Entrepreneurial University Ecosystems: Evidence for London

Literature Review Paper

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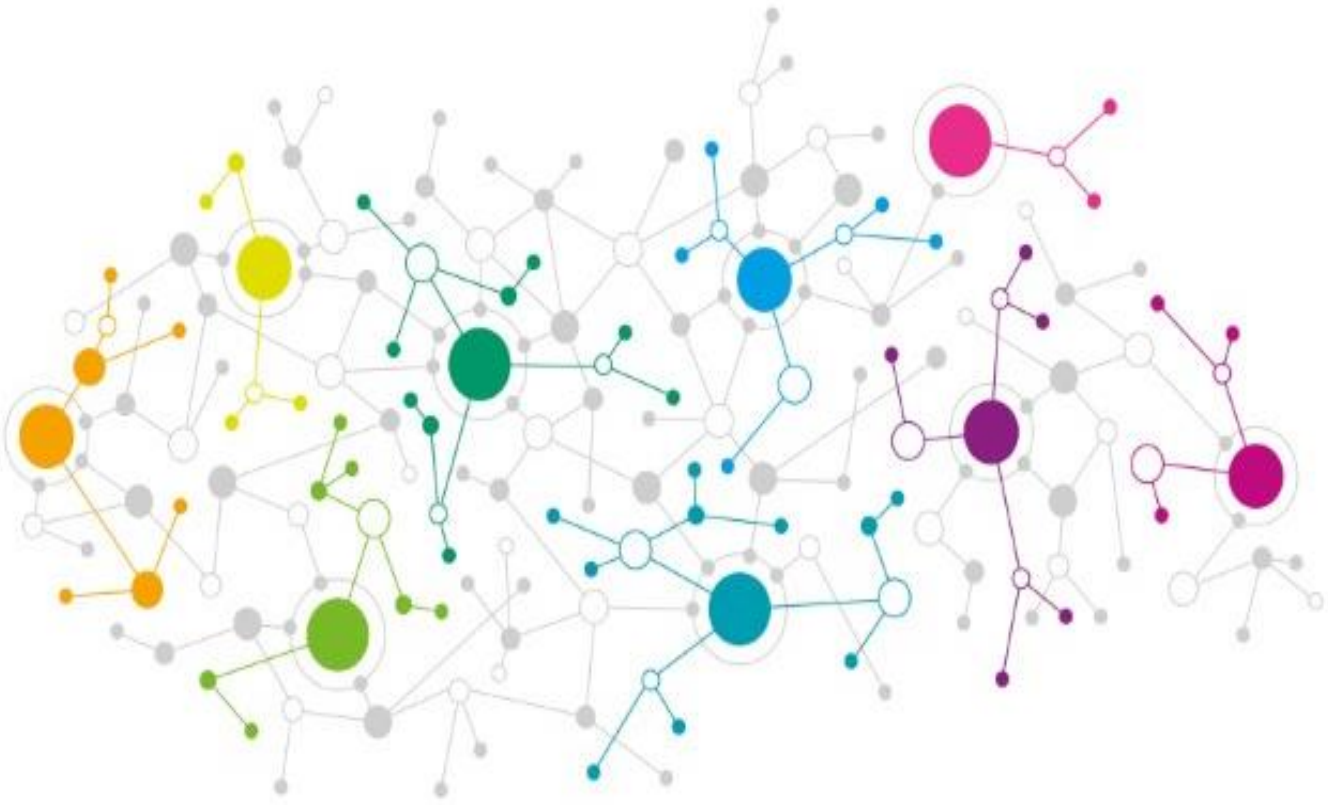

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1. Introduction

Background and purpose

1.1 The McMillan Group's (2016) review of technology transfer recommended the development of an ecosystem approach that was specific to the UK. The McMillan Review identified a number of important aspects of ecosystems, including external factors to universities and internal institutional enablers and barriers to technology transfer. It drew on good practice from elsewhere in the world, including insights from entrepreneurial places such as Silicon Valley and Kendall Square in Boston. The Review indicated that well-developed ecosystems that had been studied in the USA were not directly transferable, and so a context-specific ecosystem approach was required for the UK.

1.2 Since 2016, when the McMillan Review was published, the policy context has evolved, making its recommendations more pertinent. The Industrial Strategy (HM Government, 2017) set out five foundations for productivity growth, namely Ideas, People, Infrastructure, Business Environment and Places. In different ways, an entrepreneurial ecosystem approach captures all of these foundations and seeks to consider them in an integrated way whilst taking account of the particular circumstances of a place. This study has been driven forward by Research England, in partnership with a number of London-based universities – specifically focused on the 'London Universities Entrepreneurial Ecosystem'. In doing so it recognises the limitations of a bounded system and provides some initial insights into the operations of sub-systems both within and beyond London. An ecosystem approach could subsequently be used in the context of other areas of the UK.

1.3 One of the headline targets of the Industrial Strategy is to increase R&D spend to 2.4% of GDP. If this is to be achieved, then one of the ways in which universities can contribute is through supporting the creation and early development of the kinds of companies that will be R&D intensive, whether these are academic spin-outs, student start-ups or other companies that engage with the research base.

1.4 Against this background, this study, commissioned by Research England, and involving partners from London universities, the National Centre for Universities and Business (NCUB) and the British Business Bank, had three aims. These were to:

- produce a literature review on the concept of the entrepreneurial university eco-system, including a summary of the likely key relevant features of the London eco-system
- develop a high level conceptual model for a 'general' entrepreneurial ecosystem, with a tailored model for London for further testing
- prepare a technical note on the options to compile further evidence, including though primary data collection, to test the model in London in order to inform policy-makers.

1.5 Note that the term framework, rather than model, has been used from hereon in as this provides a more accurate description of the approach. This is because the model provided is conceptual as opposed to, say, a computational model.

1.6 This paper specifically meets the first aim, i.e. the literature review, and also sets out a framework of a general entrepreneurial ecosystem. A technical note, accompanying this paper, sets out how the general framework applies in the London context, and provides a long list of parameters and areas for further investigation that could assist in an assessment of London's ecosystem.

1.7 It is important to note that this study was not intended to propose policy implications, though the review of literature does report on policies that could be considered. Future studies may be undertaken (e.g. directly by or commissioned by London universities) to take forward some of the options contained in the technical paper, with a view to informing appropriate policy interventions.

Approach to the literature review

1.8 Given the timescales of the work, the literature review was a focused review of the evidence, involving both academic and grey literature.

Identifying the academic literature

1.9 The initial search involved using Google Scholar, followed by a more focused Scopus search which adopted a series of search terms[1] and filters[2]. This identified over 1,000 papers, which was reduced to just under 400 following the removal of: those with no digital object identifiers; duplicates; articles that were not in the Association of Business Schools Academic Journal Guide; and those that were obviously not relevant based on their titles.

Identifying grey literature

1.10 We undertook a web-based search for key sources of grey literature. The following avenues were taken to identify literature:

- government departments/agencies, notably the Department for Business, Energy and Industrial Strategy (BEIS, and predecessors), UK Research and Innovation, and Research England (and its predecessor, the Higher Education Funding Council for England, HEFCE)
- work undertaken locally, especially focused on London or major cities, such as the rounds of Science and Innovation Audits, and studies for the Greater London Authority and other London-based bodies
- other organisations operating in the innovation landscape, such as the Enterprise Research Centre, Nesta, the National Centre for Universities and Business, the Big Innovation Centre, and the Institute of Innovation and Knowledge Exchange

[1] Search terms were "university" AND at least one of the following: enterprise OR start up OR entrepreneur* AND ecosystem; enterprise AND mentor*; cluster; innovation network; spin-out OR spin-off OR start-up; technology transfer OR knowledge transfer; commercialisation OR commercialization; R&D; business support; incubat*; science park; entrepreneurial finance; enterprise AND transdisciplinary; accelerator.
[2] Filters were used to restrict articles to 2010-present (unless identified separately as seminal); and for technology transfer OR knowledge transfer, articles in the fields of business, management, accounting and social sciences.

- international organisations, including the European Commission, Organisation for Economic Co-operation and Development (OECD) and the Brookings Institution.

1.11 The team's and client's contacts also provided some additional literature, which resulted in a longlist of over 80 reports.

Final sift and the approach to the review

1.12 A manual sift was then undertaken for both the academic and grey literature to identify the most relevant articles and reports based on those that met one or more of the following criteria:

- "London" or other major international city/area in the abstract
- using a regional innovation system or ecosystem approach
- focus on university commercialisation/entrepreneurial activities
- region/place specific
- offering robust insight into general characteristics/patterns of university spin-outs, start-ups or commercialisation activities
- offering robust critique of the limitations of ecosystem approaches.

1.13 This resulted in 60 articles and reports being identified across both the academic and grey literature sources. These were reviewed formally against a set of core areas of enquiry. In the final writing up of the paper, further papers were sought and reviewed based on references found within the literature selected as well as specialist knowledge within the team. The core areas of enquiry used to structure the review were as follows:

- elements and actors in the ecosystem
- definitions of the ecosystem (if any)
- physical infrastructure and its role (including inter-relationships)
- softer infrastructure, culture and policy environment and their roles (including inter-relationships)
- success factors
- challenges
- any implications or recommendations drawn for policy or practice.

Structure of the paper

1.14 The rest of this paper is structured as follows:

- Section 2 discusses the ecosystem concept, including definitions and the elements that make up the ecosystem. It also introduces the themes identified in the literature.

- Section 3 sets out six key themes, providing an overview of how each is important in the ecosystem, and evidence from comparators and London.
- Section 4 proposes a general ecosystem framework for London and identifies some implications from the literature review. This model may offer insights when considering the transferability of findings to other localities.

2. Ecosystem definitions and elements

The 'ecosystem' concept

2.1 Whilst previous literature on business development and innovation had referred to aspects such as clusters, a firm's environment, and agglomeration[3], the term ecosystem was first used in the business literature by James Moore in a Harvard Business Review article (Moore, 1993). He claimed that businesses do not exist in a 'vacuum' and, stemming from this, developed two key interdependent ideas associated with an ecosystem, namely relationships and a need to evolve. Moore noted the relationally embedded nature of how firms interact with suppliers, customers and financiers, and that they need to draw on these to continually evolve and survive.

2.2 The concept of the entrepreneurial ecosystem has been growing in importance in research as a way of expressing the range of actors and their interactions in particular localities and sectors (Isenberg, 2010; Mason and Brown, 2014; Brown and Mason, 2017; Owen et al., 2018). Primarily, it has been used to describe the range of actors shaping entrepreneurial activity. This includes financial institutions, education and research institutions, innovation networks, infrastructure, the public sector, and the businesses and entrepreneurs themselves. The regional innovation systems (RIS) literature similarly emphasises the role of localised systemic factors in facilitating knowledge development in local firms.

2.3 Two definitions of innovation and entrepreneurial ecosystems are helpful to illustrate the key aspect of relationships and the range of factors involved in the ecosystem. The first definition in the box below, from the Brookings Institution, highlights the economic, physical and networking assets in an innovation district, and then extends this to consider the cultural and relationship elements of an ecosystem. The second definition, from an OECD report, also points to the different factors in an ecosystem, together with attitudinal aspects and the role of both formal and informal relationships.

