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West and North Yorkshire Productivity Audit and Sector Analysis

A Final Report by Hatch Regeneris
5 August 2019

West Yorkshire Combined Authority

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Contents Page

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Executive Summary

i.   In March 2019, Hatch Regeneris, in partnership with The Data City, were commissioned by West Yorkshire Combined Authority (WYCA), the Leeds City Region Enterprise Partnership and York, North Yorkshire and East Riding (YNYER) LEP to complete a productivity audit and sector analysis of the regional economy. The work was designed to develop a deeper understanding of potential opportunities for productivity and jobs growth in emerging and established sectors in order to inform the Local Inclusive Industrial Strategy development.

ii.   The research methodology is built on two different approaches to collating data: (a) a top-down analysis of productivity trends and patterns driven by nationally available datasets and Office for National Statistics (ONS) data, and (b) an innovative bottom-up approach which provides a structured database of businesses and their attributes. This is driven by Artificial Intelligence programming and data from Companies House and other open-source providers.

iii.   The top-down analysis contextualises North and West Yorkshire's productivity performance against similar economic counterparts - Northumberland and Tyne and Wear, West Midlands, Merseyside, South Yorkshire, Greater Manchester, Gloucestershire, Wiltshire and Bath/Bristol area, Derbyshire and Nottinghamshire and England. The headline findings highlight that:

- The Yorkshire and Humber economy is transitioning from an economy that relies on large-scale heavy industry, manufacturing, textiles and agriculture to a more diverse market. Despite this, manufacturing remains important for the area, more so than in other UK regions.

- In terms of productivity, GVA per hour is £29, which is lower output per hour than the English average. However, since 2012, productivity has increased by 12%.

- North and West Yorkshire has the largest business stock of all comparator areas, 136,740 in 2018, which constitutes 5% of the English business base. 17% growth between 2013 -18 was 4% slower than the English average.

- Business starts per 1,000 residents is a measure of an enterprising economy and on this measure, North and West Yorkshire falls below the English average with 4.4 business starts per 1,000 residents. In the same year, more businesses closed than started per 1,000 residents, which suggests there is a challenging environment for start-ups in the local economy.

- At the broad industrial grouping, the economy is specialised in warehousing and logistics, transport, wholesale, manufacturing in both the number of businesses and number of employees.

- The most significant export location for North and West Yorkshire is the US and The Netherlands is the most significant import location. The value of imports is more than twice the value of exports and for both imports and exports the share of trade with the EU is above the English average.

iv.   The AI -based bottom-up research demonstrates:

- A pattern of sectoral interdependence which broadly matches the comparator economies of Greater Manchester and England. This belies the notion that the North

and West Yorkshire are laggards in recognising the potential of transformative techniques and cross-sector opportunities.

- Several lines of analysis highlight a greater degree of digital integration and business connectivity in the West and North Yorkshire than in either Manchester or England.

- There is compelling evidence to indicate that there is a greater disparity in productivity performance both within and between sectors in North and West Yorkshire as compared to Greater Manchester and England.

- There is compelling evidence to indicate that North and West Yorkshire businesses are older (based on year of incorporation), and that there are more family-run undertakings. We find no evidence to suggest that family owned firms are less productive, and in-fact find evidence to suggest that family run firms display greater signs of high productivity related behaviour than companies under other types of ownership.

Policy Implications

v.   **Policies should be designed to reward current success and augment existing productivity building behaviour**. This means designing interventions that target well performing companies in strategically important knowledge intensive activities. In such circumstances, it is more important to focus on the technologies being employed and types of intervention rather than pure sector definitions.

vi.   Because the area lacks the presence of leading Tier 1 manufacturers, **the normal role of larger groups in spreading innovation and good practice through their supply chain needs to be replicated. In this area the role of Higher Education Institutions and other institutions could be crucial**.

vii. The diversity of facilities and education assets in the region presents an opportunity for cross-sector manufacturers to operate in niche areas at Tiers 2 & 3 in the supply chain. A number of regional facilities further bolster this cross-sector focus such as the Centre for Precision Engineering and the 3M Buckley Innovation Centre which can contribute to innovation and collaboration in energy transport, health, medicine manufacturing etc. BioVale in York has begun to accelerate the growth of a bio-based cluster which will also serve multiple industries.

viii. **Interventions should be designed to appeal to smaller family-based undertakings**. This means making it as easy as possible for smaller companies to benefit from support and upskilling interventions should not dilute share capital, control or autonomy. This is because smaller, family controlled firms are often resistant to any interventions that threaten to erode financial independence.

ix.   **The top down analysis suggests that Brexit could pose a risk to the region**. Local manufacturers source large amount of imports and intermediate product from the EU (especially Holland and Belgium). Awareness raising is needed amongst smaller businesses to better inform them about potential future challenges and the mitigations that may be needed.

x.   Finally, our understanding of trading addresses suggests a degree of specialisation that may favour locations where certain activities are focused. **To ensure social inclusivity, the design of interventions should recognise that a sector-based policy may have important spatial implications.**

1. Introduction

Study Remit

A.1 Traditional methods of understanding economic and productive activity struggle to reflect the evolving nature of the world around us. Productivity is hard to measure and SIC codes are poorly-suited to understanding the modern economy. Current datasets struggle to fairly reflect:

- Large companies that span many industrial sectors
- Technology companies which operate in small and frequently changing niches markets
- Companies that operate in emerging sectors that have not yet been classified

1.1 This data report is based on a new experimental and still developing approach to understanding the economic structure and performance in the target geography. It draws on a novel approach to analysis and categorising large datasets.

1.2 The project brief posed four areas of research which would need to be addressed through the sector productivity study. They are as follows:

- Existing key sector strengths and challenges
- Emerging sector strengths
- Emerging sector strengths
- The pattern of in-sector productivity

1.3 Our research methodology is built on two different approaches to collating data: (a) a top-down analysis of productivity trends and patterns driven by nationally available datasets and Office for National Statistics (ONS) data, and (b) an innovative bottom-up approach designed to create a structured database of businesses and their attributes. This is driven by sophisticated Artificial Intelligence programming, data from Companies House and other open-source providers.

1.4 These two strands are underpinned by a comprehensive review of policy and academic sources, with the work culminating in a wider sector-mapping exercise and productivity audit.

Figure 1.1 Research Approach and Methodology
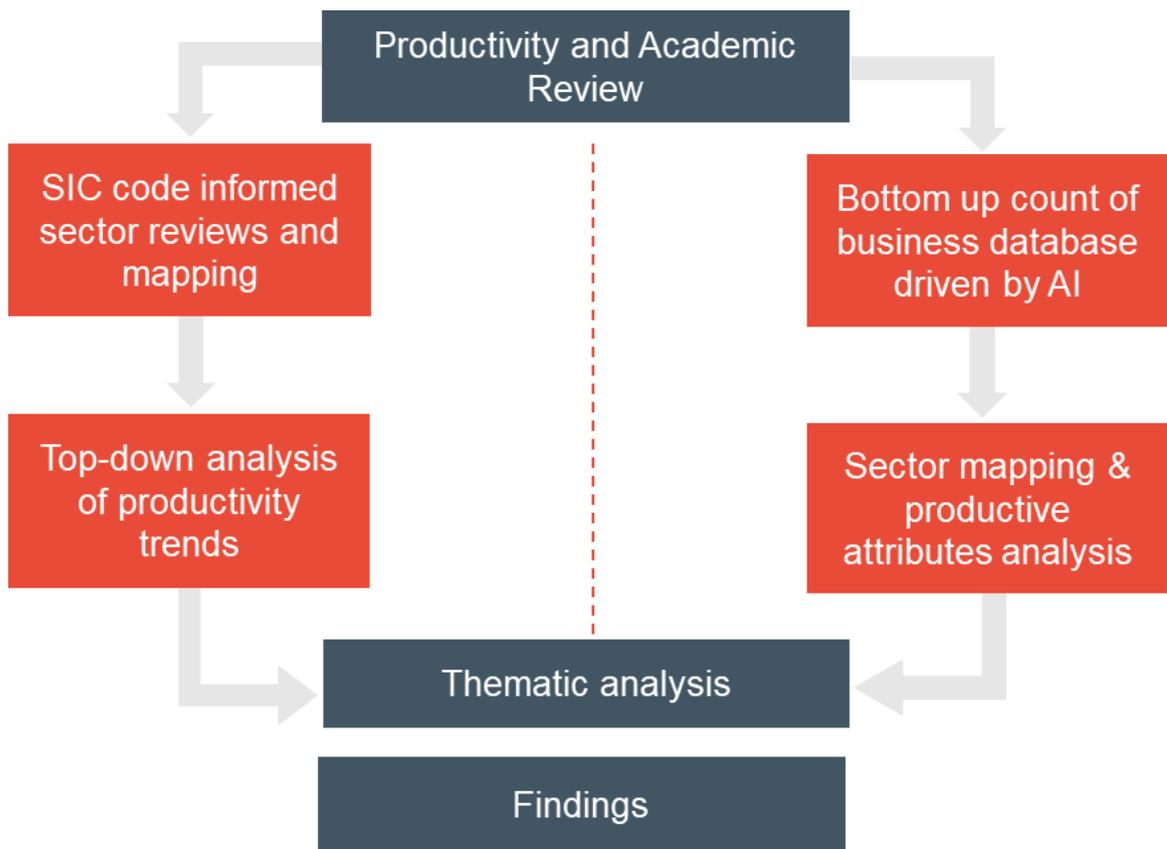
Source: Hatch Regeneris 2019

1.5 Appendices A and B provide a methodological discussion of how the sector profiling and geographic analysis were undertaken. Broadly speaking, the sectors have been defined using keywords to search the company websites and to generate profiles for each sector.

