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Entrepreneurial University Ecosystems

Towards the development of a framework for identifying comparable entrepreneurial-university ecosystems in the UK and USA

Summary Report

SQW

Contents

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1. Introduction

1.1 In 2016, the McMillan Review recommended developing an ecosystem approach that was specific to the UK. It had identified important aspects of well-functioning ecosystems, drawing on international good practice such as in the USA. However, it highlighted that comparators such as these, whilst providing useful lessons, were not directly transferable to a UK context. This led to the recommendation for a context-specific ecosystem approach in the UK.

1.2 In response, in 2019 Research England, City University of London, several other London universities[1], the National Centre for Universities and Business (NCUB) and the British Business Bank (the 'steering group' 'project group' or 'group'), commissioned SQW to develop a literature review on the concept of the entrepreneurial university eco-system. The study developed a high-level conceptual model for a general entrepreneurial ecosystem and a more tailored model for London. SQW also developed a technical note on the options to compile further evidence on the London ecosystem. This was the first stage of a longer-term study that would support the project group to develop policy recommendations on how to support the university-centred ecosystem in London – with scope for this to be rolled out elsewhere in the UK.

1.3 The project group was interested in making international comparisons between university-centred entrepreneurial ecosystems in order to learn lessons, and there was similar interest amongst counterparts in the USA. As such, SQW was commissioned to provide support in developing a simple framework of indicators that could help to match entrepreneurial-university ecosystems for the purpose of more detailed comparative analysis and learning. Drawing on the Literature Review and Technical Note, this framework was intended to be used as a pragmatic and quick-to-implement tool for identifying city pairs in the USA and the UK that *could* potentially have comparable ecosystems. In identifying potential pairs, the framework could then stimulate further discussion and possibly additional research to confirm pairings and then learn lessons.

1.4 It was agreed that the framework would consist of five to ten key quantitative indicators. It was to focus on comparisons between the UK and USA, and so should be deployable using UK and USA datasets. However, indicators were to be gathered from readily available sources and be standardised internationally as far as possible in order to provide flexibility for wider use. In addition, to illustrate how the framework would be applied, data on a small number of cities was to be gathered for each indicator. Due to the limited number of indicators and cities this study was intended to focus on, it was acknowledged to be exploratory in its ability to identify city pairs across the UK and USA.

[1] Comprising: London School of Economics, University of Greenwich, Imperial College, Brunel University, the Royal College of Art

1.5 The study was informed by the steering group, with additional input from Professor Erkko Autio (Chair in Technology Transfer and Entrepreneurship at Imperial College Business School) and relevant stakeholders (e.g. UKRI overseas representatives and TenU).

2. Approach

2.1 The approach taken to develop the framework, as well as its caveats and limitations, is set out in this section. In summary, this consisted of: developing a long list and then a short list of indicators of entrepreneurial-university ecosystems; identifying data sources for these in the UK and USA; and collecting and presenting data on a group of cities in the UK and the USA.

Identifying indicators

2.2 A long list of indicators of entrepreneurial-university ecosystems was developed to enable decisions on which the study should focus. Potential indicators for inclusion in this long list were identified through: discussions with the steering group on key areas of focus and existing practice/research; the Literature Review and Technical Report developed in SQW's previous study, with a focus on the types of indicators that could characterise an ecosystem and its outputs; and desk-based research on data sources in the UK and USA (and also more broadly), including covering indicator definitions, geographic coverage and time frames. Thirty-three indicators were identified and, alongside the steering group, refined into a shortlist of ten through an iterative process. Sources and associated definitions for each long list indicator, as well as their availability in terms of time, frequency and geography, were identified and reported.

2.3 Indicators were shortlisted for inclusion within the final framework based on their:

- Feasibility: availability of indicators across national datasets.
- Relevance: as a measure of university-centred ecosystems or the important conditions that they operate in. Alignment with the key variables of interest was also considered.
- Comparability: indicators and their definitions should be sufficiently comparable, reflecting differences in measurement approaches between countries and institutions.

2.4 A portfolio approach was adopted when shortlisting indicators. This was to enable the framework to provide some indication of the context of each place (e.g. its scale, or the structure of the local economy) as well as variables of interest (e.g. regarding the functioning of the ecosystem or ecosystem outputs). Contextual indicators were important as part of the portfolio to provide a sense of scale of the ecosystem. This was identified as a key challenge and limitation to the framework, because the scale of places differs so markedly between the USA and UK. The context indicators could allow others to be scaled. Four indicator categories were identified to ensure a portfolio of issues were captured, namely: scale/nature of higher education; research resource and commercialisation associated with higher education; local enterprise and finance; and the local economic context. For the purposes of the shortlist, these categories were streamlined into: higher education, local enterprise and local economic data.

2.5 The final short list of indicators, along with what these are indicators of and the reasons for their inclusion, is presented in Figure 2-1 and Table 2-1 below. Data sources for each indicator in the UK and USA, as well as definitions for each indicator as per the data source, are included in Annex C. As detailed in Annex C, even though start-up/spin-out activity was one of the shortlisted indicators, due to issues with data availability in the USA only spin-out data was collected within this study. The definition for this indicator within Annex C therefore refers to spin-outs only.

Figure 2-1: Short list indicators

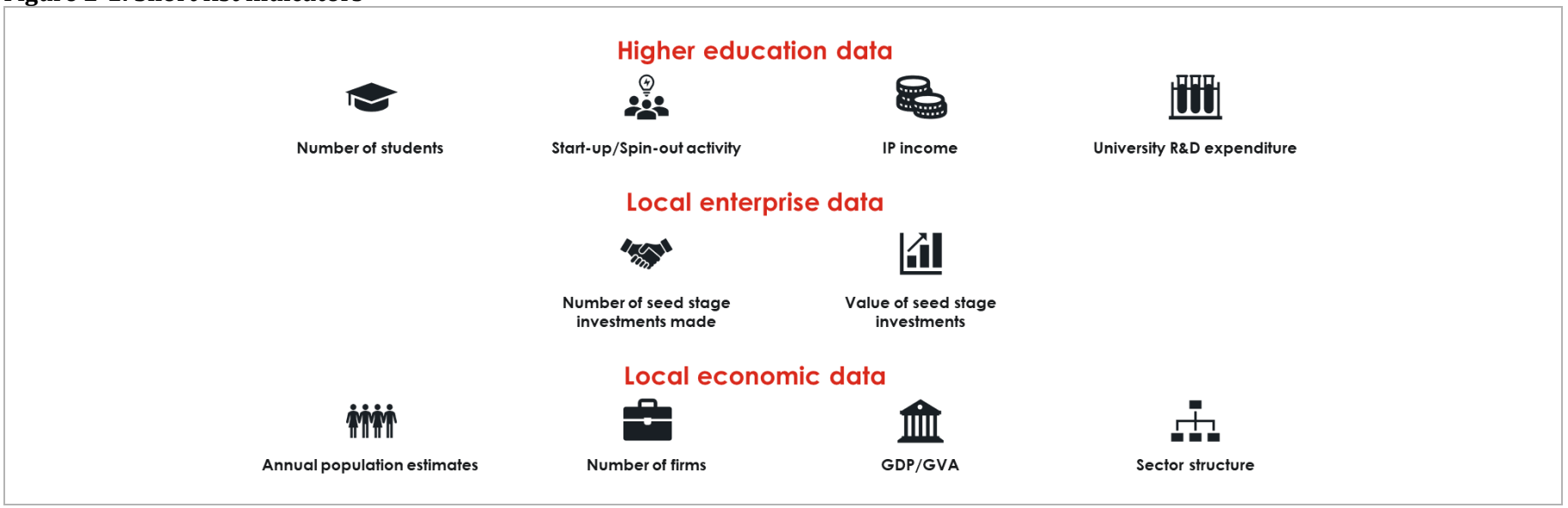


Table 2-1: Short-list indicator explanation and rationale for inclusion

Indicator name	Ecosystem definition	Practical rationale for inclusion
Number of students	Indicator of the scale of entrepreneurial talent and/or the production of knowledge relevant to/as part of the functioning of the ecosystem	Provides a sense of scale of place Can be used as a base measure Available at the institutional level in the UK and USA
Start-up/spin-out activity	Indicator of University willingness/ability to enable staff and student engagement in entrepreneurial activity/ exchange knowledge through enterprise (i.e. the number of student, staff or graduate start-ups/spin-outs linked to Universities)	Available at the institutional level in the UK and USA
IP income	Indicator of University enterprise activity/ ability to commercialise knowledge	Available at the institutional level in the UK and USA
University R&D expenditure	Indicator of the scale of University research and development activity	Available at the institutional level in the UK and USA
Number of seed stage investments made	Indicator of the scale / availability of entrepreneurial finance	Available at the firm and city/regional level in the USA and the UK
Value of seed stage investments made	Indicator of the scale / availability of entrepreneurial finance	Controls for biases from high value investments Available at the firm and city/regional level in the USA and the UK
Annual population estimates	Indicator of the scale and density of the local area	Can be used as a base measure Available at LSOA/County level in the UK and USA,
Number of firms	Indicator of the scale of local enterprise/ industry composition	Available at MSOA/County level in the UK and USA, respectively
GDP/GVA	Indicator of the scale/development of the economy	Available in the UK at the NUTS 1-3 level and Metropolitan Statistical Area Level in the USA.
Sector structure	Indicator of the size/importance of knowledge intensive sectors	UK data is available at the LSOA level

