Innovation Caucus

MAPPING THE BIOTECHNOLOGY AND BIOSCIENCE INDUSTRY IN THE UK: A KNOWLEDGE SPACE ANALYSIS

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In partnership with:

UKRI Biotechnology and Biological Sciences Research Council

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About the Innovation Caucus

The Innovation Caucus supports sustainable innovation-led growth by promoting engagement between the social sciences and the innovation ecosystem. Our members are leading academics from across the social science community, who are engaged in different aspects of innovation research. We connect the social sciences, Innovate UK and the ESRC, by providing research insights to inform innovation policy and practice. We champion the role of social science in innovation and enhance its impact. Professor Tim Vorley is the Academic Lead. The initiative is funded and co-developed by the ESRC and Innovate UK.

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EXECUTIVE SUMMARY

To better understand the UK's bioscience and biotechnology industries, this report delves into the specialisation and landscape of biotech start-ups and scale-ups in the UK. Economic prosperity in this industry is tied to start-up success, and thus by understanding the knowledge base of these businesses, knowledge is gained about the sectors' potential. Through an alternative approach using near-real-time data, this report focuses on knowledge clusters that emerge from companies' self-described public personas through medium including social media, web usage and news articles. Doing so provides a better understanding of the breadth of bioscience and its permeation across many industries. The analysis also demonstrates local strengths and the respective field of expertise in the industry, whilst it also identifies potential for sector coalescence and further opportunities for innovation. Ultimately, this report aims to provide a most up-to-date image of the knowledge sets in the bioscience and biotechnology industry and locate "where the action is" in the economic landscape within the UK.

In June 2021, we obtained a sample of 10,809 start-ups and scale-ups from the near-real-time data platform Dealroom.co. This entire sample of businesses either have a direct or indirect relevance to bioscience. The data was clustered into ten significant clusters: Health, Food, Energy, Innovative Foods, Transportation, Sustainability, Wellness Beauty, Cleaning/Hosting, Sports, AgTech. These clusters were then further analysed using a Knowledge Space Analysis method to determine the proximal relationships within and between these clusters. The analysis shows that some clusters are at the core of the bioscience industry (e.g., health, food and energy clusters), while others (e.g., sustainability, innovative foods, and transportation) appear as emergent or secondary clusters where innovation might be thriving or have the potential to thrive in start-ups. The relatedness between clusters also offers insights into the unexpected sectors that coalesce to each other, and the way that the companies through their digital footprints incorporate bioscience and communicate this to the market.

Further analysis using geographical delimitations and the identified clusters shows that the regions of London and South East of England have a higher number of start-ups and scale-ups in the different sectors. More precisely, companies are concentrated in London and its surrounding commuting areas. Other hotspot regions are Oxford and Cambridge, where important pharmaceutical corporations and Universities are located. Cities like Bristol, Birmingham, Manchester, Leeds, Edinburgh, and Glasgow arise as hotspots for specific subsectors, such as sustainability, transportation, and wellness beauty.

1. INTRODUCTION

The Biotechnology and Biological Sciences Research Council (BBSRC) is part of UK Research and Innovation (UKRI), a body which works in partnership with universities, research organisations, businesses, charities and government to create the best possible environment for research and innovation to flourish. BBSRC's mission is to lead world-class 21st century bioscience, promoting innovation in the bioeconomy and realising benefits for society within and beyond the UK.

The bioeconomy, defined as **"[a]ll economic activity derived from bio-based products and processes which contributes to sustainable and resource-efficient solutions to the challenges we face in food, chemicals, materials, energy production, health and environmental protection,"** (BBSRC, 2021) offers huge potential to support a more productive, prosperous and sustainable UK, through the projected creation of 4 million jobs and £153 billion gross value added (GVA) (BBSRC, 2015). The purpose of this project was to map bioscience knowledge spaces and their interrelationships. At present, there is limited understanding of the knowledge spaces that comprise the bioscience and biotechnology industry.

The bioscience and biotechnology industry has the potential to become a major contributor to the UK economy (Industrial Biotechnology Leadership Forum, 2018; Smith, 2004). Bioscience and biotechnology start-ups and scale-ups (from now on referred to as 'start-ups' for simplification) play an important role in achieving that (Cooke 2001a, 2001b). The UK has historically harboured an important scientific base, recognising earlier than other economies the importance of new, knowledge-driven businesses (Cooke, 2001a). However, other economies like the US have been more successful in commercialising biotechnology (Cooke, 2001b; Zechendorf, 2011). Understanding the specialisation and concentration of start-ups can contribute to proposing the right strategies for further development of the bioscience and biotechnology industry. More precisely, recognising *"where the action is"* in the bioscience and biotechnology (sub-)sectoral landscape is a valuable tool with which to improve the prospects of this sector.

Knowledge-economy clusters play a key role in the development of successful new businesses (Zechendorf, 2011). Clusters in bioscience and biotechnology are often referred to as 'bioclusters' (ibid). They represent local, complex systems where diverse organisations interact on research and innovation for economic growth. That is, in particular geographical concentrations, actors establish relationships characterised by cooperation and exchange of competencies while surrounded by a localised support infrastructure. The existence of bioclusters offers important competitive advantages for companies and the wider society in three areas: Employment, innovation and productivity. First, job creation is stimulated because of new businesses; hence more access to social capital is available because of the concentration of more qualified people (e.g., in the forms of mentoring, training, personal communication and absorptive capacity, among others). Second, the physical proximity leads to increasing knowledge exchange between different actors, which ultimately promotes innovation. Finally, lower transaction costs with non-commercial partners enhance productivity. Aside from these three areas, understanding where these bioclusters are geographically can also help address the regional economic disparities highlighted by the government's Levelling Up agenda.

Furthermore, identifying bioclusters requires examining cities or urban agglomerations where knowledge is hosted. Geographical proximity conditions the extent to which these complex systems thrive (Zechendorf, 2011). Particularly in the bioscience and biotechnology sector, areas located close to large pharmaceutical companies, universities and research institutes have been centres of systemic innovation (McDonald-Junor, Rossiter & Smith, 2018) because they act as bases upon which commercialisation of new knowledge occurs. Substantial investment, active policies to support university-industry interaction, encouragement for widespread skills development, commercialisation infrastructure, and low entry-barriers for private suppliers of innovation support once demand has grown, encourage these locations above others (Cooke et al., 2000; McDonald-Junor et al., 2018).

To capture the main sectors within the bioscience and biotechnology economic ecosystem and the knowledge-economy clusters in the UK, we use knowledge space analysis. Drawing from economic complexity theory (Hidalgo et al., 2007; Hidalgo & Hausmann, 2009), knowledge space analysis allows us to understand and visualise industry specialisations. Moreover, the approach helps to identify potential gaps in the technological composition of a cluster and can identify new technological niches where innovation can thrive. Through knowledge spaces, it is possible to understand the economic structure of an industry or sector, revealing the main economic activities based on their current capabilities. By examining regional knowledge and skills capabilities in conjunction with the sectoral composition, we can assess which sectors are coalescing and which technologies are converging (Hendrikse et al., 2020). From an economic geography perspective, recombining existing resources provides important local opportunities, for example, by creating more opportunities for economic development (e.g., innovation, creation of new businesses, and employment) (Neffke et al., 2011). Furthermore, by taking particular regions, it is possible to compare their techno-economic structure and underlying agglomerations of knowledge (Whittle & Kogler, 2020). As not all knowledge is distributed equally, and their role in the economy may vary due to their heterogenous regional nature (Whittle, 2019; Whittle & Kogler, 2020), we can expect knowledge spaces to vary according to the local structure.

This report draws on knowledge space analysis to identify the main fields of activity and the nascent clusters that populate the UK in the bioscience and biotechnology industry. Therefore, we aim to further explore bioscience and biotechnology start-ups in the UK, revealing patterns of agglomeration (i.e., clusters) on application fields and accounting by spatial variation in how such systems are geographically distributed. Ultimately, we aim to understand the following:

1. Map the bioscience knowledge spaces in the UK as represented by bioscience start-ups to understand “where the action is”.
2. The relationships between the sectors and sub-sectors both in terms of geography and sector coalescence.
3. Demonstrate the value created from bioscience across diverse and sometimes unexpected industries and markets.

The remainder of this report is structured in 3 further sections, they are: Section 2 presents the research design and analysis used in the study; Section 3 presents the geographical distribution of the different sub-sectors of activity across the UK; and Section 4 concludes by discussing some of the implications arising from the analysis and proposing further questions to be addressed in future research. This report is intended to inform and stimulate further discussion around the biotechnology and bioscience industry in the UK, and provide insights to the BBSRC to target interventions to promote a stronger culture of bioscience innovation and commercialisation.

2. METHODOLOGY

2.1. Knowledge Space

Topological spaces have contributed importantly to theories of technological branching and related variety (Engelsman & Van Raan, 1994; Hidalgo et al., 2007; Neffke et al., 2011). Based on the analysis of two-mode networks, this approach takes relational data and turns these into co-occurrence matrices that facilitate estimating relatedness between diverse attributes (e.g., patents, industries, products, or skills). Thus, these topological spaces adopt a name depending on the primary attribute used; for example, "knowledge space", "industry space", or "skills space" (Whittle and Kogler, 2019).

Producing a topological space allows quantifying and illustrating the relationships between the attributes in a specific sample, offering opportunities to look at the most central attributes, potential clusters and coalescence of the clusters and attributes. Hence, selecting a sample from the bioscience and biotechnology industry, we aim to perform a knowledge space analysis that shows the most central categories within this industry and the potential clusters that emerge from the relatedness between the knowledge categories. Delineating clusters, which represent sectors within the industry, will show how sector coalescence occurs in this industry. Further, the clusters obtained can be tracked to a regional level, allowing us to show regional trajectories and complexity for this industry (Neffke et al., 2011). We can, therefore, gain insights into the current "hotspots" of bioscience and biotechnology clusters.

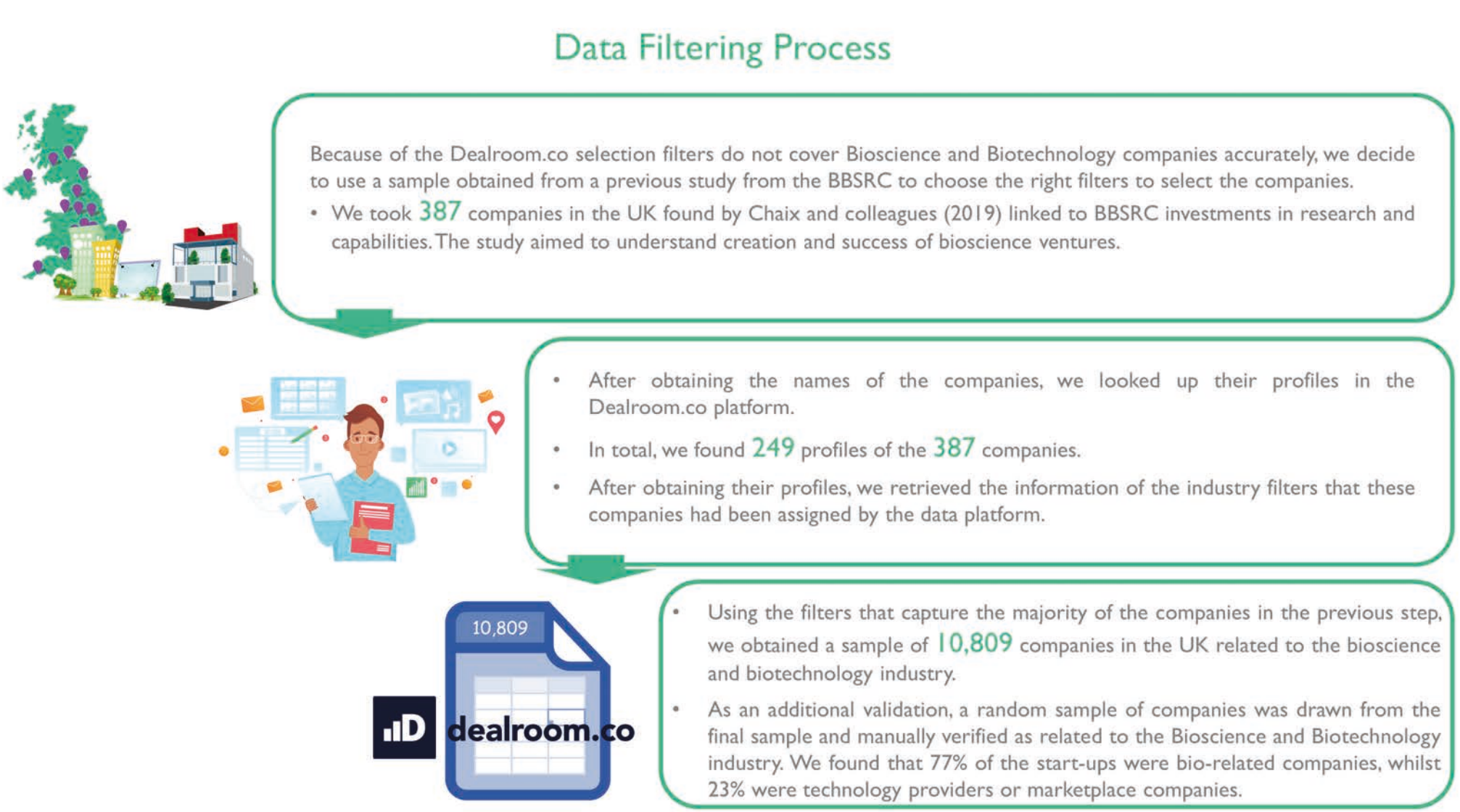
2.2. Data – Dealroom.co

In June 2021, we obtained a sample from the data platform Dealroom.co.[1] This platform contains a worldwide sample of 668,000 verified start-ups in different sectors of the economy. Dealroom.co applies algorithms to obtain near real-time data from public sources (i.e., their 'digital footprint') such as social media, domain and trade registers, job boards, web and mobile app usage analytics, news articles in over 30 languages, or investor portfolios. Partners and users can also contribute information, which also goes through automatic and manual verification processes by the company's data scientists. Furthermore, Dealroom.co applies their AI algorithms to classify the companies in one or more industries and other available criteria using diverse filters.

In the first place, we limited the sample to companies located in the UK (with either headquarters or an office in the UK). Because the biotechnology sub-industry filter (hence its definition) in Dealroom.co showed to be limited in the selection of companies, we decide to use broader industry filters and develop an alternative validation of the used filters. Using a previous study from the BBSRC (Chaix et al., 2019), we used the companies in this study to select the relevant filters that describe bioscience and biotechnology companies. The selection process is illustrated in the diagram in Figure 1. Table 1 and Table 2 show the distribution for Dealroom.co's industry and sub-industry filters for the companies found. The final filters correspond to those with the highest frequency in the sample extracted from Chaix et al. (2019) and found in Dealroom.co: "Health", "Food", "Sports", *"Wellness beauty"*, and *"Energy"*. Through a combination of industry filters, and manual validation we obtained the names of the companies used in this study. The final sample comprises 10,809 companies in the UK.

[1] https://dealroom.co/

Figure 1. Data Filtering Process.



Industry Filter	N	%
Health	**189**	**68.0%**
Food	**34**	**12.2%**
Energy	**14**	**5.0%**
Sports	**10**	**3.6%**
Wellness beauty	**8**	**2.9%**
Media	3	1.1%
Real estate	3	1.1%
Dating	2	0.7%
Fintech	2	0.7%
Hosting	2	0.7%
Legal	2	0.7%
Music	2	0.7%
Transportation	2	0.7%
Education	1	0.4%
Home living	1	0.4%
Marketing	1	0.4%
Robotics	1	0.4%
Travel	1	0.4%
	278*	**100%**

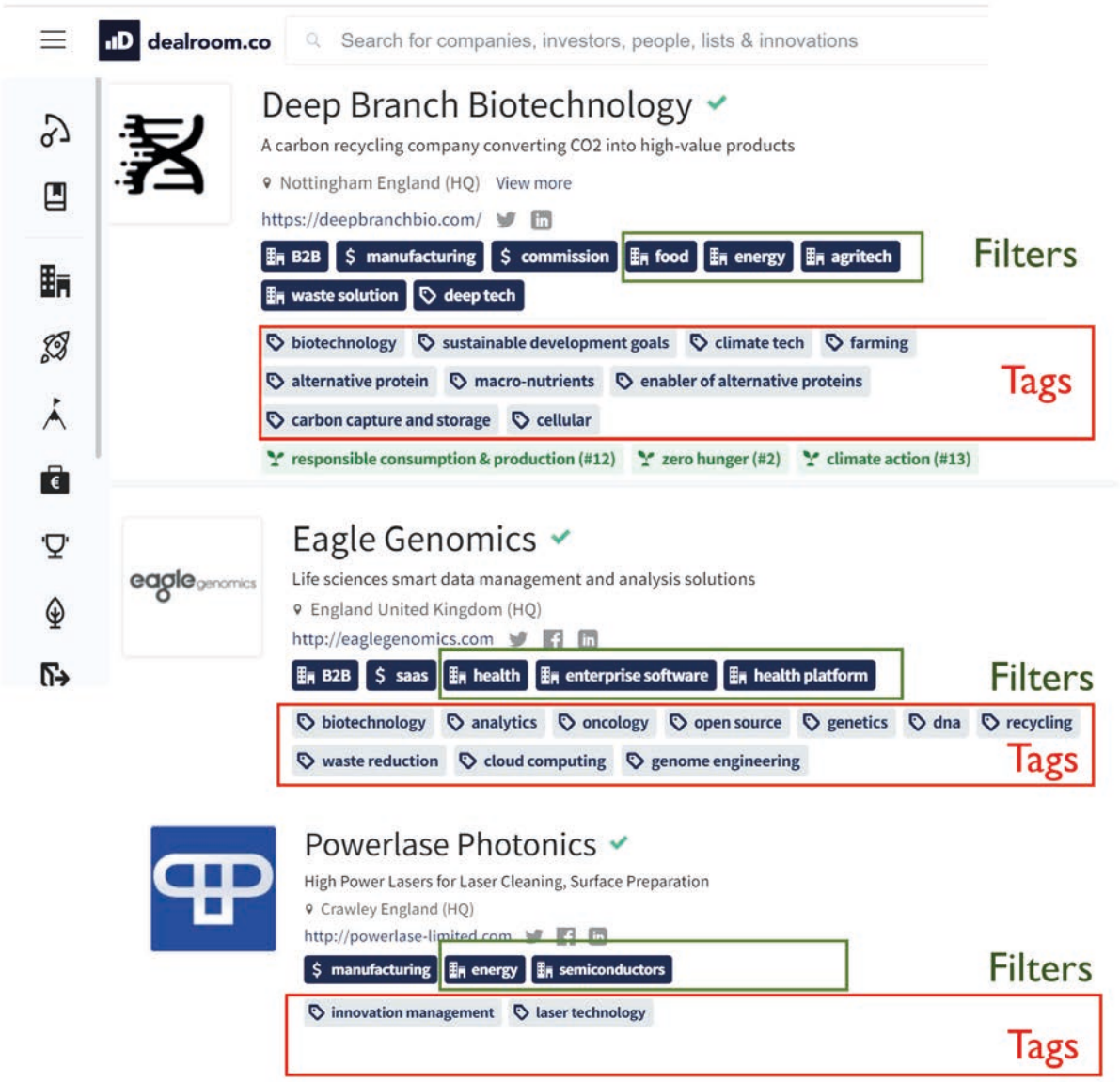
Table 1. Industry filters distribution for sample selection found in Dealroom.co (*Note: Companies can have more than one industry filter in Dealroom.co)