1.6 Traditional methods of understanding economic and productive activity struggle to reflect the evolving nature of the world around us. Productivity is hard to measure and SIC codes are poorly-suited to understanding how the modern economy functions. Current datasets struggle to fairly reflect:

- Large companies that span many industrial sectors

- Technology companies which operate in small and frequently changing niches markets

- Companies that operate in emerging sectors that have not yet been classified

1.7 This data report is based on a new, experimental and evolving approach to understanding the economic structure and performance of the target geography. It draws on a novel approach to analysis and categorising large datasets. The data upon which the analysis is based has been generated by The Data City Limited.

1.8 This represents a new way of measuring economic activity and should not be used to compare specific numbers against official statistics. The process relies on rounds of iterative learning. A detailed description of the methods used can be found at The Data City Website Our Data & Industrial Sector Classification.

1.9 The approach uses machine learning to classify businesses based on the words they use to describe themselves. The first step is to manually classify a relatively small number of

websites and businesses, which the team are confident represent a sector or area of interest. This initial dataset is then used to train a machine-learning algorithm to identify similar businesses. The dataset is then updated as examples of mis-categorised businesses are flagged up. This iterative approach over time generates much improved datasets on which more confident insights can be based.

1.10 Sector definitions were agreed with officials from the project steering group and the approach was subject to a DataCity and Hatch Regeneris Quality Assurance process. Despite repeated iterations of the model, for some sectors, it was not possible to derive an AI keyword themed sector profile. In these circumstances, standard SIC code-based definitions have been used.

1.11 The basis of our research approach to 'productivity' is that the websites of sample firms in the target and comparator geographies, contain certain keywords that can be regarded as 'high productivity' markers. These productivity markers were based on a simple review of management journals and Hatch Regeneris experience working on similar assignments. The productivity markers were then tested with the client group and applied to the DataCity sample.

Structure of Report

1.12 The report is structured as follows:

- Section 2 explores the academic and management literature on productivity issues, and places UK performance into historical and geographic context. We also a include a discussion on the important of cross sectoral technologies, and their importance for understanding in-sector productivity differences.

- Section 3 reviews the UK policy context, including local and national initiatives, projects and programmes

- Section 4 explains what we already know about sector and firm level performance in North and West Yorkshire

- Sections 5 and 6 uses the new insights provided by open data sources to explore some of the more detailed issues surrounding firm and sub-regional productivity performance

- Section 7 summarises the most important messages and provides some suggestions for evidence-based policies to support growth and productivity.

2. Productivity

What is productivity and how is it measured?

2.1 Productivity is a way of describing how efficiently inputs are converted to outputs, i.e. how much output is produced for a given input. The more efficient this process is, the more that can be produced in a sustainable fashion, therefore the term is an important measure of performance for firms, regional and national economies.

2.2 Inputs and outputs refer to almost everything in an economic system. In classical economic terms, inputs, or the factors of production are land, labour and capital which flow into the production of supply of goods and services. Output refers to those goods and services that firms in the economy produce, the sum of the value of this output is expressed as Gross Domestic Product (GDP) or Gross Value Added (GVA).

2.3 Different approaches to calculating productivity growth can be used -

- The neoclassical model treats growth as exogenous (based on capital accumulation and national savings)
- New growth theory incorporates growth as endogenous, through technical change, investment in R&D and capability building activities

2.4 Recently, UK policy direction has moved in favour of New Growth Theory and the fundamentals of its theoretical approach are espoused in policy documents such as the National Industrial Strategy.

There are three headline measures of productivity -

1) Partial Factor Productivity (PFP) – Typically, the Office for National Statistics (ONS) reports on labour productivity, which is an example of PFP. This measure reveals how effectively labour input is combined with other factors of production and used in the production process. Labour productivity only partially reflects the productivity of labour in terms of the personal capacities of workers or the intensity of their effort. The ratio between output measure and labour inputs depends to a large degree on the presence and use of other inputs (e.g. capital, intermediate inputs, technical, organisational and efficiency change).[1] Improvements in these areas will increase the amount of output for a given labour input, raising the observed labour productivity without labour necessarily becoming more efficient[2]. Capital productivity, GDP per unit of capital, is another partial measure.

2) Total Factor Productivity (TFP) - Considers the efficiency of *all inputs* to a production process. The proxy measure for this is Multi-Factor Productivity.

3) Multi Factor Productivity (MFP) – The volume of output from a bundle of both labour and capital inputs by constructing three indexes for, land, labour and capital weighted according to their respective contributions. The calculation of productivity growth is the residual of any difference between the level of output growth and the level of input growth.

2.5 Partial factor productivity is the most appropriate measure to use in this report. It is the most straightforward and easily comparable measure of productivity because it avoids the

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[1] https://data.oecd.org/lprdty/gdp-per-hour-worked.htm

[2] House of Commons Library (2017), 'Productivity in the UK'

need to aggregate capital estimates and hours worked. Multi-factor productivity, whilst being a better indicator of overall improvement in an economy's efficiency, is difficult to measure and pinpoint the source of productivity change, as this could be due to simultaneous shifts in productivity of labour, capital, materials, or just one dimension.

2.6   Labour productivity is usually expressed as a ratio of units of output (often Gross Domestic Product (GDP) or Gross Value Added (GVA) to units of input (employment levels or hours worked in an economy). Output per hour is the purest measure of productivity, as it adjusts for changes in working hours such as more part-time working. Output per worker and output per job are also widely used.[3]

Why is Productivity Important?

2.7   Seeking improvement in productivity is not an end in itself. At the highest level, the ability for an economy to continue to drive efficiency into the production of goods and services increases the long-term capacity of the economy and is essential for long-term increases in living standards. The quote by US economist Paul Krugman is commonly cited:

> "Productivity isn't everything, but in the long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker"[4].

2.8   The benefits of increasing productivity are far-reaching, benefiting participants within the system as well as the system itself. The value in improving productivity within an economy can be viewed from three different perspectives – consumers or workers, businesses and Governments.

2.9   For individuals, the value of output per hour worked is a determinant of wages, therefore the more productive an employee is, the higher they are likely to be paid. This means we would need to work fewer hours to generate the same output, potentially reducing the necessary working hours and being compensated better for the hours we do work.

2.10   For firms, productivity is intertwined with the concept of competitiveness and the volume of output obtained from each employee matters for a number of reasons –

- Labour costs tend to form a significant part of total costs
- Business efficiency and profitability are closely linked to productive use of labour
- In order to maintain competitive, a business needs to keep unit costs down

2.11   Higher productivity should translate into higher profits, allowing more working capital and improved competitive capacity. For industries, productivity growth can be important to allow sectors to compete for resources and maintain international competitiveness.

2.12   Governments will benefit from productivity improvements through higher tax receipts, allowing increased investment on services like health care, education, welfare, infrastructure.

2.13   By the same logic, improving productivity outcomes depends not only on the choices and actions of the Government, but of the private sector, individuals, businesses and communities.

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[3] House of Commons Library (2017), 'Productivity in the UK'

[4] Krugman, P, The Age of Diminished Expectations: US Economic Policy in the 1980s, MIT Press, Cambridge, 1992, p. 9.

Productivity Performance in the UK

2.14 The UK's recent productivity performance has been weak, leading to a significant response from the academic community, policy-makers and the media, exploring the causes and consequences of low productivity growth. The rate of labour productivity growth has been slow in many countries but the extent and persistence of the slow down appears more pronounced in the UK. This section examines characteristics of productivity performance in the UK.

Recent performance

2.15 Before the financial crisis, productivity was growing around the historical average of 2% per annum. During the recession productivity fell sharply, reflecting a drop in output relative to the number of hours worked. Productivity has not rebounded as would be expected in an economic recovery.

2.16 Table 1.1 demonstrates productivity trends measured by output per hour and output per worker, alongside their projected 1994 and 2007 trends. As expected, the financial crisis affected both these measures and whilst there has been a pronounced improvement in labour market performance, output growth has not kept pace. Productivity in Q3 2018 as measured by output per hour, was 18.2% below the pre-downturn trend. Productivity is 1.6% above its peak position in Q4 2007[5].

2.17 In the most recently reported statistics, labour productivity, output per hour, grew by 0.2% and has been growing for the past 8 consecutive quarters. This sluggish growth rate demonstrates a continuation of the UK's productivity puzzle, with productivity growth still below the steady pre-recession uptick.

Figure 2.1 Output per hour and output per worker (1994 – 2018), 2007 = 100
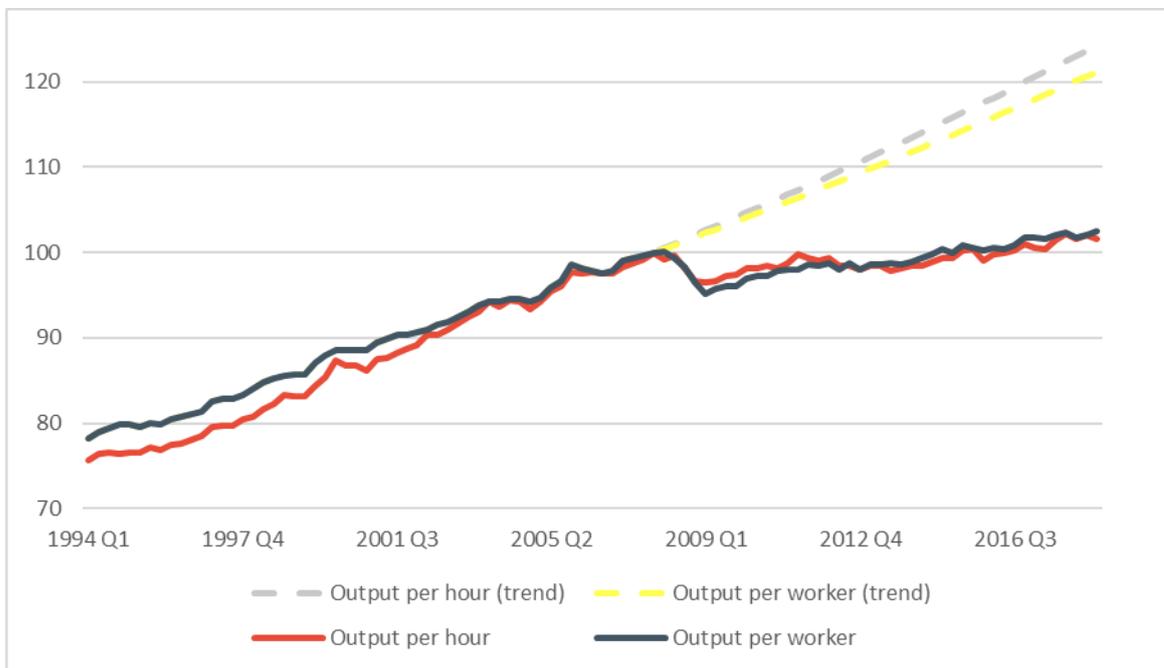
Source: ONS (2019) 'Seasonally adjusted output per hour and output per worker

[5] ONS (2019), 'Labour productivity, UK: July to September 2018'

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2.18   Current productivity performance is below the historical trend and there are also challenges with productivity vis a vis international counterparts and the gap between the UK and other developed economies remains stubbornly wide.