Source: SQW

Identifying cities and potential matches

2.6 Working with the steering group, five UK cities were identified as being the focus of this study. These are detailed and defined in Table 2-2 below. The geography of each city's ecosystem was reviewed and agreed with relevant local stakeholders. More granular definitions could be developed, and we are aware of work that has done this for certain areas. For the purpose of this exercise, district-level based definitions were desirable to ensure consistency in the use of secondary datasets.

2.7 The five cities were identified because they are home to the six largest research universities in the UK: universities within these cities are most active in terms of spinout formation[2] as well as IP exploitation[3]. This does not preclude applying the framework, matching and learning to ecosystem pairs that involve other UK cities. However, for the purpose of this initial work it was seen as a means of identifying a set of cities that could benefit from further development of a knowledge-intensive entrepreneurial-university ecosystem.

Table 2-2: UK Cities and Definitions

City	Definition
London	All London boroughs as per area covered by the Greater London Authority
Cambridge	Cambridge City and South Cambridgeshire
Oxford	Cherwell, West Oxfordshire, Oxford City, South Oxfordshire and Vale of White Horse
Edinburgh	Edinburgh, Fife, East Lothian, Midlothian, West Lothian and Scottish Borders
Manchester	All councils covered by the Greater Manchester Combined Authority, i.e. Bolton, Bury, Manchester, Oldham, Rochdale, Salford, Stockport, Tameside, Trafford, and Wigan

Source: SQW

2.8 Data on the shortlisted indicators was collected for these UK cities. Subsequently, 20 US cities were identified for consideration, set out in Box 1 below. Working alongside the steering group, a pragmatic approach was adopted to identifying the US cities and developing possible matches between these and the UK cities detailed above. This involved the following steps:

- **Identifying a set of higher education institutions (HEIs) using university rankings**[4]: this linked to the approach used to select UK cities by identifying the homes of the USA's largest research-intensive universities.

[2] Coates Ulrichsen (2019), Developing University Spinouts in the UK: Key Trends in Spinout Activity, Investments and Investor Involvement, available at https://re.ukri.org/documents/2019/developing-university-spinouts-in-the-uk-tomas-coates-ulrichsen-v2-pdf/
[3] HESA, HE-BCI Survey
[4] The Times Higher Education World University Rankings for best Universities overall, available here: https://www.timeshighereducation.com/world-university-rankings/2020/world-ranking#!/page/0/length/25/sort_by/rank/sort_order/asc/cols/stats

- **Using the AUTM dataset, identifying further US cities**: these were identified based on their similarity to the relevant UK cities on a sub-set of indicators in the AUTM dataset, namely the number of students[5], start-up/spin-out activity[6], IP income and university R&D expenditure[7].
- **Identifying initial possible ecosystem pairs**: this was based on the first indicators collated. Differences in indicators and how these may have been affected by the scale of the place/ecosystem overall was considered throughout this analysis by drawing on data on local populations[8].
- **Agreeing definitions for US cities**: following a review with the steering group and some input from relevant stakeholders (e.g. UKRI overseas representatives and TenU), geographic definitions for each city's ecosystem were agreed. These are set out in the box below and defined in Annex A. For consistency, we have suggested defining cities by their Metropolitan Statistical Areas or Metropolitan Divisions unless feedback identified alternatives. Focussing on a broad geographic area is recommended at this stage since the ecosystem within each city is not yet understood well enough to confidently adopt a more granular definition – though this could be undertaken in future research.
- **Collecting all available[9] data for each of the shortlisted indicators for the 20 US cities**. Based on analysis of this data, the initial ecosystem pairs were refined.

[5] Data for student numbers was not available within the AUTM dataset provided. Therefore, for the purposes of this initial comparison, available information on US city student numbers was gathered from the CityLab: https://www.citylab.com/equity/2016/09/americas-biggest-college-towns/498755/. For shortlisted US cities, data on student numbers can be gathered from the specific HEIs' websites.
[6] Data on start-up activity (i.e. graduate and staff start-ups, including social enterprise) were not available in the AUTM dataset, which only includes start-up companies that are "new companies that were dependent on licensing your institution's technology for their formation". Therefore, for the purposes of comparison. only spin-out data for UK cities was used. UK spinout data included spin-offs with some Higher Education Provider (HEP) ownership as well as those not HEP owned. Spin-offs with HEP ownership are defined by HESA as "registered companies set-up to exploit IP that has originated from within the HEP, where the HEP continues to have some ownership."
[7] This is reported in £000s. AUTM figures were converted from their value in dollars to pounds using the exchange rate as of the 11/05/2020 when it was 0.81 pounds to the dollar.
[8] At this stage, the geographic definitions for US cities had not yet been agreed and so population estimates were not exact.
[9] It was agreed with the project group that due to the focussed nature of this study, only readily available data would be gathered for all 21 US cities. Therefore, due to the fact that CrunchBase and Pitchbook require a paid subscription, data on the number and value of seed stage investments was not collected at this stage. In addition, owing to the fact that a source for sector structure was not identified for the US, data was not available for this indicator either.

Box 1: USA Cities

- New York
- Boston
- Pittsburgh
- Los Angeles
- San Francisco
- Seattle
- San Diego
- St Louis
- Chicago
- Philadelphia
- Baltimore
- Raleigh-Durham-Chapel Hill
- Atlanta
- Austin
- Houston
- Birmingham
- Phoenix
- Washington
- Miami
- Ann Arbor

Caveats and limitations

2.9 Given the focussed nature of this study, it is subject to several caveats and limitations. Details regarding these are set out below.

- This research was intended to be exploratory. It was agreed with the steering group that the framework would be simple and pragmatic, with the sole purpose to identify cities in the USA and UK that *could potentially* have comparable ecosystems. Therefore, there are many aspects of the ecosystem that have not been considered within the framework (which are extensively set out in the original literature review and technical note that preceded this work). It is anticipated that pairings identified in this study could be tested more, including qualitatively, before committing resources to further comparative work. For example, testing and comparative work could include understanding of: the availability of innovation centres/co-working spaces, the incentives higher education institutions provide to their staff for engaging in entrepreneurial activity or the number and quality of support programmes or funding allocated to students or staff for entrepreneurship. A list of additional possible indicators that could form part of further examination are provided in Annex F.

- Potential city pairs for this study have been identified pragmatically rather than purely objectively. UK cities were identified first and used as a starting point to identify US cities. UK cities included were those that hosted the most research-intensive universities in the country in terms of spend and IP exploitation. Due to this focus and the fact that US institutions were selected based on their similarity to the UK institutions, the US cities selected were to some extent pre-determined and thus also focussed on research-intensive universities. Put simply, the research-intensive nature of universities was used as a way of focussing the scope of this initial research.

- The accuracy of the data gathered is limited by the availability of comparable data in both the UK and US at the right geographic level and timeframe. For example, in several cases, AUTM data was available for only a subset of the universities present in each city/area, or for certain years. In addition, how genuinely comparable the data is will depend on how each indicator is defined by data sources in the UK and US. Whereas this was considered when identifying possible data sources, in some cases the detailed definitions for variables were not readily available. In addition, due to limitations in data availability, there were some inconsistencies in data sources. For example, student data for the USA was sourced from university websites, whereas the UK has a centralised database on enrolments. The definitions for all the variables included within the shortlist as per the data sources in the UK and US, as well as any discrepancies or issues with the comparability of the data across the two countries are reported in Annex C.
- Considerations of scale and geography pose challenges for the framework and the effectiveness of comparisons. The economic geography of the USA means that cities tend to be on much larger scales and so some consideration of this is required, e.g. scaling indicators by population or student numbers. In addition, the geographic definition of a place and its ecosystem can be variable and subject to judgement; definitions may also not be in line with the definitions used to collect data.

