Science in the city region: establishing Liverpool’s life science ecology

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ABSTRACT
This article focuses on the development of soft and hard infrastructures to support a life science ecology in a peripheral European city region. Liverpool City Region has received almost £1.7bn in capital investment through the EU Cohesion Policy to redevelop the city region and reinvigorate its economy towards knowledge based industries. The analysis of the city region’s life science ecology highlights the uneven development of hard and soft infrastructures. Due to the diversity of firms within the region it has proven difficult to establish soft infrastructure related to scientific knowledge. The outcome has led to soft infrastructures being more business support orientated rather than scientific knowledge based, reducing inter-firm connections on a product or service basis. The evidence shows that not all types of soft infrastructure emerge as an outcome of investment. Hence, policy makers need to provide a clearer narrative on their investments, focusing on fewer core competencies rather than breadth of activities.

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Life science ecology; hard infrastructure; soft infrastructure; assets; Liverpool City Region (LCR)

INTRODUCTION
Governments and international organizations at all levels have seen the potential economic and social benefits that a strong regional life science industry can yield (Benneworth, 2002). Deloitte (2014) estimated that the global life science industry was worth over US$1.5 trillion in 2012. If a region can develop appropriate hard infrastructures that enable the softer financial and knowledge flows associated with the industry to be captured, that may stimulate regional development. Drawing on this hard/soft distinction from Colapinto and Porlezza (2012), this paper explores investments in particular hard infrastructures that are seeking to support the development of soft life science infrastructures in peripheral city-regions.

This paper thus asks the research question of whether public investment in hard infrastructures can also stimulate the emergence of the soft infrastructures necessary for dynamic life science ecologies. It reports a case study from Liverpool, an old industrial region that shifted its economic development path from the 1980s managed decline towards new creativity- and science-based industries. Drawing on primary qualitative data, the analysis highlights the problem of a cognitive distance barrier between firms. The paper concludes that building new hard infrastructure can under certain conditions further the development of life science ecologies in a peripheral region.

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ECOLOGIES: LIFE SCIENCES AND REGIONAL DEVELOPMENT

Economic development no longer depends on the availability of traditional production factors such as land, labour and capital, but also knowledge capital. Where there are many firms that are active in the same kinds of knowledge fields, what Nooteboom (2000) calls cognitive proximity, then there can be positive linkages and feedback that produce increasing returns to scale. These places are then attractive as investment opportunities for others. Klepper (2010) argued that places serviced well by venture capitalists and/or business angels tend to foster more entrepreneurial activity. Business angels are individuals or collectives who provide capital for a business start-up, usually in exchange for convertible debt or ownership equity (Festel, 2011). They usually invest both money in and their time to the venture.

There has been much interest in the potential of life sciences as a quintessential knowledge-intensive industry to drive regional economic development within regions including South East England, Scotland and Central England (Cooke, 2004; Kasabov, 2011) but also internationally (Cooke, 2004; Moodysson, Coenen, & Asheim, 2008). Given the 5–15-year time scales that exist in the commercialization of new products in this industry, there are potential gaps that exist in the funding models between start-up and phase one approval. Life science firms in the United States and Europe have noted that business angels are significant players in bridging the gaps between early start-ups and raising the levels of capital needed to sustain a venture (Festel, 2011). Birch (2011) argues further that less-favoured regions tend to suffer from a lack of venture capital that can service innovations through to commercialization. These analyses highlight a number of key factors underpinning successful life science-based development:

- Presence of star scientists in research-intensive universities (Zucker, Darby, & Brewer, 1998).
- Presence of government-led research institutions (Klepper, 2010).
- Highly successful firms well serviced by venture capitalists can accelerate successful spin-outs (Feldman and Francis, 2003; Festel, 2011).
- A mix of star scientists, government institutions, venture capitalists and successful businesses collaborating with universities and public organizations (Cooke, 2004; Moodysson et al., 2008).

We conceptualize these factors as hard and soft infrastructures (Colapinto & Porlezza, 2012). Hard infrastructure are tangible structures such as roads, buildings, telecommunications and ports, whilst soft infrastructures are intangible such as networking, knowledge exchange, business environments, human capital and regional institutions. For these latter soft infrastructures, a greater cognitive distance (i.e., less cognitive proximity between actors) can reduce the overall benefits the soft infrastructures bring (Maskell, Bathelt, & Malmberg, 2006). In this paper ‘ecology’ is used to conceptualize the life science development in Liverpool City Region (LCR). Toulmin (1990, p. 194) states:

Once we begin to think in ecological terms, we shall soon learn that every niche or habitat is one of its own kind, and that it demands a call for a careful eye to its particular, local, and timely circumstances. The Newtonian view encouraged hierarchy and rigidity, standardisation and uniformity: an ecological perspective emphasises, rather, differentiation and diversity, equity and adaptability.