2.19   Data published by the ONS on international productivity comparisons indicates that the UK ranks fifth in terms of productivity performance. Against a measure of the G7 average excluding the UK, the national economy performs almost 20% lower[6].

Figure 2.2 GDP per hour worked, 2016, where UK = 100

Source: ONS (2019), UK Whole Economy: Output per hour worked SA

2.20   The persistent productivity gap between the UK and continental European economies can be mainly explained by the fact that they hav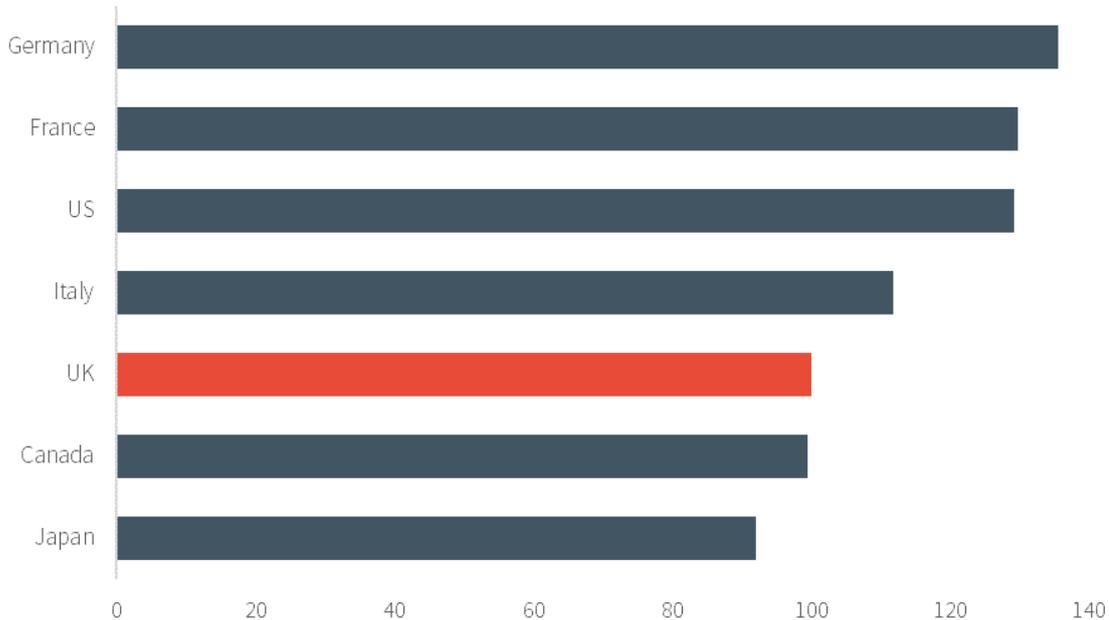e more capital invested per worker and their workers are more skilled. Shortfalls in investment in physical and human capital account for a smaller proportion of the productivity gap with the United States. Around half of the gap can be accounted for by different ways of working, how firms are organised and how they use technology. The sectoral composition of productivity performance also indicates that differences in productivity have an unequal distribution[7].

Regions

2.21   Regions and sectors are closely intertwined in determining productivity outcomes. Not all sectors make the same contribution to national productivity, not all places have the same industrial mix and the performance of these sectors plays out differently across the country. Industries with the strongest productivity performance tend to be those with markets that extend beyond the city in which they operate and industries with lower productivity performance are more likely to be geared around serving the local market only.

2.22   Weaker performance in productivity performance outside the South East reflects a difficulty in places attracting sufficient jobs in more productive sectors, but also a failure to attract the higher-skilled, higher-value aspects of these sectors.

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[6] ONS, International comparisons of UK productivity (ICP), final estimates,6 April 2018

[7] ESRC, 'The UK's Productivity Gap –What research tells us and what we need to find out'

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2.23 This highlights the importance of 'place' in productivity, as different places have different benefits on offer to firms. For example, London offers firms access to lots of skilled workers and connections to high skilled businesses. Firms are prepared to pay a premium to base their high-value activities in London. Other UK towns and cities do not have the same offer of knowledge, but they might have cheaper land and access to a pool of workers. This makes these places more attractive to other, more routine and lower value service lines[8].

Sectors

2.24 There is considerable variation in productivity across UK sectors when considering productivity as a static indicator.

Figure 2.3 Productivity and proportion of hours worked by sector, 2015
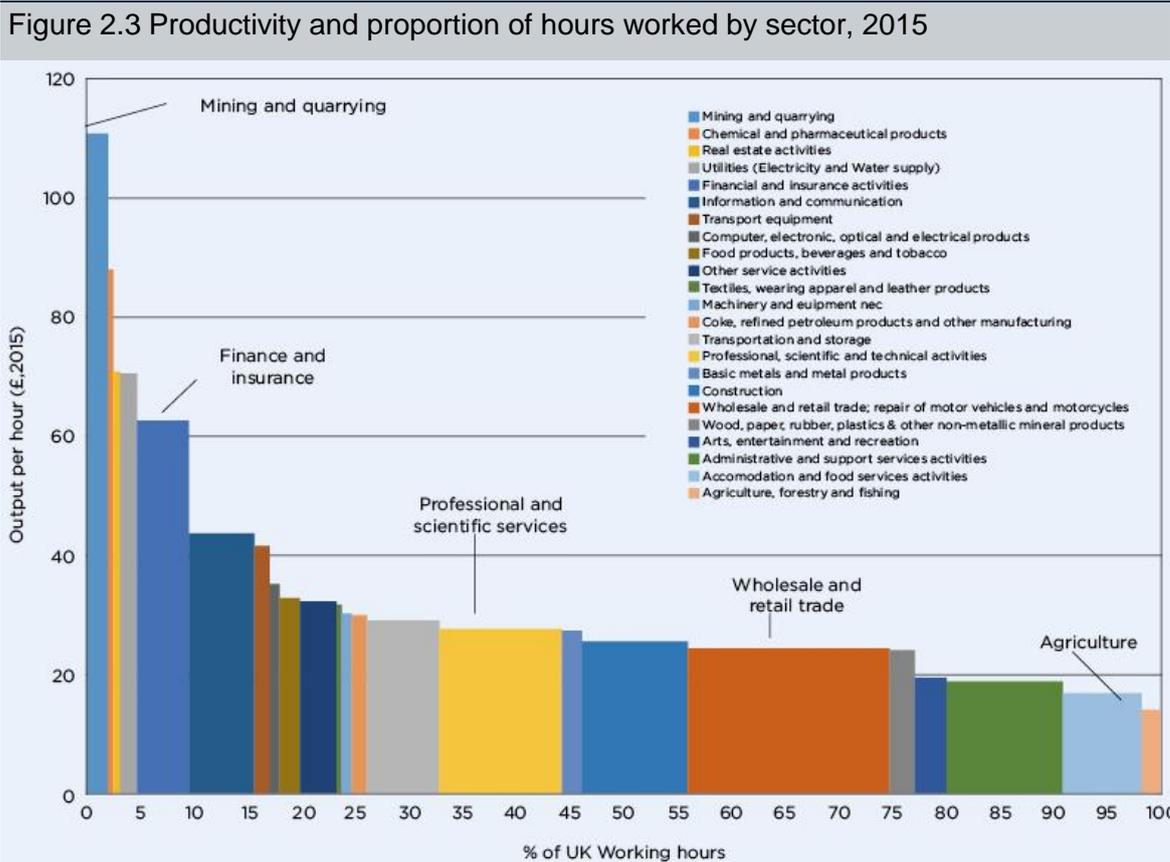
Source: Cabinet Office (2017) 'Charting productivity in the UK'

2.25 Figure 2.3 highlights the following -

- Sectors with high productivity, like financial services and pharmaceuticals are relatively small in terms of the proportion of hours worked

- The largest proportion of hours worked is in sectors with low productivity, such as retail and administrative services

2.26 In terms of productivity growth, while the UK economy grew on average 2.8% per annum between 1999 to 2007 before the financial crisis, high skilled service sectors such as financial and insurance and ICT, professional and scientific services were growing faster – around 5 and 7% per annum respectively. This resulted in labour productivity rises of around 4.5%, as shown in figure 1.2.

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[8] Centre for Cities (2017), 'The role of place in the UK's productivity problem'

2.27   Contrasting labour productivity growth in the period before and after the financial crisis evidences a marked weakening in productivity growth. The productivity growth shortfall is most apparent in the three broad industry groups where labour productivity had been rising quickly from 1999 to 2007. Computer programming, energy, finance, mining, pharmaceuticals and telecoms — which together account for only one-fifth of the economy — generated three-fifths of the decline in productivity growth.[9]

Figure 2.4 Productivity growth in sectors

Source: Economic Statistics Centre of Excellence (2018), 'Below the Aggregate: A Sectoral Account of the UK Productivity Puzzle'.

