innovative sectors. Two innovation systems exhibited features of hubs and links (London designer fashion and the automotive sector around Coventry), one

exhibited strong hub features (ICT in the Thames Valley) and there were two essentially links-based systems (biotech and microtech in Dundee and Dortmund).

The Dundee example points strongly towards the value of our ‘local links’ innovation model. The university’s central position in the innovation system and the importance for firms of using the university as a forum for networking, as well as accessing its expertise, facilities and labour supply, all suggest that the ‘local links’ model is useful in explaining innovation in Dundee’s life sciences sector.

Coventry’s auto-engineering and design sector illustrates the importance of urban hub factors such as connectivity, knowledge infrastructure and a critical mass of expertise. It also exhibits features of a local links system, with specialist labour markets, close business networks between local firms and knowledge networks mediated by public research institutions. And it reinforces the argument that history can play a role in determining the structure and nature of an innovation system.

Four important policy lessons can be learned from this research. First, cities and their hinterlands matter for innovation. In many countries, and especially in the UK, innovation policy has been rather top down, with great emphasis on a ‘national innovation system’ and shows little apparent interest in where and how innovative activity takes place on the ground. For the UK, the recent national government’s Department for Innovation, Universities and Skills (DIUS) White Paper, ‘Innovation Nation’, makes a number of positive steps towards creating a ‘place narrative’, recognising the role of urban areas in innovation and proposing ‘New Innovation Partnerships’ to develop spatial innovation systems (Department for Innovation, Universities and Skills, 2008). However, like many national policy proposals, much is made of governance arrangements and structures rather than ensuring that policy can support actions that are tailored to local circumstance and will also, critically, make a positive impact on rates of innovation.

Second, this work helps to show that different cities have different innovation trajectories based on the presence and growth of different economic sectors but also making use of different 'urban factors' to support innovative activity. For sectors that depend on knowledge transfer and networks, policy to help promote and develop links and communities is what matters. Where innovation depends on large scale markets and assets, the city has to develop these or has to take advantage of any proximity it may have to markets or assets in neighbouring cities. Proximity can be improved, for example, by transport infrastructure developments to reduce travel times. Cities can attempt to attract businesses who may want to access markets in neighbouring cities but do not necessarily want to locate there.

Third, our research suggests that a number of policy levers outside traditional innovation policy have an important role to play in supporting innovation. In particular, urban assets – skilled workers, business space and transport and communications infrastructure – play a critical role, alongside relevant public institutions and knowledge networks. Policies to grow and densify larger cities are thus also likely to reap innovation benefits. Effective innovation policy and delivery needs to bring together a range of government functions and departments.

Fourth, scale and powers matter. Given the geography of innovation, there is a strong case for co-ordinated working between cities and for less prescriptive top-down national solutions.

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