Industry Filter	N	%
Medical devices	16	8.0%
Pharmaceutical	19	9.5%
Health platform	9	4.5%
Biotechnology	**5**	**2.5%**
Agritech	4	2.0%
Content production	2	1.0%
Sport platform & application	1	0.5%
Adtech	1	0.5%
Oil & gas	1	0.5%
Innovative food	1	0.5%
Fitness	1	0.5%
Waste solution	1	0.5%
No sub-industry filter	138	69.3%
	199*	**30.7%**

Table 2. Sub-industry filters distribution for sample selection found in Dealroom.co (*Note: Companies can have more than one or none sub-industry filter in Dealroom.co)

From the data obtained, we extracted the companies' tags. Tags appear in each company's profile and refer to categories that describe the technologies, application sectors, or other characteristics particular to that company obtained from their digital footprint. Dealroom.co apply their proprietary algorithm to 'search' and categorise the digital appearance into those tags. Tags are different from filters (as can be seen in some examples in Figure 2). To narrow down the sample of companies, we only extracted companies with information from at least two tags (as companies with only one tag will not contribute to further analysis). To the obtained tags, we performed a minimum intervention, only changing acronyms, aligning plural and singular words, and eliminating tags that refer to events or awards. Companies and tags are the primary input for further analysis. It is relevant to clarify that all the start-ups in the sample will not include a tag related to bioscience and biotechnology as we purposely decided a not too narrow or broad sample selection. Looking beyond the self-identified bio-companies can offer important insights into companies that have multiple identities, can be classified into different sectors, or they connect to bioscience companies by means of their business model. Furthermore, it can help to capture the potential of bioscience along the journey that companies take to innovate in related sectors.

Figure 2. Example of a start-up's profile at Dealroom.co (Note. These companies appear in Chaix et al. (2019) and have been funded by the BBSRC)



2.3. Knowledge Space Operationalisation

For operationalising the knowledge space in the bioscience and biotechnology industry, we used methodologies developed in social network analysis and economic geography. We performed the following steps:

1. With the tags obtained from companies' profiles from Dealroom.co, we built a bipartite matrix with companies in the rows and tags in the columns (Figure 3 - Step 1). We discarded all tags that appeared in less than five companies.

2. By projecting the bipartite matrix, we constructed a matrix of co-occurrences of tags (Figure 3- Step 2). The co-occurrences are the baseline to calculate relatedness between tags. We used an association strength approach to calculate a standardised measure of relatedness (see van Eck and Waltman, 2009). In this stage, we 'let go' of the companies' observations as a unit of analysis and continued focusing on the relatedness between 'tags' that emerged from the selected sample of companies.

3. Before constructing the knowledge space, we used the Stochastic Degree Sequence Model (SDSM), available in the package backbone in the suit R (Domagalski, Neal & Sagan, 2020), to determine the most significant relations ($p < 0.05$) (Figure 3 - Step 3). Those ties[2] constitute the backbone of the network of relations between tags; that is, the most meaningful connections among all the tags found on the companies' profiles within the selected sample.

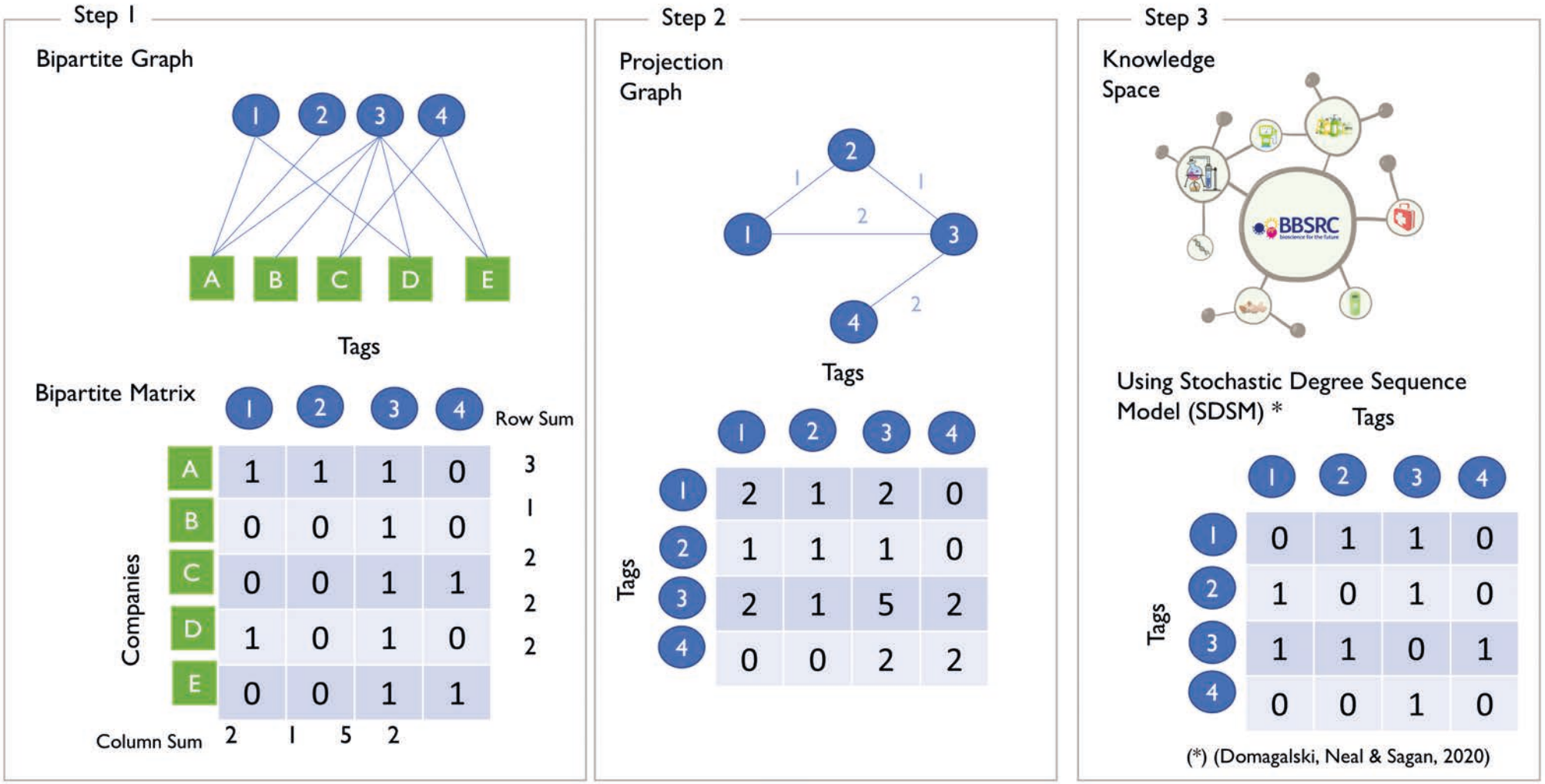
4. Using the backbone ties and the relatedness values as weights, we used multilevel clustering analysis to determine the groups of tags. We found ten significant clusters of tags, which we named after the tag(s) with the highest occurrence in the sample of companies.

5. We finally plotted the knowledge spaces of the bioscience and biotechnology industry using different colours to identify the main clusters. We used a force-directed drawing algorithm (Fruchterman-Reingold) in the package ggraph in the suit R (Pedersen, 2017), which places the strongly connected and hence more related nodes closer to each other.

6. To capture geographical differences in the UK between the identified clusters, we geolocated the companies' coordinates using the packages sf, sp and rgdal (Bivand, Pebesma, and Gomez-Rubio, 2013) in the suit R. On a more general level, we use NUTS 1 classification to capture differences between regions in the UK (we geolocated 9,892 companies from the total sample using this demarcation). For more precise identification of key regions, we used the MREG-COD metropolitan region delimitation (Eurostat, 2016a, 2016b). The metropolitan demarcations consider commuting areas, thereby providing a more accurate delimitation for the economic activities of a determined location (we geolocated 8,942 companies from the total sample using this demarcation).

[2] Ties refer to the connections between those tags after applying Social Network Analysis techniques.

Figure 3. Graphical representation of the construction of a knowledge space.



3. RESULTS

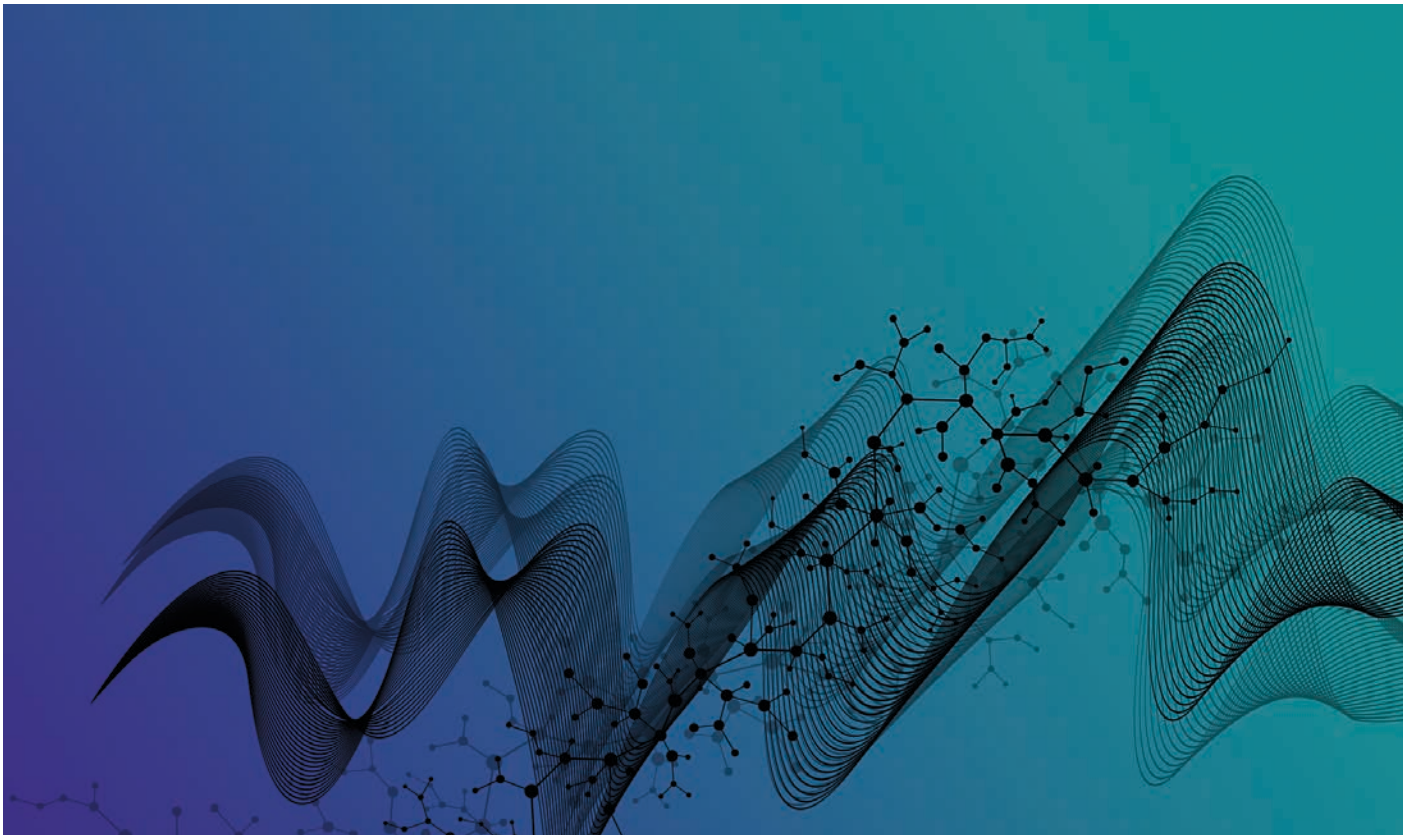
3.1. Sample Descriptive Statistics

Using Dealroom.co, we harvested a database of 10,809 start-ups in the UK (with 10,288 having headquarters in the UK). Figure 4 describes some characteristics of the obtained sample.

In terms of growth stage, 40.5% of the companies in the sample are in a seed-stage, 23.4% in an early growth stage, and 13.6% in a late growth stage. In terms of size, measured by the number of employees, like many other industries in the UK, the lion's share are SMEs. Specifically, close to 60% of the companies in the sample have fewer than 50 employees. Concerning age distribution, more than half of the companies are 15 years old or less, with 32% of these companies being active less than five years.

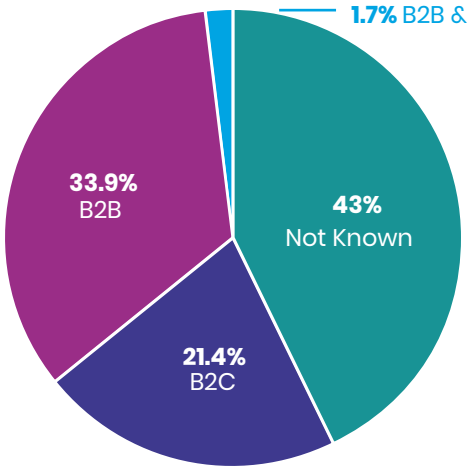
With respect to their business model, 33.9% of the companies have a business-to-business)B2B) business model, 21.4% of the companies have a business-to-customer (B2C) business model, and 1.7% of the companies combine the two. Only 2,000 companies are tagged as manufacturers, and another 500 companies use digital marketplace and e-commerce platforms.

In terms of funding obtained, almost 70% of the companies have not participated in, or do not register, rounds of investment . 18% of the companies have obtained an amount smaller than €100 million, while 0.6% of the companies have obtained more than €100 million.

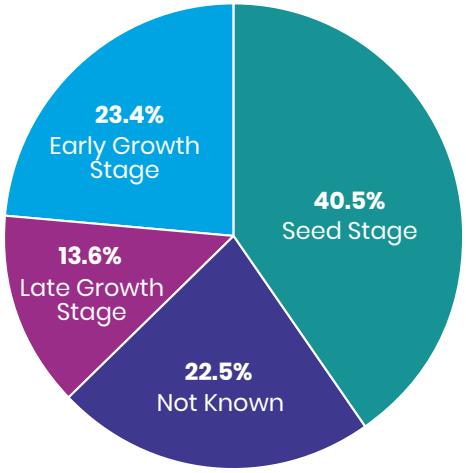


[3] The large number of companies without information regarding investment can be attributed to missing data or no available blueprints. Further investigation is necessary to understand the investment patterns, as this figure can also be explained by other reasons such as a higher tendency for private investment or corporate investment.