2.28   Bank of England research suggests that three-quarters of the productivity growth shortfall is accounted for by just two sectors: manufacturing and finance. A further quarter of the slowdown is explained by two more sectors – ICT and professional, scientific and technical services. Together, these four sectors, which make up just one-third of value-added, can entirely account for the slowdown[10].

Within-sector productivity

2.29   Productivity at the firm level can reflect characteristics of firms such as production technology, capital intensity, investment, firm size, firm age, innovation, foreign ownership, managerial capability, market power. It can also reflect the characteristics of product and factor markets they operate in or consumer tastes and preferences for the firms' products. Firm productivity may also be influenced by local factors such as infrastructure, agglomeration and pricing.

[9] Economic Statistics Centre of Excellence (2018), 'Below the Aggregate: A Sectoral Account of the UK Productivity Puzzle'

[10] Bank of England (2018) 'The fall in productivity growth: causes and implications'

2.30 Analysis of the non-financial business economy reveals that **differences in productivity across the regions are more closely related to different firm-level productivities within industries and less impacted by the local industry structure.**

2.31 Therefore, London and the South East's labour productivity advantage over other regions is not just about having more firms in certain industries. Rather, they reflect that within certain industries (and particularly in the services industries), London firms display a significantly higher level of labour productivity on average than firms in equivalent industries elsewhere in the country.

2.32 The implication of this analysis points to the importance of understanding productivity challenges within sectors, i.e. at sub-sector and firm level.

Figure 2.5 Firm productivity and industry mix effects on aggregate average productivity (2015)
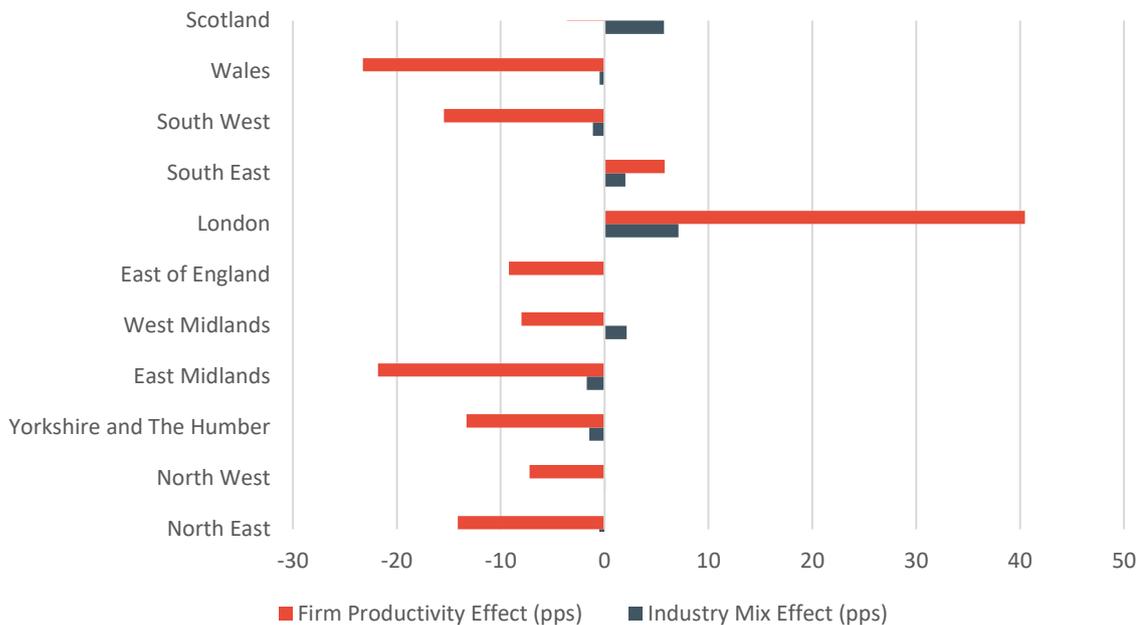
Source: Annual Business Survey, ONS

2.33 ONS analysis highlights the following –

- For non-financial services, labour productivity in knowledge intensive sectors is twice as large as productivity in less knowledge intensive service sectors.

- In every region, there are firms with very low and very high productivity performance. However, the skewed distributions illustrate that there are more firms in all the regions with productivity clustered at lower levels and fewer with productivity clustered at higher levels.

- Firms in the bottom 10% of the labour productivity distribution were relatively small businesses, with micro firms (1 to 0 employment) accounting for 90% of the laggard firms. See figure 2.6.

- Across the NUTS1 regions in 2014, Wales, the North East and Yorkshire and the Humber accounted for a disproportionately large share of establishments in the bottom 10% compared with their shares of the business population as a whole[11].

- There is significant variation in within-sector productivity. The top 10% of firms in each industry can be as much as five times as productive as the bottom 10%[12]

Figure 2.6 Distribution of real firm-level productivity
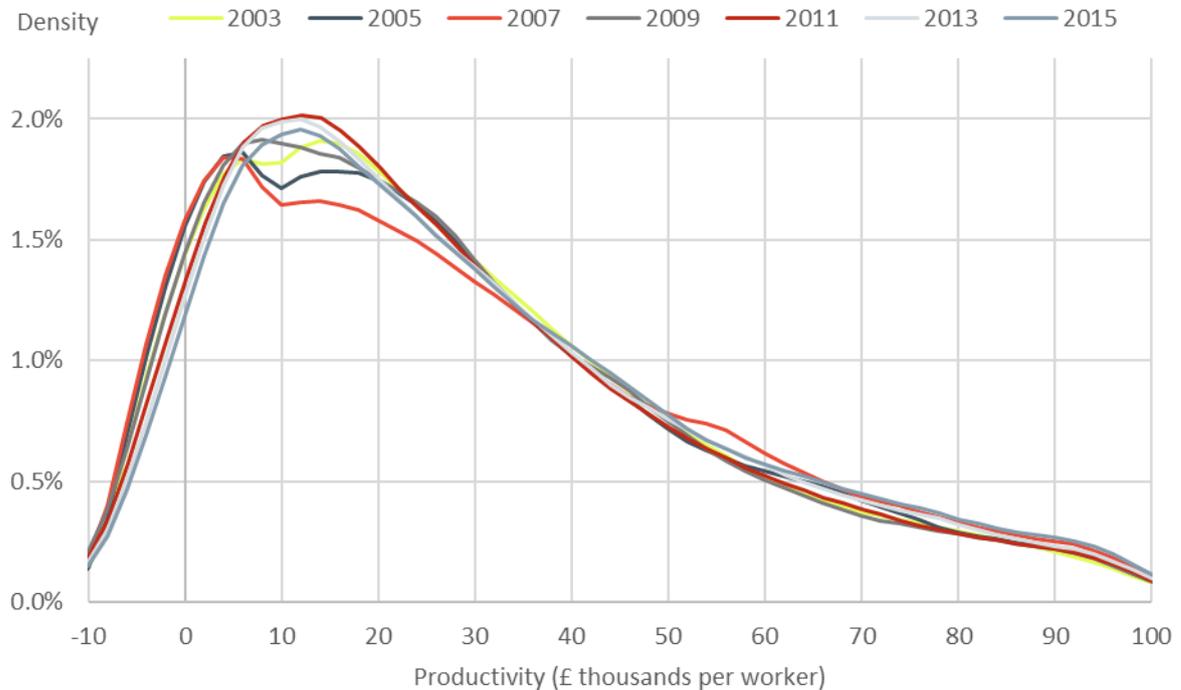
Source: Annual Business Survey (ABS), Inter-Departmental Business Register (IDBR) – Office for National Statistics (ONS)

2.34 A Centre for Cities report argues that in order to drive the level of productivity up, policymakers should focus less on underperforming firms and more on improving the performance of already highly-productive businesses[13].

2.35 It is worth noting that most regions exhibit over 3 times higher employment in less knowledge intensive services sectors than employment in knowledge-intensive services sectors.

Drivers of productivity

2.36 Understanding the drivers of productivity offers an opportunity to develop effective policies to raise productivity. This section identifies characteristics of firms with higher productivity and broad areas of improvement that are linked to higher productivity.

2.37 Some drivers will be industry and firm specific and other factors will drive productivity irrespective of the sector. The national Industrial Strategy focuses on factors responsible for higher productivity – 5 foundations of ideas, people, infrastructure, business

[11] ONS (2017), 'Understanding firms in the bottom 10% of the labour productivity distribution in Great Britain: "the laggards", 2003 to 2015'

[12] Building the evidence base for productivity policy using business data linking. Criscuolo, C., Haskel, J., and Martin, R. (2003), Economic Trends 600

[13] Centre for Cities (2018) 'The Wrong Tail'

environment and places. These are supply side, cross-cutting drivers that underpin all productive economies.

Ideas

The role of innovation

2.38 An important driver of relatively slow UK productivity growth is lower levels of investment in research and development (R&D). Whilst studies by the OECD and Nesta show that **innovation accounts for 25-50% of labour productivity growth**. There is difficulty in translating scientific achievement into productivity, reflected in low R&D expenditure and low levels of patenting. R&D is important in making it possible for firms to absorb innovation from elsewhere.

Diffusion of technology

2.39 There is evidence that the difference between firms within sectors, particularly in the service sector, is increasing over time, and that diffusion of ideas, technologies and business practices is not diffusing from the 'best to the rest' as quickly as it once was, meaning that the best firms are accelerating away from rest[14].

2.40 An OECD study finds that firms at the global productivity frontier are over 10 times more productive than non-frontier firms in terms of labour productivity[15].