3. Findings

3.1 This section presents the key findings from the data collected on all available[10] shortlisted indicators for the US and UK cities detailed in Section 2. It also sets out possible ecosystem pairs between the two countries.

3.2 Table 3-1 below sets out the data collected for each of the shortlisted indicators for the five UK cities and 20 US cities that were the focus of this initial study. When interpreting this data, it is important to note the following points:

- Figures reported for the number of spin-outs formed, IP income and University expenditure on R&D are totals for the last three years of available data: 2016-2018. Totals were reported to reduce the effect of outliers in one year that may have skewed the data. For all other metrics, the latest available figure was reported.
- We have not scaled indicators to the size of the local economy/population or any other relevant indicator, and this may limit the number of matches due to the scale differences between the UK and the USA. As such, in considering city pairs we do not expect close matches on all indicators, and this could be for various reasons including difference in the size of the local economy, or differences in strengths within the ecosystem. It is therefore important to consider the indicator set as a whole. Due to the significant variations in the size and scale of places between the UK and US in most cases, certain indicators may need to be interpreted relative to a scale. Future research could explore the possible benefits and limitations of the different metrics that could be used as scales or to normalise data, or how best to interpret comparisons based on raw figures. For example, indicators could be presented as per capita figures, or per numbers of students. However, the AUTM dataset in some cases did not include data for all universities within a given geography in the USA. Therefore, the number of students reported may not be comprehensive[11]. Another consideration would be whether the comparators reported below are potentially more or less similar due to the fact that they have been identified based on raw figures, and what this implies in terms of lessons that each city could derive from the other.

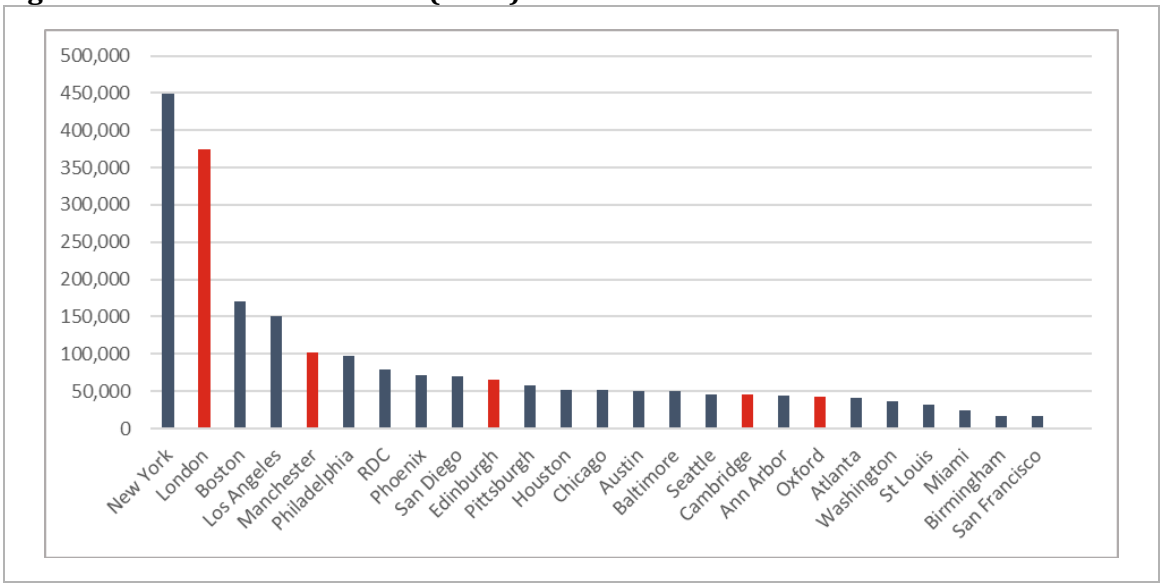
3.3 The charts below illustrate some of the differences in scale between ecosystems in the UK and the USA. Figure 3-1 sets out the number of students, and this shows that UK ecosystems are spread across the set of cities considered. However, in Figure 3-2, showing the level of University R&D expenditure across the cities, the relative smaller scale of UK ecosystems is

[10] Data on the number and value of seed stage investments was not collected for this exercise but could be added by drawing on relevant proprietary databases. In addition, we are aware that the USA County Business Patterns offers a disaggregation of firm numbers by NAICS codes. However, within the scope of this study we were unable to access this data. Therefore, data for this indicator was only collected for UK cities.

[11] In addition, in some cases the AUTM dataset did not differentiate between the campuses of certain systems of universities within the US, such as the University of California system, which has campuses in several different cities. In the instance where a component of the university "system" was located within a defined geography, the institution was deemed to be part of the city's ecosystem and thus the overall university system data was included. The AUTM data also did not differentiate between campuses of the same university. Where a university had a campus within a defined geography but only the overall data for the institution was available in the AUTM data, the institution was deemed to be part of the ecosystem and thus the overall data was included.

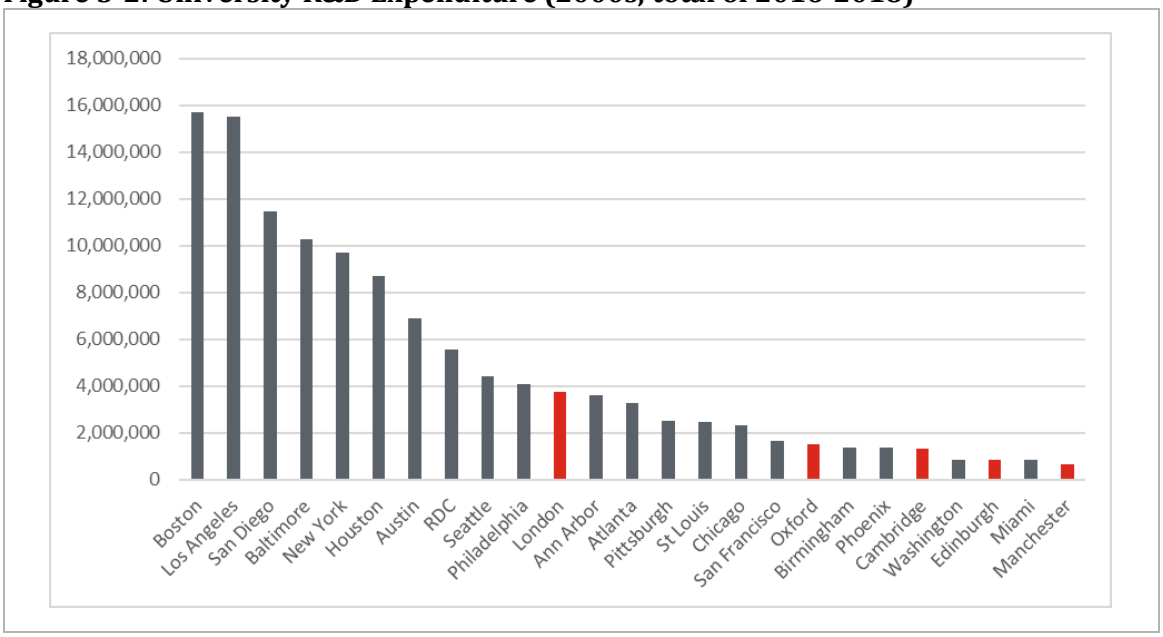
more marked. Figure 3-3 also shows the average values of IP Income and GDP/GVA, again showing the much higher average amongst US cities as compared to UK cities.