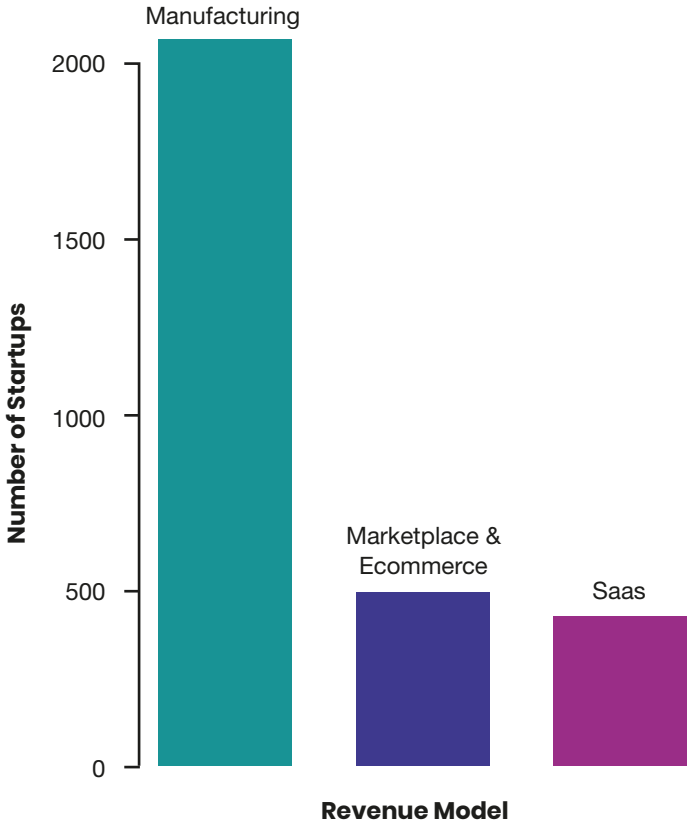
Figure 4. Descriptive Figures of the final sample. Note: 1C% refers to cumulative percentage. 2 NI refers to no information



Age	N	%	C%
Less than 3 years	153	1%	1%
3-5 year	1,650	15%	17%
6-10 years	2,456	23%	39%
11-15 years	1,379	13%	52%
16-20 years	878	89%	60%
21+ years	713	7%	67%
NI	3,580	33%	100%
Total	**10,809**	**100%**	



Employees	N	%	C%
1	1,159	11%	11%
2-10	3,191	30%	40%
11-50	2,025	19%	59%
51-200	695	6%	65%
201-500	195	2%	67%
501-1,000	55	1%	68%
1,001+	73	1%	68%
NI	3,416	32%	100%
Total	**10,809**	**100%**	



Funding Obtain (EU M)	N	%	C%
0	7,452	69%	68.9%
0.01-1.00	758	7%	76.0%
1.01-2.50	345	3%	79.1%
2.51-5.00	260	2%	81.6%
5.01-10.00	241	2%	83.8%
10.01-25.00	228	2%	85.9%
25.01-50.00	106	1%	86.9%
50.01-100.00	68	1%	87.5%
100.01-250.00	47	0.4%	87.9%
250.01-500.00	12	0.1%	88.0%
500+	10	0.1%	88.1%
NI	1,282	12%	100.0%
Total	**10,809**	**100%**	

3.2 United Kingdom Bioscience and Biotechnology Knowledge Space

The UK has been a pioneer of many research breakthroughs in bioscience and biotechnology, from Watson and Crick's work at Cambridge's Cavendish Laboratory (supported crucially by Rosalind Franklin's X-ray diffraction results) to recent breakthrough discoveries in the fight against COVID-19 at Oxford University's Laboratory. In recent years, an increase in the number of bioscience and biotechnology firms, especially in the healthcare, biopharmaceuticals, agri-food, and bioenvironmental sectors, has raised questions regarding the 'bioclusters' that exist in the UK.

The knowledge space analysis of the bioscience and biotechnology companies in the UK in Figure 5 shows significant clusters among the companies. Precisely, ten clusters have been identified:

1. The Health cluster has one of the most significant numbers of categories, encompassing areas such as biotechnology, genetics, medical devices, health platforms and compliance.
2. The Food cluster includes categories such as food delivery, in-store retail and restaurant, event tech and food sales.
3. The Energy cluster includes tags such as energy efficiency, clean energy, monitoring, and an important number of financial management services and energy consumption categories.
4. The Innovative Foods cluster includes tags related to alternative protein and nutrition, superfoods and healthy food, plant-based food, beverages and pet food.
5. The Transportation cluster encompasses tags related to fuel, logistics and delivery, energy storage and batteries, parking and, more importantly, electric vehicles and mobility.
6. The Sustainability cluster is characterised by tags related to waste management and solutions, innovation management and sustainable development goals, and marine and water solutions.
7. The Wellness & Beauty cluster encompasses tags related to skincare and beauty, fashion and apparel.
8. The Cleaning/Hosting cluster includes tags such as cleaning services, security and interior design.
9. The Sports cluster is related to sports platforms, fitness and training.
10. The AgTech cluster includes farming, primary production and robotics.

While Health, Food and Energy include the highest number of tags, hence companies, that can be classified in each sector, new and emergent clusters can be distinct from these traditionally important sectors. The Transportation, Innovative Foods, Sustainability and AgTech clusters reveal how new sectors are emerging in the industry and differentiating from the central ones. Looking at the knowledge space representation in Figure 5, Food, Innovative Foods and Agtech have significant coalescence, revealing relatedness yet differentiation among them. Energy, Sustainability and Transportation have a similar position, interacting significantly. Sports and Wellness & Beauty coalesce between the Health and the Food clusters, revealing interactions between them.

Focusing on the distribution of companies and clusters within the geographical region in the UK, as shown in Table 3, most of the companies are concentrated in London (36.5%) and the South East (27.2%). Scotland (5.3%), the East of England (7.4%) and the North West of England (6.9%) also have important numbers of companies. When looking more in detail at the distribution of companies and bioclusters considering the metropolitan regions of the UK shown in Table 4, the London metropolitan area is where most companies are concentrated. Other significant bioclusters of start-ups can be found in Manchester, Cambridge and Oxford, with nascent agglomerations in Scotland, Leeds, Birmingham and Bristol. Although the availability of public funding for basic scientific research, which turns into potential innovation, could play an important role in attracting companies to particular places, the UK's distribution of significant regions shows a concentration (apart from London) in only a small number of places. The bioscience and biotechnology companies are located in geographical proximity to universities, research hospitals and public research laboratories.

3.3. Clusters

A more detailed description of the clusters found through the knowledge space analysis is shown in the following section. Clusters and sub-clusters are identified in some of the sections, and geographical distribution of bioclusters is shown at three levels: 1. the UK regions; 2. Metropolitan regions including London; and 3. Metropolitan regions excluding London.

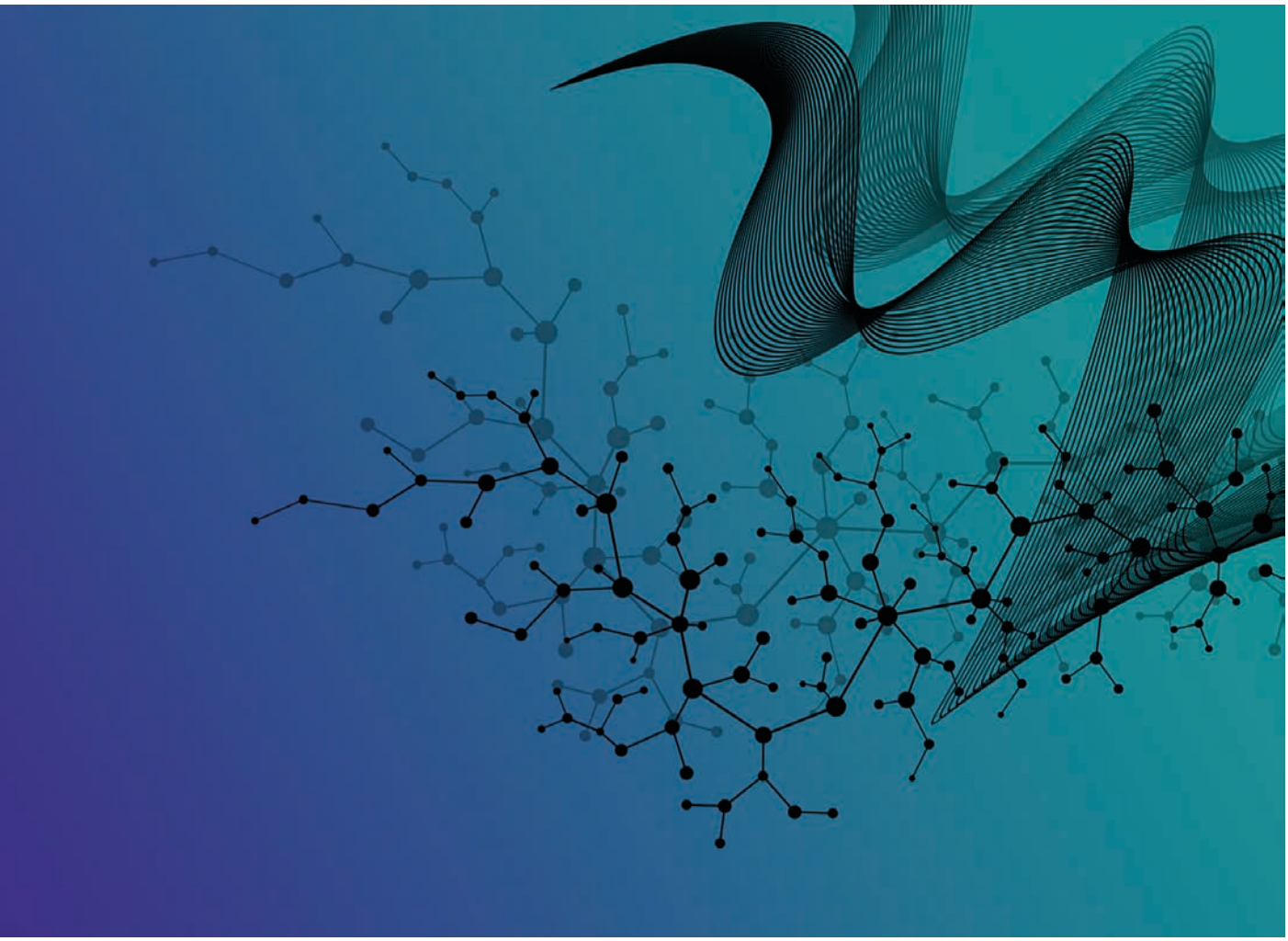


Figure 5. UK Bioscience and Biotechnology Knowledge Space.

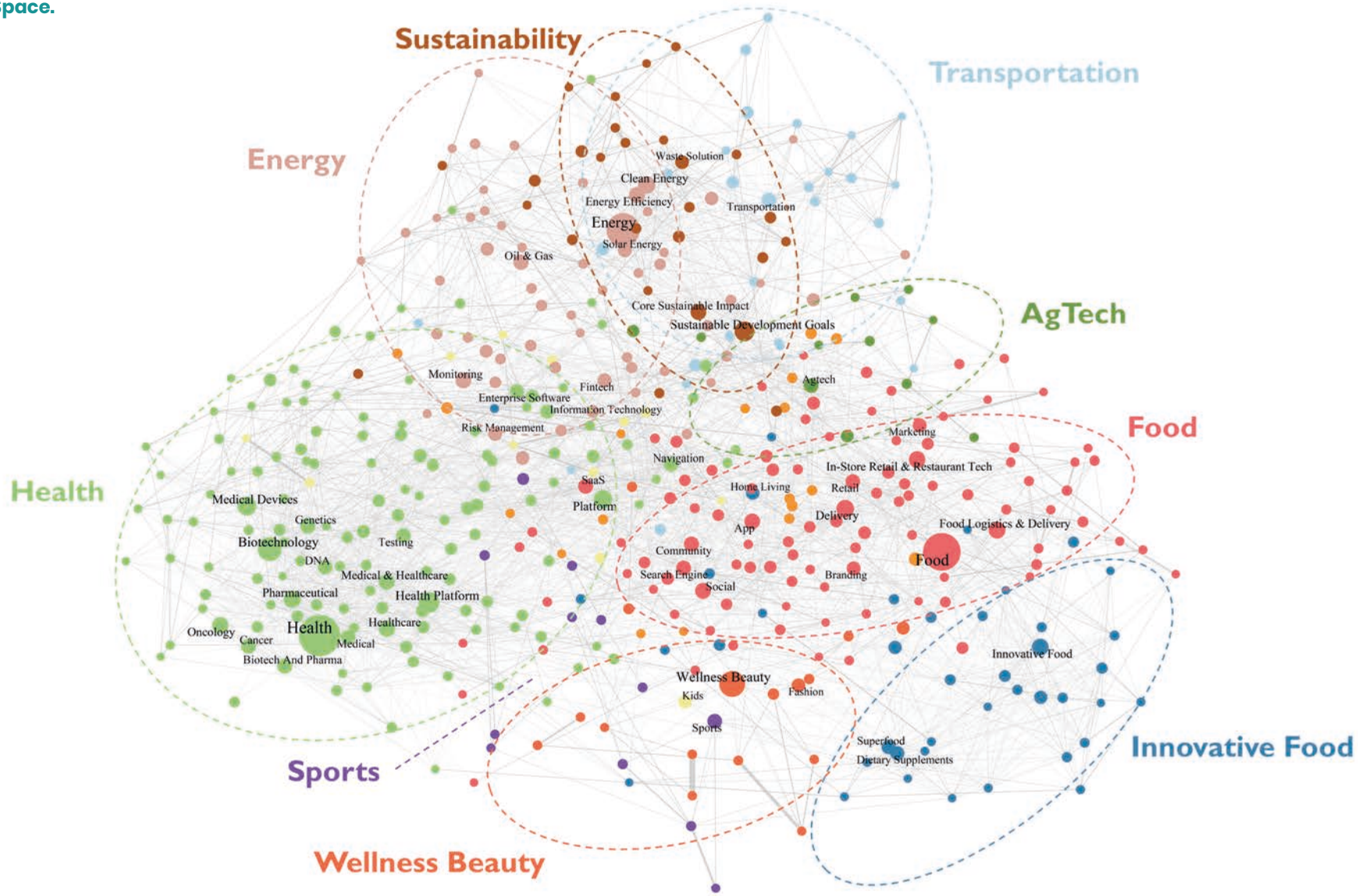


Table 3. Distribution of Bioscience and Biotechnology start-ups in the UK by Cluster and Region (NUTS 1)

Region	NUTI	Number of Companies	Clusters									
			Health	Food	Energy	Innovative Food	Transportation	Sustainability	Wellness Beauty	Cleaning/ Hosting	Sports	AgTech
North East (England)	UKC	149 *1.5%*	69 *1.6%*	46 *1.2%*	65 *2.3%*	9 *1.5%*	18 *4.6%*	14 *2.1%*	12 *1.0%*	4 *2.9%*	3 *1.3%*	2 *0.8%*
North West (England)	UKD	679 *6.9%*	311 *7.3%*	226 *5.8%*	211 *7.4%*	32 *5.2%*	17 *4.3%*	32 *4.7%*	83 *6.8%*	8 *5.8%*	25 *11.2%*	12 *4.8%*
Yorkshire and The Humber	UKE	309 *3.1%*	136 *3.2%*	125 *3.2%*	96 *3.4%*	27 *4.4%*	21 *5.3%*	24 *3.5%*	22 *1.8%*	2 *1.5%*	5 *2.2%*	5 *2.0%*
East Midlands (England)	UKF	239 *2.4%*	106 *2.5%*	97 *2.5%*	85 *3.0%*	8 *1.3%*	11 *2.8%*	11 *1.6%*	31 *2.5%*	5 *3.6%*	7 *3.1%*	10 *4.0%*
West Midlands (England)	UKG	322 *3.3%*	151 *3.6%*	120 *3.1%*	111 *3.9%*	17 *2.8%*	25 *6.3%*	17 *2.5%*	28 *2.3%*	9 *6.6%*	8 *3.6%*	10 *4.0%*
East of England	UKH	730 *7.4%*	426 *10.0%*	238 *6.1%*	239 *8.4%*	58 *9.4%*	36 *9.1%*	72 *10.6%*	49 *4.0%*	13 *9.5%*	12 *5.4%*	24 *9.5%*
London	UKI	3,606 *36.5%*	1,500 *35.3%*	1,545 *39.8%*	980 *34.3%*	254 *41.2%*	141 *35.7%*	281 *41.3%*	555 *45.2%*	47 *34.3%*	95 *42.4%*	92 *36.5%*
South East (England)	UKJ	2,691 *27.2%*	1,011 *23.8%*	1,060 *27.3%*	612 *21.4%*	130 *21.1%*	68 *17.2%*	97 *14.2%*	372 *30.3%*	23 *16.8%*	38 *17.0%*	55 *21.8%*
South West (England)	UKK	377 *3.8%*	155 *3.6%*	157 *4.0%*	132 *4.6%*	29 *4.7%*	22 *5.6%*	36 *5.3%*	157 *4.0%*	7 *5.1%*	8 *3.6%*	19 *7.5%*
Wales	UKL	143 *1.4%*	80 *1.9%*	37 *1.0%*	51 *1.8%*	7 *1.1%*	10 *2.5%*	18 *2.6%*	37 *1.0%*	4 *2.9%*	4 *1.8%*	1 *0.4%*
Scotland	UKM	524 *5.3%*	241 *5.7%*	186 *4.8%*	228 *8.0%*	40 *6.5%*	22 *5.6%*	62 *9.1%*	186 *4.8%*	10 *7.3%*	16 *7.1%*	19 *7.5%*
Northern Ireland	UKN	123 *1.2%*	66 *1.6%*	46 *1.2%*	46 *1.6%*	6 *1.0%*	4 *1.0%*	17 *2.5%*	46 *1.2%*	5 *3.6%*	46 *1.3%*	46 *1.2%*
TOTAL		**9892**	**4252**	**1,545**	**2856**	**617**	**395**	**681**	**1227**	**137**	**224**	**252**

Table 4. Distribution of Bioscience and Biotechnology start-ups in the UK by Cluster and Metropolitan Regions (MREG)