2.41 A general example of this is ICT. The adoption of basic IT like use of computers and laptops and access to internet are near saturation, whilst more sophisticated technology for e-commerce and business organisation is less prevalent. These include -

- E-commerce - website sales, electronic data interchange (EDI) sales and e-purchases

- Business organisation – the use of software for customer relationship management, supply chain management and enterprise resource planning

- ICT resourcing – hiring ICT specialists, outsourcing ICT services and/or providing employees with ICT training

2.42 An ONS study finds that the use of any combination of enterprise resource planning, customer relationship management and supply chain management technologies is associated with a **productivity premium of around 25%**[16].

2.43 There is a strong relationship between e-commerce and business organisation indicators and productivity in the services industry, but less so for production. Conversely, we find stronger productivity relationships among more ICT resource intensity categories in the production industry, relative to services[17].

Automation

2.44 The development and application of technology to control and monitor the production and delivery of goods and services is affecting businesses across all sectors and size bands.

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[14] Frontier Firms, Technology Diffusion and Public Policy - Micro Evidence from OECD Countries. Dan Andrews, D., Criscuolo, C., Gal, P.N. (2015), OECD Paris.

[15] Frontier Firms, Technology Diffusion and Public Policy - Micro Evidence from OECD Countries. Dan Andrews, D., Criscuolo, C., Gal, P.N. (2015), OECD Paris.

[16] ONS (2018) 'Information and communication technology intensity and productivity'

[17] ONS (2018) 'Information and communication technology intensity and productivity'

The introduction of new automatically controlled systems and processes can increase efficiency and reduce costs, raising productivity.

Infrastructure

2.45   Accessible infrastructure is essential for future growth and prosperity. Improvements to transport connectivity brings firms, consumers and suppliers closer together and influences investment. Clean and affordable energy holds down the cost of living and the cost of doing business. Digital infrastructure allows us to lead modern lives and to do business in the technologies and industries of the future.

People

The role of skills

2.46   In the run up to the financial crisis in the UK, the up-skilling of the workforce accounted for around **20% of total labour productivity growth**[18].

Management practices

2.47   Management practices can influence the deployment of skills in the workplace. An ONS and Economic Statistics Centre of Excellence (ESCoE) study found significance correlation between management practices and labour productivity[19].

2.48   Practices relating to continuous improvement and employment management – such as those relating to hiring, promotions, performance reviews, training and managing underperformance – were most correlated with productivity.

2.49   These more structured management practices are identified among larger, foreign-owned, non-family-owned and businesses with more-educated workers than among smaller, domestically-owned, family-owned and firms with less-educated workers. A separate study found that there is no regional variation in management practice.

Business environment

The role of competition

2.50   Increased competition increases productivity growth. It is driven by 'survival of the fittest', with competitive pressures on firms force them to improve[20].

Capital investment

2.51   Capital investment plays an important role in productivity growth. But the UK has less physical capital per worker than the United States and considerably less than France and Germany[21].

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[18] BIS (2015), 'UK skills and productivity in an international context'

[19] ONS (2018) 'Management practices and productivity in British production and services industries - initial results from the Management and Expectations Survey: 2016'

[20] ESRC Seminar Series, 'The UK's Productivity Gap'

[21] ESRC Seminar Series, 'The UK's Productivity Gap'

Exporting

2.52   ONS finds that UK businesses which declare international trade in goods were around 70% more productive on average than non-traders in 2016. The study highlighted that businesses which report goods exports or imports were around 21% and 20% more productive respectively than businesses which do not trade after controlling for their size, industry and ownership status.

2.53   These effects appear to differ between the EU and non-EU markets: the productivity premia associated with trading with non-EU markets are considerably larger than those associated with EU trade, suggesting that lower productivity businesses find it easier to access EU than non-EU markets[22].

2.54   A study found that the productivity gain is because the more productive firms self-select into export markets, exporting in itself does not necessarily improve productivity[23].

Foreign direct investment and labour productivity

2.55   An ONS study highlights differences in productivity between firms with FDI compared to firms with no FDI. Keeping size, industry, time and region constant, firms with inward FDI were 74% more productive than non-FDI firms; higher productivity outcomes among firms with outward than inward FDI, with the highest productivity outcomes among firms with both inward and outward FDI flows[24].

Place

2.56   Place is where the drivers of productivity come together, and this is not evenly distributed across the UK. The benefits of firms locating close together, or clustering, arise in the following ways –

- Low transport costs

- Costs of production may decline significantly as firms have competing multiple suppliers; greater specialization and division of labour

- A large supply of labor and thus the increased chance of supply and demand for labor, particularly for specialists to compensate for fast matching, lower search costs

- Knowledge spillovers between firms

A note on Key Emerging Technologies

2.57   Traditionally, economists have placed the accumulation of conventional factors of production such as land, labour and capital as the primary focus of economic growth. Where technology was considered, it was regarded as an either exogenous element in measurements of Total Factor Productivity (TFP), or as an endogenous, incremental component related to the development of social capabilities and growth inducing

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[22] ONS (2018) 'UK trade in goods and productivity: new findings'

[23] Wagner, J (2005): Exports and productivity: a survey of the evidence from firm level data, Working Paper Series in Economics, No. 4, Universität Lüneburg, Institut für Volkswirtschaftslehre, Lüneburg

[24] ONS (2017), 'Foreign direct investment and labour productivity, a micro-data perspective: 2012 to 2015'

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institutional structures.[25] With the exception of Schumpeter, few focused on the role of drastic innovations that introduce discontinuities into the growth process.[26]

2.58 The notion of General-Purpose Technologies (GPTs) emerged in the 1990s to explain and explore these discontinuities. General Purpose Technologies are technologies that, over time, become pervasive and widely applied across all sectors and all types of businesses. They are transformative, allowing new markets, industries and business models to emerge. They are also disruptive, killing off old business models and accelerating industrial decline. They can be physical (the steam engine, the printing press), but might also constitute a process or an organisational innovation.[27]

2.59 As the notion of GPTs became accepted by growth economists, the idea of Key Enabling Technologies (KETs) emerged as adjunct to the central thesis. KETs were seen as the individual conduits through which GPTs could spread through an economy. KETs are generally knowledge and capital-intensive technologies associated with high research and development (R&D) intensity. They are marked by rapid and integrated innovation cycles, high capital expenditure and highly-skilled employment.

2.60 Joel Mokyr's ground-breaking research distinguished between micro and macro inventions. Macro-inventions are those that change society in a significant way, transcend the technological area of their initial applications, and lead to a multiplicity of micro-inventions. Micro-inventions include the process and product modifications that often constitute much of research and development (R&D).[28] These micro-inventions, over time, bring an initially crude idea or model to commercial viability and extend the application of the original idea to fields and applications not considered by the original inventor. Micro- and macro-inventions are bound together, with each playing important roles in enabling the other.

2.61 These ideas place a premium on adaptability, technical prowess and commerciality. Pure research is of no use unless it can be turned into practical solutions which are commercially viable. Here a technician's input in the laboratory may be crucial in overcoming production difficulties unforeseen by research professionals; while a researcher's understanding of marketing strategy may alter the direction and scope of a particular drug's development. Compare for example the following two quotations from Sir Henry Bessemer, inventor of the Bessemer Converter which revolutionised the production of steel in the 1850's. The comments speak loudly of an on-going struggle in balancing invention with practicality and commercial success

> "At this period the enthusiasm of the amateur was fast giving way to a more steady commercial instinct, and I let no opportunity slip of improving my position, but I felt that I was still labouring under the disadvantage of not having acquired some technical profession.
>
> I fear this little episode does not speak very favourably for my business capacity in those early days, for I certainly ought to have made much more than I did by this really important invention." [29]

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[25] One of the most concise reviews of wider growth literature remains Crafts (1995) 'The Golden Age of Economic Growth in Europe', Economic History Review, (3) pp.429-447.

[26] Schumpeter, J.A. (1939) Business Cycles A Theoretical, Historical, and Statistical Analysis of the Capitalist Process. McGraw-Hill, New York

[27] A good explanation may be found in Anderson, Brinkley & Hutton (2011) Making the UK a Global Innovation Hub: How business, finance and an enterprising state can transform the UK", Big Innovation Centre Report

[28] Mokyr, J. (2009) The Enlightened Economy, Yale University Press, New York.

[29] Dudley (2010).

Implications for the Current Study

2.62   From a practical point of view this type of analysis suggests that any investigation into productivity should be focused on workplace-based learning and innovation as well as major technological breakthroughs and academically-led research and patent activity.

2.63   The literature also suggests that an emphasis should be placed on cross-sectoral technologies and approaches, an ideal embraced and codified in the UK's current approach to Industrial Strategy (see below).

3. UK Policy Context

3.1　In Autumn 2017, the Government published the UK Industrial Strategy (IS) which positions productivity growth and prosperity as central goals. The Industrial Strategy is about coordinating a range of economic policies to achieve particular objectives, it charts a plan for how we will build a Britain fit for the future - help businesses create better, higher-paying jobs across the UK with investment in the skills, industries and infrastructure of the future.

3.2　In contrast to past industrial strategies that fell back on 'picking winners' and state subsidies - and were heavily criticised for doing so - the Government's approach has been to emphasise the supply side of the economy and the key elements needed to drive economic growth. The IS takes on the hallmarks of different approaches to Industrial Strategy and can be described as a "blended" approach: involving horizontal policies (the foundations), sectoral or more selective policies (sector deals) and mission-based policies (through Grand Challenges)[30]. This section will outline the headline elements of the Industrial Strategy and the most notable funding announcements.

3.3　The Industrial Strategy Green Paper proposed 10 foundations of productivity, which were subsequently condensed into five foundations in the Industrial Strategy White Paper: ideas, people, infrastructure, places and business environment, with a vision for -

- The world's most innovative economy
- Good jobs and greater earning power
- A major upgrade to the UK's infrastructure
- The best place to start and grow a business
- Prosperous communities across the UK

3.4　These five attributes are what the Industrial Strategy argues are "essential attributes of every successful economy". The Government argues that many of the foundations will be strengthened through the process of tackling challenges facing modern society. These are both disruptors to the status quo as much as they are new opportunities for innovation and new market opportunities. This is the most future looking aspect of the strategy.