Figure 3-1: Number of students (2018)



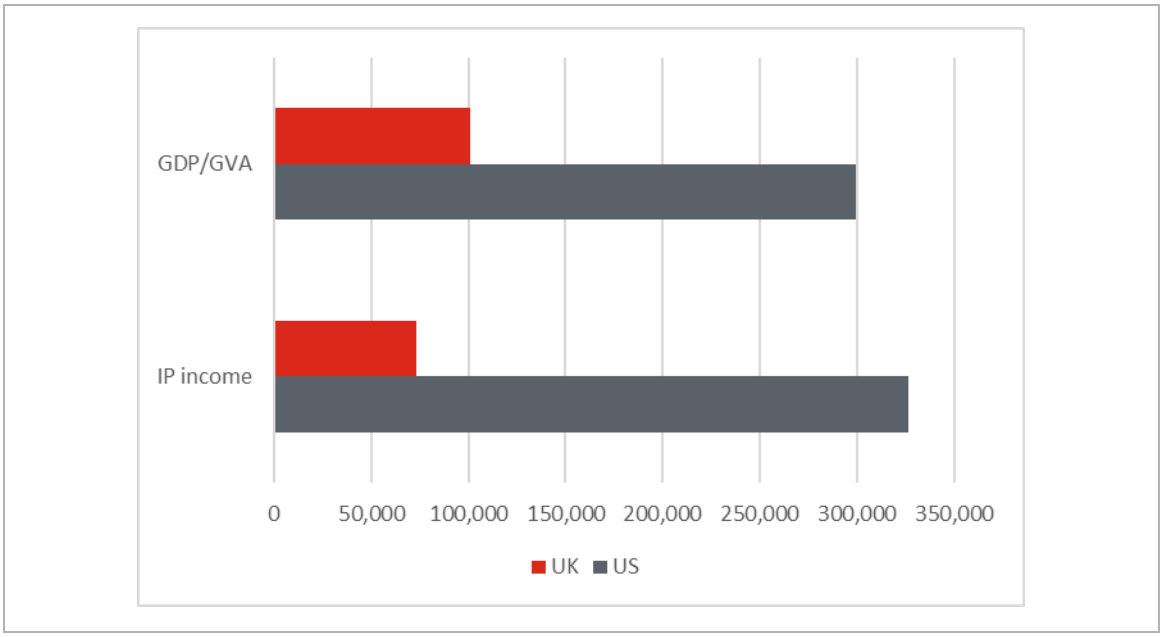
Source: SQW

Figure 3-2: University R&D Expenditure (£000s, total of 2016-2018)



Source: SQW

Figure 3-3: Average value of IP Income (£000s, 2016-2018) and GDP/GVA (£m, 2018) across the UK and USA



Source: SQW

Table 3-1: Full set of data collected on shortlisted indicators for all UK and US cities

City	Number of students (latest available: 2018)	Spin-outs (total of the last three years 2016-2018)	IP income (in £000s) (total of the last three years 2016-2018)	University R&D expenditure (in £000s) (total of the last three years 2016-2018)	Annual population estimates (latest available: 2018)	Number of firms (latest available: 2016)	GDP/GVA (£m) (latest available 2018)	Sector structure (location quotients for knowledge intensive industries) (latest available 2019)
London	375,000	106	166,000	3,747,000	8,908,000	477,000	378,000	1.18
Cambridge	45,000	23	27,000	1,313,000	283,000	13,000	10,000	1.31
Oxford	42,000	60	157,000	1,505,000	688,000	31,000	22,000	1.09
Edinburgh	66,000	8	8,000	844,000	1,385,000	42,000	34,000	1.12
Manchester	102,000	14	8,000	638,000	2,813,000	92,000	60,000	0.97
New York	449,000	178	1,148,000	9,701,000	21,362,000	641,000	1,392,000	*Source not found*
Boston	171,000	260	778,000	15,710,000	4,421,000	119,000	314,000	
Pittsburgh	58,000	79	653,000	2,490,000	2,323,000	60,000	112,000	
Los Angeles	151,000	364	1,510,000	15,506,000	13,250,000	379,000	762,000	
San Francisco	17,000	82	146,000	1,639,000	2,701,000	70,000	341,000	
Seattle	46,000	52	59,000	4,420,000	3,935,000	108,000	288,000	
San Diego	70,000	272	395,000	11,447,000	3,334,000	86,000	178,000	

City	Number of students (latest available: 2018)	Spin-outs (total of the last three years 2016-2018)	IP income (in £000s) (total of the last three years 2016-2018)	University R&D expenditure (in £000s) (total of the last three years 2016-2018)	Annual population estimates (latest available: 2018)	Number of firms (latest available: 2016)	GDP/GVA (£m) (latest available 2018)	Sector structure (location quotients for knowledge intensive industries) (latest available 2019)
St Louis	32,000	39	51,000	2,454,000	2,770,000	72,000	122,000	
Chicago	52,000	56	626,000	2,338,000	6,969,000	187,000	388,000	
Philadelphia	98,000	94	183,000	4,085,000	5,264,000	122,000	267,000	
Baltimore	51,000	119	84,000	10,271,000	2,751,000	66,000	147,000	
Raleigh-Durham-Chapel Hill	79,000	105	129,000	5,565,000	1,900,000	47,000	98,000	
Atlanta	42,000	42	24,000	3,267,000	5,879,000	145,000	288,000	
Austin	51,000	105	269,000	6,906,000	2,165,000	54,000	109,000	
Houston	52,000	141	378,000	8,702,000	6,976,000	144,000	360,000	
Birmingham	17,000	16	17,000	1,367,000	1,166,000	26,000	47,000	
Phoenix	72,000	45	10,000	1,363,000	4,849,000	100,000	184,000	
Washington	37,000	12	13,000	860,000	4,983,000	105,000	315,000	
Miami	24,000	25	19,000	823,000	6,144,000	198,000	255,000	
Ann Arbor	45,000	45	40,000	3,583,000	369,000	8,000	18,000	

Source: SQW, sources for each indicator are detailed in Annex C

Table 3-2: Notes for associated with Table 3-1

	Notes
1	Within this study, only spin-out activity data was collected for shortlisted cities. This differed from the shortlisted indicator: start-up/spin-out activity since start-up data was not readily available for US cities. In the US, start-up companies were defined as companies that were dependent on licensing the institution's technology for their formation. UK data for spin-outs included those with some HEP ownership as well as those not HEP owned.
2	In the UK, the latest available data for number of students was in 2016. USA data pertaining to the number of students per institution was retrieved via an internet search. The most recent data for the number of students varied per institution, for example some institutions had data from 2019 or 2018 and others from 2016. In the case of university systems, only the number of students at the university within the defined geography was included in the totals.
3	In some instances, the GDP data for the US counties was grouped, for example the Bureau for Economic Analysis presented the data for Fairfax, Fairfax City and Falls Church in Virginia as an overall total, rather than the individual GDPs. We were only interested in Fairfax and Falls Church, however we had to include the overall total. This happened on two occasions when collecting the data for Washington, therefore the GDP data for that ecosystem should be treated with caution. The GPD data for the US counties was presented in thousands of chained 2012 dollars, to convert the data into millions of pounds (in line with how the UK data was presented) the data was multiplied by 0.001 (to convert to millions), and then by 0.81 (to convert to pounds).
4	Knowledge intensive industries were defined by the 2-digit SIC codes for knowledge-intensive services and high-technology manufacturing industries, as defined by Eurostat: https://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an3.pdf. National comparators were England and Scotland, respectively. There were no location quotients within any of the cities for knowledge intensive industries above 1.5. However, this may be due to the relatively broad definition of knowledge-intensive industries. Regardless, for all UK cities except for Manchester, employment in knowledge intensive industries was greater than the national average, since they were greater than one. Location quotients are the ratio of the percentage of employment within knowledge intensive industries within a specific city to that of the nation i.e. England or Scotland.
5	Where possible, all figures have been rounded to the nearest 1000.

Source: SQW

Possible ecosystem pairs

3.4 Based on the data presented in Table 3-1, possible US comparators to the five UK cities have been identified. These are presented in this section. This discussion will focus on possible city pairs where at least two of the US cities' indicators were within 20% of the UK city's equivalent indicator. Further detail on possible comparators can be found in Annex B[12]. It is important to note that this is not a final list of established and agreed matches, but rather a view of some initial, possible pairs that appear to be similar based on the data collected to date and could therefore potentially be explored further.

London

London was found to be most similar to Philadelphia and San Francisco in terms of the indicators considered in this study. In both cases, values for three ecosystem indicators were within, or close to 20% of those for London.