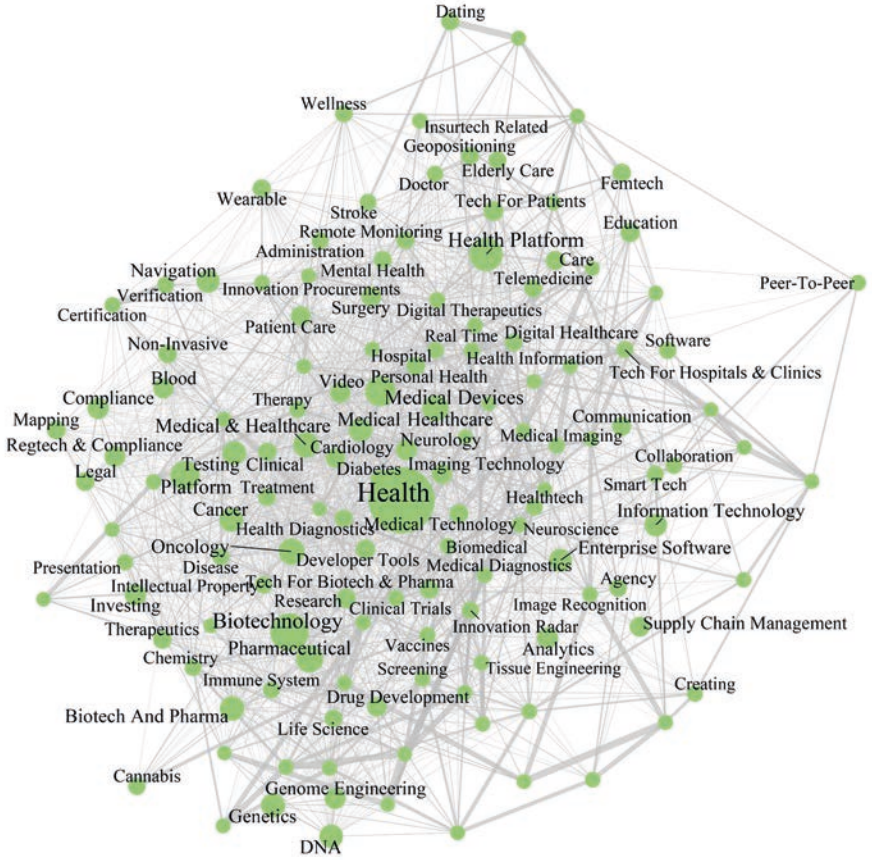
Metropolitan Region Name	MREG Code	Number of Companies	Clusters									
			Health	Food	Energy	Innovative Food	Transportation	Sustainability	Wellness Beauty	Cleaning/ Hosting	Sports	AgTech
London	UK001MC	5875	2239	2497	1436	368	191	331	906	63	131	139
West Midlands urban area	UK002M	120	58	46	35	6	7	6	10	5	4	3
Leeds	UK003M	144	66	59	44	12	12	14	13	1	3	2
Glasgow	UK004M	135	72	42	55	9	3	10	9	6	5	3
Bradford	UK005M	15	8	7	1	1	0	2	1	0	0	0
Liverpool	UK006M	79	43	22	21	2	1	4	6	2	3	2
Edinburgh	UK007M	179	90	63	74	15	10	26	5	1	5	7
Manchester	UK008M	465	216	149	146	22	11	21	64	3	13	6
Cardiff	UK009M	69	50	14	23	1	2	8	6	3	2	0
Sheffield	UK010M	51	23	18	20	1	5	4	1	0	0	0
Bristol	UK011M	125	58	50	40	10	4	12	11	2	3	7
Belfast	UK012M	85	47	32	33	3	3	10	4	3	2	1
Newcastle upon Tyne	UK013M	92	44	30	36	6	9	6	9	2	1	2
Leicester	UK014M	67	27	26	22	2	3	4	7	2	0	1
Aberdeen	UK016M	74	18	15	53	3	3	8	3	2	1	2
Cambridge	UK017M	347	258	88	113	27	19	35	14	8	2	11
Exeter	UK018M	38	18	13	13	6	4	2	4	0	3	0
Portsmouth	UK023M	15	8	4	6	0	2	1	3	0	0	0
Coventry	UK025M	93	52	34	37	3	11	3	2	2	2	4
Kingston upon Hull	UK026M	26	10	10	7	4	0	3	2	0	2	2
Stoke-on-Trent	UK027M	44	17	16	15	3	3	2	8	1	0	2
Nottingham	UK029M	65	43	23	27	2	2	4	7	0	3	1

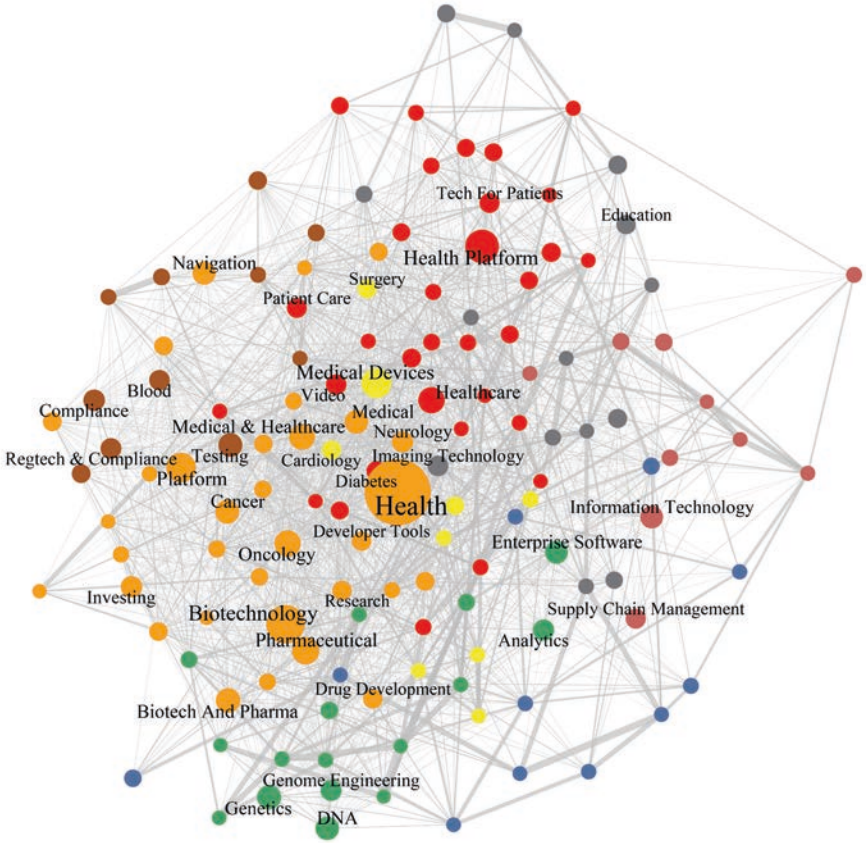
Table 4. Distribution of Bioscience and Biotechnology start-ups in the UK by Cluster and Metropolitan Regions (MREG) cont

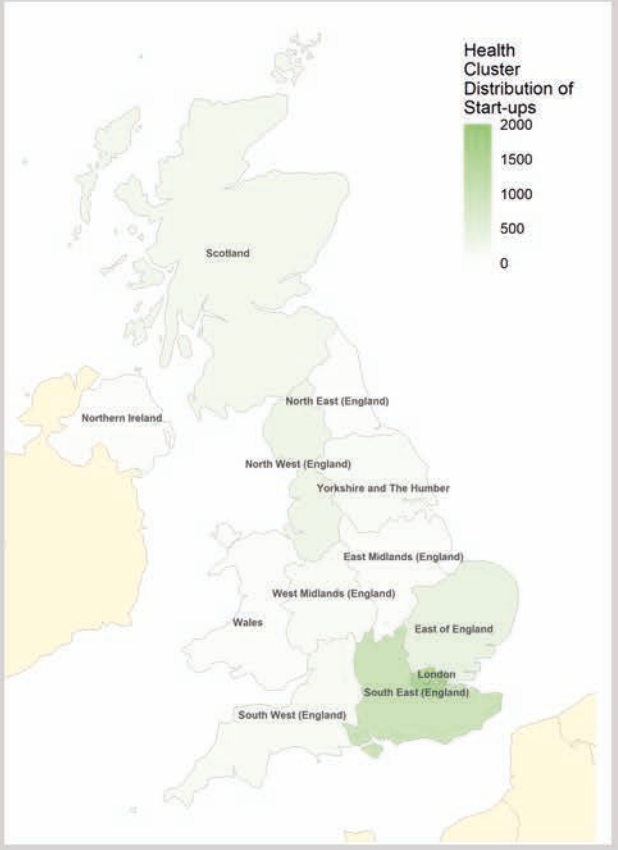
Metropolitan Region Name	MREG Code	Number of Companies	Clusters									
			Health	Food	Energy	Innovative Food	Transportation	Sustainability	Wellness Beauty	Cleaning/ Hosting	Sports	AgTech
Kirklees	UK501M	21	7	11	4	5	0	0	1	0	0	0
Doncaster	UK506M	19	6	7	9	1	3	1	1	1	0	0
Sunderland	UK510M	13	4	4	8	0	3	2	1	0	0	0
Medway	UK513M	3	1	0	2	0	0	1	0	0	0	0
Brighton and Hove	UK515M	37	17	19	6	3	0	3	3	0	3	0
Plymouth	UK516M	11	6	4	4	1	0	1	0	0	0	3
Swansea	UK517M	27	14	4	10	2	3	2	3	1	0	0
Derby	UK518M	15	6	7	4	0	1	0	3	2	2	1
Southampton	UK520M	78	37	14	37	2	4	9	6	2	1	1
Northampton	UK528M	14	5	4	4	0	1	0	4	0	0	1
Bournemouth	UK539M	23	12	8	6	2	0	4	3	1	0	0
Colchester	UK546M	26	9	12	8	5	2	0	2	0	2	1
Dundee	UK550M	10	4	3	4	0	0	1	1	0	0	0
Blackburn - Blackpool - Preston	UK553M	42	12	19	15	4	0	2	1	1	0	0
Middlesbrough	UK559M	19	7	5	10	1	3	5	1	0	1	0
Oxford	UK560M	259	196	63	88	11	13	39	9	3	1	7
Norwich	UK566M	29	13	8	8	1	0	3	4	0	1	0
Cheshire West and Chester	UK568M	61	31	21	19	2	3	3	2	0	4	2
Ipswich	UK569M	32	9	9	12	4	1	6	5	0	1	0
TOTAL		**8942**	**3861**	**3480**	**2515**	**550**	**342**	**598**	**1145**	**117**	**201**	**211**

3.3.1. Health Cluster

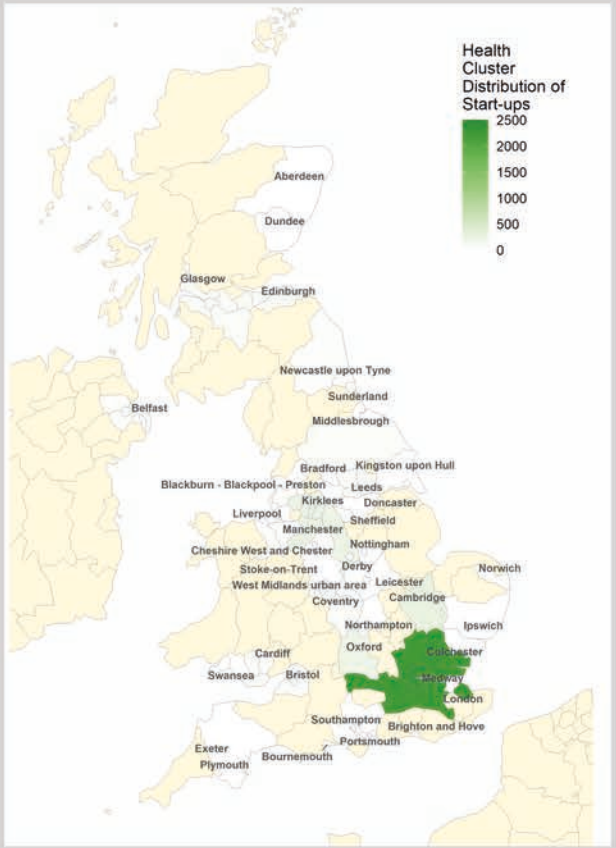
The Health cluster represents the categories that group companies on healthcare, biotechnology, medical devices and pharmaceuticals. It combines businesses that are described as having technology, products and services related to health care, biotechnology and pharmaceuticals. In addition, at least five subclusters can be identified, including health platform, medical/RegTech, biotechnology, genetics, and medical devices. Companies within the clusters are mainly located in London. Cambridge, Oxford and Manchester also host an important number of companies. Leeds, Edinburgh, and Glasgow have a more nascent concentration of Health bioclusters.



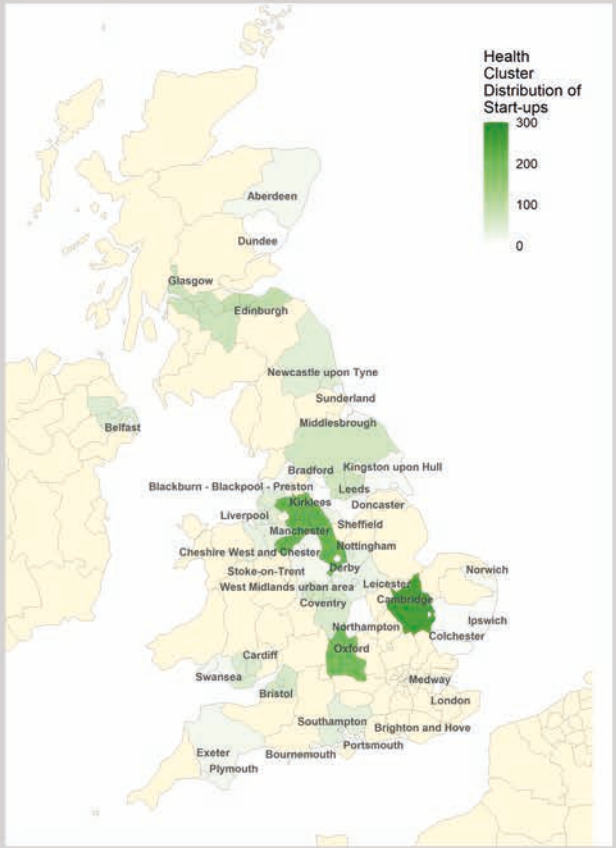




Health Cluster Distribution in the UK by Region



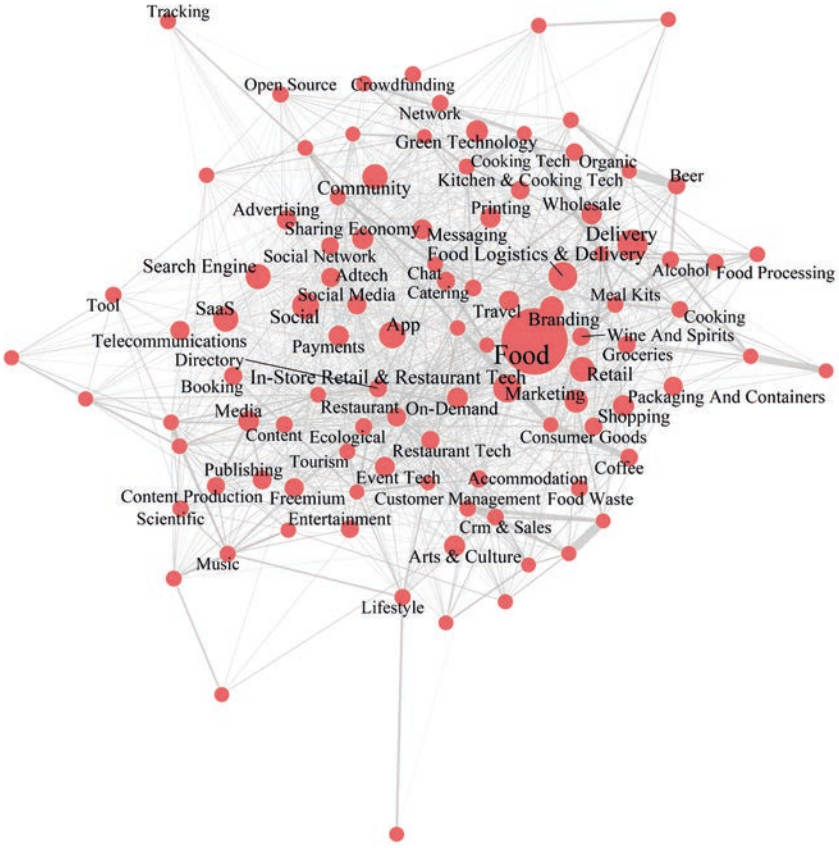
Health Cluster Distribution in the UK by Metropolitan Areas including London

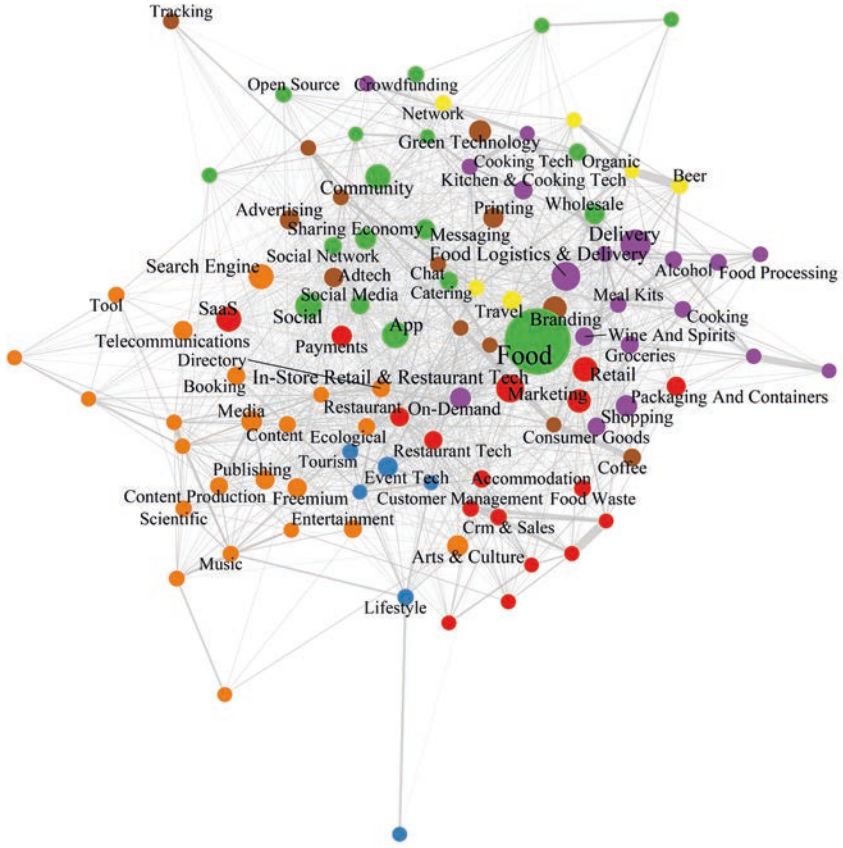


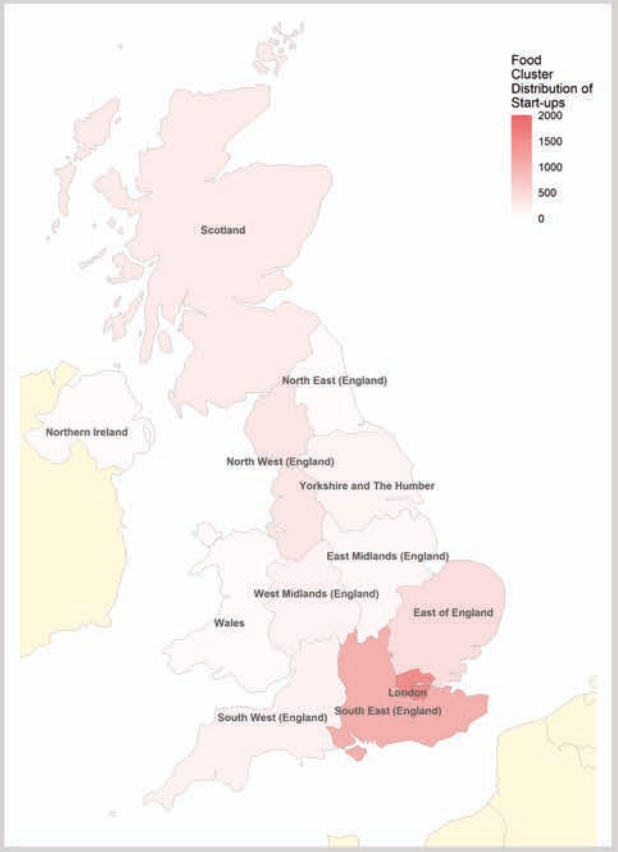
Health Cluster Distribution in the UK by Metropolitan Areas excluding London