Definitions

"Innovation districts contain economic, physical, and networking assets. When these three assets combine with a supportive, risk-taking culture they create an innovation ecosystem – a synergistic relationship between people, firms, and place (the physical geography of the district) that facilitates idea generation and accelerates commercialization." (Katz and Wagner, 2014, Brookings Institution)

"A set of interconnected entrepreneurial actors (both potential and existing), entrepreneurial organisations (e.g. firms, venture capitalists, business angels, banks), institutions (universities, public sector agencies, financial bodies) and entrepreneurial processes (e.g. the business birth rate, numbers of high growth firms, levels of 'blockbuster entrepreneurship', number of serial entrepreneurs, degree of sellout mentality within firms and levels of entrepreneurial ambition) which formally and informally coalesce to connect, mediate and govern the performance within the local entrepreneurial environment." (Mason and Brown, 2014, OECD).

[3] For instance, see Michael Porter's work in the 1980s on strategy and clusters, and Alfred Marshall's insights on relations in industrial districts from 1890.

One size does not fit all

2.4 The literature shows us that as the locational context varies, the ecosystem can vary. This also raises the question as to what entrepreneurial ecosystem success looks like. Is it the number and scale of stellar business investment exits, the development of a sustainable business culture or something else (Samila and Sorenson, 2010)? This complexity is illustrated in the different development paths of ecosystems, for instance:

- MIT and its relation to Route 128 in Boston is a much-celebrated example where university research and expertise has facilitated growth of a high-tech ecosystem. The cluster stemmed from the strong research at MIT in the late 19th century, an encouraging entrepreneurial ethos through the one-fifth rule (where one day a week was available for professors to pursue other activities) and supporting finance through seed capital from the 1940s onwards. The ecosystem around Boston has evolved, with new technology areas developing, such as around biotechnology. The MIT example highlights how universities can provide technological knowledge for new and growing firms and be a source of start-ups (Etzkowitz, 2012).

- Tech City, around Shoreditch in East London, provides a different example where universities were not involved (or certainly not directly or formally) in its emergence. Following industrial decline in this part of East London in the 1980s, rents were low. There was a grass roots development of the area as a home to artists and new media companies, which evolved into the growth of digital technology companies in the 2000s. As technology-based businesses grew and more attention became focused on the area, it was rebranded as "Tech City", and a range of national and London-level policies have since been developed, e.g. covering finance, workspace, connectivity, business development, people and skills, and research collaborations (Nathan and Vandore, 2014).

2.5 Therefore, whilst universities may be key to helping to generate start-ups, develop entrepreneurialism or otherwise support the successful commercialisation of knowledge as part of a triple Helix (relationship between universities, policy or government, and industry; Etzkowitz, 2012), in other contexts their role may be more modest.

Key themes

2.6 As highlighted so far, relationships between different types of actors or assets are crucial to the development of an effective entrepreneurial ecosystem. The strength of the roles of different actors or assets may vary depending on context. In addition, the ecosystem itself is dynamic and ever evolving over time. To understand the role of different elements and the relationships between them, a systems-based approach can be instructive. This requires determination of parameters and boundaries of focus, as it is not possible, or certainly not tractable, to include everything in the system.

2.7 At the centre of the ecosystem is the entrepreneurial process of business formation, growth and the recycling of expertise. Mason and Brown (2014) highlighted the role of the entrepreneurial process as distinctive to the ecosystem approach. They showed how the growth in entrepreneurial activity occurs through a spin-off process, with people leaving the initial start-ups to set up their own businesses, and these businesses in turn are the source of

further waves of the same process, thereby building its own momentum. This also results in the emergence of both commercial and community-oriented support organisations, such as business angels and venture capital funds, professional service firms, and mentors and business support organisations. A significant element of this is the process of entrepreneurial recycling, in which entrepreneurs who have exited from their businesses (through sale or failure) put their expertise and capital to work as serial entrepreneurs, financiers, mentors and advisers.

2.8 From the literature review, six key themes have been identified that sit around the entrepreneurial process, and these have provided the core basis for our enquiry and the development of a conceptual framework. Elements that have been identified as being important are as follows, and are discussed in more detail in section 3:

- **The roles of universities**: this includes internal factors and external links. It also includes a range of roles, e.g. as knowledge and technology generating actors, cultural aspects such as in fostering an environment for enterprise amongst staff and students, and softer elements such as creating networking assets. Certain approaches that have been found to work are likely to be highly context-specific.
- **Leadership**: this comes from various parties, including national/regional/local government, universities, business leaders, entrepreneurs, and student leaders.
- **Physical space and infrastructure**: there are various types of commercial space, including science parks, incubators and accelerators. This, combined with how they are connected, provides a part of the physical infrastructure required to support the ecosystem.
- **Business support**: there is a need for complementary and networked support, which can come from a variety of sources, including university, public and private sources.
- **Entrepreneurial finance**: the literature highlights a number of success factors, including scale, quality, skills and attitudes to risk. Again, some of these factors may be context-dependent.
- **Networks**: there are a number of different characteristics of networks, including both formal and informal. There is a need to consider inter-university linkages, as well as those to other actors, and a need to look beyond the region.

3. Key ecosystem themes

3.1 This section provides an overview of evidence on the key themes identified, drawing on general evidence, case studies of comparators and evidence from London. The purpose of the section is to set out key findings from the literature, in particular on London. It is not intended to recommend particular policy implications, although it does identify policies and initiatives from the literature as well as areas for possible further investigation that could help to fill evidence gaps. These are intended to guide future work that study partners, in particular London universities, may wish to take forward.

University Roles

Overview

3.2 Universities are critical components of the ecosystem, and within the literature it is noted that ecosystems often emerge in areas where there is already an established and reputed university that acts as an anchor institution (Finger et al., 2016) or 'knowledge base' (Mason and Brown, 2014). Finger et al. (2016) defined anchor institutions as large, resource-laden organisations that are relatively immobile and locally active. As institutions, universities play several key roles in facilitating the development of a sustainable ecosystem. Finger et al. (2016) listed several potential roles for such institutions, discussed in further detail below.

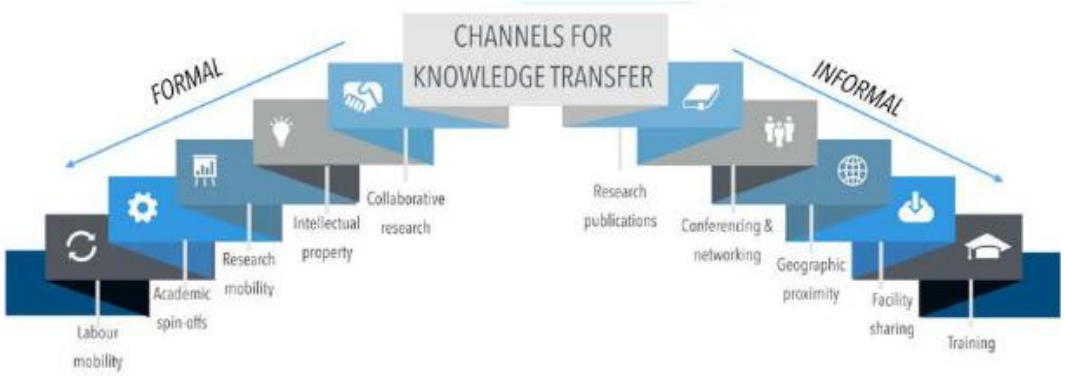
> *Such institutions may spawn spinouts directly and can also act as a reservoir of technical skills which can benefit start-ups through employment of skilled individuals, training courses, collaborative research, contract research, consultancy and equipment hire. They can act as testing, measurement and certification facilities, providing validation, advice about metrology, equipment calibration, standards and quality control. They may aid with prototypes, especially where start-ups have needs beyond the technical capabilities of 'makerspaces'.* (Finger et al., 2016)

3.3 First, universities, amongst other cultural and lifestyle-related characteristics of a place, attract, employ and train a skilled labour force. Typically, this would include the scientists, technicians and highly qualified researchers that create knowledge for commercialisation (Mason and Brown, 2014). An abundance of talent is a key ingredient to enabling a fruitful ecosystem, as it enables more effective collaboration, catalysing entrepreneurship. Baily and Montalbano (2017) indicated that qualified researchers are essential to an innovation-based cluster. Indeed, they suggest that access to talent, amongst other assets within clusters, to promote collaboration, is a potential solution to the productivity problem. They cite the example of Austin, Texas, where the presence of Texas A&M University, University of Texas at Austin and several colleges and training institutes as well as the city's cultural offer, attracted and supplied the skilled workforce that made up the strong technology cluster it currently boasts. In another example, Boston's Seaport Innovation District, the presence of several renowned universities such as Harvard and MIT were thought to be large sources of talent, whilst others, such as Babson College, served also to train entrepreneurial talent. Conversely, locations where a research base is lacking, such as Singapore, have resorted to using high

salaries to attract researchers to enable the growth of clusters, which may not be an option in some cases (Baily and Montalbano, 2017).

3.4 Second, universities play a critical role in knowledge exchange and developing transdisciplinary capabilities. Both Aalto University in Finland and Imperial College were formed through the merging of several universities specialising in areas as varied as engineering and business (Graham, 2014). Cross-fertilisation across disciplines and industry was one of the key determinants of Imperial's entrepreneurial strengths. The McMillan Group (2016) outlined the key institutional capacity and competency areas required to support knowledge exchange mechanisms. These broadly include strategic and institutional elements, such as governance structures and incentives, as well as those relating to human and physical capital assets, networks, skills development, community engagement, enterprise education and facilitation of research exploitation, for example through marketing and corporate relations (McMillan Group, 2016). The OECD (2019) observed that 'co-creation' of knowledge by firms and research institutions was key in enabling ecosystems to benefit from scientific research. Knowledge transfer can occur through formal or informal channels, as illustrated in Figure 3-1. Despite being difficult to measure, informal mechanisms can be critical to innovation due to their ability to transfer tacit knowledge. However, the importance of each mechanism depends on sectors or areas of research (OECD, 2019). Table 3-1 details findings within the literature regarding the relative importance of each channel.

Figure 3-1: Channels for knowledge transfer



Source: OECD, 2019

Table 3-1: Relative importance of different channels of knowledge transfer by sector and field

Sector/Field	Significant knowledge transfer mechanisms
Materials science	Patenting and licensing
Chemical engineering	Patenting and licensing
Engineering	Contract and collaborative research, labour mobility, student flow into industry
Social science	Personal contacts, labour mobility, training courses for firms
Biotechnology	University spinoffs

Source: OECD, 2019

3.5 Technology Transfer Offices (TTOs) play a significant role in enabling universities to exchange knowledge with industry, commercialising university-generated IP and supporting academics or students of the university in enterprise (Brandy et al., 2015). Baglieri et al. (2018) found

that there were four models for conducting technology transfer at the university level. The models that were found to correlate with higher economic performance were those where the TTO acts as a catalyst for disruptive innovation, focusing on the value of research and maximising their income from exploitation and where universities focused on start-up creation, appreciating the relevance of entrepreneurialism in its own right in boosting local economic development (Baglieri et al., 2018)[4]. In this way, support for entrepreneurial development provided by the university, and its TTO, can help to increase the productivity of spin-outs and address some of the key barriers to spin-out generation. This may include the negotiation of equity, licence and corporate agreements and potential conflicts between job roles for academics (Fini et al., 2011). However, TTOs are not always perceived to be effective, and are occasionally viewed as barriers to the commercialisation of research, often due to stringent licensing terms and IP protection (Mason and Brown, 2014).

Case Study: Silicon Valley

Silicon Valley, located in San Francisco Bay, California, is renowned as the premier tech cluster in the world, with a GDP worth $722 billion in 2016, despite the fact that Northern California had no technological industries of its own at the end of the 19th Century. The Universities and research institutions played a key role within the development of this ecosystem. Firstly, the ecosystem was built around a pre-existing core competency, semiconductors, developed in part through research from Stanford and Berkeley. The presence of universities, particularly Stanford and Berkeley, attracted highly qualified researchers to the talent pool. They also trained and provided highly skilled, qualified workers, supporting the needs of the technology cluster firms. Finally, Stanford University's leadership played a key role in the development of the cluster, with Frederick Terman, its Dean of Engineering in the 1930s, developing a strategy that encouraged collaboration between science and engineering departments and graduate students to become entrepreneurs, concentrating resources on a few research areas and making internal changes regarding approaches to IP. He also created the Stanford Industrial park for start-up companies.