Much of the literature here emphasized specific factors that have led to success, overlooking factors that may have hindered regional development and been liabilities to the region’s development. The ecological perspective focuses on the configuration of firms and infrastructures in studying how a life science region develops over time and how individual infrastructure
configurations develop within their respective contexts (Tsoukas & Dooley, 2011). Where there are complementarities between knowledge infrastructures related to specific kinds of knowledge, skill and expertise and local actors, regions may develop innovation ecologies by stimulating knowledge networks and spaces whereby communities of practice can develop specifically to develop an innovation ecology (Coe, Hess, Yeung, Dicken, & Henderson, 2004, p. 470; Shearmur, 2011).

METHOD AND CASE: LIVERPOOL CITY REGION

This paper seeks to answer the overall research question drawing on a case study of the Liverpool City Region (LCR) in the North West of England (Figure 1). In 2014, LCR had an economy of 1.5 million people, 38,000 value added tax (VAT)-registered businesses worth £25.3 billion to the UK economy, and has been one of the fastest growing UK regions outside of London (LCRLEP, 2014). Since the early 1990s, public money has been invested in developing new industries in the city-region (Southern, 2014). Recently, local institutions formulated a knowledge economy strategy identifying the life science industry as one of four key sectors for development. However, there has been no identifiable research and development (R&D) activity in LCR by private pharmaceutical companies since 1961, supporting the rationale for public sector-led investment to support R&D.

The case study explores the development and outcomes of hard and soft infrastructure within LCR. The primary empirical evidence for this case study is drawn from 25 semi-structured interviews with life science firms’ managers and supporting institutions at a local and national scale during 2012–13. The research used the Bionow (2012) industry directory verified via Companies House. Secondary qualitative and quantitative data were used to supplement the analysis and inform the broader economic and industrial context.

Figure 1. Liverpool City Region. Source: LCRLEP (2014).
There is a diverse range of firm activity in the LCR life science ecology (Table 1). At the time of writing, 53 life science firms were active and present in LCR, giving a relatively small ecology compared with the South of England and the United States. The majority of firms have registered locations in designated science or innovation park developments (Figure 2). These R&D sites are largely the result of publicly financed hard infrastructure developments.

Alongside the firms are a set of organizations that are considered assets to the industry and which can be regarded as complementing the firm ecology. The National Bio-manufacturing Centre (NBC) was completed in 2005 at a capital cost of £34 million to provide facilities and infrastructure for life science-related firms. It has subsequently attracted the largest concentration of pharmaceutical manufacturers in Europe, making it a significant hard infrastructure development. Five further manufacturers are located outside the NBC, four of which are independent manufacturers that acquired sites already equipped with bespoke capabilities to increase operational capacity.

Local policy-makers have attempted to put in place a strategy to diversify this ecology towards more knowledge-intensive and high value-added activities such as R&D. The most significant

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**Table 1.** Life science firms by activity in Liverpool City Region.

| Activity                        | Number of firms, 2012 |
|---------------------------------|------------------------|
| Consultancy                     | 7                      |
| Discovery (research and development – R&D) | 13                    |
| Diagnostic                      | 7                      |
| Drug manufacturing              | 9                      |
| Medical devices                 | 8                      |
| Other                           | 9                      |
| **Total**                       | **53**                 |

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**Figure 2.** Life science firms by location.

**AN OVERVIEW OF LIVERPOOL’S LIFE SCIENCE ECOLOGY**
Table 2. Regional assets in the Liverpool City Region life science ecology.

| Asset                        | Policy rationale                                                                                                                                   | Issue                                                                                                                                 |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| University of Liverpool      | Offers education and research across the biosciences, medicine, dentistry, health sciences, tropical medicine and veterinary science             | The strategies recognize these assets are sources and infrastructures for innovation, spin-out firms and world-leading research. All enrich the labour market with graduates |
| Liverpool John Moore’s       | Has a long record of expertise in teaching, research, consultancy and knowledge transfer partnerships in the life sciences                         | Graduate retention is low in the region. Employers in the sector cast doubt on the work readiness of graduates                           |
| University                     | The first institution in the world dedicated to tropical disease. It leads the field in research against infections, debilitating and disabling diseases | Many jobs in the sector require postgraduate-level education and training                                                              |
| MerseyBio Incubator          | State-of-the-art facility for developing biotechnology businesses. Offers office and laboratory space with access to high-value capital equipment   | The facility has been managed by a consultancy firm with expertise in biotechnology commercialization                                  |
| National Bio-manufacturing   | Received £34 million capital investment to build state-of-the-art manufacturing facilities and supporting infrastructures such as road and telecommunications | Limited in size with five companies in 2012                                                                                        |
| Centre (NBC)                  |                                                                                                                                                   | Largest concentration of pharmaceutical manufacturers in Europe. Hosts four multinational firms that are large employers in the region |
| Royal Liverpool University   | Large provider of frontline health services as well as being a centre of excellence and research for health issues such as cancer, neurology and pancreas translation research | No research and development (R&D) activity recorded on this site since the 1960s. Seasonal production with limited linkages to city-region firms |
| Hospital                     |                                                                                                                                                   | Undergoing a £600 million rebuild designed to integrate bioscience infrastructures                                                     |
|                              |                                                                                                                                                   | Suffered delays due to changes in national government. Due for completion in summer 2017                                               |

additional R&D infrastructure intervention came through the development of MerseyBio Incubator located at the University of Liverpool in 2001. In the interviews, the local policymakers identified a range of life science ‘assets’ in LCR; these are listed in Table 2 along with their rationale for public support.