3.3.2. Food Cluster

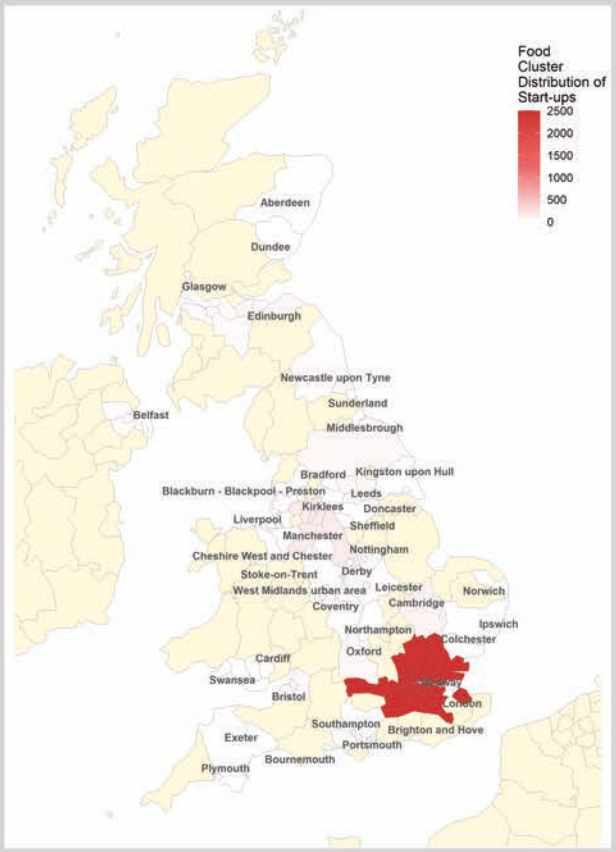
The Food cluster gathers companies related to food manufacturing, delivery and in-store retail and restaurant services. A critical component is related to the food and restaurant commercialisation and marketing businesses, another group of businesses that work with restaurants and food delivery. Five main sub-clusters emerge from a more detailed analysis: A general food and app cluster, delivery, retail and marketing, in-store retail and restaurant, and eventtech. London and the South East of England hold the majority of businesses related to the Food cluster. When looking at the metropolitan demarcations, London has the highest concentration of start-ups, followed by Oxford, with an important number of food-related businesses.



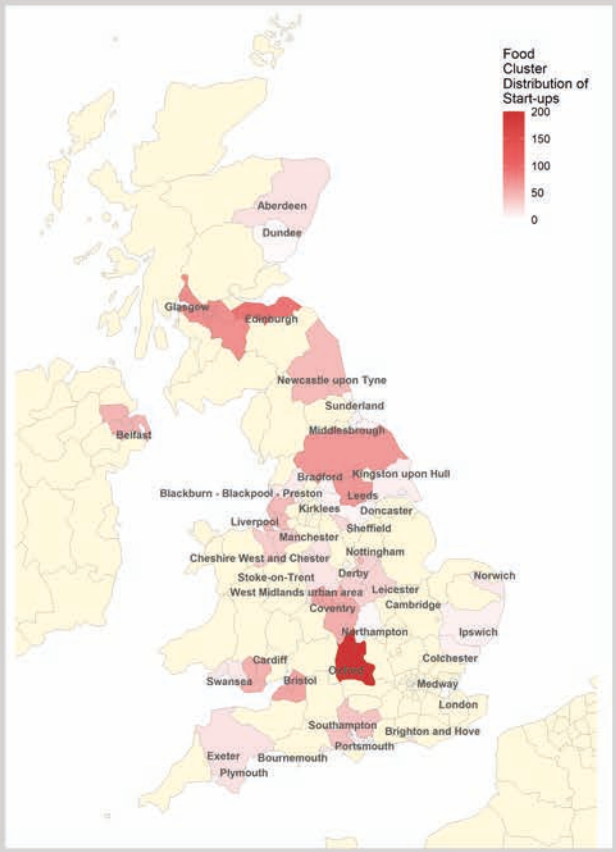




Food Cluster Distribution in the UK by Region



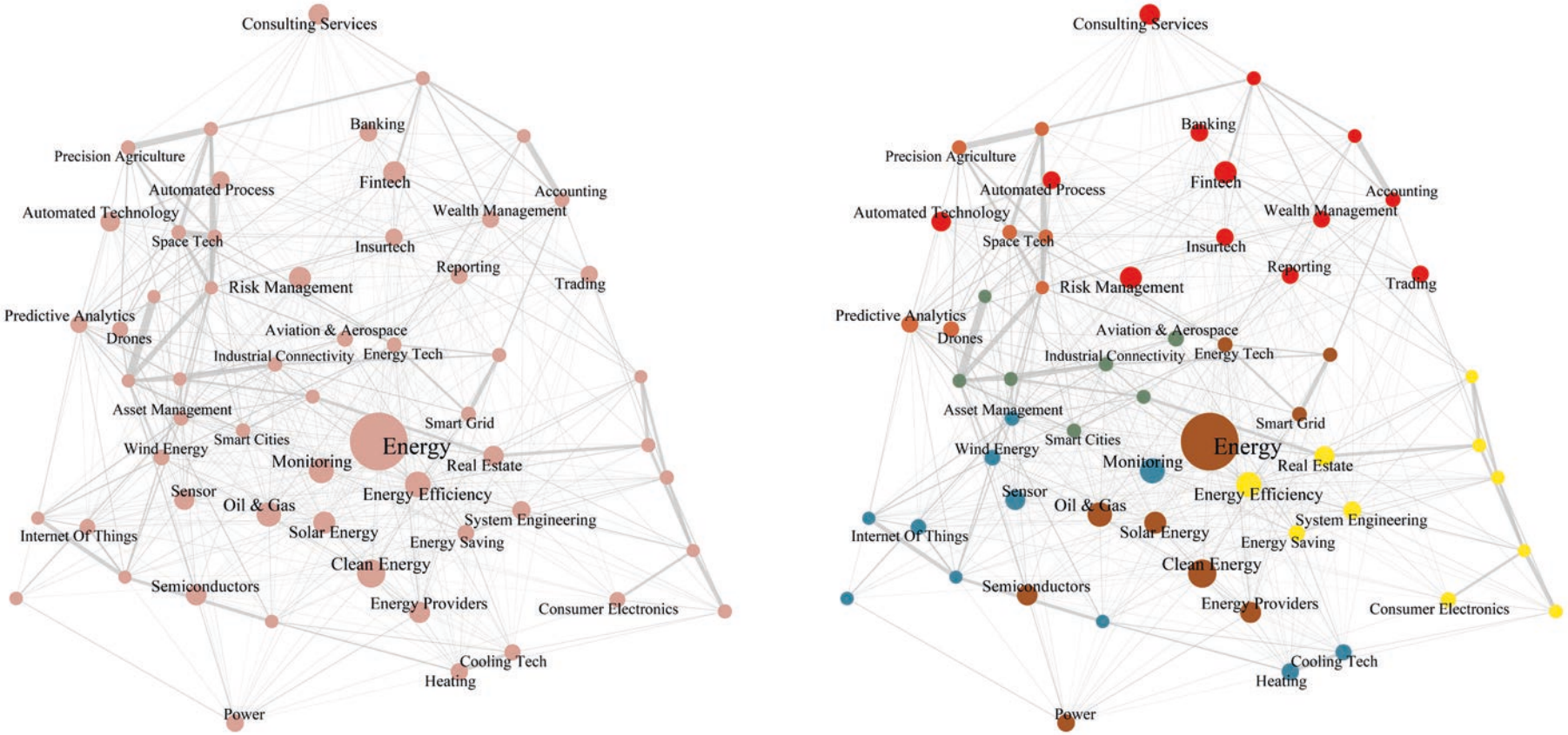
Food Cluster Distribution in the UK by Metropolitan Areas including London

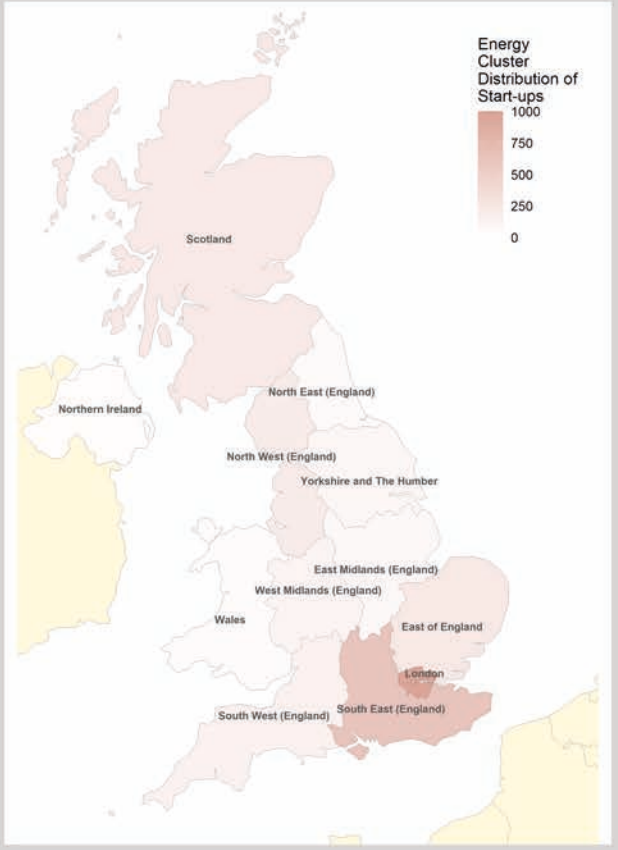


Food Food Cluster Distribution in the UK by Metropolitan Areas excluding London

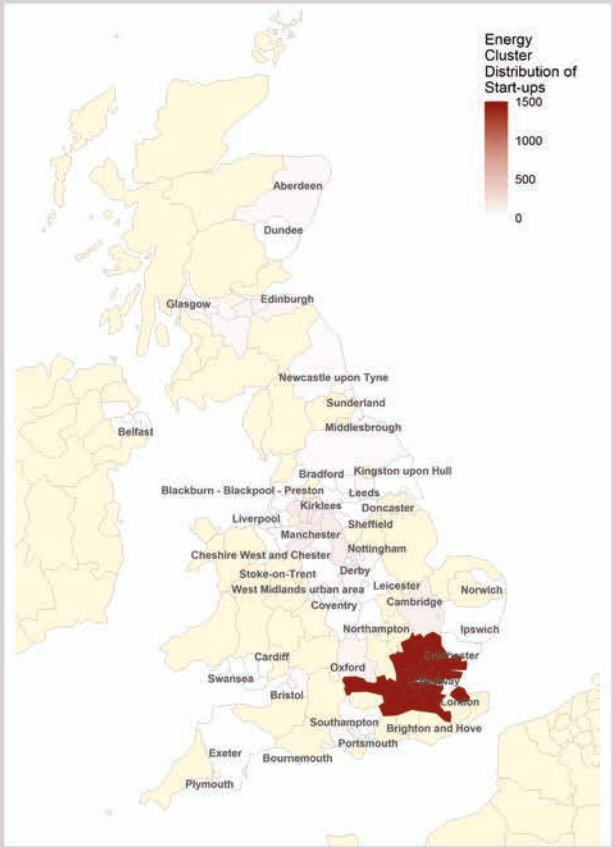
3.3.3. Energy Cluster

The Energy cluster combines categories related to energy efficiency and monitoring, real estate, industrial connectivity, and financial services. Companies that fall under this cluster provide services in energy cost reduction, monitoring of energy, predictive analytics, smart devices, and consumer electronics. Among the main sub-clusters, a risk management and FinTech group coalesces with energy categories related to money-saving and insurance. London and the South East of England have the majority of businesses related to the Energy categories. While London has the highest number of start-ups, Manchester and Cambridge also have an important number of companies in this sector.

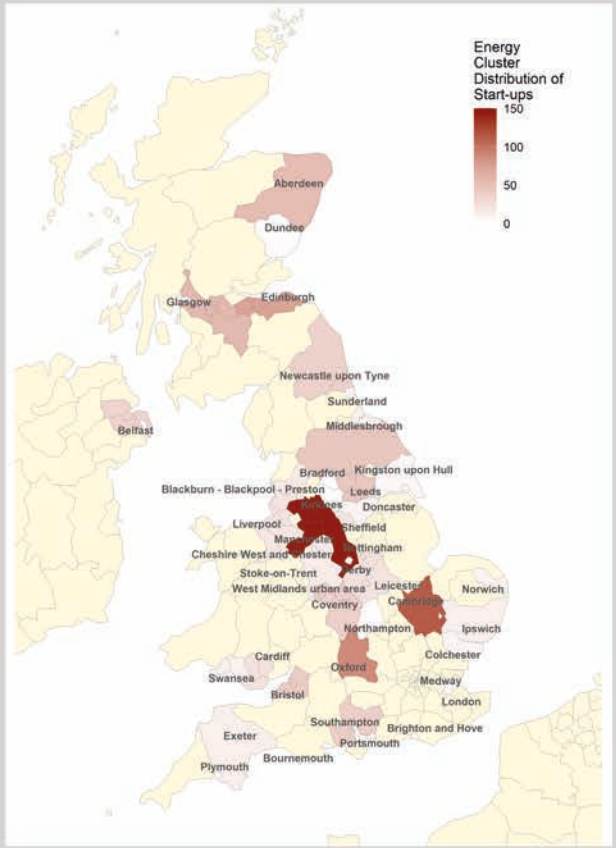




Energy Cluster Distribution in the UK by Region



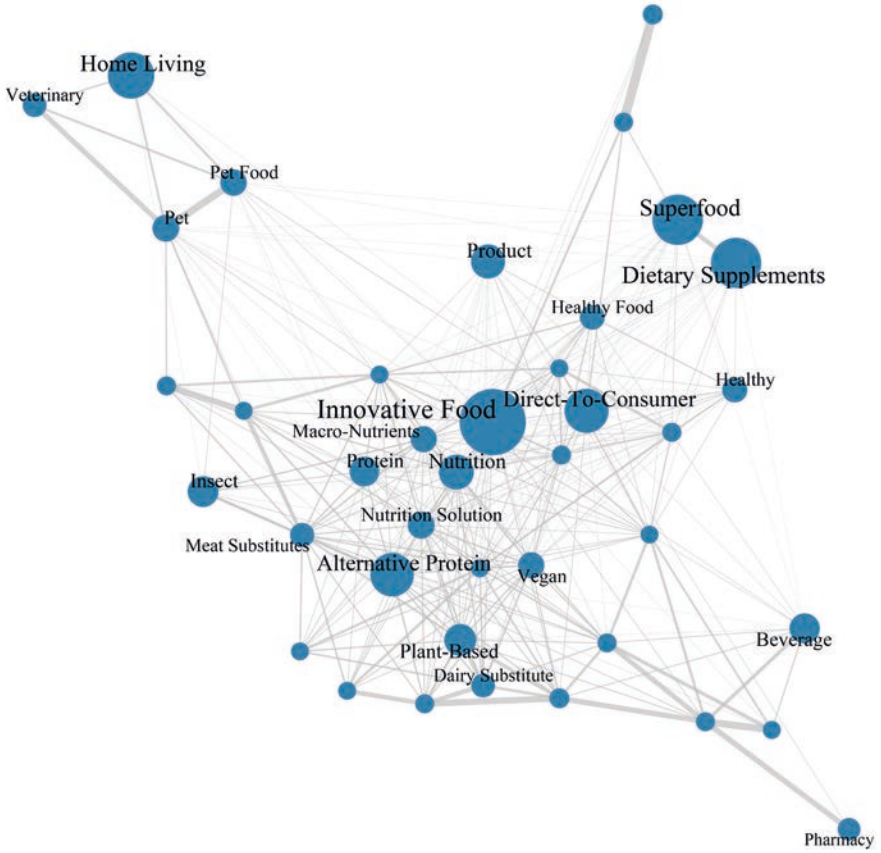
Energy Cluster Distribution in the UK by Metropolitan Areas including London