City	Similarities
Philadelphia	Spin-out activity, IP income and university R&D expenditure
San Francisco	IP income and GDP/GVA

Source: SQW

Similarities between London and New York, Chicago and Houston were also identified, as detailed in Annex B. However, in these cases, only one of the framework's indicators was within the 20% range of its equivalent in London. For New York, this was its number of students. In addition, New York's levels of spin-out activity and number of firms, whilst not being within 20% of the values for London, were potentially comparable (but outside of this range). Differences between New York and London are particularly subject to variations in the scale of the cities. As seen in Figure 3-4, New York is of much larger scale in terms of population.

Comparability is also subject to the geographic definitions adopted. For instance, with narrower definitions, our preliminary review of the data showed closer comparability between London and New York, as well as between London and Boston and Seattle.

[12] Within this Annex, indicators were defined as 'similar' if the US indicator was within 20% (+/-) of its UK equivalent. These 'matched' indicators are represented by a double tick. A single tick represents where ecosystem indicators for the US and UK city were relatively similar, but not within the 20% range. In these cases, it is thought differences in scale may explain those in the values of the indicators.

Cambridge

The framework developed in this study identified Atlanta as a possible comparator to Cambridge. Ann Arbor was also of a similar scale, with its number of students being within 20% of that of Cambridge. Ann Arbor also had a comparable (though out of the 20% range) annual population, number of firms and GDP/GVA. Atlanta's number of students was also similar to that of Cambridge, and its level of university IP income was also within this range. It is likely that the comparability of Cambridge's indicators were skewed by issues of scale, due to its much smaller size in terms of population compared with most US cities.

City	Similarities
Atlanta	Number of students, IP income
Ann Arbor	Number of students

Source: SQW

Within our preliminary review, Cambridge had been matched with Palo Alto, Boston and Cambridge. However, following feedback from the steering group, the geography for Palo Alto was revised to include the wider San Francisco Bay Area, and Boston and Cambridge were combined into a single ecosystem. Following these revisions, Cambridge was no longer closely matched with these cities based on the indicators within this framework. Nevertheless, they could provide additional cities to consider through further analysis.

Oxford

Oxford was found to be comparable to four US cities: San Francisco, Seattle, Birmingham and Ann Arbor. Despite being over double its size in terms of population, San Francisco's values for IP income and university R&D expenditure were within 20% of those of Oxford. The issue of scale would need to be carefully considered here as part of any further work. Ann Arbor, on the other hand, was mostly similar to Oxford in terms of indicators that provided a sense of context/scale, in particular number of students and GDP/GVA.

City	Similarities
San Francisco	IP income, university R&D expenditure
Seattle	Number of students, spin-out activity
Birmingham	University R&D expenditure, number of firms
Ann Arbor	Number of students, GDP/GVA

Source: SQW

Seattle was found to have similar levels of spin-out activity and numbers of students as Oxford. However, the two cities are very different in terms of population. Birmingham, on the other hand, is relatively close to Oxford in terms of its population size and was within the 20% range in terms of its university R&D expenditure and number of firms.

Within our initial analysis, possible comparators for Oxford had included Los Angeles, Pittsburgh, Philadelphia, Raleigh-Durham-Chapel Hill and Palo Alto. However, following revisions to the geographic definitions for US cities, none of these cities were identified as potential matches. Nonetheless, some similarities between Oxford and these cities were identified. For example, Raleigh-Durham-Chapel hill and Philadelphia had similar levels of IP income.

Edinburgh

The only US city found to have at least two indicators within 20% of the equivalent indicators for Edinburgh was Raleigh-Durham-Chapel Hill. This was mainly based on similarities in scale i.e. numbers of students and firms. Some similarities were also found between Edinburgh and Washington, based on similar levels of University R&D expenditure (levels of spin-out activity were similar though just outside of the 20% range we used for matching). In addition, Phoenix had similar numbers of students, and IP income levels that were just outside of the 20% range.

City	Similarities
Raleigh-Durham-Chapel Hill	Number of students, number of firms
Washington	University R&D expenditure
Phoenix	Number of students

Source: SQW

Within the preliminary analysis, additional comparators for Edinburgh that had been suggested included San Diego and Miami. However, once geographies and data had been refined, San Diego was only within 20% of Edinburgh on the number of students, and Miami was similar only for the level of University R&D expenditure.

Manchester

Manchester's closest matches were to Washington and San Diego. Washington and Manchester were similar (i.e. figures reported for these indicators were within 20% of each other) in terms of levels of spin-out activity and number of firms. Washington also had a comparable level of University R&D expenditure. San Diego was matched with Manchester based on similar population estimates and numbers of firms.

Whereas Phoenix was not matched on two indicators, it's number of firms was within 20% of that for Manchester, and it also had levels of IP income that were just outside of the range used for matching. Birmingham was also identified as a possible comparator, with similar levels of spin-out activity and comparable GDP/GVA.

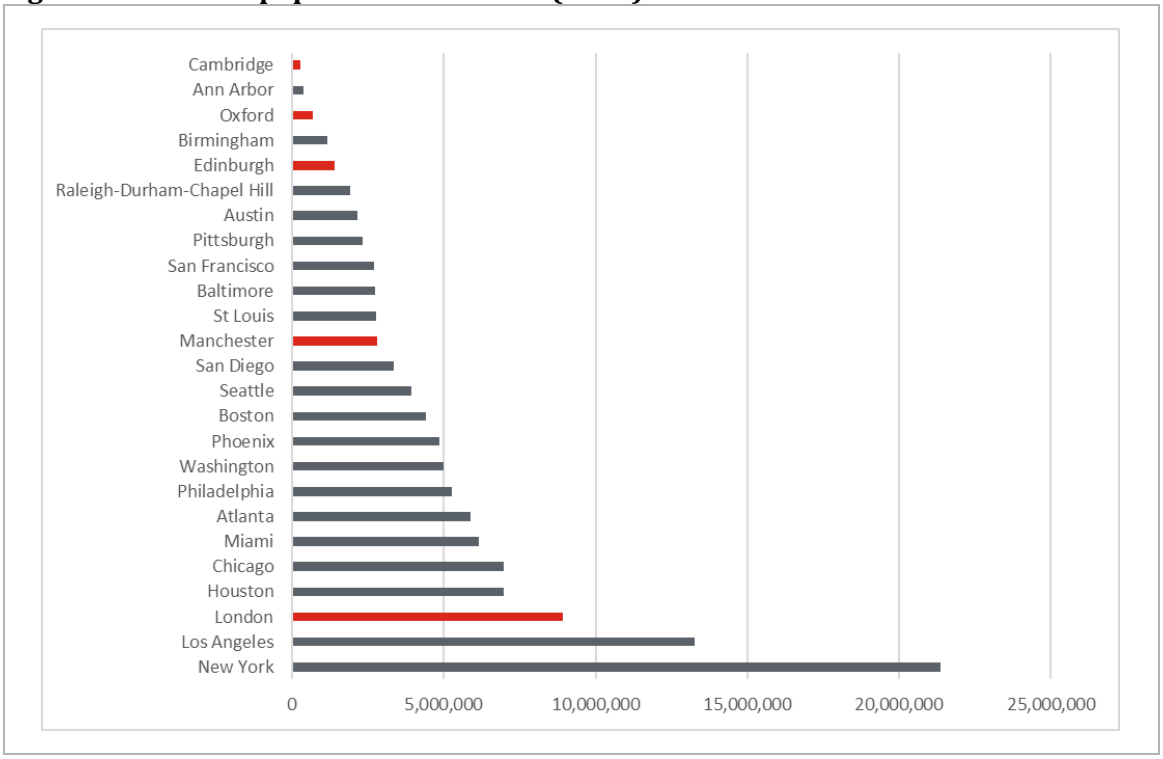
City	Similarities
Washington	Spin-out activity, number of firms
San Diego	Annual population estimates, number of firms

Source: SQW

Other observations on the data

3.6 As has been raised throughout this report, the above analysis emphasizes challenges posed by differences in scale between UK and US cities. Whilst some cities are comparable in terms of scale, e.g. in terms of population sizes, 11 US cities have population sizes of around 4 million and above, considerably above any UK city except for London – see Figure 3-4 below. The differences in scale of cities may have implications on the extent to which, for example, London or Ann Arbor were found to be similar to other US or UK cities, being by far the largest UK city and smallest US city, respectively. Future research should consider how these differences may be accounted for, including for example how the data collected in this study could be scaled or normalised.