Source: Baily and Montalbano (2017); Etzkowitz (2012)

3.6 Universities also play a role within the ecosystem by creating networking assets and developing strategic partnerships within industry. Networking assets, defined as formal and informal meetings used to foster interactions within a cluster, are highlighted in the literature as a key building block of innovation districts. These can include workshops, training, cluster-specific meetings and conferences. They are useful in generating, refining or accelerating the advancement of ideas (Baily and Montalbano, 2017). In Helsinki, Aalto University successfully developed networking assets by mobilising and empowering its student community, who developed an inclusive, dynamic entrepreneurship movement, organising innovative events and activities that engaged the local start-up community (Graham, 2014).

3.7 Universities play a crucial role in fostering an entrepreneurial culture within the institution and the local community. Universities can encourage entrepreneurship and an

[4] The other two models include: one where universities generate and openly disseminate research and another where universities use the technology transfer process to drive research outputs that exist in the marketplace through patents.

entrepreneurial culture by making changes at an institutional level. For example, this can be done by changing targets and expectations to provide faculties with the freedom to devote time to entrepreneurial ideas and recognising the entrepreneurial achievements of staff and students (Graham, 2014). The University's ability to support staff and student entrepreneurs, as well as the role of its TTO and IP practices can also affect culture by incentivising spin-offs and their development. MIT and Stanford have been cited as examples of good practice. They have an 'arms-length' approach to licensing IP, in which they take a low percentage of return in the form of equity (McMillan Group, 2016) – though this does not mean that this approach would be appropriate in the UK context. In fact, it has been noted that MIT's 'arm's length' approach was appropriate due to the nature of the established and well-functioning ecosystem that already existed; simply adopting their approach would not create such an ecosystem. Aalto University in Helsinki instead focused on regional investments, downplaying the importance of its IP ownership and start-up affiliation (Graham, 2014). Institutional culture is widely accepted to be an essential ingredient for a successful ecosystem. The literature found that where successful ecosystems have emerged, they have often benefitted from institutions where an entrepreneurial culture and ethos was integral and long-standing, such as in Stanford and MIT (Graham, 2014).

3.8 Relatedly, a forward-paying culture has also been found to be an important element of a successful ecosystem. This occurs where universities are incentivised to work on pro-bono projects with the local start up community, with the expectation that the university would receive compensation once the firm became successful (van Stijn et al., 2018). This culture is often necessary as young start-ups may lack the resources to pay for academic support, since Universities can be expensive due to their large overheads. The literature also finds partnerships to be of increasing importance within ecosystems. Partnerships are capable of allowing universities to enhance capabilities, for example by focusing research on industrial and innovation challenges and allowing access to research facilities (Ulrichsen, 2014).

Evidence from the London ecosystem

3.9 The role played by universities and research institutions may be more significant within the London ecosystem, than in other UK cities. London boasts a wide range and high concentration of globally renowned universities, with a higher education sector that is growing in size (Hanna, 2016). London is home to more than forty-two HEIs, consisting of multidisciplinary institutions (e.g. UCL), 'modern' universities (e.g. Southbank), and smaller institutions (e.g. teaching hospitals) (Lawton Smith et al. 2014). The literature sourced and reviewed on the role of London universities focused on its larger, more research-intensive institutions, as well as particular technologies and disciplines. This does not reflect the priorities of this research project, but rather the evidence available.

3.10 Within the context of London's life sciences cluster, the literature points to the presence of an outstanding research base and concentration of universities as an enabler (SQW, 2015). The presence and growth of the sector in London is largely attributed to its ability to draw on high-quality research infrastructure and organisations. Indeed, the input of technological innovation from outstanding universities was found to be one of the key success factors within the UK venture capital sector, alongside the observed increase in the number of students of entrepreneurship, leading to a rise in venture capital firms that employ partners with entrepreneurial backgrounds (Arundale, 2017).

Case Study: Imperial College

Imperial College, located in South Kensington, West London, was originally established as an engineering and natural science college but later broadened due to the establishment of Imperial College Business School and Faculty of Medicine. Since its foundation, Imperial has committed to knowledge transfer, including within its mission the application of its work to industry and commerce. Over more than 100 years, this shaped the university's institutional culture towards entrepreneurialism. Graham (2014) highlighted some key factors as follows:

- Ability to bring together transdisciplinary capabilities to tackle challenges faced by industry, enabling 'cross-fertilisation' between disciplines and sectors.
- World-class science and technology research base.
- Strong strategic partnerships with industry, making Imperial one of the largest academic recipients of corporate research and development funding outside of the US.
- Lean and dynamic university structure, making it more resilient to change within the internal or external landscape.
- High-profile and highly reputed centres, including Imperial Innovations and Imperial College Business School.

Despite the above, some characteristics and institutional behaviours were perceived to be hindering its role in facilitating ecosystem growth. First, the culture supporting entrepreneurship was found to be lacking within the university. It was found that a relatively low proportion of staff and students were involved in entrepreneurial activity. In addition, student perceptions of entrepreneurialism were found to be mainly associated with careers in finance rather than technology or science. These challenges were attributed to the proximity of the City of London, an institutional culture within Imperial where only university-protected IP was seen as valuable and a lack of clarity over student IP ownership rights. Second, the entrepreneurial community, including investors and entrepreneurs on campus lacked visibility. This is perhaps due to its location and the high property prices in its surroundings, or the high proportion of non-EU students at Imperial making it difficult to engage alumni entrepreneurs.

To tackle some of these challenges, the university has undertaken projects such as the establishment of the Imperial Create Lab within the Imperial White City development in 2011, which targets on-campus, student-led activity that embraces the regional entrepreneurial community.

Source: Graham (2014)

3.11 Universities cannot act unilaterally to create successful innovation, but rather are part of an ecosystem that includes a market for specialised labour and intermediate services (Hannah, 2016). Indeed, in the case of Tech City in London, there was initially a lack of conventional cluster actors such as universities within the thriving ecosystem.

Areas for further consideration

3.12 There are many examples within the literature of the roles universities have within successful ecosystems in comparator cities. Much of the literature sourced on London focused on Imperial and UCL and the associated biosciences clusters that they are key operators within. There were fewer studies identified and examined in this literature review on the role of other universities and technology areas in London (such as creative arts and media activities), and this represents an evidence gap. A fuller, clearer picture of the differences between the roles played by anchor institutions across the London ecosystem would be beneficial. It would be helpful to understand what works in terms of specific technology transfer and IP practices, ways of engaging student and staff entrepreneurship and models of knowledge exchange on a more granular level. Relatedly, within London further information should be gathered regarding how different universities might best interact with one another to create mutual benefits or wider benefits for the ecosystem.

3.13 The literature suggests that government agencies have the potential to encourage knowledge exchange, the creation of spin-outs, and the improvement of relationships between universities and industry. Examples include providing a brokerage role to identify industry-relevant material, financial support such as innovation grants or funding for TTOs, regulatory changes such as to IP rights, incentive schemes and softer instruments such as awareness raising. It would be helpful to consider what policies are active in London, how they affect and influence the role of universities, and to what degree they are required in what is already quite a well-developed ecosystem (OECD, 2019). There may also be a spatial aspect whereby the boundaries of London boroughs affect what is available to businesses depending on location. It is important to note that care should be adopted in transferring practice across universities within London and also from outside (especially outside of the UK), as effectiveness can often be context-dependent.

Leadership

Overview

3.14 Within the literature, examples of the role of leadership within ecosystems came from a variety of different sources. Leaders were found within central and local government bodies, university staff, student bodies, and businesses. Individual entrepreneurs were also found to play significant leadership roles within some ecosystems, particularly through entrepreneurial recycling. Local leadership is widely acknowledged as a key success factor within cluster development, particularly in helping areas to harness and build upon local capabilities and competitive strengths (Baily and Montalbano, 2017; McMillan Group, 2016). Building a leadership network, particularly one that is inclusive, meritocratic and collaborative with the right level of expertise, was identified as one of the five key strategies for harnessing and accelerating an ecosystem to enable economic growth (Mason and Brown, 2014; Baily and Montalbano, 2017; Katz and Wagner, 2014).

3.15 One of the key success factors identified throughout the literature was consistent, committed and passionate leadership or championship of the ecosystem (Baily and Montalbano, 2017). For example, in developing strategic partnerships between universities and industry, committed buy-in from senior leadership was a crucial success factor (Ulrichsen, 2014).

Graham (2014) found that within a university, champions who could inspire and establish change towards an entrepreneurial culture and push to grow entrepreneurial activities within the institution enabled an increased focus on developing entrepreneurialism and innovation. Strong leadership, enacting fundamental change in the institutional culture and strategy of a university, was found to lead to strengthened ecosystem performance in many cases (Graham, 2014). Features of such leadership include vocal and clear promotion of an entrepreneurial and innovation agenda capable of supporting regional and national economic growth strategies and creating impact (McMillan Group, 2016; Graham, 2014).

3.16 Another key mechanism driving entrepreneurial growth is leadership from the grassroots, including university students (Graham, 2014). An empowered, innovative, inclusive student-led entrepreneurial community with direct connections with university senior management and industry is a common success factor, as shown in the case study below from Finland (Graham, 2014).

Case Study: Aalto University, Helsinki

Aalto University is based in the metropolitan area of Helsinki and was established in 2010 through a merger of three existing universities, combining strengths in engineering, design and business. The economy is dominated by high-technology manufacturing, export-driven industry that is highly supported by a strong R&D base that has strong links with industry. This has been a key success factor in the development of the university and ecosystem. In addition, student and university leadership were identified as critical. An anti-establishment entrepreneurship movement was born in 2008, led by a small cohort of students that was frustrated with the lack of support for entrepreneurship. The movement was seen to have been encouraged by the increased interest in entrepreneurial careers amongst students, driven by a decrease in the presence of major employers of local graduates such as Nokia. The students organised innovative activities and events to engage and develop the local start-up community. This movement was successful in harnessing the local community to establish Aalto as a hub for high-growth technology-driven entrepreneurship and innovation.

The university's senior management team were highly vocal supporters of the student entrepreneurship movement, helping it where possible to grow entrepreneurial activities, communities and culture through the provision of financial support and infrastructure as well as endorsement. Nevertheless, the university ensured the expertise and interests of the founders of the movement and activity guided it, leading to investments in regional capacity rather than institutional when entrepreneurship spread from the students to university support functions.

The emerging ecosystem in Aalto is recognised as having considerable potential. However, it was relatively young (at the time of study) and needed to embed entrepreneurship within the institution by changing incentives and policies to enable stability. The enthusiasm that drove the student leadership may be fragile and time-limited.