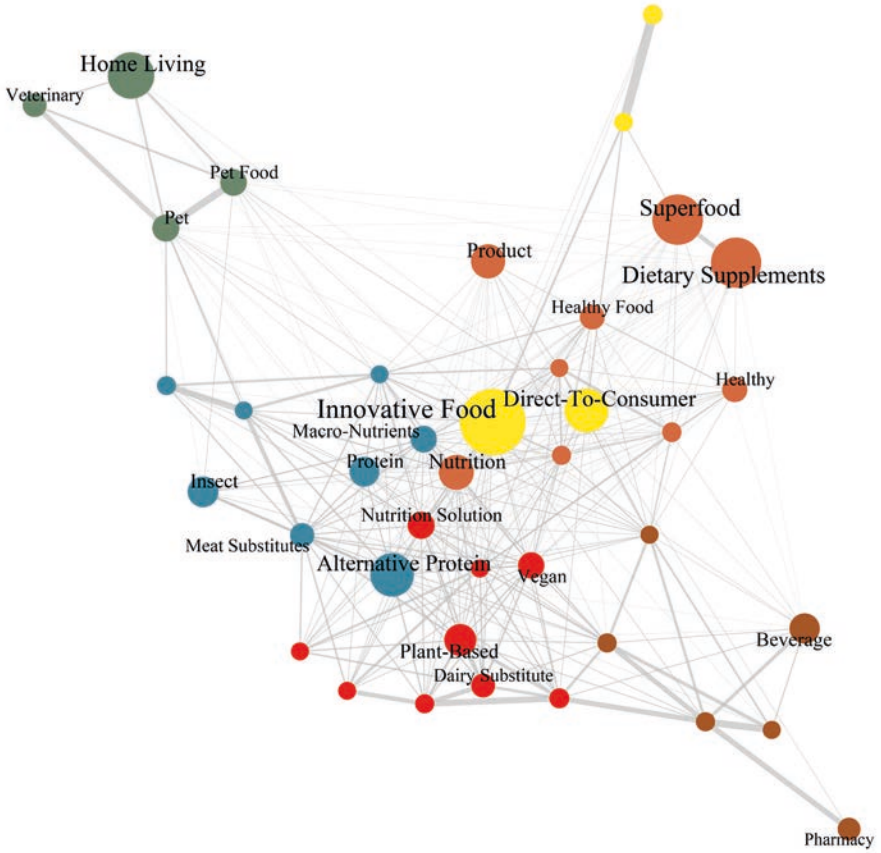


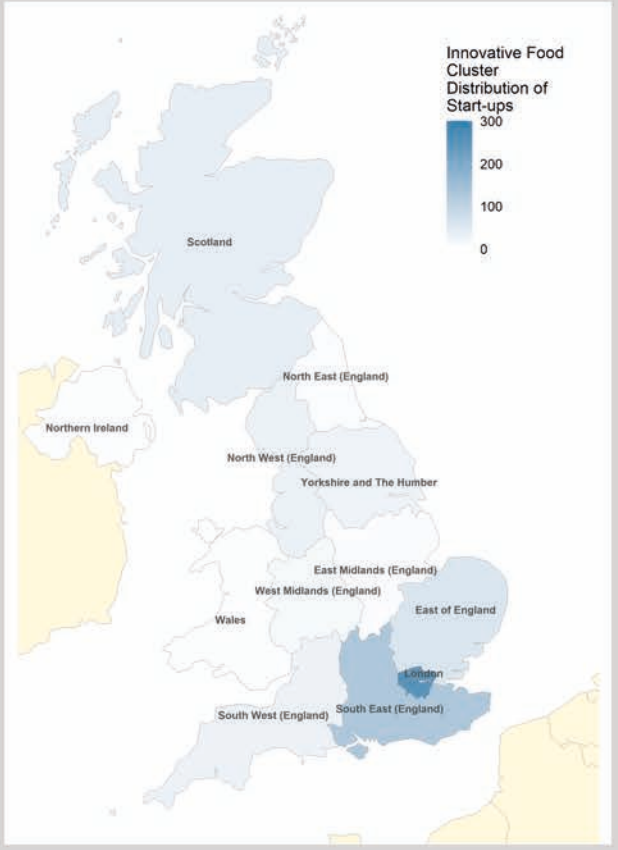
Energy Cluster Distribution in the UK by Metropolitan Areas excluding London

3.3.4. Innovative Foods Cluster

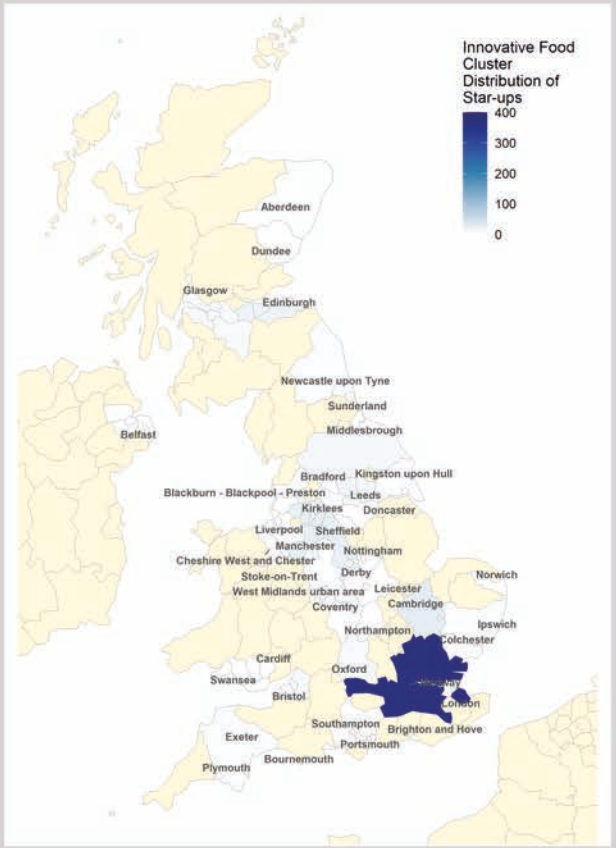
The Innovative Foods cluster combines categories related to developing new or alternative food, food and beverage that is considered healthier, more nutritious, and tailored to specific customers. Companies under this cluster find novel and sustainable ways to provide food, packaging, and processing. Home living, including pet food, is part of this cluster. Superfoods and dietary supplements are also part of this cluster. London has the highest concentration of start-ups. More nascent bioclusters are found in Cambridge, Manchester and Edinburgh.



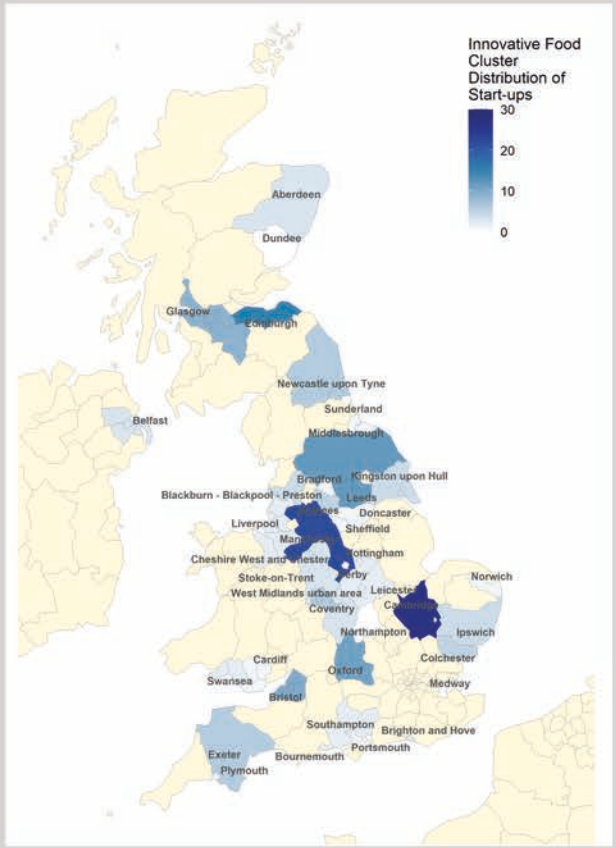




Innovative Food Cluster Distribution in the UK by Region



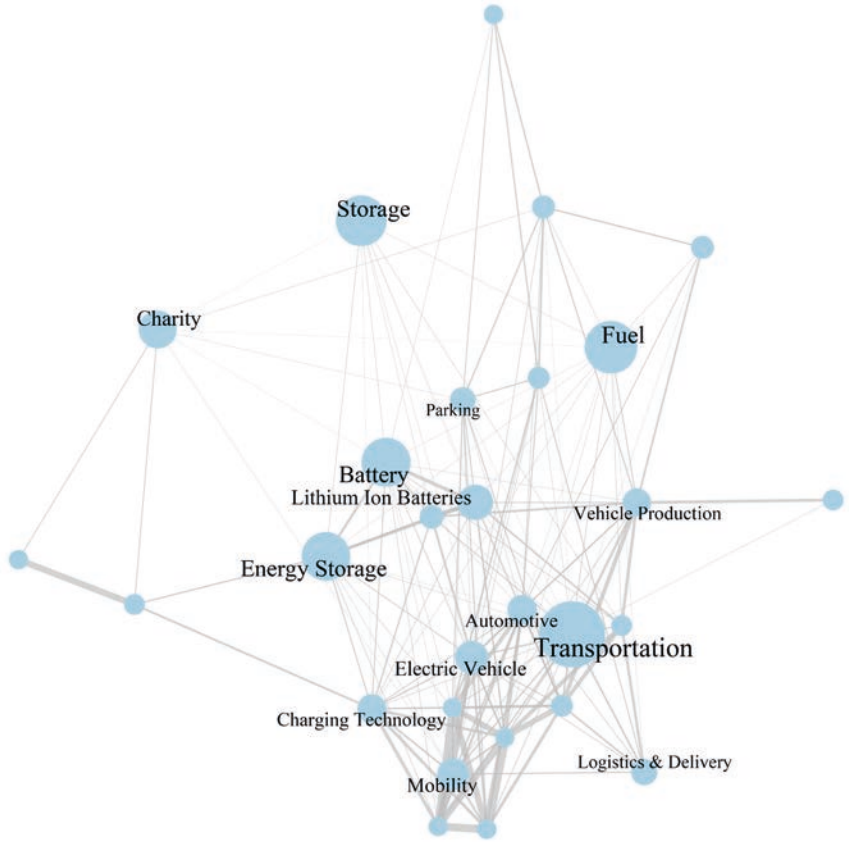
Innovative Food Cluster Distribution in the UK by Metropolitan Areas including London

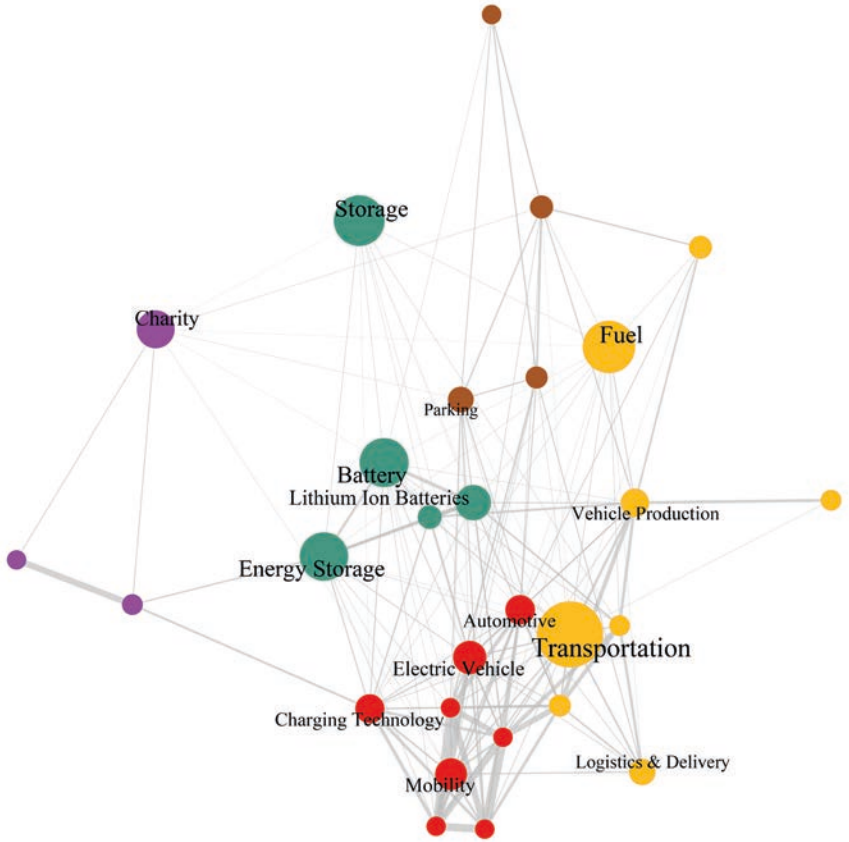


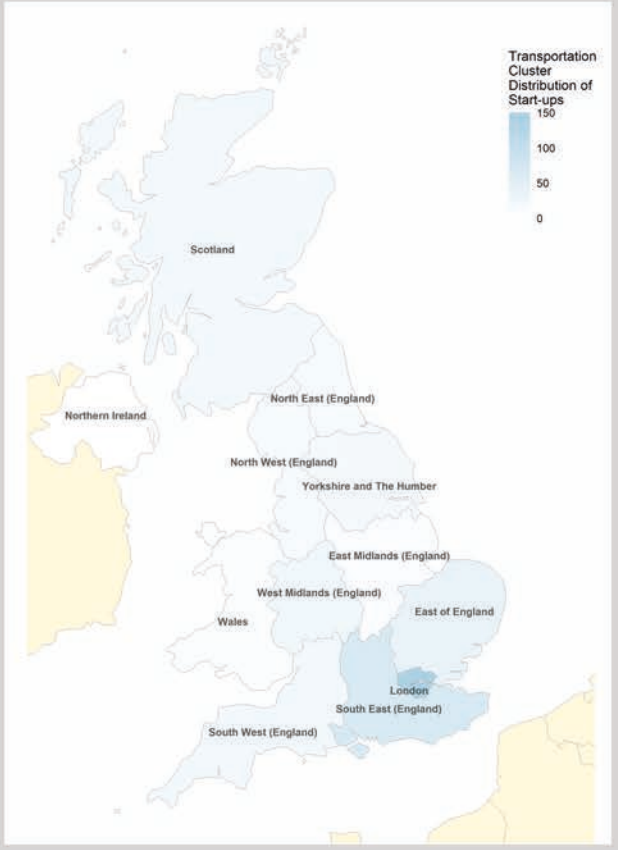
Innovative Food Cluster Distribution in the UK by Metropolitan Areas excluding London

3.3.5. Transportation Cluster

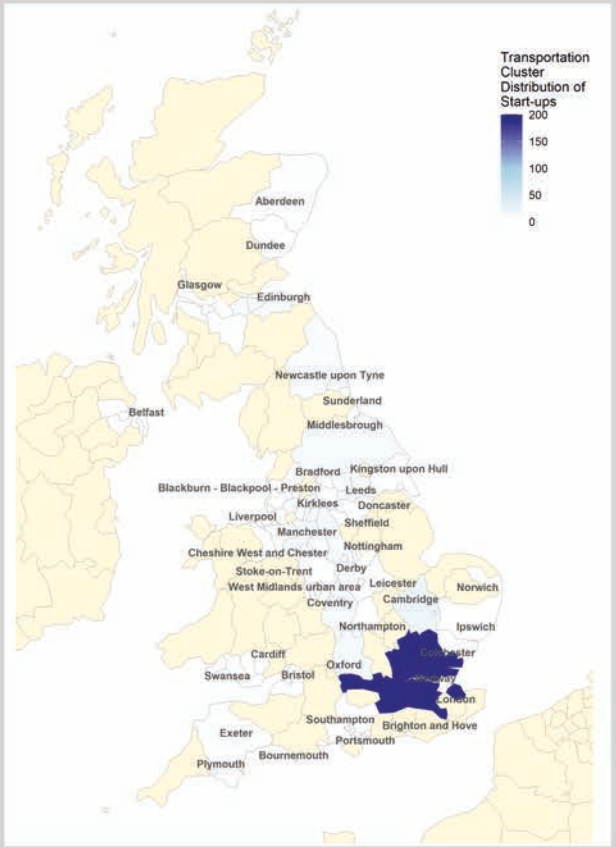
The Transportation cluster includes categories related to energy storage, fuel and electric vehicles. Companies that fall under this cluster work on the future of global transport by offering services and manufacturing products related to clean transportation, energy-saving and sustainable mobility. Five sub-clusters can be identified within the Transportation cluster: 1. transportation, fuel and vehicle production; 2. energy and battery; 3. electric vehicles; 4. charity; and 5. parking. Start-ups in this cluster are mainly in London, with a more nascent cluster in Cambridge.