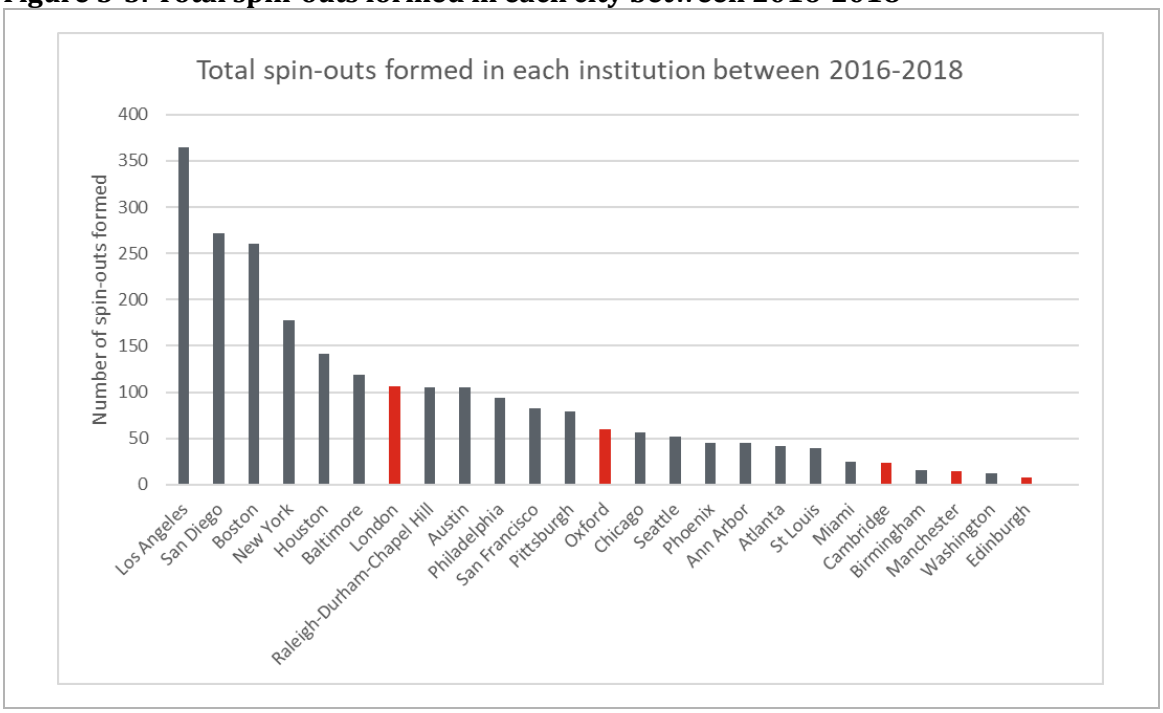
Figure 3-4: Annual population estimates (2018)



Source: SQW

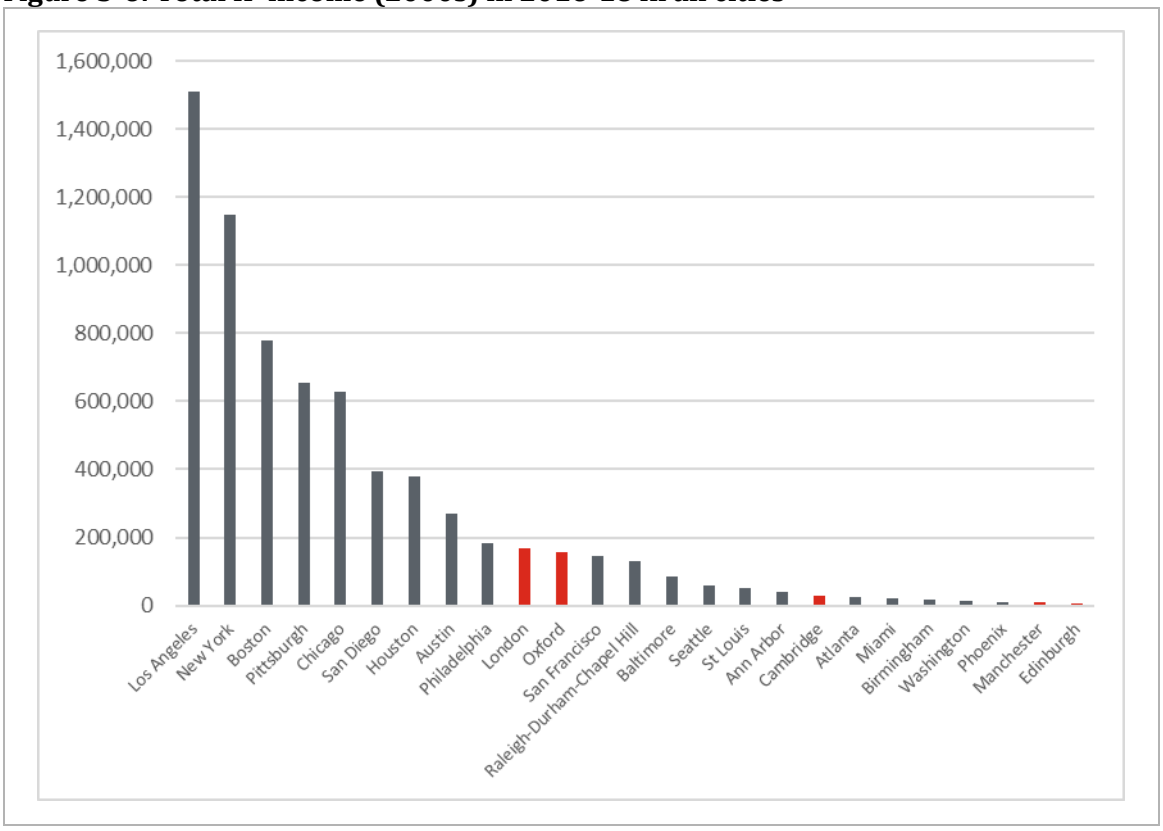
3.7 Despite differences in scale, cities considered and matched were relatively more comparable in terms of their levels of IP income and spin-out activity. Figures 3-5 and 3-6 represent these similarities graphically. These graphs also show, however, that some cities, for example New York, Boston and Los Angeles, display much greater levels of IP income and spin-out activity than all UK cities. They also highlight that London and Oxford are the UK cities with the highest levels on both indicators.

Figure 3-5: Total spin-outs formed in each city between 2016-2018



Source: SQW

Figure 3-6: Total IP income (£000s) in 2016-18 in all cities



Source: SQW

4. Conclusions and next steps

4.1 This study set out to develop a simple headline framework of 5-10 indicators that could be used to match possible city-based university ecosystems to inform further comparative analysis and learning. In doing so, the research aimed to identify cities in the UK and the USA that may have comparable ecosystems. Following an iterative process in partnership with the study's steering group, we have developed a portfolio of indicators that could be used for this purpose. This comprises the following indicators.

Framework indicators

- Higher education data, including:
  - Number of students
  - Start-ups/spin-out activity
  - IP income
  - University R&D expenditure
- Local enterprise data, including:
  - Number of seed stage investments made
  - Value of seed stage investments
- Local enterprise data, including:
  - Annual population estimates of the resident population
  - Number of firms
  - GDP/GVA
  - Sector structure

4.2 Based on an agreed set of 25 cities that the study focused on, available data on the shortlisted indicators was gathered. An initial set of possible city matches is set out in Table 4-1. These are based on the closest matches found across the indicator set, though others could be considered (as set out in section 3).

Table 4-1: Possible ecosystem pairs

London	Cambridge	Oxford	Edinburgh	Manchester
Philadelphia San Francisco	Atlanta	San Francisco Seattle Birmingham Ann Arbor	Raleigh-Durham-Chapel Hill	Washington San Diego
Other possible matches include:				
New York Chicago Houston	Ann Arbor Miami	Chicago	Washington Phoenix	Birmingham Phoenix

Source: SQW

4.3 Given the focussed and pragmatic nature of this study, it is subject to several caveats and limitations. These include the following:

- As an intentionally simple and pragmatic framework, there are inevitably many aspects of an ecosystem that are not considered when identifying the possible ecosystem pairs.
- The framework is based on readily available quantitative indicators and so does not include a qualitative perspective.
- Differences in scale and geography across the UK and US may influence the metrics collected.
- The data and possible matches identified is limited by the availability of genuinely comparable data at the right geographic level and timeframe.