Source: Graham (2014)

3.17 Successful leadership practice includes prioritising the establishment of a market for the university's innovative output, ensuring the approach taken to innovation harnesses regional opportunities and is responsive to constraints (Graham, 2014). To support ecosystem growth, campus leaders must understand and be able to seize opportunities and resources (Leih and Teece, 2016). The importance of this characteristic is exemplified in the comparison, by Leih and Teece (2016), between the development of Stanford and UC Berkeley. Stanford's President and Dean of Engineering in the 1950s were able to seize the opportunity of the Cold War to obtain federal support to conduct research and commercialise university technologies, making significant changes including establishing a computer science programme and the Stanford Industrial Park. This took Stanford from being a regional to a top-tier University between 1950 and 1975. UC Berkeley, in contrast, did not seize the same opportunities and was late to develop a strong local ecosystem by not openly embracing new enterprise development. Whilst Berkeley did eventually embrace entrepreneurialism, becoming influential within molecular biology, it missed an early opportunity and developed some cultural challenges related to working with industry that may be difficult to overcome (Leih and Teece, 2016). For example, staff and leaders often perceived the main mission of the university as being technology transfer realised through publishing research and training engineers, rather than working with industry. Perhaps related to UC Berkeley being a public university, it seems to have retained a culture of prioritising research and perceiving collaboration with industry as limiting (Leih and Teece, 2016).

3.18 Continuity of leadership has also been identified as helpful in building an ecosystem (Graham, 2014), given that ecosystems often require several years to develop. Therefore, continuity enables leaders to execute the longer-term strategies required. Specifically, at the university level, continuity enables leaders to embed strategies and develop dependable networks (Mason and Brown, 2014; Graham, 2014). Local and national government leadership that made commitments to continued support was also identified as critical to success (Graham, 2014). For example, two individuals are credited with Akron, Ohio's transformation from an industrial stronghold suffering from an economic downturn to a global leader in polymers with a GDP of $37 billion in 2016 (Baily and Montalbano, 2017). The former Mayor of Akron played a key role. He served from 1987 to 2015, enabling continuous leadership that many have attributed to the area's success by prioritising economic development and education. The University's President at the time also contributed significantly. He developed the Akron Model, whereby the university has generated economic growth by building on local expertise in polymers (Baily and Montalbano, 2017).

Evidence from the London ecosystem

3.19 According to Hanna (2016), London's sub-ecosystems can be understood in terms of four institutional leadership models. These are described in Table 3-2 below. The study found that London has recently been mainly characterised by university-plus or radical mixed-use models. This means that, certainly in London, universities are not the sole leaders within the ecosystem, and that partnerships between universities, research institutions and the private sector are critical.

Table 3-2: Institutional models of London's ecosystems

Institutional Model	Description	Example in London
University-led	These are where innovation districts are largely or completely dominated by university facilities, with some retail provision or commercial space that is generally reserved for students.	Examples of this model include Brunel University, UCL Bloomsbury and South Bank University. It is noted that none of the more recently developed sites in London operate with this model.
University-plus	Universities play a key leadership role, but work with a private sector partner, research institute or teaching hospital.	An example is Imperial College, working with Hammersmith Hospital and the Molecular Sciences Research and Translation Hub at Imperial White City Campus. In common within this model, Imperial worked with its development partner Voreda on its White city site, as a joint venture.
Radical mixed use	Sites where there is no dominant lead, but rather there is a mixture. Sites can include residential space alongside offices, universities, incubators and accelerators.	Examples of this are the knowledge quarter around Bloomsbury/Fitzrovia and Here East in Stratford.
Enterprise-led	Sites where there is no significant presence of university or major institutional leadership. Leadership is dominated by a private sector firm or multiple smaller companies.	Example are Tech City in East London and Tech City Croydon, discussed within the section on Physical Space.

Source: Hanna, 2016

3.20 Brooke et al., (2014) found the quality of management of London's incubator, accelerator and co-working spaces to be a key aspect of its offer to start-ups. This is because they provide actively-managed support mechanisms which enable businesses to gain a competitive edge and benefit from their co-location with other innovative start-ups. Quality of management and business support, for example with business administration, networking or training, is considered to be critical to the level of benefit businesses derive from working in such spaces. This is particularly true for accelerator spaces. Another example in which prominent leadership was significant within the London ecosystem is described in the case study below.

Case Study: Imperial College

Imperial College's Rector between 2001 and 2008 played a significant role in strengthening the university's standing within the entrepreneurial ecosystem. Richard Sykes, previously the CEO of GlaxoSmithKline, was committed and dedicated to the mission of ensuring Imperial improved its innovative capability. He vocally supported the entrepreneurial and innovation activity within the university and worked to inspire a cultural change at the institutional level, whilst enacting major structural changes. He did so by incentivising academics to invest more of their time in innovation activities, creating an environment in which the successes of entrepreneurs are celebrated and did not lead to a loss in academic credibility. He also incentivised Imperial Innovations, the university's TTO, to emphasize and demonstrate the impact and value of their activity, encouraging it to expand its role within the university.

Source: Graham (2014)

Areas for further consideration

3.22 Within this literature review, several leadership models were identified within London. A trend is also observed towards developing partnership-led innovation districts. However, it is not clear whether this trend is substantiated by evidence on which models are more effective in the London ecosystem, and whether this varies according to sector or geographical context. If not already available, conducting further research into this may be informative.

3.23 It is clear from the literature that local leadership is critical to the development of a successful ecosystem. However, this review has come across limited evidence that specifies what the current roles of London's leaders, such as the GLA or the Mayor, are or could be. Hanna (2016) provides a series of recommendations on behalf of the Centre for London. For example, it was suggested that the GLA should be mobilised to work with local authorities to understand local assets and refine local economic development strategies to factor in the role of innovation districts (Hanna, 2016). It was also suggested that the Mayor could better support ecosystems by recognising the role they play within the London Plan. In addition, auditing and documenting innovation districts, where possible designating them as districts similar to Opportunity Areas to enable favourable planning regulations to be put in place, was recommended (Hanna, 2016). These are policy suggestions sourced from the literature, and it may be beneficial to conduct further research into the potential impact of such interventions, as well as whether their efficacy is likely to vary across sectors or universities. Drawing on comparator city evidence regarding the role of local leadership as a specific theme may also be helpful.

3.24 It is evident from the case studies presented that the role of leadership is largely dependent on an individual's character and charisma. This means that it is difficult to make recommendations on how to improve leadership. Nevertheless, the public sector could potentially play a role in identifying potential leaders, whether these are individuals or within the community or student bodies. Central or local government may also effectively support university and business leaders in conducting their duties, for example by identifying the core competency of a potential cluster and strategies to develop it (Baily and Montalbano, 2017). Alternatively, the public sector could also work to create the conditions that may generate strong leadership by making changes to regulations and institutional practices to incentivise the championing of entrepreneurship and ecosystems. It could be beneficial to review wider research to understand what the role of the public sector has been in other comparable ecosystems, as well as what policies and incentives can be put in place that would nurture an environment that encourages individuals to champion and lead entrepreneurial movements.

3.25 Finally, the literature acknowledges that one of London's advantages is an abundance of skills within the city. However, it is not clear whether this means that London is also at an advantage when it comes to leadership skills. In fact, Arundale and Keith (2017) found that the relative lack of experienced CEOs within venture capital firms in Europe compared to the USA partly explained the stronger performance of such firms in the latter. Whether, and the extent to which, the provision of 'leadership' skills within the context of innovation is an issue which could be investigated further in London.

Physical Space

Overview

3.26 Physical space plays a critical role within entrepreneurial ecosystems. As well as providing premises for businesses and other organisations, it has the potential to facilitate knowledge exchange, skills development, partnerships and innovation. The role of space occurs at a range of scales, from office cafes and co-working spaces to high-tech university laboratories and innovation districts (Hanna, 2016).

3.27 First, physical proximity can play a key role in attracting entrepreneurs, talent and organisations to an area and in stimulating further entrepreneurship and innovation within the ecosystem. The geographic concentration of interconnected economic actors and activity can contribute to the exchange of ideas, knowledge diffusion, and increased collaboration through partnerships and networks (Finger et al., 2016). Geographic concentration can also engender a virtuous cycle of ecosystem growth, as complementary firms and industries (including financial and professional services) and a skilled workforce are attracted to the area. For example, Nesta's study of digital entrepreneurship highlighted that a "*shorter travel time between VC firms and their portfolio companies leads to more attention, better performance and increased likelihood of successful exits*" (Finger et al., 2016). As such, high-performing ecosystems tend to emerge where there is concentrated activity, typically in places with established knowledge bases (Mason and Brown, 2014). Florida and Hathaway (2018) noted a global 'winner-takes-all' pattern in start-ups and venture capital, with most activity clustered in a few postal codes within a small number of cities.

3.28 Second, physical space is crucial in providing supportive infrastructure to other aspects of the ecosystem. Workspaces are embedded within the broader set of elements of an ecosystem, interacting with and shaping softer institutional forms (e.g. norms, values and culture), as well as softer infrastructures (e.g. networking groups and business support services).

3.29 The key types of workspace are shown in Table 3-3. There is a range of literature on the definitions and developments in types of workspace (Bone et al., 2017; Dee et al., 2011). This demonstrates how the infrastructure of incubators, accelerators, co-working spaces, makerspaces etc. has evolved in recent years. Accelerators, a relatively new concept, have rapidly changed with new variants, such as pre-accelerators (which support early stage companies that have an aim to join an accelerator), accelerators that are not necessarily physically-oriented, and those that receive funding from - corporates rather than venture capital firms (Bone et al., 2017). Incubators tend to more often be funded by the public sector or by universities.

Table 3-3: Types of business space

Spaces	Role
Science Parks	Support start-ups and businesses through business support, incubation facilities, networking opportunities and university links.
Incubators	Typically physical spaces with flexible terms, which provide additional incubation services, such as start-up and growth support, training, and access to networking opportunities and, in some cases, specialist equipment.

Spaces	Role
Accelerators	Support start-ups or small businesses with high-growth potential through business support and networking opportunities. Usually highly selective and require an equity stake / profit share, which distinguishes them from incubators.
Co-working	Offer varying degrees of business support and networking opportunities. They often have affordable rates and flexible contracts, with flexibility potentially significant (e.g. easy-in easy-out terms, time slots for booking space). They are usually private initiatives but can be supported by the public sector.

Sources: London Enterprise Panel (n.d.); Bone et al. (2017); Dee et al. (2011); Belmana and CEEDR (2018)

3.30 An emergent theme in the literature is the trend away from suburban office provision and science parks towards high density, urban innovation districts. A Brookings Institution paper indicated that innovation districts consist of "*geographic areas where leading-edge anchor institutions and companies cluster and connect with start-ups, business incubators and accelerators*" (Baily and Montalbano, 2017). Katz and Wagner (2014), in another Brookings Institution paper, identified three models of innovation district:

- **Anchor plus:** large-scale mixed-use developments, usually in the central or main commercial areas of a city. These are centred around anchor institutions (e.g. universities) and their interconnected firms, entrepreneurs and spin-offs.
- **Re-imagined urban areas:** re-developed industrial/warehouse areas.
- **Urbanised science park:** the urbanisation of suburban or exurban science parks through increasing density and new mixed-use activities (e.g. retail).

3.31 The role of different partners can vary depending on the context. The box below presents the case study of the Boston Innovation District, a local government initiative which drew on private investment. Case study boxes later on in this section demonstrate how physical space can develop to support an emerging cluster without substantial public involvement (in the case of Tech City) and a university focused example (Queen Mary Bioenterprises Innovation Centre). As shown for Boston (in the box below), other physical assets are important, including; land availability for new developments, the presence of or links to universities, housing, transport systems and amenities (including retail, restaurants, and the quality of design and spaces). Such aspects were also found in a UK study on the building of space for university researchers to work with businesses (Belmana and CEEDR, 2018).

Case Study: Boston Innovation District

The Boston innovation district was a local government initiative to develop 1,000 acres of prime but undeveloped real estate along Boston's waterfront. It aims to generate civic-tech ideas, encourage regional growth and facilitate public collaboration. The district includes various types of business space, including co-working, incubator and live/work spaces, civic spaces to encourage formal and informal dialogue and idea-sharing, and various cultural amenities including restaurants and retail facilities. It has strong transport links to MIT, downtown Boston and Logan airport. Since 2010, the district has created 5,000 new jobs, 30% of which are in the tech sector. Two-fifths of companies utilise either a co-working or incubator space on the site.