3.5　The IS articulates 4 Grand Challenges –

1)　**AI and Data** - the importance of data to the economy, and the increasing prevalence of AI provide an opportunity for the UK's high skilled economy to become a world leader in these fields.

2)　**Future of Mobility** - the opportunities presented by modernising the transport network and infrastructure are great. This includes improving the connections between cities, encouraging the growth of electric vehicles and ensuring automation can be adopted safely.

3)　**Clean Growth** - ensuring that the UK is able to continue the move towards a less carbon reliant economy with the adoption of 'clean' technology across the economy.

4)　**Ageing Society** - A rapidly aging society poses a number of health and labour market challenges across the UK economy.

3.6　A clear message in the Industrial Strategy has been that Government – and local governments and LEPs – have a key role to play in supporting the development and growth of new industries. It also brings the role of place into focus, recognising that productivity

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[30] House of Commons Library (2018), 'Briefing paper – Industrial Strategy'

outcomes and economic interactions play out in cities, towns and rural communities across the UK.

Headline policies and spending commitments

3.7   The policies, alongside others introduced but not detailed here, are the first strategic actions of a long-term approach to transform productivity and earnings power as a country, as businesses, places and individuals.

Table 3.1 Key policies by foundation of productivity[31]		
Ideas	**R&D, innovation and the challenge of bringing scientific ideas to market**	R&D investment raised to 2.4% of GDP by 2027 (including £12.5 billion more public R&D investment by 2021/22)
		R&D tax credit increased from 11% to 12% in January 2018
		£725 million over four years invested in Wave 2 of the Industrial Strategy Challenge Fund. This competitive funding programme will address themes related to the Grand Challenges
		UK Research and Innovation (the research funding council for universities in the UK) will work to increase global investors' activities taking place in the UK
People	**Skills, retaining and the labour market**	New technical education system as recommended in the Skills Plan, including 'T Levels' (emphasising technical skills) and apprenticeships
		Invest £400 million in maths, digital and technical education
		Create a National Retraining Scheme by the end of the Parliament, including £64 million investment for digital and construction retraining
		Increase ethnic minority employment and employment of disabled people and support carers into work
Infrastructure	**Transport, digital and housing**	National Productivity Investment Fund increased to £31 billion by 2022/23 to develop transport, housing and digital (of which £24 billion already allocated)
		Electric vehicle infrastructure (such as charging points and battery grants) investment increased by £100 million
		Digital infrastructure investment in 5G, rural broadband and data accessibility

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[31] HM Government (2017) 'Industrial Strategy, 'Building a Britain fit for the future'

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Business Environment	**Increasing SME productivity and encouraging more start-ups**	Sector Deals a major component in this area. The Deals will be used to overcome specific issues that particular industries face
		Create an "incubator" fund within the British Business Bank with the aim of "unlocking £7.5 billion investment from the private sector for potentially high growth new businesses
		Increase productivity in SMEs through a range of policies including encouraging the adoption of modern business practices, ensuring businesses have access "local growth hubs" which give access to expertise and networking opportunities and developing more policies to support supply chains
Places	**Tackling regional disparities in productivity and economic performance**	Local Industrial Strategies to deliver economic growth across the UK, helping to develop high growth clusters where appropriate
		Transforming Cities Fund providing £1.7bn to develop transport links between cities
		£42m to pilot a Teacher Development Premium that will help develop high quality teachers in areas with lower performing schools

Source: HM Government (2017), 'Industrial Strategy'

Sector Deals

3.8   The Government has partnered with industry to understand sector specific challenges and create opportunities to boost productivity, employment, innovation and skills. This approach has been trialled by successive Governments seeking to establish close relations with sectors viewed as significant to the UK economy. A notable partnership has been between the Automotive Council, established in 2009 to combat the pressures posed by the financial crisis. The aim is to generate this same level of close collaboration with other industries.

- **Aerospace** – Position the UK to take advantage of the global move towards hybrid-electric and electric propulsion as well as exploiting valuable emerging markets such as drones and urban air mobility.

- **Artificial intelligence** – Advance our AI and data-driven economy grand challenge, anchoring the UK as the go to destination for AI innovation and investment.

- **Automotive** – Ensure that the UK continues to reap the benefits from the transition to ultra-low and zero-emission vehicles by continuing to build the agile, innovative and cost competitive supply chain needed to secure international investment.

- **Construction** – Boost the sector's productivity through greater investment in innovation and skills, creating new and well-paid jobs and maximising its export potential. This will also reduce the environmental impact, improve the efficiency and reduce whole life cost of new projects and buildings to help build the houses, schools, hospitals and major transport projects we need.

- **Creative industries –** The deal builds on the recommendations of Sir Peter Bazalgette's independent review of creative industries, which explored the challenges facing a sector comprised of firms rich in intellectual property.

- **Life Sciences –** Ensure new pioneering treatments and medical technologies are produced in the UK, improving patient lives and driving economic growth.

- **Nuclear -** Ensure that the UK's nuclear sector remains cost competitive with other forms of low-carbon technologies to support our Clean Growth Strategy and Grand Challenge.

- **Offshore wind -** Build on the UK's global leadership position in offshore wind and maximise the advantages for UK industry from the global shift to clean growth, consistent with the Clean Growth Grand Challenge.

- **Rail –** Set out a new approach to the rail industry and the government working in partnership to transform the rail sector by taking actions to increase the use of digital technology, boost productivity, improve the service received by those who use our railways and build the skills of the UK workforce to capitalise on these opportunities.

4. What do we know about West and North Yorkshire?

- The Yorkshire and Humber economy is transitioning from an economy that relies on large-scale heavy industry, manufacturing, textiles and agriculture to a more diverse market. Despite this, manufacturing remains important for the area, more so than in other UK regions.

- In terms of productivity, GVA per hour is £29, which is lower output per hour than the English average. However, since 2012, productivity has increased by 12%.

- North and West Yorkshire has the largest business stock of all comparator areas, 136,740 in 2018, which constitutes 5% of the English business base. 17% growth between 2013 -18 was 4% slower than the English average.

- Business starts per 1,000 residents is a measure of an enterprising economy and on this measure, North and West Yorkshire falls below the English average with 4.4 business starts per 1,000 residents. In the same year, more businesses closed than started per 1,000 residents, which suggests there is a challenging environment for start-ups in the local economy.

- At the broad industrial grouping, the economy is specialised in warehousing and logistics, transport, wholesale, manufacturing in both the number of businesses and number of employees.

- The most significant export location for North and West Yorkshire is the US and The Netherlands is the most significant import location. The value of imports is more than twice the value of exports and for both imports and exports the share of trade with the EU is above the English average.

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4.1   For the purposes of this study, the North and West Yorkshire area is defined as cover the proposed new LEP geography [32] of West and North Yorkshire which includes the districts of Bradford, Calderdale, Leeds, Wakefield, Kirklees, York, Selby, Harrogate, Craven, Hambleton, Scarborough, Richmondshire and Ryedale.

Figure 4.1 Study Geography

Source: North and West Yorkshire (2019)

4.2   From previous work in the region, we know that Leeds City Region has a large base of manufacturers with a wide range of skills and specialities. Although all sub-sectors are relatively well-established and have solid employment base, the City Region's advanced manufacturing businesses tend to operate across sectors and supply chains rather than being ordered behind a major prime/OEM. This means there is no single landmark business or market around which to develop the area's reputation, but it does point to a resilience and breadth in its manufacturing business base. At the same time, the area benefits from a strong professional services sector which hosts several regional headquarters of larger UK organisations e.g. Asda, Tetley's Brewery and GHD.

4.3   The area of North Yorkshire is currently part of the wider region of Yorkshire and Humberside. The Yorkshire and Humber economy is in transition as it moves from an economy that relied on large-scale heavy industry, manufacturing, textiles and agriculture to a more diverse market. However, manufacturing and other traditional industries are still important for the region and although the numbers employed in this sector have fallen and are likely to continue to fall in the next five years, output in the sector is forecast to grow and it will remain important to the region, more so than in other UK regions. Manufacturing currently accounts for just under a fifth of the region's economy (13.7% of the Gross Value Added in 2015). Services feature heavily in the regional economy but to a lesser extent than in other regions. It has a higher percentage of firms in distribution, hospitality, manufacturing and public administration than in other regions whilst there is a smaller proportion of firms in banking, finance and insurance and other services. The growth sectors of the economy include digital industries, environmental technologies, financial

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[32] The map shows the proposed revised LEP geography covering North and West Yorkshire.

services, construction, retail, real estate and public services - primarily for health and education.

Productivity and Economic Contribution

4.4   Using the ONS preferred measure of labour productivity, Figure 4.2 illustrates the performance of North and West Yorkshire in 2017. Amongst comparators, the two areas were among those with lower output per hour than the English average.