4.4 Moving forward, and reflecting on the caveats, this study could be used as a basis for further discussion and research into the possible city matches identified. Further quantitative and qualitative research could be conducted to better understand the cities considered and their ecosystems. Qualitative insights could include interviews with key stakeholders within each city. Quantitative data could draw on proprietary datasets or other research that has been undertaken at a granular level. This would add to and enrich the initial data collected under the framework, possibly identifying new potential city pairs or deepening the understanding of the similarities and differences between the pairs proposed.

4.5 Beyond the research to refine ecosystem pairs, future research may then investigate how the ecosystems are functioning, for instance drawing on the previous literature review and technical note to identify lessons and to share practice.

Annex A: USA city definitions

A.1 The below sets out the geographic definitions (by county) for each of the US cities considered as part of this study.

Table A-1: USA Cities and Definitions

New York	Metropolitan area, including the five New York City boroughs (Staten Island, Queens, Bronx, Manhattan, Brooklyn) as well as Northern New Jersey, Westchester, and Southern Connecticut.
Boston	Boston Metropolitan Statistical Area (MSA) including Plymouth, Norfolk, Suffolk, Essex and Middlesex counties.
Pittsburgh	Pittsburgh MSA including counties of Beaver, Butler, Washington, Armstrong, Westmoreland, Fayette and Allegheny
Los Angeles	Los Angeles-Long Beach-Anaheim MSA, including Los Angeles and Orange counties.
San Francisco	The San Francisco Bay area. This would include San Mateo and Santa Clara counties.
Seattle	Seattle-Tacoma-Bellevue MSA, including Pierce, King, and Snohomish counties.
San Diego	San Diego-Carlsbad MSA, including San Diego county.
St Louis	St. Louis MSA including St. Louis, Jefferson, Franklin, Warren, St. Charles and Lincoln counties in Missouri, and St. Clair, Clinton, Jersey, Calhoun, Bond, Madison and Macoupin counties in Illinois.
Chicago	Chicago-Naperville-Arlington Heights Metropolitan Division including Cook, Will, Kendall, Grundy and DuPage Counties
Philadelphia	The Philadelphia-Camden-Wilmington MSA including Gloucester, Camden, Burlington, Philadelphia, Bucks, Chester, Delaware, Cecil, New Castle and Salem counties.
Baltimore	Baltimore-Columbia-Towson MSA, including Carroll, Howard, Baltimore, Harford, and Anne Arundel counties. Potentially including Montgomery and Prince George's counties as well, to include the University of Maryland system.
Raleigh-Durham-Chapel Hill	The Raleigh and Durham-Chapel Hill MSAs, including Wake, Johnston, Franklin, Durham, Orange and Chatham counties.
Atlanta	Atlanta-Sandy Springs-Roswell MSA including Bartow, Pickens, Dawson, Cherokee, Forsyth, Haralson, Paulding, Cobb, DeKalb, Gwinnet, Barrow, Carroll, Douglas, Fulton, Clayton, Rockdale, Walton, Heard, Coweta, Fayette, Henry, Newton, Morgan, Jasper, Butts, Meriwether, Pike and Lamar counties
Austin	Austin-Round Rock MSA including Williamson, Travis, Hays, Caldwell and Bastrop counties.
Houston	Houston-The Woodlands-Sugar Land MSA including Austin, Waller, Montgomery, Liberty, Fort Bend, Harris, Chambers, Galveston and Brazoria counties.

Birmingham	Birmingham-Hoover MSA including Walker, Blount, St. Clair, Jefferson, Shelby, Bibb, Hale and Chilton counties.
Phoenix	Phoenix-Mesa-Scottsdale MSA including Maricopa and Pinal counties.
Washington	Washington-Arlington-Alexandria MSA including Jefferson, Clarke, Warren, Rappa-Hannock, Culpeper, Fauquier, Spotsylvania, Charles, Calvert, Frederick, District of Columbia, Arlington, Fairfax, Prince George's, Falls Church, Fairfax, Alexandria, Prince William, Manassas, Manassas Park and Loudoun counties
Miami	Miami-Fort Lauderdale-West Palm Beach MSA including Miami-Dade, Broward, Palm Beach counties.
Ann Arbor	Ann Arbor MSA including Washtenaw county.

Source: SQW, including analysis of https://www2.census.gov/geo/maps/metroarea/us_wall/Jul2015/cbsa_us_0715.pdf

Annex B: Possible ecosystem pairs

B.1 The below sets out possible ecosystem pairs, based on cities that were found to be similar based on at least two of the indicators considered as part of this framework. Some potential matches are included despite being similar on only one indicator, if they were possibly comparable on at least one more. Indicators were defined as 'similar' if the US indicator was within 20% (+/-) of its UK equivalent. These 'matched' indicators are represented by a double tick. A single tick represents where ecosystem indicators for the US and UK city were relatively similar, but not within the 20% range. In these cases, it is thought differences in scale may explain those in the values of the indicators.

Table B-1: Initial view of possible city pairs and the indicators they were matched on

UK City	Possible US city pair	Number of students	Spin-outs	IP income	University R&D expenditure	Annual population	Number of firms	GDP/GVA
London	New York	✓✓	✓				✓	
	Philadelphia		✓✓	✓✓	✓✓			
	Chicago					✓		✓✓
	San Francisco		✓	✓✓				✓✓
	Houston					✓		✓✓
Cambridge	Ann Arbor	✓✓				✓	✓	✓
	Miami		✓✓	✓				
	Atlanta	✓✓		✓✓				
Oxford	San Francisco			✓✓	✓✓			
	Seattle	✓✓	✓✓					
	Chicago	✓	✓✓					
	Birmingham				✓✓		✓✓	
	Ann Arbor	✓✓				✓		✓✓
Edinburgh	Washington		✓		✓✓			
	Phoenix	✓✓		✓				
	Raleigh-Durham-Chapel Hill	✓✓				✓	✓✓	
Manchester	Washington		✓✓		✓		✓✓	
	Phoenix			✓			✓✓	
	Birmingham		✓✓					✓
	San Diego					✓✓	✓✓	

Source: SQW indicator definitions, reasons for inclusion and issues

Annex C: Indicator definitions, reasons for inclusion and issues

C.1 The table below sets out the definitions and possible sources for all the shortlisted indicators. It also details reasons for including the indicator, and possible issues with it.

Table C-1: Indicator definitions

Indicator	Definition (UK)	Definition (US)	Reasons for inclusion	Possible issue	Possible source (UK)	Possible source (US)
Number of students	Higher education (HE) student enrolment by HE provider, also shows breakdown by sex or domicile (UK/EU/non-EU). Most tables of HESA data count students at publicly funded higher education institutions plus the University of Buckingham. From 2016/17, HE level students at further education (FE) colleges in Wales are included, but not students at FE colleges in England, Scotland or Northern Ireland.	Numbers of students (excluding post-doctorate students) at each higher education institution (HEI), as reported on individual institution websites.	Data for these indicators is readily available at the institutional level in the USA and the UK. Provides a measure of the scale of the places and universities present within them which could be used as a base measure to enable more effective comparisons across ecosystems of varying scales.	Student data for the USA was only available at the right geographic level if sourced from university websites. This is inconsistent with the UK, since it has a centralised database on enrolments.	Higher Education Statistics Agency (HESA) - Students by Higher Education (HE) provider	Individual university websites
Spin-out activity	Number of spin-offs by HE provider broken	Number of spin-outs linked to Universities i.e. start-up	Data for these indicators is readily	Data on start-up activity (i.e. graduate	HESA – Higher Education Business	Association of University

Indicator	Definition (UK)	Definition (US)	Reasons for inclusion	Possible issue	Possible source (UK)	Possible source (US)
	down into spin-offs with some HE provider ownership and formal spin-offs that are not HE provider owned. Spin-offs are companies set up to exploit IP that has originated from within the HE providers. Spin-offs with some HE provider ownership are companies set up to exploit IP that has originated from within the HE provider, where the HE provider continues to have some ownership. Formal spin-offs, not HE provider-owned are companies set up based on IP that has originated from within the HE provider but where the HE provider has released ownership (usually through the sale of shares and/or IP).	companies that were dependent on licensing the institution's technology for their formation.	available at the institutional level in the USA and the UK. Provides an overview of university-linked enterprise activity.	and staff start-ups, including social enterprise) was not available in the AUTM dataset, which only includes start-up companies that are "new companies that were dependent on licensing your institution's technology for their formation". Without a subscription to the AUTM STATT survey, the availability of definitions of variables was limited.	& Community Interaction (HE-BCI) Survey	Technology Managers (AUTM) – Statistics Access for Technology Transfer (STATT) survey
IP income	Intellectual property income (including patents, copyright,	Gross Licensing Income received (i.e. total of licensing income from	Data for these indicators is readily available at the	Without a subscription to the AUTM STATT survey,	HESA – HE-BCI Survey	AUTM – STATT survey