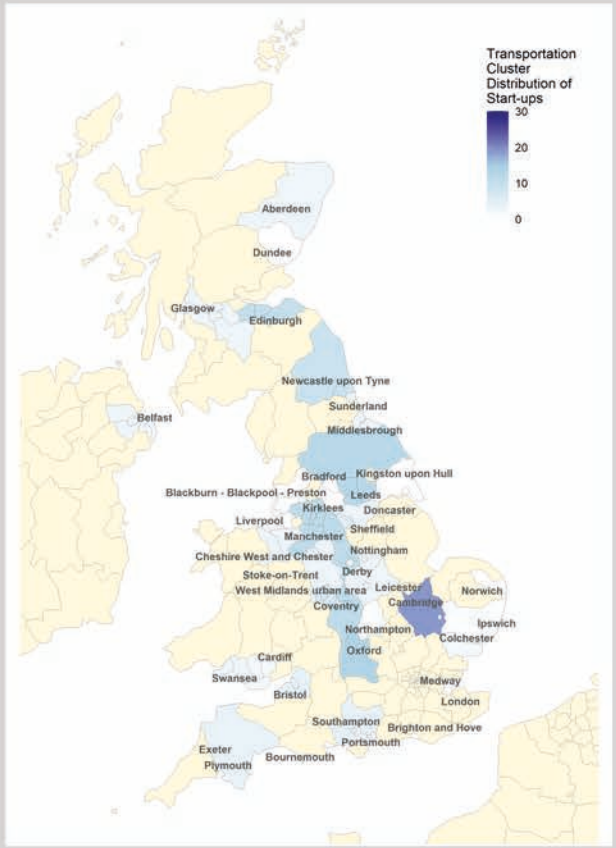




Transportation Cluster Distribution in the UK by Region



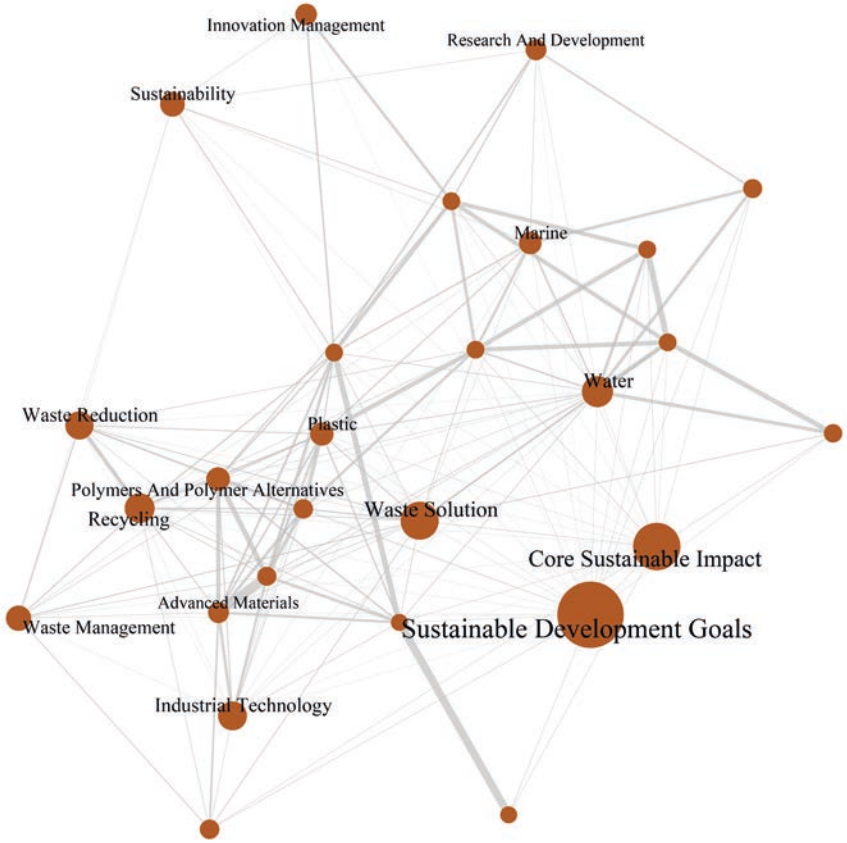
Transportation Cluster Distribution in the UK by Metropolitan Areas including London

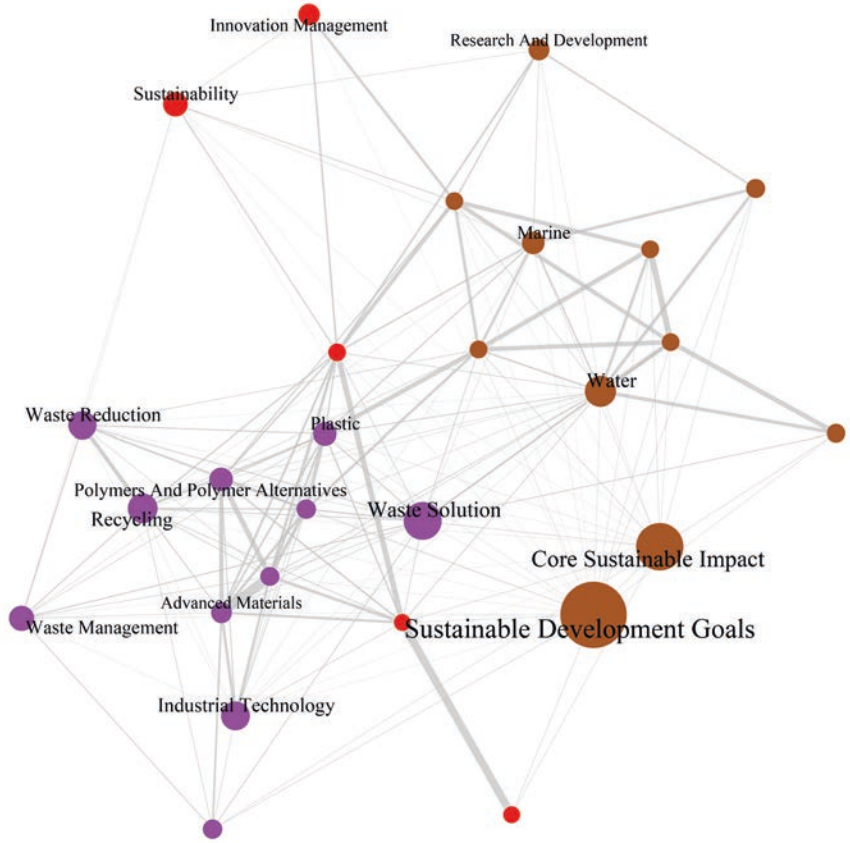


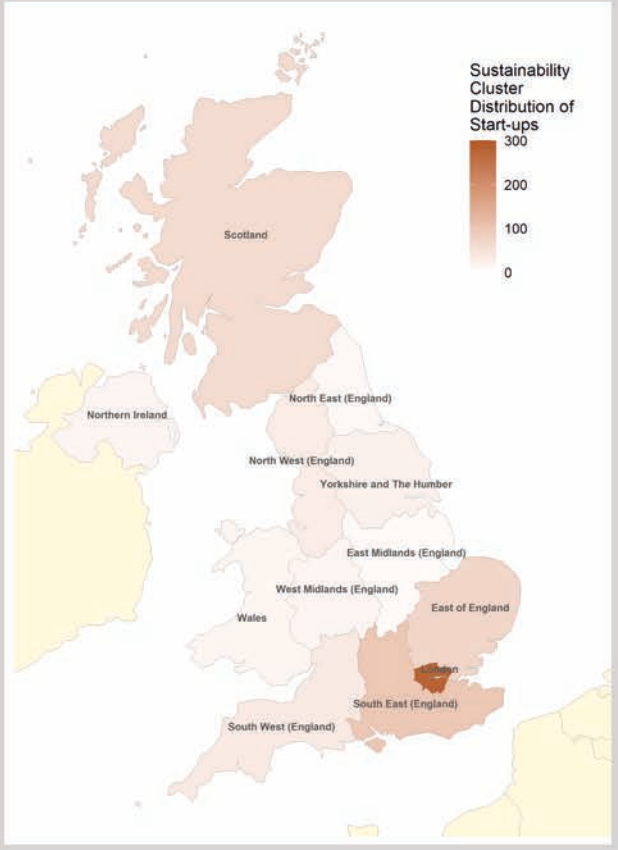
Transportation Food Cluster Distribution in the UK by Metropolitan Areas excluding London

3.3.6. Sustainability Cluster

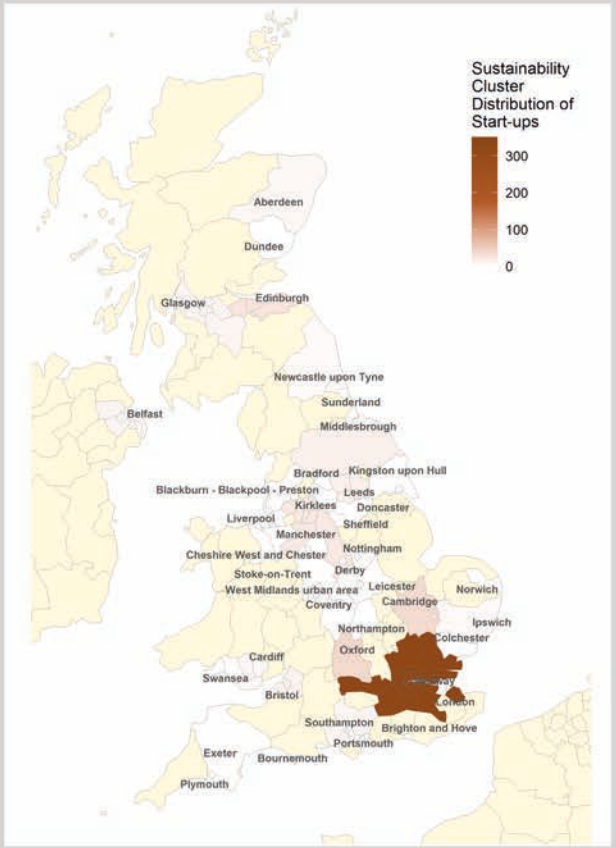
Although sustainability start-ups thrive across most of the found clusters, a sustainability cluster emerged centred around sustainable development goals. Businesses in this cluster are tackling climate change concerns, offering innovations that allow more sustainable development. Three main sub-clusters can be identified, a waste solution, innovation management and a more central sustainable development goals sub-cluster, including research and development and water categories. Apart from London, start-ups related to this cluster thrive in UK regions such as Oxford, Cambridge, Manchester, Edinburgh and Leeds.



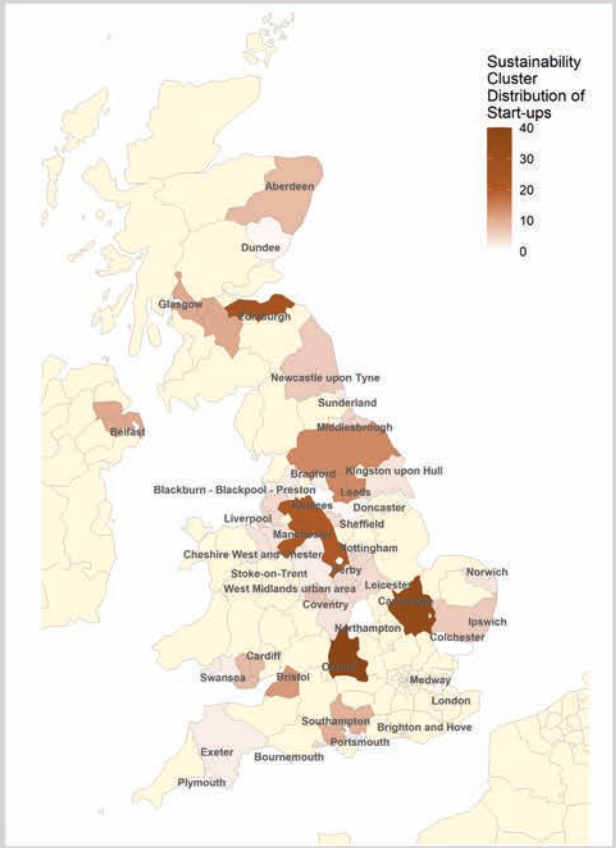




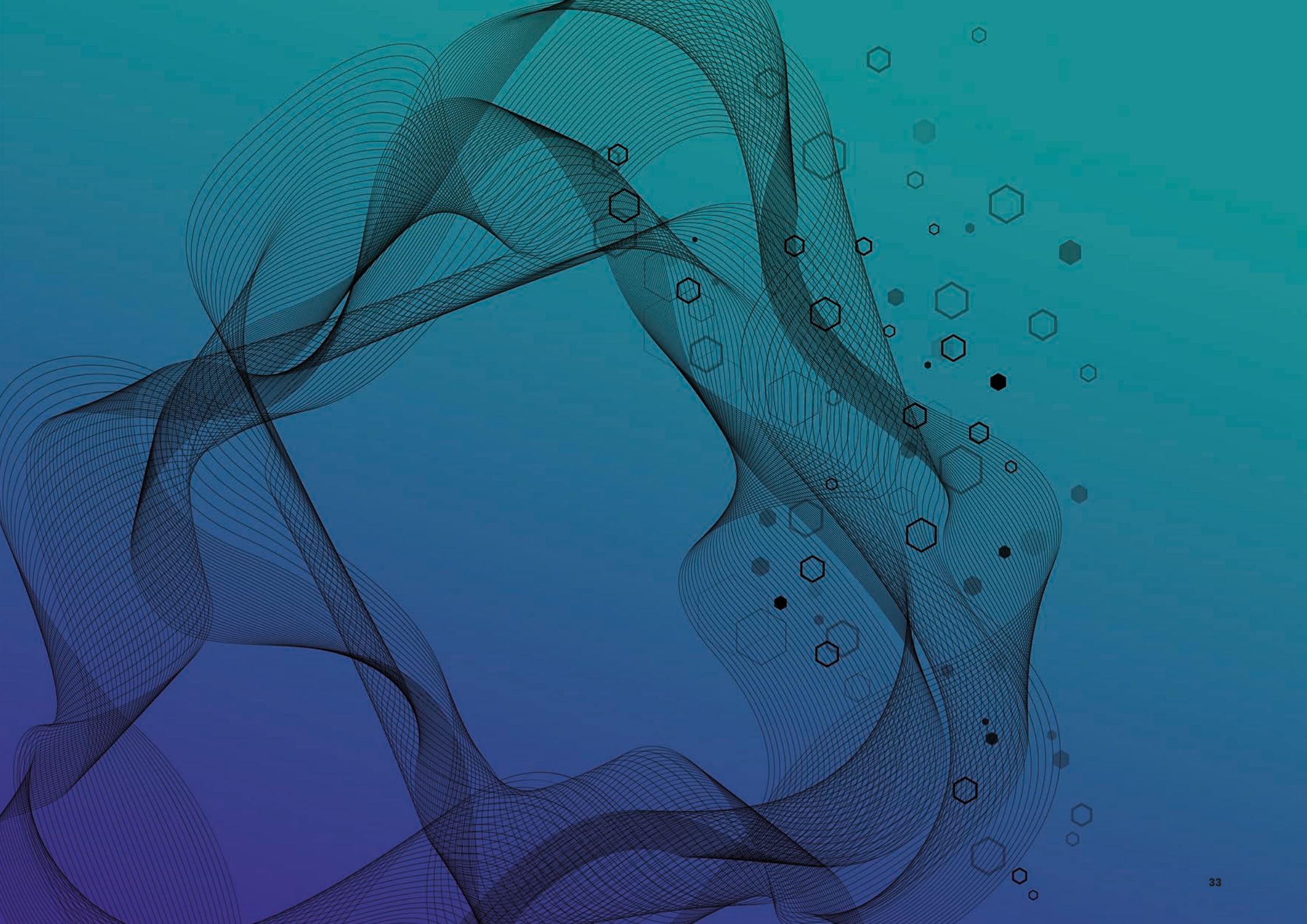
Sustainability Cluster Distribution in the UK by Region



Sustainability Cluster Distribution in the UK by Metropolitan Areas including London

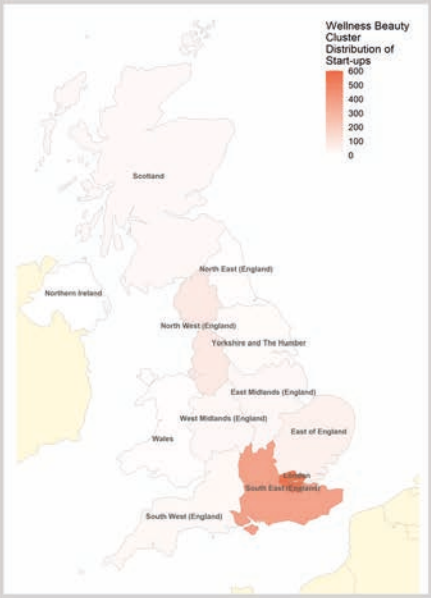


Sustainability Cluster Distribution in the UK by Metropolitan Areas excluding London

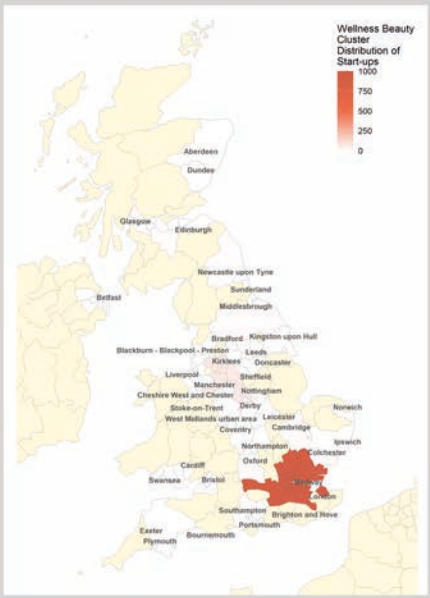


3.3.7. Wellness & Beauty Cluster

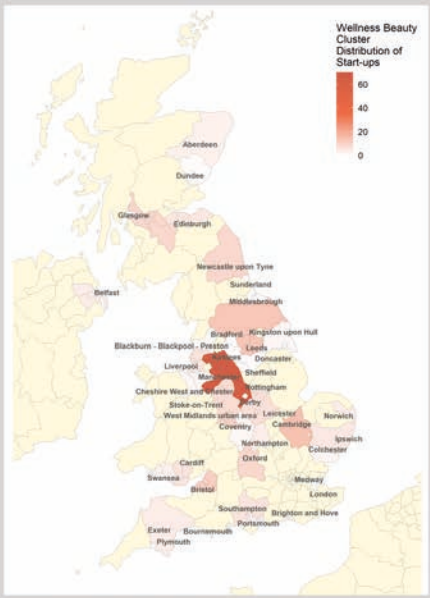
A cluster around wellness and beauty can be identified in the bioscience and biotechnology knowledge space. Companies within this cluster are centred around skincare, fashion, and apparel. Start-ups that can be classified under this cluster can be found mainly in London, with an important number also in Manchester and the North West of England.