Figure 4.2 GVA per Hour, 2017
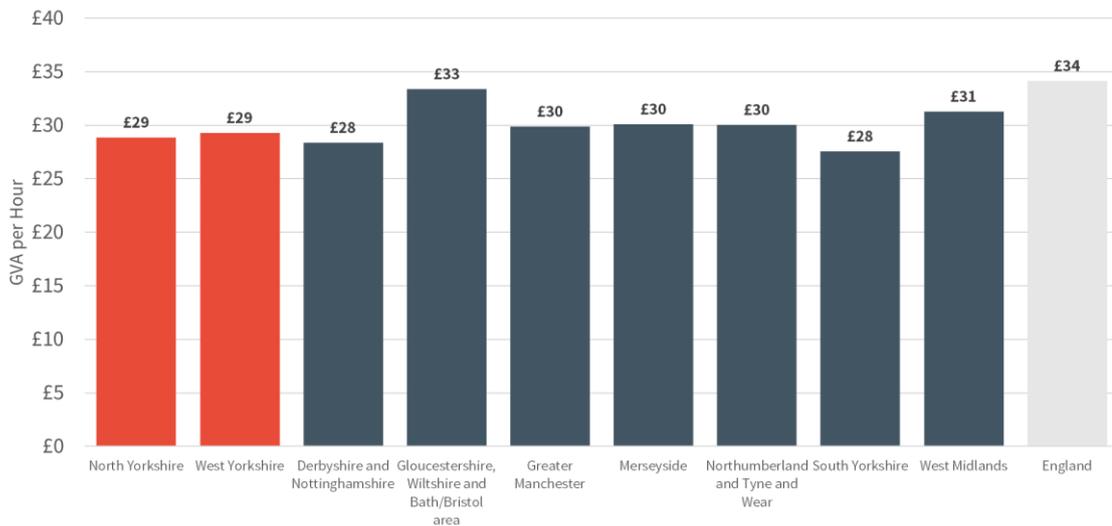
Source: ONS Regional and Subregional Productivity, 2019

4.5   There has been significant improvement in productivity performance in the last five years. The combined GVA per hour growth of North and West Yorkshire was above the English rate of growth and only surpassed by the West Midlands in terms of comparator areas. Growth in the output per hour demonstrates increasing values in final product or service and/or a more efficient conversion of inputs to outputs.

Figure 4.3 GVA per Hour Growth, 2012-2017
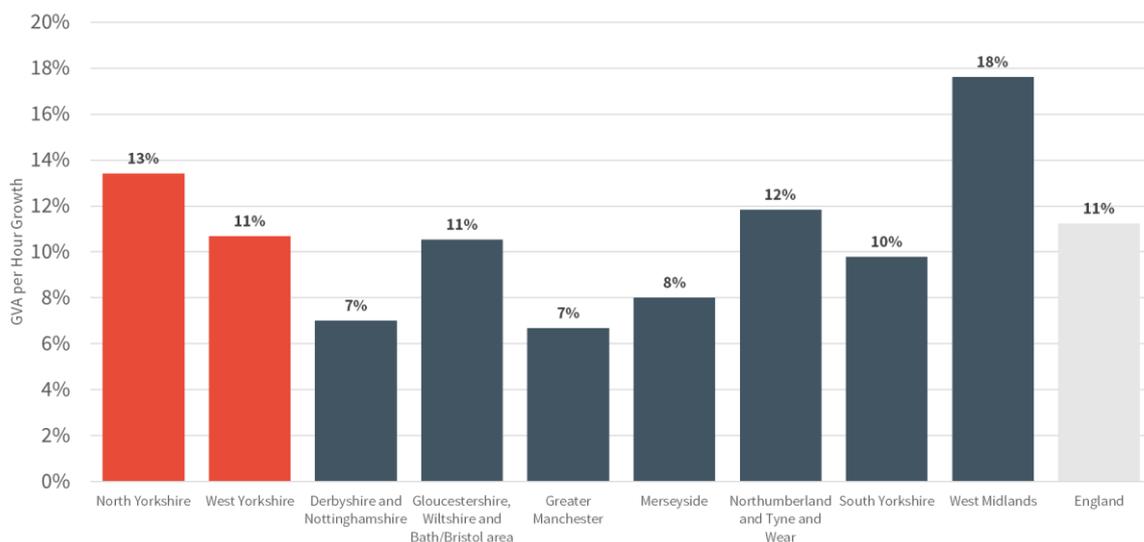
Source: ONS Regional and Subregional Productivity, 2019)

Business Base

4.6   North and West Yorkshire has the largest business stock of all comparator areas, 136,740 in 2018, which constitutes 5% of the English business base.

4.7   The business stock grew 4% slower than the English average between 2013 -18, but on a par with comparators Northumberland and Tyne and Wear, Gloucestershire, Wilshire and Bath/Bristol area and Derbyshire and Nottinghamshire.

Figure 4.4 Business Growth, 2013-18
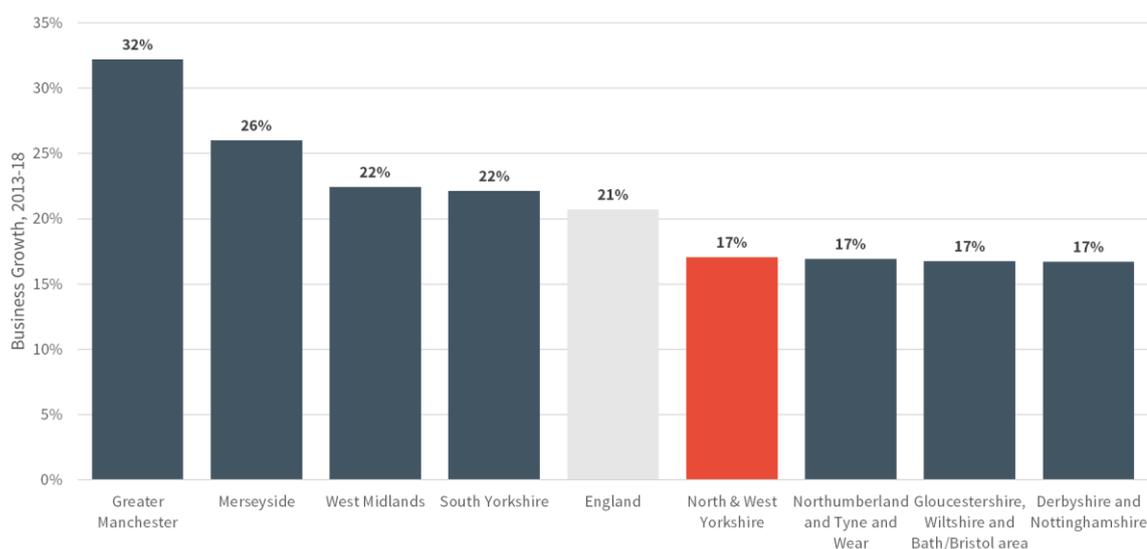
Source: UK Business Counts, 2013, 2018

4.8   The structure of the business base is largely consistent across the country and at the broad level there is limited variation in the proportion of micro, small, medium of large businesses. The most significant portion of the business base is made up of firms with 0-4 employees in the micro size band.

Table 4.1 Business Size, 2018

Area	Total	Micro	Small	Medium	Large
Northumberland and Tyne and Wear	49,135	80%	16%	3%	1%
West Midlands	103,520	82%	14%	3%	1%
Merseyside	52,305	82%	14%	3%	1%
South Yorkshire	46,630	81%	15%	3%	1%
Greater Manchester	123,720	84%	13%	3%	0%
North & West Yorkshire	136,740	83%	14%	3%	0%
Gloucestershire, Wiltshire and Bath/Bristol area	123,295	84%	13%	3%	0%
England	2,697,200	85%	12%	3%	0%
Derbyshire and Nottinghamshire	86,500	82%	14%	3%	0%

Source: UK Business Counts, 2018

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Figure 4.5 Business Starts per 1,000 Residents, 2017
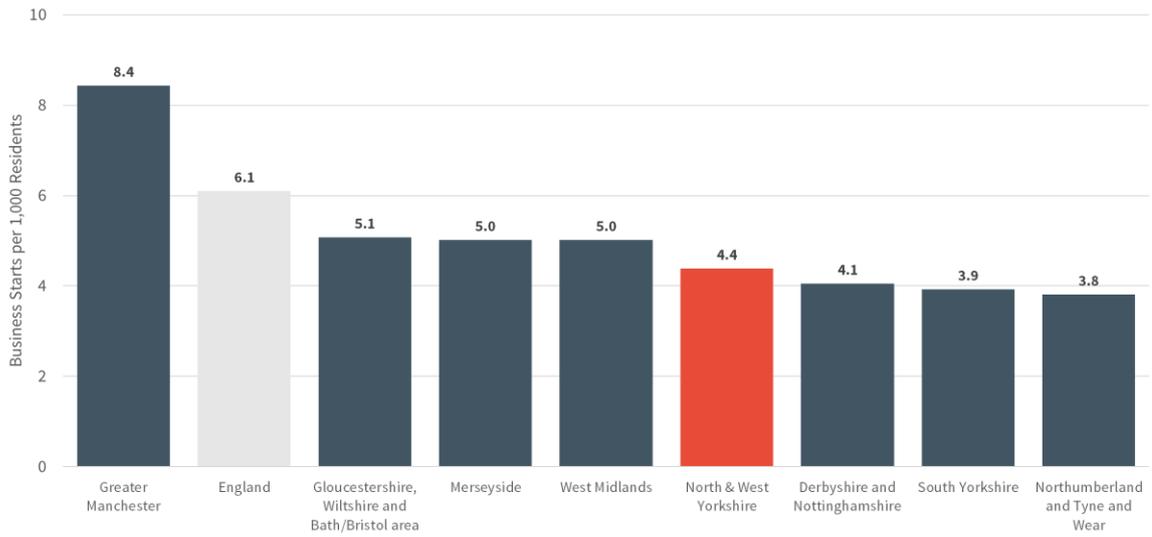
Source: ONS Business Demography, 2017

The number of business starts and the survival rate of new businesses are strong indicators of business dynamism. Business starts per 1,000 residents is a measure of an enterprising economy and on this measure, North and West Yorkshire falls below the English average with 4.4 business starts per 1,000 residents. Of all the comparators, only Greater Manchester has more business starts than the English average.