Indicator	Definition (UK)	Definition (US)	Reasons for inclusion	Possible issue	Possible source (UK)	Possible source (US)
	design, registration and trade marks) by HE provider. Metrics include: Subtotal IP income (£000s), Subtotal overseas (£000s), Sale of shares in spin-offs (£000s), Total IP revenues (£000s), Total costs (£000s)	running royalties and from other sources)	institutional level in the UK and USA. Provides an insight into university licencing activity.	the availability of definitions of variables was limited.		
University R&D expenditure	Data on annual operating expenditure - includes data on total expenditure on research grants and contracts by institution.	The total research expenditures (i.e. from federal government and industrial sources).	Data for these indicators is readily available at the institutional level in the USA and the UK. Provides an understanding of the scale of university research and development activity.	Without a subscription to the AUTM STATT survey, the availability of definitions of variables was limited. In addition, issues around comparability may arise due to differences in the split between public and private higher education institutions as well as their funding sources between the USA and the UK.	HESA - UK University expenditure breakdown by activity and HESA Cost Centre	AUTM – STATT survey

Indicator	Definition (UK)	Definition (US)	Reasons for inclusion	Possible issue	Possible source (UK)	Possible source (US)
Number of seed stage investments made	Definition not found due to proprietary data source	Definition not found due to proprietary data source	Data for these indicators is available at the firm and city/regional level in the USA and the UK. Provides a view of the functioning/ availability of finance for businesses within the ecosystem.	Without a subscription to CrunchBase or Pitchbook, definitions for indicators were not available. In addition, the completeness of the datasets at regional geographic levels is uncertain.	CrunchBase and/or Pitchbook	CrunchBase and/or Pitchbook
Value of seed stage investments	Definition not found due to proprietary data source	Definition not found due to proprietary data source	Data for these indicators is available at the firm and city/regional level in the USA and the UK. Provides a valuable control for any biases from particularly high value investments.	Without a subscription to CrunchBase or Pitchbook, definitions for indicators were not available. In addition, the completeness of the datasets at regional geographic levels is uncertain.	CrunchBase and/or Pitchbook	CrunchBase and/or Pitchbook
Annual Population Estimates of the Resident Population	Estimate of the resident population available by single year of age and by age bands (e.g. 0-15, 16-64, 65+). Also available by sex.	Annual Population estimates of the resident population, based on the 2010 Census.	Data for these indicators is readily available at County/Lower Layer Super Output Area (LSOA) level in the		Office for National Statistics (ONS) - Population estimates	U.S. Census Bureau, Population Division

Indicator	Definition (UK)	Definition (US)	Reasons for inclusion	Possible issue	Possible source (UK)	Possible source (US)
			USA and the UK, respectively. Provides a sense of scale and density of the ecosystem area. Could also be used as a base measure to enable more effective comparisons across ecosystems of varying scales.			
Number of firms	An extract compiled from the Inter Departmental Business Register (IDBR) recording the number of enterprises that were live at a reference date in March. Estimates can be broken down by employment size band, detailed industry (5 digit SIC2007) and legal status. An enterprise can be thought of as the overall business, made up of all the individual sites or workplaces. It is defined as the smallest combination of legal units (generally based on	A firm is a business organisation consisting of one or more domestic establishments in the same state and industry that were specified under common ownership or control. The firm and the establishment are the same for single-establishment firms. For each multi-establishment firm, establishments in the same industry within a state will be counted as one firm; the firm employment and annual payroll are summed from the associated establishments.	Data for these indicators is readily available at County/Middle Layer Super Output Area (MSOA) level in the USA and the UK, respectively. Simple measure of live enterprises that provides a sense of scale of local enterprise. Could also be broken down into industry codes (SIC codes in the UK and NAICS codes in the USA) to provide a	USA data is collected in one year only (2016). In addition, whilst both UK and USA data sources include multiple establishments within one firm, in the USA this is done at state level. It is also possible that this may not be an accurate measure of enterprise/ entrepreneurial activity	UK Business counts - enterprises by industry and employment size band	2018 County Business Patterns

Indicator	Definition (UK)	Definition (US)	Reasons for inclusion	Possible issue	Possible source (UK)	Possible source (US)
	VAT and/or PAYE records) that has a certain degree of autonomy within an enterprise group.		view of industry composition.			
GDP/GVA	Regional gross value added is the value generated by any unit engaged in the production of goods and services.	GDP is the value of the goods and services produced in the United States.	GVA data is available in the UK at the NUTS 1-3 level. For the US, GDP data is available at the Metropolitan Statistical Area Level. Provides a view of the scale of the economy within which the ecosystem operates	ONS collect regional Gross Value Added (GVA) data in the UK at sub-national geography. However, in the USA, the slightly different Gross Domestic Product (GDP) indicator is collected	ONS	Bureau of Economic Analysis (U.S Department of Commerce)
Sector structure (location quotients for Knowledge Intensive[13] sectors using national comparators)	BRES measures the number of employees (part time and full time) and the amount of employment in an area. An employee is anyone aged 16 years or over that an organisation directly pays from its payroll(s), in return for carrying out a full-time or part-time job or being	Source not found	Whereas a source for USA data was not found, UK data is available at the LSOA level. Provides a view of industry composition and the prevalence and importance of knowledge intensive sectors within the economy.	No source was identified for the USA.	Business Register and Employment Survey	Not found – though County Business Patterns do offer some disaggregation of numbers of firms by NAICS code.

[13] Using 2-digit SIC codes for knowledge-intensive services and high-technology manufacturing industries, as defined by Eurostat: https://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an3.pdf

Indicator	Definition (UK)	Definition (US)	Reasons for inclusion	Possible issue	Possible source (UK)	Possible source (US)
	on a training scheme. Location quotients measure a region's industrial specialization relative to a larger geographic unit					

Source: SQW

Annex D: Bibliography

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Annex E: Possible additional data sources

E.1 The table below lists possible additional indicators that were considered for inclusion within the framework, as well as possible data sources. These were indicators from the long list developed as part of this study.

Table E-1: Possible additional indicators and data sources for these

Indicator category	Indicator name	Possible source (UK)	Possible source (US)
Higher Education - Students & Universities	University rankings (e.g. world university rankings)	Times Higher Education World University Rankings 2020	Times Higher Education World University Rankings 2020
	Number of unicorn founders associated with universities	Statista	Statista
	Number of university staff	Higher Education Statistics Agency (HESA) – Higher Education (HE) staff by HE provider and employment conditions	Not found
Local enterprise data	Enterprise start-up rate	ONS Business demography - birth rates	Not found
	Enterprise failure rate	ONS Business demography - death rates	Not found
	Business Expansions / Growth	ONS Business demography	Not found
	Net change in establishments	Not found	2017 Statistics of US Business Annual Datasets by Establishment Industry
Higher Education - Research Commercialisation	Number of student or graduate start-ups/ spin-outs linked to Universities	Higher Education Business and Community Interaction (HE-BCI) Survey Data from HESA	AUTM STATT
	Number of staff spin-outs/start-ups linked to Universities	HE-BCI Survey Data from HESA	AUTM STATT

Indicator category	Indicator name	Possible source (UK)	Possible source (US)
	Number of social enterprise start-ups/ spin-outs linked to Universities	HE-BCI Survey Data from HESA	AUTM STATT
	Spin-out performance (e.g. value, employment)	HE-BCI Survey Data from HESA	Not found
	Start-up performance (e.g. value, employment)	HE-BCI Survey Data from HESA	Not found
	University income	HESA - HE Provider data: finance	Not found
	Industrial research/consultancy (e.g. value)	HE-BCI Survey Data from HESA	Not found
Local economic data	Employment rate	Nomis annual population survey	2016 County Business Patterns
	Employment	Business Register and Employment Survey	Bureau of Economic Analysis (U.S Department of Commerce)
	Business R&D expenditure	ONS: Business Enterprise Research and Development (BERD)	Not found

Source: SQW

SQW

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