Wellness Beauty Cluster Distribution in the UK by Region



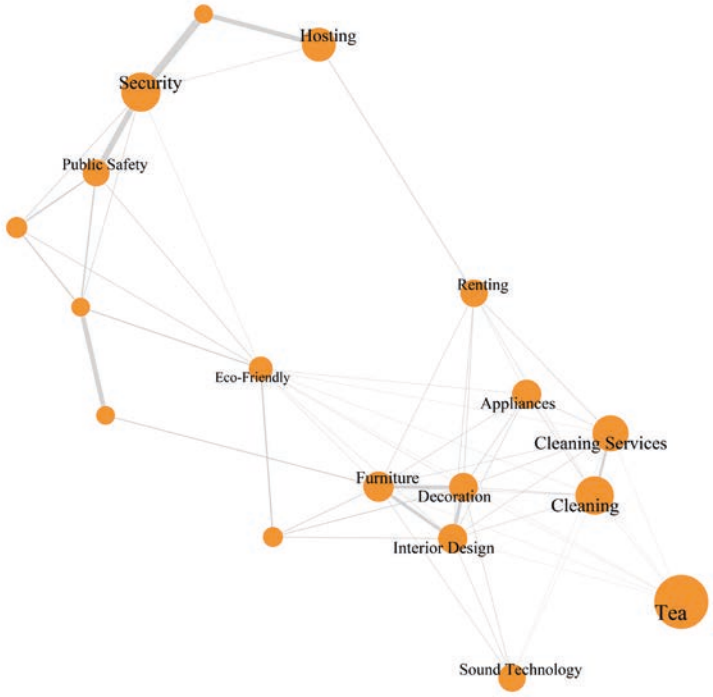
Wellness Beauty Cluster Distribution in the UK by Metropolitan Areas including London

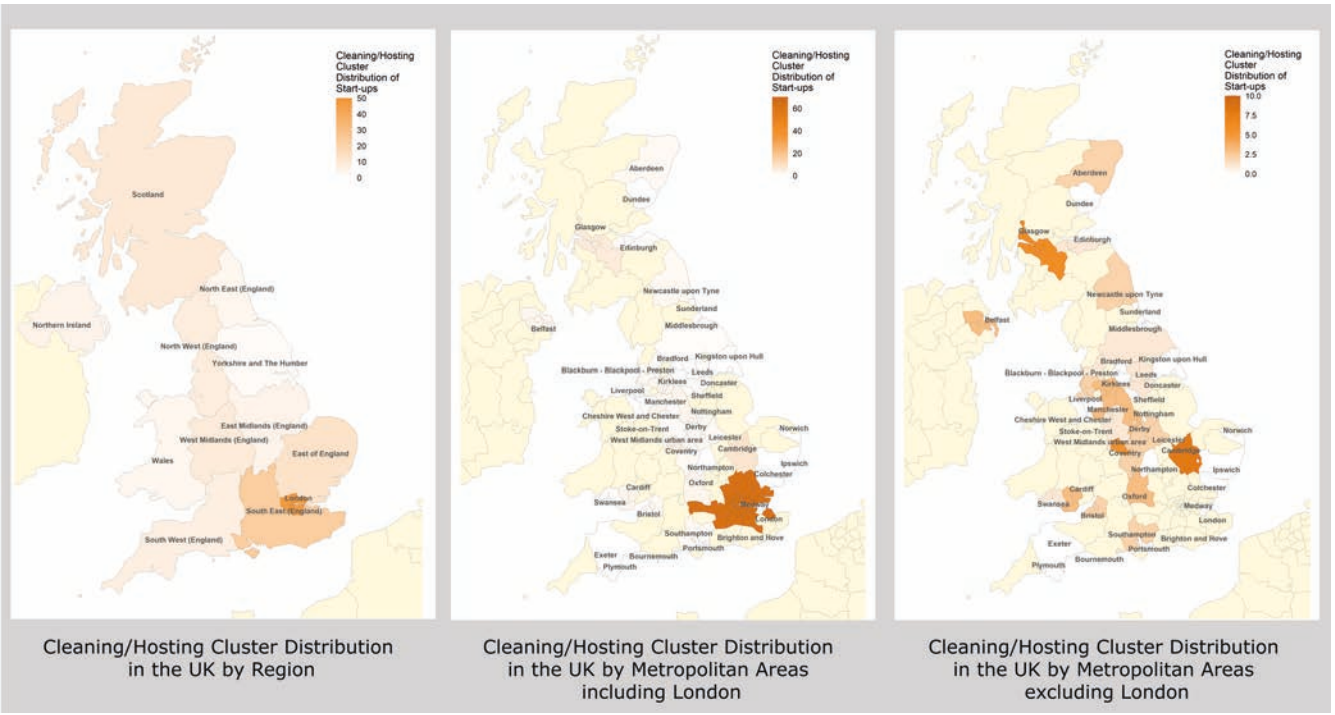


Wellness Beauty Food Cluster Distribution in the UK by Metropolitan Areas excluding London

3.3.8. Cleaning/Hosting Cluster

The Cleaning/Hosting cluster includes categories related to interior design, cleaning services and security. Start-ups related to this cluster provide eco-friendly services, appliances and solutions that contribute to cleaner and safer environments or sustainable buildings. Although this is a nascent cluster, businesses identified with this cluster are located mainly in London, Cambridge, Coventry and Glasgow





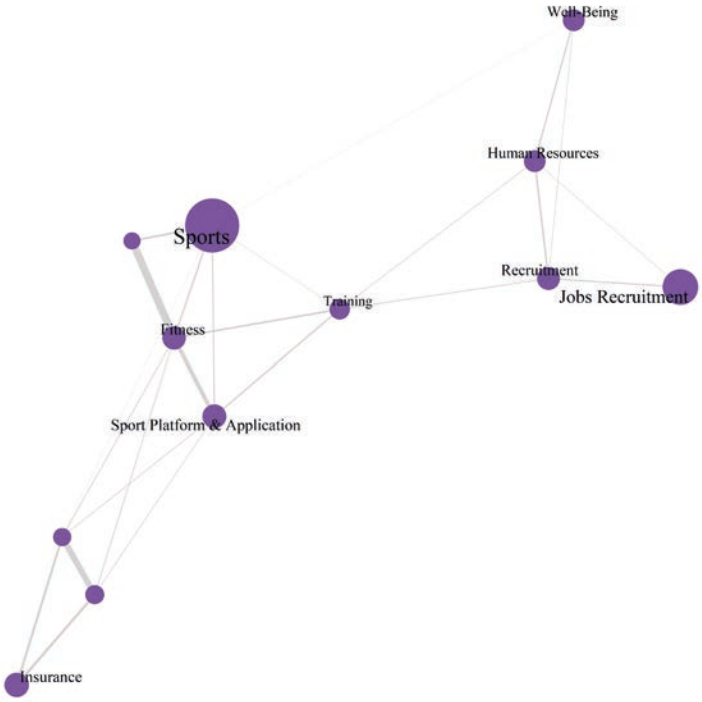
Cleaning/Hosting Cluster Distribution in the UK by Region

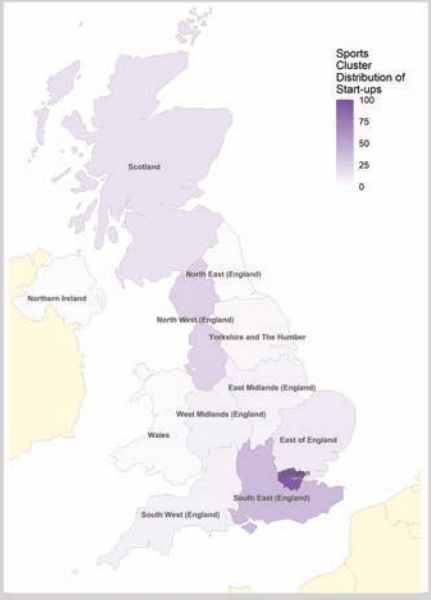
Cleaning/Hosting Cluster Distribution in the UK by Metropolitan Areas including London

Cleaning/Hosting Cluster Distribution in the UK by Metropolitan Areas excluding London

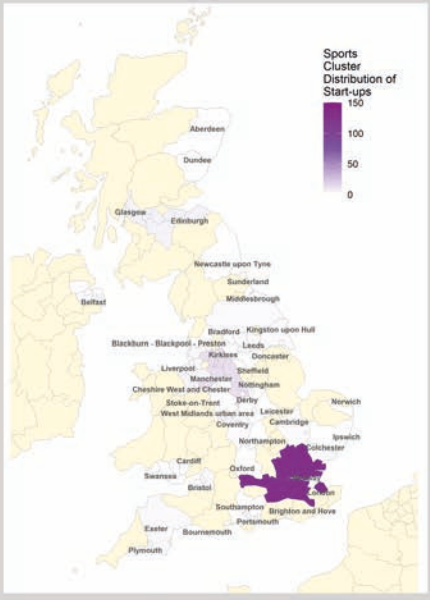
3.3.9. Sports Cluster

The Sports cluster includes businesses related to sports services and products, sports insurance and well-being. Although less related to the core of this cluster, start-ups that provide HR and recruitment services also coalesce with the sports firms. Companies within this cluster are mainly located in London and Manchester. Not many companies can be classified under this cluster, possibly because it is less related to the core of the bioscience and biotechnology knowledge space.

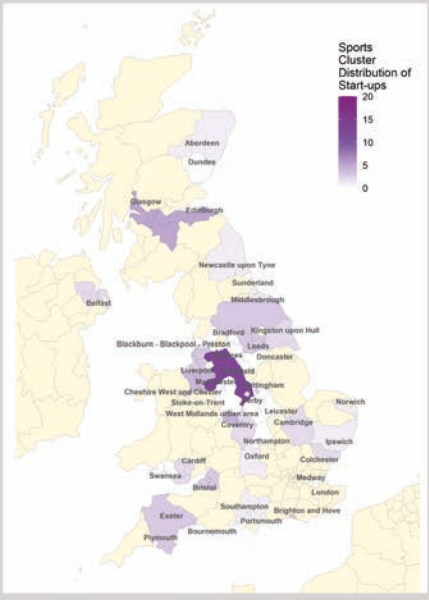




Sports Cluster Distribution in the UK by Region



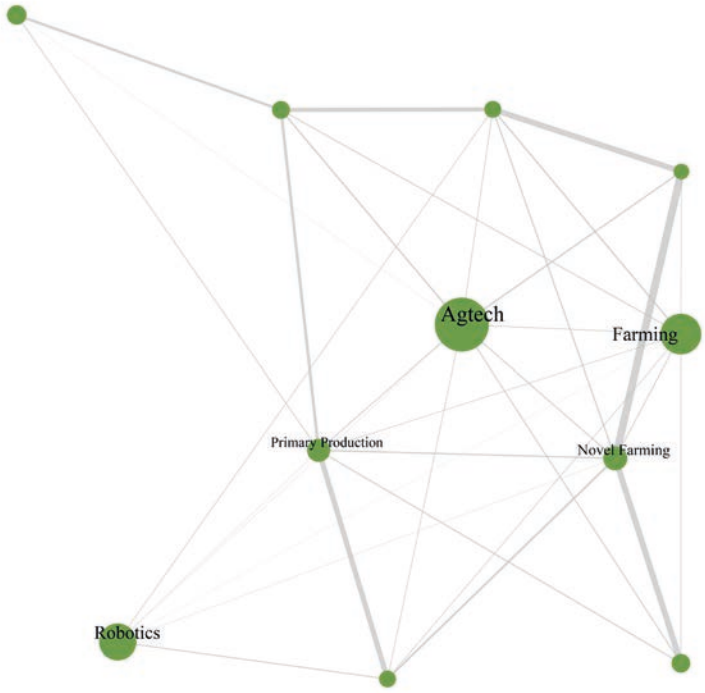
Sports Cluster Distribution in the UK by Metropolitan Areas including London

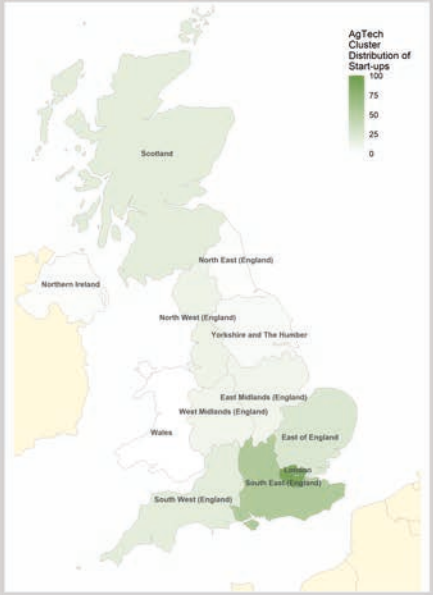


Sports Cluster Distribution in the UK by Metropolitan Areas excluding London

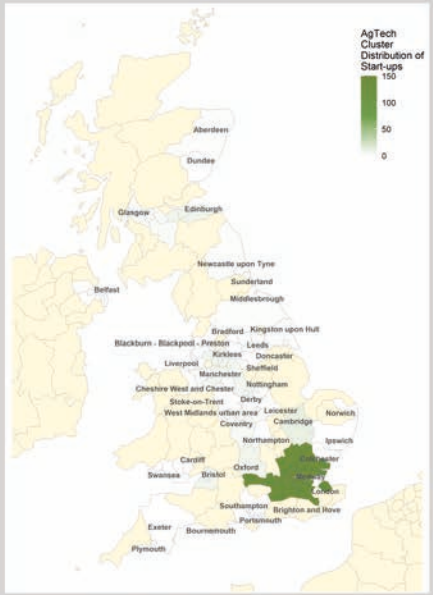
3.3.10. AgTech Cluster

The AgTech (also known as AgriTech) cluster includes companies related to farming, novel farming and robotics. This is an emergent cluster that answers recent tendencies for sustainable agricultural technology. Start-ups related to this cluster use technology in agriculture, horticulture and aquaculture. Robotics is an important node within this cluster, as drones and robotic solutions are central to sustainable and efficient farming. London and Cambridge are the main regions for these companies.

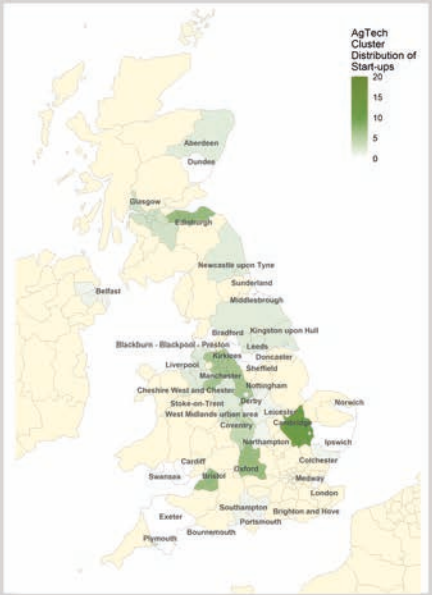




AgTech Cluster Distribution in the UK by Region



AgTech Cluster Distribution in the UK by Metropolitan Areas including London



AgTech Food Cluster Distribution in the UK by Metropolitan Areas excluding London

4. CONCLUSIONS

The start-up landscape and specialisation constitutes a pillar of the potential success of the UK bioscience and biotechnology industry. Through knowledge space analysis and the geolocation of start-ups in the UK we revealed the presence of 10 significant clusters of knowledge. Furthermore, we showed how these clusters and their diverse specialisations are distributed throughout the UK.

Our analysis shows that most start-ups in the UK can be grouped in three main sectors: Health, Food and Energy. That is, companies can be characterised through categories related to these sectors, providing evidence of how the UK bioscience and biotechnology industry is understood. Furthermore, emergent sectors are revealed as promising areas for innovation and further development of crucial clusters around the UK. Innovative Foods, Transportation, and Sustainability are promising areas for development. Finally, AgTech, Wellness & Beauty, Cleaning/Hosting and Sports are clusters that show niche start-ups or nascent sectors.

Geographically, our analysis also answers the question of "where the action is" in the UK bioscience and biotechnology industry. On a general level, the highest number of start-ups in the industry are concentrated in London and the South East of England. More precisely, the London metropolitan area has the highest number of start-ups in all the sectors found. However, Cambridge and Oxford also appear as significant bioclusters. Other cities such as Manchester, Leeds, Birmingham, Edinburgh and Glasgow host an important number of companies for some of the main sectors identified in this report, comprising more specific bioclusters.

Although this report addresses important issues regarding the landscape and specialisation in the UK, we identify potential areas for further research:

- The strengths and weaknesses of the UK bioscience and biotechnology industry compared to other economies
- The specific sectors which present opportunities for innovation among knowledge clusters that were illustrated in this report
- The ways that the UK can position itself to compete with other economies on start-up commercialisation strategies
- Investment gaps within biotechnology industry with respect to start-ups' growth stages and technology sets
- The need to identify nascent clusters following this research, which might have greater potential to become a global leader in bioscience and biotechnology industry, and the likelihood to expand strings within and between bioclusters in the UK
- Paths for bioclusters to leverage on the UK growing ecosystem of biotechnology incubator and accelerator programmes

While our findings using the start-ups data from Dealroom.co and knowledge space analysis reveal important insights, it still is necessary to triangulate more information that complement our conclusions. For example, combining the identified clusters, geographical information, and investment and incubator data can offer greater understanding with which to nurture the bioscience and biotechnology industry ecosystem.

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Innovation Caucus

MAPPING THE BIOTECHNOLOGY AND BIOSCIENCE INDUSTRY IN THE UK: A KNOWLEDGE SPACE ANALYSIS

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