Source: Finger et al. (2016)

Evidence from the London ecosystem

3.32 London has an extensive network of physical infrastructure catering for its entrepreneurship ecosystem. As a result of a processes of clustering, agglomeration and pressures associated with cost and land availability, London has a distinct and evolving spatial geography. Hanna (2016), in a Centre for London report, indicated that, within the context of "*a growing knowledge economy and a hot real estate market",* universities and businesses were forming innovation districts in post-industrial and outer London areas. These were often high-density and mixed-use developments.

3.33 In recent years, Hanna (2016) reported that London universities have been expanding out of core central London areas into ex-industrial districts and outer London employment centres often on the edge or just outside central London. These expansions have tended to follow two models: university plus (developments by a university or universities in partnership with the private sector or a research institute) and radical mixed use (including university space, workspaces and residential space). Examples include Imperial College London's new Imperial White City campus and the Francis Crick Institute in the Knowledge Quarter around King's Cross. The box below provides an example of a university plus development in East London at Whitechapel, illustrating the model and the expansion out of core central London areas.

Case Study: QMB Innovation Centre Whitechapel

QMB Innovation Centre is a specialist biotech incubator linked to Queen Mary University (QMU). Established in 2012, it is London's only commercial early and late stage wet lab and is part of a cluster of university institutions in London connected to science research and innovation (including hospitals, QMU, Barts, and the Blizard Institute of Cell and Molecular Science). The centre is the result of a collaboration between Queen Mary University and the public sector.

The centre aims to capture IP-driven start-ups emerging from London's universities and retain high-value science jobs in the city. It is also designed to benefit Queen Mary University by establishing a medical presence in East London through its onsite medical school. Between 2012 and 2016, the centre created and/or safeguarded over 370 jobs and supported over 200 businesses. However, a lack of urban science parks in London has raised concerns over bioscience companies being pushed out of the capital once they require further grown-on space.

Source: London Enterprise Panel (n.d.)

3.34 A mapping exercise, conducted in 2014 by the London Enterprise Panel, found 132 incubators, accelerators and co-working spaces (IACs) in London, half of which were established between 2012 and 2014 (London Enterprise Panel, n.d.). Put into a national context, a mapping study undertaken by Nesta found that over half of accelerators in the UK were in London, although they were found to be growing in number in other cities (Bone et al., 2017). Whilst the capital was found to have the highest number of incubators, when standardised to business formation rates, the number of incubators in London was the lowest across all UK regions. Of

the 177 London-based incubators and accelerators included in the directory, around 20 had funding from a university[5].

3.35 The IACs mapped by the London Enterprise Panel are concentrated in central London boroughs, in particular Camden, the City of Westminster, Islington and the City of London – see Figure 3-2. In addition, the map shows concentrations to the east in the boroughs of Hackney and Tower Hamlets, providing examples of the shifts to ex-industrial areas. The case study box below provides an example of the emergence of the Tech City digital cluster in Hackney, which has followed the Brookings Institution's reimagined urban area model. Over two-thirds of IACs in London offered office space, a quarter offered workshop space, and under ten IACs laboratory space. Key characteristics of the offer to businesses were: flexibility in membership and pricing; high levels of support; and design of space to facilitate interaction.

Case Study: Tech City in East London

London's Tech City is located in inner east London, in the neighbourhoods of Clerkenwell, Shoreditch, Hoxton and Haggerston, and with the Old Street roundabout at the centre. The area suffered from de-industrialisation in the 1980s, and then developed organically in the 1990s and 2000s as affordable rents attracted artists, new media and digital technology firms. Physical space for these entrepreneurs and companies was developed in former warehouses, as the urban fabric of the area was redeveloped. Since 2010 the area has been subject to specific London-level and national policies, and the Tech City Investment Organisation was created to encourage further the development of innovation and entrepreneurship in the area. This included policies covering workspace and planning, but also other aspects such as finance, business support, talent attraction (including immigration) and research collaborations.

Source: Nathan and Vandore, 2014

Figure 3-2: Distribution of incubators, accelerators and co-working spaces in London

Source: London Enterprise Panel (n.d)

[5] See https://www.gov.uk/government/publications/business-incubators-and-accelerators-the-national-picture for the directory [Accessed 13th June 2019]

3.36 It is important to note the ways in which London's physical space and infrastructure may also hinder the growth of its entrepreneurial ecosystem. First, London has a lack of residential and commercial land, leading to competition, including between ecosystem actors, and unaffordable rents (Hanna, 2016). Second, London has a lack of grow-on space for businesses. This is particularly evident in the life sciences sector, where firms are usually pushed out of the capital due to lack of laboratory provision (SQW, 2015). When compared to life sciences clusters in other leading ecosystems (e.g. Boston or San Francisco), there is evidence to suggest that London's cluster infrastructure, such as specialist and mixed tech incubators, is less well developed (SQW, 2015). Supporting this finding, Lawton-Smith et al. (2014) reported that almost a quarter of London university spinoffs are located outside the M25 motorway, suggesting London is not catering for their space requirements. The movement of talent and business out of London may not be detrimental; however, it may mean capabilities and networks are not recycled back into the London ecosystem. Further research is required on this subject. Third, innovation in London occurs in localised clusters, which means that certain areas are 'left behind'. For example, whilst spatial patterns are evolving, Hanna (2016) highlighted a scarcity of incubators, accelerators and co-working spaces in outer London boroughs.

Areas for further consideration

3.37 Whilst there is evidence on the distribution of incubators, accelerators and other workspaces, further in-depth examination would be useful, including on: the links to universities, the nature of these links, and the evidence on whether university-supported incubators and accelerators are working (and why); the extent to which tenants or programme participants are from spin-outs or graduate start-ups (and any associated enablers or barriers to this); and the extent to which these workspaces are associated with sectoral and/or localised concentrations, including innovation district models. This research could build on the mapping work of Bone et al. (2017) and that undertaken by the London Enterprise Panel – including existing available directories of workspaces.

3.38 The literature also points to a lack of grow-on space and specialist space when compared to other international comparators, and also a scarcity of incubators and accelerators in outer London areas. The specific drivers of these gaps, the extent to which it is a hindrance to the performance of the ecosystem, and the options for addressing them could be examined. As part of this, there is an evidence gap on university-developer partnerships, and potential options relating to such links could be considered.

Business support

Overview

3.39 Businesses can access different types of support from a range of public and private sector sources, and this makes up an important element of the entrepreneurial ecosystem. Much previous research has focused on particular types of support, such as business skills, advice, mentoring, coaching, specific support on IP issues, ideas sharing and incubation (Baily and Montalbano, 2017).

3.40 Universities themselves are taking a key role in this area, going beyond the provision of physical assets (space) to include knowledge and technology support, and access to wider skills. As Katz and Wagner (2014) stated: "*Universities … are successfully advancing innovations into the market …. investing resources in accelerators, encouraging and supporting spin-offs, and developing adjacent land to concentrate future economic growth. Incubators, accelerators, proof-of-concept centers, tech transfer offices, shared working spaces support idea and firm development and training/skill centres, alongside neighborhood-building amenities.*" University business support is therefore diverse, covering entrepreneurial teaching, technology transfer offices fostering spin-outs (Berbegal et al., 2015), as well as incubation, accelerator, and science park services (Fini et al., 2011). While physical space is important, it needs to be combined with softer forms of business support that can facilitate interactions between business and academics (Baily and Montalbano, 2017; Belmana and CEEDR, 2018).

3.41 Business support in universities does not start with the provision of services to new and established enterprises, but rather with creating an entrepreneurial culture amongst both university staff and students. Mason and Brown (2014) referred to this as a process of bottom-up entrepreneurial culture development. While there are different support requirements and trajectories of university spin-outs as opposed to student/graduate start-ups (Marzocchi et al., 2019), the two are also linked as internal support for students is allied to external private linkages (Graham, 2014). For example, university based entrepreneurial teaching can include inputs from entrepreneurs amongst teaching staff, or from those who have spun out. University entrepreneurial teaching can also be focused on particular R&D specialisms, using linkages with industry as well as with specialists in finance (Mason and Brown, 2014).

3.42 Academics also support businesses through joint or collaborative research, contract research, research consortia, consulting and university research centres (co)funded with industry. Collaborative research and contract research have been shown to account for the majority of the income from university commercialisation activities in a UK context (Harrison and Leitch, 2010). Indeed, another UK surveys shows that industrial firms find it cost-effective to gain new technologies from universities, and university-industry collaboration enhances firms' technological capacity and economic competitiveness (Ankrah et al., 2013). Participation in UK EPSRC funded projects, for example, has been found to have a positive impact on the industrial firms' subsequent (increased) R&D expenditure (Scandura, 2016). For the service sector, a study of UK and US knowledge intensive business services firms shows that collaboration with universities is perceived to be highly important for innovations for certain professional services firms – firms that are science-based or highly interactive (in interacting with external partners) and highly customisation-oriented (Lee and Miozzo, 2019).

3.43 In addition, universities contribute to social and economic development through direct commercialisation of academic research. The commercialisation activities often start with business support from the university TTOs. TTOs work with academics and networks of external business services professionals (patent attorneys, accountants, management consultancies, investors, etc.) for academic knowledge commercialisation. A study of US and European universities shows that the presence of TTOs, their age and the number of staff are positively associated with university licensing success (Conti and Gaule, 2011). Based on a study of 115 UK universities, Horner et al. (2019) further highlighted that when TTO support is in alignment with the strategic priorities in knowledge commercialisation set out by university management, commercialisation success is enhanced. Because TTOs bridge the

academic and the business worlds, scholars have stressed the importance of identity building as well as the skills and competence of TTOs in facilitating effective academic knowledge commercialisation (O'Kane et al., 2015).

3.44 The literature highlights the need for complementary and networked support, which includes universities as well as other public and private providers working in synchronization (Wright et al., 2012). Fini et al. (2011) demonstrated the need for a balanced complementary, networked, approach to university and other public support programme provision. They found that there is a greater impact of university level support mechanisms if they are complemented by other local public and private sector support (Fini et al., 2011). Research also shows that science-based R&D start-ups are more likely to benefit from university interactions, whereas start-ups that are closer to market require support focused on commercialisation (van Stijn et al., 2018), which may be better provided by others (e.g. experienced entrepreneur mentors, corporate/private accelerators and VC).

3.45 Private sector support provision is often important for commercialisation. This can include building staff skills and management/entrepreneurial experiences, particularly through bringing in external private sector mentors (Berbegal et al., 2015). The importance of mentoring is an issue that was found in a number of studies (Baily and Montalbano., 2017; Owen and Mason., 2019; van Stijn et al., 2018). Research showed that the "*Forward paying* Route 128 culture" creates an ecosystem for supporting start-ups, with an expectation that successful entrepreneurs will mentor new starts, invest in new enterprises or donate their time to universities (van Stijn et al., 2018).

3.46 Based on a study of a social network of academic spin-offs/start-ups in New York, Hayter (2016) showed that professional services are particularly valued by academic entrepreneurs in enabling the sustainability of a business. Even so, throughout the development of the new ventures, the number of contacts with professional services accounts for less than 7% of these entrepreneurial academics' total contacts. However, as Lerner (2010) highlighted from examples of the financing of US and Israeli high growth potential firms, professional support services (e.g. specialist accountants, lawyers) are crucial elements for the effective operation of the entrepreneurial finance ecosystem. This also includes having an early stage initial public offering (IPO) market service support structure (Baldock, 2015), which London benefits from through the Alternative Investment Market (AIM), and which Amini et al. (2012) recognised as an advantage over more peripheral (distant to London) parts of the UK. Furthermore, as Mole et al. (2017) found from their study of UK business support service take up, the most successful SMEs are those that regularly use specialist private services.