**TOWARDS A LIFE SCIENCE ECOSYSTEM IN LIVERPOOL**

In LCR the development of infrastructures has seen a clear split between hard and soft infrastructures. Firstly, investment came in developing hard infrastructures such as MerseyBio Incubator, science parks and road network improvements. Secondly, there has been substantial attention for
the development of soft infrastructures such as networking, business support, scientific knowledge exchange, human capital and institutional bodies.

MerseyBio Incubator encountered problems diversify the industry towards commercial R&D, with a perception that local universities were not full exploiting the commercial potential of their intellectual property in the life sciences. Primarily, scientists were reluctant to spin-out of the university and form a company due to the perceived risks in investment. Furthermore, the universities lacked softer infrastructures to facilitate the spin-out process, supporting the commercialization of Intellectual Property (IP) and attracting new investment. Respondents attributed this primarily to underlying issues of control and ownership:

This idea of spin-outs or doing something with your IP was something that sat there and you know people had it in documents but it was never, ever taken seriously. I think that was part of the problem. (Consultancy firm 3, 9 May 2012)

LCR is not well served by venture capitalists or business angels. The majority of R&D firms stated they had received funding from national, regional and local government grants that compensate for a lack of private funding available, but which do not come with sector-specific investors who bring their own soft infrastructures:

So people have to find it [money] somewhere. In the past people would look at a mixture, so it would be their own money, plus grants, plus some VC money. I don't think the VC money's been particularly good for life sciences in the North West let alone Liverpool. (Consultancy firm 1, 26 June 2012)

Furthermore, there has been a mismatch between the quality of research and the level of funding available. As one participant commented:

The science is normally terrific, the enthusiasm is unmatched, but it's matching money with the damp and hard edged enthusiasm of business, which is the hardest piece. (Discovery firm 5, 15 August 2012)

The 13 identified R&D firms are highly specialized and at various stages of development, with no identifiable inter-firm connections on a product or services bases, a high ‘cognitive distance’ in Nooteboom’s (2000) terminology. The high fragmentation of life sciences activities shown in Table 1 and their highly specialized nature led to an inability to share knowledge, research focus and connections. Hence, firms must look beyond the ecology (e.g., attending conferences elsewhere) to build soft infrastructures and secure scientific knowledge assets and inputs. These tend to be held in the larger life science ecologies such as Cambridge (UK) or Boston (USA) with comparatively more firms, specialized in fewer subsectors or types of R&D. These regions have life science-related hard and soft infrastructures in which Liverpool life science firms seek to participate temporarily to acquire knowledge assets. In short, despite over 15 years of public investment, LCR is not recognized as a 'place to be' for life sciences in comparison with other regions:

There seems to be a lack of awareness of what’s in the North West [which includes LCR] because when you say life sciences people are drawn to think of London and Oxbridge because of their reputations. (Public organization 2, 5 August 2012)

Despite the hard infrastructures projects, the absence of international awareness further undermines the development of soft scientific knowledge-based infrastructures. However, what is developing are soft business support infrastructures related to common problems faced by firms:
Now they're [other firm] in completely different areas to us, but it shouldn't actually matter whether they're in different areas or not ... we share common issues, we're going to have issues around funding, we're going to have issues around facilities, we're going to have issues around staff, we're going to have issues around the perception of the industry nationally and, national policy that's going to allow the industry to thrive. So it's important that those sort of links are engendered. (Discovery firm 2, 23 October 2012)

CONCLUSIONS

The development of hard and soft infrastructures has been uneven in LCR. The hard infrastructures are expensive but have been easy to promote for policy-makers and have supported the development of LCR so far. In comparison, soft infrastructures are potentially inexpensive, but are harder to achieve in ways that help to make the region more attractive to knowledge and capital flows. The type of soft infrastructure that has developed is non-scientific relating to business support. Given the diversity of firms, it has been difficult to develop scientific soft infrastructures relating to research and knowledge exchange for product development.

This paper has sought to explore how soft life science infrastructures emerge and contribute to the ecology's development. The soft infrastructures identified here have not been publicly funded, but were outcomes of bringing people together in hard infrastructure projects such as science parks. Although the level of funding available has not increased and at the same time government funding has become more centralized, these comparatively inexpensive soft infrastructures are highly valuable to the ecology's continued development.

Unlike other peripheral regions that saw scientific soft infrastructure emerge (Benneworth, 2002), not all ecologies can develop scientific soft infrastructures by funding hard infrastructure investment alone. Hard and soft infrastructure configurations need to provide a clear narrative, specializing in fewer core competencies rather than a breadth of activities. In particular, further investment and support of the soft infrastructures, locally and extra-locally, can be used as a measure to reduce cognitive distance in the ecology and further the scientific soft infrastructures.

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