Case Study: Boston Seaport, Austin Model Health City: Business Support

US evidence (Baily and Montalbano, 2017) suggests that highly effective university business support involves a holistic approach combining open innovation with supportive hard and soft infrastructure to facilitate innovation district development, such as Boston Seafront and Austin Model Health City. Key elements include:

- Infrastructural provision of university worker-space, incubation and networking connections in the innovation district, drawing on university sector specialist R&D – in these cases in AI and bio-meditech – and embedding linkages with industry, including drawing in large corporate investment, such as GEC in Boston.
- An open sharing HEI culture (exemplified by University of Texas and local HEIs) allied to the forward paying input of former university spin-out and graduate entrepreneurs investing time and money into mentoring, coaching and financing future university entrepreneurial spin-outs.
- Close, dense, embedded linkages to the private sector through a range of teaching and outreach training programmes, contract research and established small business professional support services, including relating to private finance (e.g. VC).

Evidence from the London ecosystem

3.47 Evidence on London's university entrepreneurial ecosystem demonstrates the breadth in the types of support that can be offered – as introduced above. For example:

- Imperial and UCL provide support and incubation in bioscience, likely to be associated with these two universities providing a large proportion of London's spin-outs in these sectors (Lawton-Smith et al., 2014).
- There is also evidence of public sector funding of university support. For example, a London Enterprise Panel study points to the success of Queen Mary's bio-incubator and other sources of public assistance (Lawton-Smith et al, 2014). There is also growing private/corporate support and investment in digital technologies in London (SQW and CEEDR, 2013; Baldock and Mason, 2015)
- Business support also comes from professional networks, with evidence that Tech City in Shoreditch has built subcultures of support that inspire creativity. This is based on social networks involving professionals, and the area's soft infrastructure (food, coffee, nightlife) that have become sources of collaborations (Nathan and Vandore, 2014).

3.48 However, there is evidence of some potential weaknesses compared to other cities. The "forward paying" culture found in some parts of the US is not replicated (as much) in London, with a lack of a mentoring culture identified as a constraint for Tech City (Nathan and Vandore, 2014). This limits the extent of support from the private sector/mentors, which has been associated with success elsewhere. London also has less sector specialist support for start-

ups compared to the Boston ecosystem, which features specialist sector-specific start-up support (van Stijn et al., 2018; Nathan and Vandore, 2014). Efforts have been made to address this, with public funding (from BEIS/its predecessor departments and the then Department for Culture, Media and Sport) helping to support the development of programmes of activity to instigate more mentoring and passing on of expertise. These have been orchestrated by Tech City UK (now Tech Nation) and involved working with the private sector and universities (especially on digital skills in the latter case).

3.49 In terms of knowledge exchange through research collaboration, Imperial College London is the second only to Oxford in UK universities in attracting industrial funding. Imperial has long-standing relationships with leading firms such as Shell and Rolls Royce. However, compared to its international counterpart, MIT, Imperial's industrial collaborators appear to be mainly large corporations (Gann et al., 2016).

Areas for further consideration

3.50 There are well-documented gaps in the evidence on what works in relation to business support, though this in part reflects the significant diversity in types of support, the mechanisms of delivery (including who delivers support), target groups (e.g. whether support should be given to start-ups who lack capacity, or to enterprises who are more likely to be fast growers) and the specific context within which it is delivered (e.g. place, sector etc.). Therefore, whilst there is evidence on whether individual programmes have worked, understanding related to transferability is still developing.

3.51 There is a need, therefore, for ecosystem actors to consider how they can contribute to this developing evidence base by putting in place robust monitoring and evaluation processes where this is possible. This should allow sufficient time and resource for impacts to be assessed, with the effects of business support often taking a number of years to occur. There is considerable potential to understand business support by tracking supported and less supported enterprises over time.

3.52 Other gaps identified in the literature, which could be prioritised for further investigation in the context of London, are as follows:

- Mentoring is a crucial factor for the ecosystem and is often related to the local culture. Building such culture takes many years and may be linked to traditions of philanthropic donations to universities that are more evident in the US. Greater understanding of the emerging cultures of mentoring in London could show where future investment might be best placed.

- Cultural change is a fundamental element of developing the university entrepreneurship ecosystem. Academic culture does not sit easily with entrepreneurship in many institutions and greater understanding of the processes for encouraging transdisciplinary (boundary spanning) practices would be useful. Such cultural change needs to address diversity in academics' research incentives and promote fundamental research as well as academic commercialisation activities such as spin-offs and research collaborations. It also needs to permeate through teaching and student engagement. Therefore, there would be merit in identifying good practice

in teaching entrepreneurship, in order to encourage start-ups and graduate intrapreneurship.

- Behind TTOs, there are networks of professional services firms indirectly connected to entrepreneurial academics. Indeed, Lee and Miozzo (2019) showed that some specialist recruitment firms, marketing firms, and firms specializing in IP commercialization see universities as highly important innovation partners. However, the mechanisms within which professional services firms work with academics for the commercialisation of science is a gap in the literature.

Entrepreneurial finance

Overview

3.53 Entrepreneurial finance is considered the life blood of new venture start-ups and often involves high risk equity investment in potential high growth firms. It covers any form of finance - e.g. bank debt (loans), crowdfunding, or equity investment, such as from business angels – but frequently refers to Venture Capital (VC), organised pools of investment addressing early and growth stage venture requirements, first established in the US in the 1950s (Lerner, 2010) and now considered a key element in the entrepreneurial ecosystem (Owen and Mason, 2019).

3.54 From an ecosystem perspective, the literature recognises the crucial role that VC can play in forming a cohesive finance escalator for university R&D and the commercialisation of innovative spin-outs (Clarysse et al., 2014). However, it also highlights the inadequacies of a one size fits all approach (Wright & Fu, 2015). Studies show highly nuanced findings between types and locations of universities, relating to quality tier, age, size, sector, and embedded corporate/investor linkages – notably, whether there is an internal VC fund. Higher tier universities' spin-outs are more likely to obtain VC, while the lower tier universities are more effective when they perform an incubation function to help start-ups overcome their capital limitations (Baroncelli and Landoni, 2017).

3.55 Views as to what constitutes the university financing entrepreneurial ecosystem vary, but stress Triple Helix inclusivity (Samila and Sorenson, 210) and a balance between universities, government support (including regulation and policy, such as to facilitate innovation (Finger et al., 2016), and private industry and finance-related services (Clarysse et al., 2014). Developing the soft network infrastructures of finance support services (accountants, lawyers, finance finding consultants) is seen as crucial to VC development (Lerner, 2010). Hayter's (2016) review of 117 spin-outs in five US metropolitan areas suggested a "nonlinear," network-centric perspective of spin-off success analogous to Chesbrough's (2003, 2009) Open Innovation paradigm. The evidence highlights the benefits of external sources of technology, outside management, and industry experience of academic entrepreneurs, with an emphasis on inclusivity and open innovation approaches. Such an embedded approach that delivers a pipeline of investible university spin-outs is what private VC is attracted to and thrives on (Brown and Mason, 2014).

3.56 Academic and grey literature studies tend to focus on longer established, embedded, university and VC relationships from the US. Whilst their transferability to London is

questionable, they benefit from many years of experience and may have universal lessons to share. Baroncelli and Landoni's (2017) study of spin-outs from nine Boston universities found few spin-outs (5/81) receiving VC and only those from top tier universities with embedded VC and corporate ties. Baily and Montalbano's (2017) technology cluster work points to the importance of co-financing angels and VCs, for example in Austin, Texas, to encourage VC investment into an emerging pipeline of university (anchor institution) spin-outs.

3.57 A key anchor institution role is played by University TTOs, which help to negotiate university spin-out financing (Brandy et al., 2015; Munari et al., 2018). A key gateway sticking point can be negotiation of IP rights where 'double-dipping' of equity and royalty by TTOs can lead to misalignment with VCs. In addition, complexities of multiple angel and founder equity shares can also be problematic. The more open and embedded culture of academics working with industry in Boston and particularly San Francisco is perceived as a considerable advantage in enabling university spin-out investment to thrive (Brandy et al., 2015). Munari et al. (2018) also pointed to the need for university proof of concept and seed grants to be linked to VC for fluent next stage financing. This finding was supported in a recent BMG and CEEDR (2017) report on UK innovative firms' journeys to finance.

3.58 Florida and Hathaway (2018) recognised the critical mass of activity which facilitates the strong convergence of population density and innovative high-tech activity attractive to VC. This is exhibited in cities like Boston, San Francisco, New York, Los Angeles and also in London. Indeed, in relation to US cities, Florida and King (2016) highlighted the concentration of equity investment in a small number of neighbourhoods using zip code-level data. This identified micro-clusters of VC investment and start-up activity at the neighbourhood level. Such critical mass and density can involve combinations of hard and soft infrastructure, including the provision of brownfield sites for co-working space, incubators, accelerators, science parks and innovation districts, incorporate universities as anchor institutions, and be assisted by formal networking linkages. It also requires local informal networking environments, such as the local neighbourhood coffee and night cultures identified by Nathan and Vandore (2014) in relation to Tech City, East London.

3.59 Drawing on recent VC literature, Arundale (2018, 2017, 2016), compared US VC practices with those in Europe and the UK. His study of 64 VCs and 40 stakeholders revealed the more 'open' practices of US VCs and particularly those on the West Coast, from San Francisco, where there are long established, experienced VC networks that share opportunity and early stage funding risk. Syndication between VCs occurs in order to increase the investor skills and network base, rather than to increase the size of the investment round. Arundale (2018) highlighted the far greater scale of US VC (funds are typically 3 to 4 times the size of those in Europe/UK), which enables funds to invest across a spread of earlier and later stages and is manifested in their greater appetite for early stage investing and friendlier terms of business for entrepreneurs. A key point here is the ability for experienced individual fund managers to move fast to invest in portfolio ventures, without recourse to lengthy VC partner discussions. This is achieved through fund managers taking a themed approach, using their specialist sector and business stage knowledge, to seize the investment opportunity. This approach means that US investors may avoid the maxim that 'consensus kills outliers' – whereby lengthy discussions can prevent the selection of the stellar business performers that can provide most return to the VCs. Thus, Lerner (2010) advocated recruiting expert fund managers into government backed co-finance programmes. In the UK, Passion Capital VC is a prime example of early stage US fund

management practice being delivered in London's TechCity, stimulated by the UK government's Enterprise Capital Fund (ECF) programme and providing a demonstration model of seed investing that others have followed (Baldock and Mason, 2015).

Case Study: Boston Route 128

There is a culture of "forward paying" in Boston Route 128. Actors in the ecosystem support start-ups, but they expect that when their start-ups are successful, they will show their gratitude for the support e.g. by mentoring new start-ups or financing them (van Stijn et al., 2018).

This 'virtuous cycle' is crucial for VC development, recycling investment and entrepreneurial skills (Owen & Mason, 2019). Furthermore, co-financing facilitates seed VC, whose demonstrable success attracts other VC and spins-out new fund managers with key local/sectoral knowledge skills (Lerner, 2010).

Boston's long-established top tier universities demonstrate successful linkages with industry and VC leading to spin out commercialisation.

An open innovation culture of sharing between HEIs, alongside corporate industrial linkages and supportive government policy (e.g. co-financing) has been central to innovation district development focused on bio-meditech activities in the Boston Seaport and Austin, Texas, model health city innovation districts.

Evidence from the London ecosystem

3.60 There is relatively little recent academic literature that specifically addresses financing with respect to the entrepreneurial university ecosystem in London. As with business support, the evidence that does exist highlights a degree of variety, from university-centred to broader technology-based entrepreneurship elsewhere in London.

3.61 Lawton-Smith et al. (2014) found that London's spin-out ventures were dominated by Imperial and UCL, with these institutions being responsible for 80% of spin-outs between them. These are predominantly focused on the bio-medical science sector and benefit from the universities either having internal VC funds (Imperial), or a close alliance with a VC (e.g. IP Group), and a similar parallel can be drawn with Oxford University and Oxford Science Innovations VC. Lawton-Smith et al. (2014) also pointed to the fact that almost a quarter of London's university spin-outs were located outside of the M25, which could raise questions about the ability of spin-outs to scale-up within London and whether a recycling culture will effectively take place. As noted earlier the spatial location outside of the M25 is not necessarily a bad thing. Nevertheless, managing tensions between benefits to the wider UK economy, through rebalancing of growth outside of London and the South East (HM Government, 2017) and the benefits of a feedback loop of entrepreneurial skills and finance are critical. This is potentially important, since VC ecosystems (Lerner, 2010; Owen and Mason, 2019) develop most effectively where successful entrepreneurs re-invest their funds from successful business sales and their IP and expertise into new start-ups – which can include university spin-outs (see Boston's 'forward paying' culture).

3.62 Of course, the entrepreneurial ecosystem is broader than spin-outs, and London's diversity was demonstrated by Nathan and Vandore (2014) in Tech City. This area of Shoreditch, in East London, has attracted corporate incubator investors, angel groups and seed VCs, notably to Whitebear Yard (Baldock and Mason, 2015). SQW and CEEDR (2013) recognised that the growth of seed finance did not meet the growing demand and that there was also a gap in scale-up VC to ensure commercialisation of ventures, which led to the establishment of the London Co-Investment Fund (LCIF). This match funds, on a case by case basis, digital and bio-science investment opportunities provided by preferred supplier equity investors (including VCs and an equity crowdfund).

3.63 Nathan and Vandore (2014) indicated that Tech City firms found UK investors to be risk averse, small-size and focused on later stage opportunities. In comparison with Silicon Valley, it was much more difficult for them to find investment. They found few UK co-finance VC (such as Passion Capital and Episode 1 ECFs; Baldock, 2016) digital seed specialists in London. There were also few banks and business angel digital economy specialists in the area. This presented a dual problem, since on the one hand, seed VCs and angels like to invest locally where they have hands-on access to their portfolio businesses (Baldock and Mason, 2015), whilst on the other hand the lack of an embedded entrepreneurial finance culture means that local "young entrepreneurs often lack networking skills or [do not] gravitate to the events where [there are]… more experienced players" (Nathan and Vandore, 2014). However, a strength of Tech City is that it grew out of a self-propelled digital arts movement, with production side collaborations providing a venture pipeline that is attractive to seed VC.

Areas for further consideration

3.64 There are a number of important implications for London from this evidence review. It is notable that very few studies specifically focus on London and there are concerns around the transferability of US and European studies. Moreover, one size does not fit all, and what may be suited to particular types of universities (e.g. by tier, quality, specialism) in particular locations will vary. Nevertheless, some findings from large cities and well-established ecosystems with embedded university and VC linkages may offer insights into more generalisable aspects of good practice. This shows the following key points:

- There is a general consensus that the ecosystem should be inclusive, with a need to consider a range of actors. Clarysse et al. (2014) discussed value networks which operate between universities and the private sector, with public policy as a conduit (e.g. to encourage collaboration and guide towards sustainable development goals). They also require university and other HEI collaboration and effective parallel networks between and within industry and private finance.

- The ecosystem needs to link beyond the local city or district. Clarysse et al. (2014) made an important point that corporate linkages may need to be brought into the region. These can facilitate growth within the region, and also outflow of growth to the wider UK economy.

- An efficient local entrepreneurial finance escalator requires complementarity. Notably, PoC grants need to knit together with follow-on funding from business angels and VCs in order to facilitate scale-up commercialisation and more optimal investment exits (BMG and CEEDR, 2017).

3.65 There are several implications from the evidence where further study would be particularly beneficial:

- There are a number of established VC lessons, particularly drawn from experience in the USA, such as those relating to VC scale, close proximity, expertise, and investment culture and practices (Lerner, 2010; Arundale, 2018). Given London's scale and the different innovation districts, these findings appear highly pertinent, but would benefit from further examination to test applicability.
- The lessons from Tech City, where a new venture investment culture has been facilitated through government co-financing of VCs, business angels and equity crowdfunding could offer scope in other London innovation districts. Such lessons, and the potential of corporate accelerator investors and importing US fund manager skills should be considered for their role elsewhere in London.
- The 'forward paying' culture applies to successful VC ecosystem building through blockbuster successes reinvesting funds in new ventures, entrepreneurial mentoring and support and also the spin-out and development of new VC fund managers. The extent to which this is taking place, and the conditions and mechanisms that encourage it, would merit further study.

Networking

Overview

3.66 Current thinking in innovation ecosystem research recognises that innovation processes are increasingly distributed, open and networked (Chesbrough, 2003)[6]. Firms seek knowledge external to organisational boundaries for product, service, process, organisational, managerial and market innovations. Heterogeneous actors, such as clients, consultants, universities, public organisations and competitors, are intertwined with focal firms in innovation processes. Start-ups notably lack market legitimacy and are resource constrained. University start-ups/spin-offs, while possessing technological advanced knowledge, often face scale-up problems, and lack specialist knowledge in IP, operations, business strategy, finance and marketing (Bathelt et al., 2011; Brown, 2016). Other high-growth/high-tech start-ups, unlike large corporations, have limited capacity (financial constraints, absorptive capacity, etc.) in accessing cutting-edge scientific knowledge generated in academia (van Stijn et al., 2018). Indeed, research constantly shows that small firms rarely consider universities as important innovation partners (Bathelt et al., 2011). Universities, while creating knowledge contributing to the scientific communities and industrial sectors, benefit from feedback loops of practices and experimentation from industry (Etzkowitz, 2012; Macdonald, 2016). Renowned university entrepreneurial ecosystems such as Route 128 in Boston and Silicon Valley exhibit well connected networks among multiple actors. Notably these ecosystems feature the "forward paying" culture, a high volume of venture capital-backed investment, an

[6] Chesbrough (2003) sets the current paradigm of thinking. Indeed, in an increasingly globally networked and informed world, the benefits of open innovation are considerable and evident (e.g. open source software). However, critics argue that open innovation is neither new, nor the only successful route. For further detail on this, see: Trott P and Hartmann D (2009) Why Open Innovation is Old Wine in New Bottles. International Journal of Innovation Management 13(3): 715-736 and Dahlander L and Gann D (2010) How Open is Innovation? Research Policy 39(6): 699-709

embedded active entrepreneurial business environment with supporting organisations, and the presence of leading universities (Casper, 2013; Etzkowitz, 2012; Gupta and Wong, 2016; van Stijn et al., 2018).

3.67 Networks are important for entrepreneurs, business executives and academics. Start-ups in Silicon Valley find themselves in a pool of experienced entrepreneurs and senior executives who are ready to invest in, to join, to start or to simply help other new ventures (Gupta and Wong, 2016). The volume of investments draws more investment. Academics in the San Francisco region have a significantly larger network connectivity (with industry) than academics in the Los Angeles region and a higher commercialisation output (Casper, 2013).

3.68 Lubik et al. (2013) focused on upstream collaborative partnerships of UK university spin-offs and showed that high value creators have more external partners. 60% of the surveyed spin-offs indicated that they were involved in corporate partnerships, followed by partnerships with parent universities, other academics and government assistance respectively. Hayter (2013) also found that US university spin-offs that are involved with joint venture with other companies are more likely to be commercially successful.

3.69 For downstream collaborative partnerships, Laage-Hellman et al. (2018), based on a case study of a Swedish academic spin-off, showed the need for academic start-ups to integrate clients as early as possible for product development. Clients are seen as innovation partners and therefore internal organisation of the start-up strategy should be aligned with ambitions for product development collaboration with clients.

3.70 A study of academic spin-offs/start-ups in New York showed that non-academic networks, including partnerships with investors and business services, are particularly valued by academic entrepreneurs regarding the sustainability of the business. Moreover, apart from bringing financial resources by investors, and business advice provided by professional services, these non-academic partners are most valued for their contacts in market knowledge that can facilitate commercialisation (Hayter, 2016).

3.71 It is important to note that, in the context of ecosystems, many university-industry links are non-local. A study of licensing activities of the German Max Planck Society exploring how commercial success of academic research is affected by geographic distance between licensors and licensees suggested that geographical proximity does not lead to superior commercialisation outcomes. By contrast, focusing on foreign licensees, there is evidence of a negative association between distance and commercialization success for (star) inventions licensed to more than one firm (Buenstorf and Schacht, 2013).

3.72 The evidence indicates, therefore, that networks and connectivity matter, both within and outside the ecosystem. Three sets of factors were identified in the literature:

- Boundary permeability between universities, government and industry is a key driver to successful innovative regions (Etzkowitz, 2012).
- The quality of a university's regional environment may have stronger impacts on whether the networks through which such knowledge flows develop (Casper, 2013). Affordable house prices, local government social welfare, a favourable climate, café and nightlife culture are all reported to contribute to the attractiveness of an

entrepreneurial ecosystem (Hayter, 2013; Macdonald, 2016; Nathan and Vandore, 2014).

- Brand and reputation of an area matter. New firms indicated that their location decision was deliberate due to their awareness of the London Tech City. The initiative has positively raised the area's profile (Nathan and Vandore, 2014). VC firms are attracted to regions, such as Silicon Valley and Boston, that have had high venture capital-backed investment (Chen et al. 2010).

Case Study: Boston Route 128: Practices of university-start-ups interactions that are mutually beneficial

van Stijn et al. (2018) explored interactions between start-ups and universities in Route 128. They showed that in spite of limited resources of start-ups and the absence of immediately tangible return to universities in such interactions, start-ups and universities find the interactions mutually beneficial. This is achieved by the exchange of complementary knowledge in the following ways:

- Paying it forward: The entrepreneurial culture in the area has evolved over time just out of people helping others and when successful wanting to pay it back by helping someone else.
- Academic consulting: Engineering professors are happy to share knowledge and provide voluntary technical advice to start-ups (including student start-ups). In return, faculty may be financially compensated or offered with mentoring or specialist programmes by successful start-ups for the advisory work.
- Entrepreneurship courses: Peer advisory groups at the university entrepreneurship centres that consist of many different entrepreneurs who are currently involved with start-ups or developed and sold successful start-ups as mentors to students/staff.

Evidence from the London ecosystem

3.73 As previously noted, London has a significant critical mass of more than 42 HEIs. These include large, multidisciplinary institutions, modern universities, and many smaller institutions specialising in medical and other scientific areas. There are also some renowned colleges offering training in technical and creative skills in media, journalism, art and design, the performing arts, and information and communication technologies (ICT) (Lawton Smith et al., 2014). With this critical mass, London accounts for more than 20% of total UK spending on higher education and 27% of UK funding from Research Councils. London HEIs educate more than 56,000 graduates per year through some 11,000 undergraduate and 4,000 postgraduate courses.

3.74 The capital is also a major international city for finance, business, media, culture and tourism. With particular note to the entrepreneurial ecosystem, the City of London is a hub of UK and European VC and specialist professional services (SQW, 2015). Key high-tech industries in London include the digital sector and life sciences (SQW, 2015).

3.75 A survey of 12 London university spin-offs/start-ups showed that Imperial College London and UCL are leading the commercialisation activities, and the specialisms of these spin-offs/start-ups are consistent with the research strength of the London region, i.e. research in biomedical, pharmaceutical and computer software (Lawton Smith, et al., 2014). This also reflects the ownership of equity stakes of many of these spin-offs/start-ups to a group of pharmaceutical companies. It is suggested that the market opportunities in London are so varied that university spin-offs are able to find spaces to operate regardless of the size of the markets (Lawton Smith et al., 2014). Notably, Imperial College London has established a web of embedded strategic corporate partnerships with industry (Baily and Montalbano, 2017), and UCL plays a key role in IDEA London (Innovation Digital Enterprise Alliance London), and the digital technology incubator centre in Wilson Street (Shoreditch) (SQW, 2015).

3.76 However, when compared to other international life science clusters, the London cluster is less commercial, less networked and less collaborative than Boston or San Francisco, and the cluster infrastructure (e.g. VC, specialist and mixed tech incubators) is less well developed (SQW, 2015).

3.77 Firms in the London Tech City cluster suggest that the local buzzy amenities and nightlife act as a kind of social wallpaper to attract and maintain staff. Shoreditch subcultures further provide inspirations for content/creativity. Professionals and social networks, and the area's soft infrastructure (food, coffee and nightlife) offer a source of production side collaborations. However, evidence suggests that networks amongst young entrepreneurs, firms, advisors and financiers could potentially be improved. Young firms commented on UK investors' risk aversion, small size, and focus on established prospects, whilst established entrepreneurs and venture capital providers indicated that they are often happy to help with advice (to young entrepreneurs). However, *"young entrepreneurs often lack networking skills or gravitate to the [beer and pizza] events where they talked with each other, rather than older, more experienced players."* In addition, conventional cluster actors such as universities were found to be relatively absent in the cluster (Nathan and Vandore, 2014).

3.78 Evidence shows that London university spin-offs and start-ups out-perform (measured by the proportion of high growth academic spin-offs among the total academic spin-offs in London) general new ventures (the proportion of high growth new ventures in general) (Lawton Smith, et al., 2014).

Areas for further consideration

3.79 There is a heterogeneous set of actors in the system, including entrepreneurs, customers, suppliers, consultants, business services, investment, universities etc. Evidence indicates that high levels of formal and informal networks among actors, and links outside of the ecosystem can improve start-up and commercialisation performance. The environment, branding, and permeability of organisations can contribute to these networks. There are gaps in the existing literature about the networks of actors and their interactions in the London university entrepreneurial ecosystem.

3.80 First, it may be useful to examine the extent of collaborative networks in the cluster infrastructure, including at a granular level. Questions to explore may include the following:

- What is the extent and nature (including formal and informal) of the interaction between different actors in the ecosystem, including universities, professional business services, financiers, firms etc.? How does the interaction differ by sector and geography?
- How could the collaborative relationships in the cluster infrastructure be improved upon to provide a more networked support system?

3.81 Second, there is a related set of issues in relation to how entrepreneurs (both new and established) can become better connected and able to access this cluster infrastructure. This could include issues associated with the skills and soft infrastructure that is required.

4. Implications

General implications

Key principles for ecosystems

4.1 In order to better understand the current university entrepreneurial ecosystem in London, and the potential further research and future actions that could be taken to support and develop it, this literature review has identified a number of key issues that need to be taken into account. The following are particularly noteworthy:

- **Context matters**: as has been shown, the development of ecosystems has depended to a large extent on history, context and the particular circumstances of a place and its actors. Therefore, it is important to identify what is right for a place, rather than seeking to emulate somewhere else. A range of lessons can be drawn from successful ecosystems, in particular in the USA, and also on the theme of entrepreneurial finance, such as those relating to VC scale, close proximity, and investment culture and practices. Given London's context, its scale and the presence of a range of different innovation districts, these findings appear highly pertinent, but would benefit from further examination to test applicability. It has also been shown that ecosystems can develop out of challenging circumstances such as economic shocks: Tech City emerged following deindustrialisation in parts of East London that made rents cheap and attracted artists; and interest in entrepreneurship grew in Finland following decreasing dominance of Nokia recruiting graduates coinciding with emerging national role models (Graham, 2014).

- **The ecosystem needs to be considered at various levels**: evidence from London and other comparators has highlighted that there are various sub-systems within an ecosystem, e.g. by sector/technology or neighbourhood. Examination of the granular detail can provide a focused view on the needs of different aspects of the ecosystem. We have seen, for instance, how different parts of London's ecosystem have evolved in relation to their particular context. There seems to be a gap in the literature on how such sub-systems inter-relate as part of the whole.

- **A holistic approach is important given the diverse actors**: there is consensus that the ecosystem should be inclusive, with a need to consider a range of actors. Universities are a key part of this, with networks between universities, the private sector (including the range of industry actors, private finance and professional support) and public policy also being important. The literature has shown the wider role played by other actors or elements, including those associated with an ecosystem's infrastructure and cultural offer, and the important role of less tangible aspects such as local leadership and branding.

- As part of a holistic approach, **interactions and networks are critical**: the literature finds partnerships to be of increasing importance within ecosystems. Partnerships enable universities to focus their research on industrial challenges and private firms to address innovation challenges, accessing stable research activity and capabilities.

Networks are also important for entrepreneurs and early stage companies in being able to identify and seek customers, suppliers, collaborators, finance and people.

- A recurring theme is the idea of a **forward-paying culture**: the recycling of expertise, money and support was found to be an important element of some successful ecosystems. Such a culture could incentivise universities to work with the local start up community, with the expectation that the university would receive contributions or compensation once entrepreneurs and firms become successful. Such a culture is also important in other aspects, for instance as successful entrepreneurs become the mentors, investors and leaders to the next cohort. Again, how far this might be (or already is) applicable in London could merit examination.

Evidence gaps

4.2 Section 3 identified a series of areas for further consideration under each of the themes. There are several cross-cutting aspects to these evidence gaps.

4.3 First, in the context of London, much of the literature sourced was focused on higher profile examples, such as Imperial College and UCL, and particular districts such as around Tech City in East London. This neglects other activities, such as London's creative and cultural sectors. London's ecosystem is very diverse, with a range of different universities and actors. A fuller, clearer picture of the range of institutions, sectors and districts, and the differences between the roles played by anchor institutions and sub-systems across London would be beneficial.

4.4 Second, and related to this, it may be helpful to probe into the granular detail of different elements of the ecosystem and the interactions that bring them together within London. This is true in the case of understanding how incubators and accelerators act effectively, as well as localised concentrations of activity. It would also help to understand the roles played by different institutions and how performance and needs vary by sector and technologies. In taking forward further stages of research, it will be important to prioritise areas of focus.

4.5 Third, there are well-documented gaps in the evidence on what works. In part, this reflects the significant diversity in programmes and policies. For instance, business support can vary by types of support, mechanisms of delivery, target groups and the specific context within which it is delivered (e.g. place, sector etc.). Therefore, whilst there is evidence on whether individual programmes have worked, the confidence placed on findings to inform transferability is still developing. Ecosystem actors should consider how they can contribute to this developing evidence base by putting in place appropriate monitoring and evaluation processes.

4.6 A final point worth noting relates to context and the issue of responding to shocks. The literature that has been reviewed has identified some examples of how ecosystems have emerged from particular sets of circumstances. The ways in which entrepreneurial university ecosystems emerge or change in response to significant shocks is a further area of interest, closely linked to wider literature on economic resilience.

Towards a conceptual framework

Systems approaches

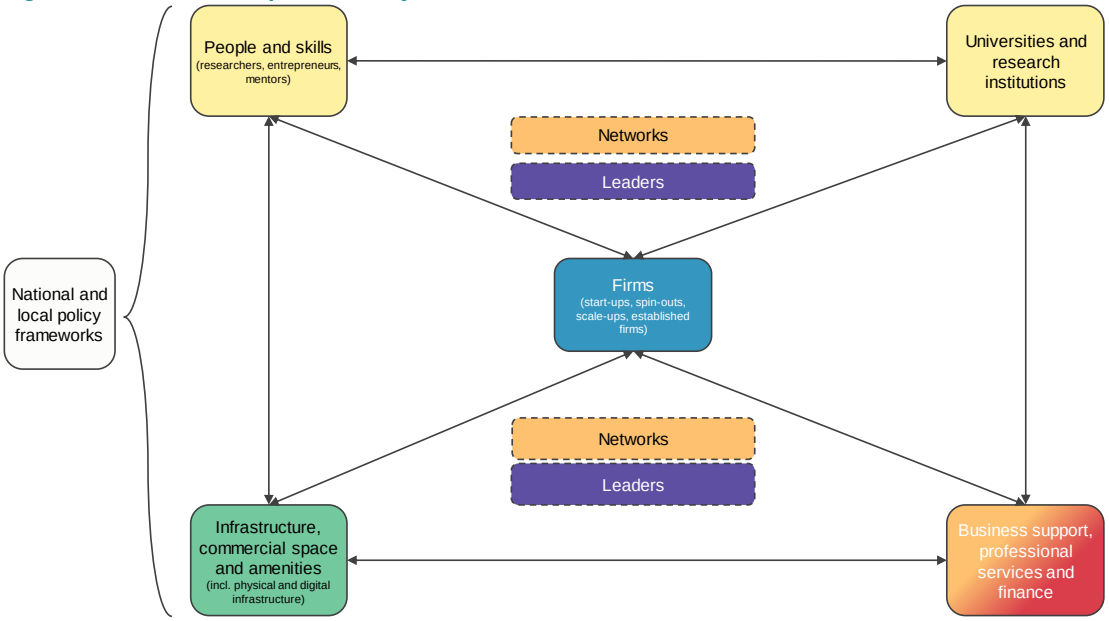
4.7 Reflecting on the range of elements that have been identified, the importance of networks and interactions, and the need for a holistic approach, a systems-based approach (Freeman, 1987) is well-suited to understanding the entrepreneurial university ecosystem. Systems-based approaches can help in complex situations and can be useful where issues need to be reframed as understanding develops or the ecosystem itself changes. Three particular aspects are important in using systems-based approaches (Imam et al., 2006):

- **Perspectives**: systems are as much about how you view the world, and so it is important to consider different perspectives, as well as seeking to describe or present a particular set of elements and links.
- **Boundaries**: these define what is inside and outside a particular inquiry, in this case the ecosystem (e.g. to make a system tractable). These require judgements as to what is important or most important.
- **Openness:** systems can occur within systems and inter-relate with others. This has been found in the literature on ecosystems, with subsystems identified as well as a need to consider interactions outside of the ecosystem. Openness in a systems inquiry acknowledges that these issues need to be considered in some way.

A general ecosystem framework

4.8 Drawing on the literature review, a general ecosystem framework has been developed. Currently, the graphic in Figure 4-1, developed based on the evidence, shows a simple stylised framework. A more complex set of interactions and networks is likely to more closely reflect reality, and this is illustrated in the more complicated graphic shown in Annex B. An inquiry into the ecosystem could hone in on particular elements and interactions, and could also focus on subsystems, e.g. how do these elements and interactions work in this area or for this sector? The technical paper that complements this literature review provides a set of parameters and issues for further investigation that would explore these aspects in the London context.

Figure 4-1: General simplified ecosystem framework



Source: SQW, Middlesex University

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Annex B: Complicated ecosystem graphic

Figure B-1: Complicated ecosystem model

Source: SQW, Middlesex University