Figure 4.6 Net Business Starts per 1,000 Residents, 2017
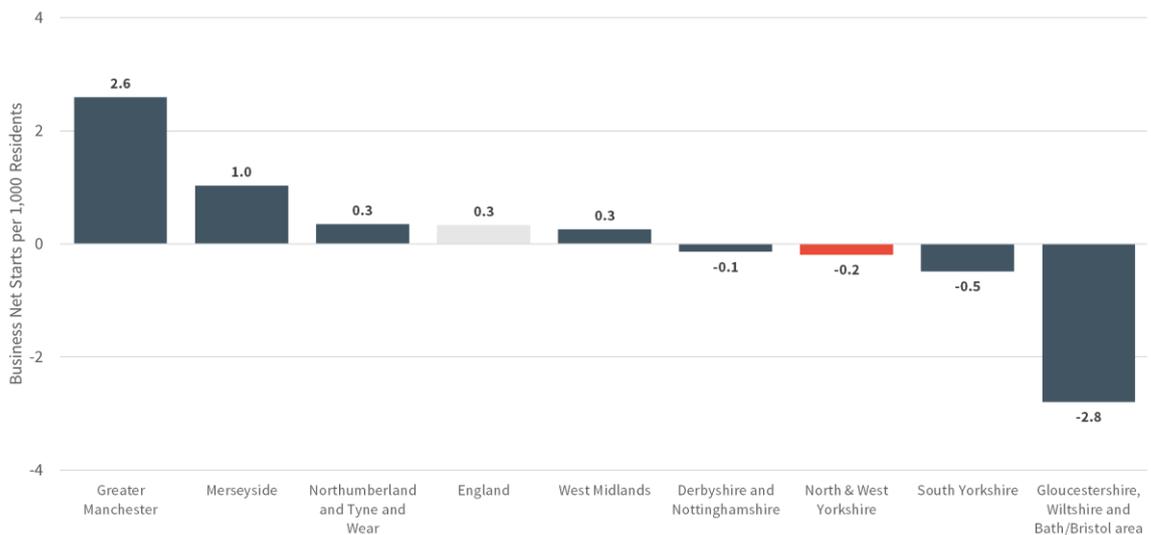
Source: ONS Business Demography, 2017

4.9   Figure 4.6 tracks the number of business starts per 1,000 residents less business closures per 1,000 residents in 2017. Given more businesses closed than the number of businesses started, the net result is negative, this suggests there is a challenging environment for start-ups in the local economy. Overall in England in 2017, the environment was one in which more businesses survived than not.

Table 4.2 Sector Profile (2013-2018)								
	Businesses				Employment			
Sector	No.	%	LQ	Change 2013-18	No.	%	LQ	Change 2012-17
Public Admin, Education, Health	12,500	9%	1.1	11%	370,000	**25%**	1.0	-2%
Financial and Professional Services	24,100	**18%**	0.9	22%	191,700	**13%**	1.0	20%
Retail	18,200	**13%**	1.1	4%	161,400	**11%**	1.0	13%
Hospitality, Leisure and Recreation	13,500	10%	1.2	19%	150,300	10%	1.0	25%
Manufacturing	7,700	6%	**1.2**	6%	145,800	10%	**1.3**	4%
Business Support Services	9,100	7%	0.8	**41%**	130,500	9%	1.0	**36%**
Construction	13,700	**10%**	0.9	20%	68,800	5%	1.0	9%
Wholesale	6,300	5%	1.1	-2%	65,800	5%	**1.1**	2%
Transport	4,600	3%	**1.2**	**65%**	45,400	3%	1.1	18%
ICT & Digital	6,600	5%	0.7	27%	37,500	3%	0.7	**26%**
Warehousing and Logistics	2,100	2%	**1.2**	**79%**	33,100	2%	**1.2**	**35%**
Creative	4,200	3%	0.6	16%	21,400	1%	0.6	-29%
Other Services	4,600	3%	1.0	20%	19,000	1%	0.8	-13%
Utilities and waste	800	1%	1.0	21%	14,700	1%	0.9	-6%
Agriculture and Mining	8,600	6%	**1.6**	6%	2,100	0%	0.1	-52%
	4,200	100%	1.0	17%	21,400	100%	1.0	10%

Source: UK Business Counts, 2013-18, Business Register and Employment Survey, 2012-17

4.10 Figure 4.2 highlights the level of specialisation relative to England, by the number of people employed in those sectors and the number of businesses operating at the broad industrial grouping. Fastest growth in the number of businesses can be seen in the warehousing and logistics sector, the transport sector and in business support services, with 79%, 65% and 41% increases in the number of businesses respectively. Industrial specialisation exists in manufacturing, transport, warehousing and logistics and agriculture and mining.

4.11 In the distribution of employment, growth has been significant in business support services, ICT and digital and warehousing and logistics, establishing specialisation in these industries.

4.12 In the sectors of warehousing and logistics, transport, wholesale, manufacturing, there is concentration in both the number of businesses and employees.

Exports and Trade

4.13   The following tables provide a breakdown of the flows of goods imported and exported between North and West Yorkshire and other countries.

4.14   Table 4.3 demonstrates that the US is the most significant export location for North and West Yorkshire, however within this group, the value of exports going to Europe exceeds those goods going to non-EU locations.

Table 4.3 North & West Yorkshire top 10 Export Locations	
Location	**Value (£m)**
USA	951
Netherlands	670
Germany	660
France	564
Irish Republic	541
Belgium	345
Italy	336
China	243
Spain	221
Sweden	180

Source: HM Revenue & Customs, 2017

4.15   A similar trend is observed with the location of imports, with the value of imports from the EU surpassing those goods originating in countries outside Europe. The Netherlands is the most significant import location, which can be attributed to geographical proximity.

Table 4.4 North & West Yorkshire top 10 Import Locations	
Location	**Value (£m)**
Netherlands	4,173
China	2,005
Germany	1,727
USA	1,577
France	702
Belgium	608
Italy	521
Irish Republic	430
Turkey	335
India	304

Source: HM Revenue & Customs, 2017

4.16   The value of imports coming into North and West Yorkshire is more than twice the value of exports, a trend which is reflected in all comparator areas, bar the West Midlands. Of all the areas compared, North and West Yorkshire has amongst the highest share of trade with the EU and for both imports and exports the share of trade with the EU is above the English average.

4.17   North and West Yorkshire has the largest number of businesses importing and exporting of all the comparators. Given that the value of exports lag behind areas like

Gloucestershire, Wiltshire and Bath/Bristol area, the West Midlands and Derbyshire and Nottinghamshire, the implication is that there are more small businesses exporting less, or that those businesses are exporting lower value goods.

Table 4.5 Exports and Imports in goods, 2017						
Type	Exports			Imports		
Area	Value (£m)	Share of Trade with EU	Business Count	Value (£m)	Share of Trade with EU	Business Count
North & West Yorkshire	**7,591**	**56%**	**55,648**	**16,244**	**60%**	**35,957**
Greater Manchester	6,660	57%	46,176	13,049	50%	30,513
Gloucestershire, Wiltshire and Bath/Bristol area	13,433	45%	42,575	16,114	40%	26,420
Merseyside	6,101	40%	21,222	6,343	56%	14,656
West Midlands	17,795	38%	40,355	15,220	61%	26,767
Derbyshire and Nottinghamshire	12,299	50%	33,674	12,230	54%	20,520
South Yorkshire	3,410	60%	24,324	4,430	55%	14,784
Northumberland and Tyne and Wear	7,859	59%	22,105	8,097	61%	15,524
England	328,380	49%	153,046	468,384	55%	232,537

Source: HM Revenue & Customs, Regional Trade in Good Statistics data 2017

5. Results (1): Sector Profile and Geographies

5.1   Appendices A and B provide a methodological discussion of how the sector profiling and geographic analysis was undertaken.

5.2   The purpose of this chapter is to summarise key patterns, to explain the questions this analysis could address and to suggest policy implications arising from the findings.

5.3   **The full result of this exercise is provided in Appendix E.**

Table 5.1 North and West Yorkshire Sector Profile			
Sector	Identified Companies	Proportion of Total Businesses	Total Number of Businesses
Agri-Tech	84	40%	210
AI and Data	603	NA	NA
Clean Growth	89	NA	NA
Creative	131	1%	12,605
Digital	980	13%	7,705
Energy	251	9%	2,925
Fintech	219	NA	NA
Food and Drink	1,626	17%	9,365
IoT	32	NA	NA
Manufacturing	177	2%	7,710
Medicine Manufacturing	93	30%	310
Retail	304	2%	18,200
Science and R&D	340	NA	NA
Telecoms	741	NA	NA
Transportation components	436	NA	NA
Waste	143	25%	565
Total	**5,079**	**4%**	**136,740**
Accommodation and Food Services*	1,193	12%	9,980
Agriculture, Forestry and Fishing*	225	3%	8,490
Construction*	3,675	27%	13,685
Health and Care*	1,591	20%	8,090
Transport and Logistics*	812	12%	6,720

Source: Hatch Regeneris/Data City (2019), UK Business Counts
* indicates sectors defined by SIC code only

5.4   Table 5.1 summarises the sector profiles that have been generated through this approach. As a result of the sector definition process, in some cases, there is no straightforward way to compare official statistics with the study definitions. Nonetheless, the table does show that we have been able to achieve reasonably strong representation across all sectors.

5.5   The next stage of the work was designed to assess the degree to which activities are integrated across different sectors. Section 2 demonstrates how future productivity growth is likely to be centred on those businesses best able to borrow from techniques and innovations pioneered in other areas. We have therefore taken our bespoke AI and keyword derived prime sector definitions and cross-referenced them with the second best matched broad sector definition. This gives an independent measure of

cross-sector integration and allows us to test (for example) the degree of adoption of AI techniques in other sectors. We provide some examples of our findings below. It should be noted that for some areas, no AI derived second-match was defined. This was because there was no appreciable cross-over indicated by keyword analysis.

Figure 5.1 Sector Map of the AI and Data Sector

603
companies in North & West Yorkshire

North & West Yorkshire Companies Crossing Over to Other Sectors

Digital 65
Fintech 14
Food and … 5
Ma… 2
Telecoms 347

693
companies in Greater Manchester

Greater Manchester Companies Crossing Over to Other Sectors

Transportation components 3
Digital 92
Fintech 20
Foo… 2
IoT 15
Ma… 2
Retail 11
Telecoms 406
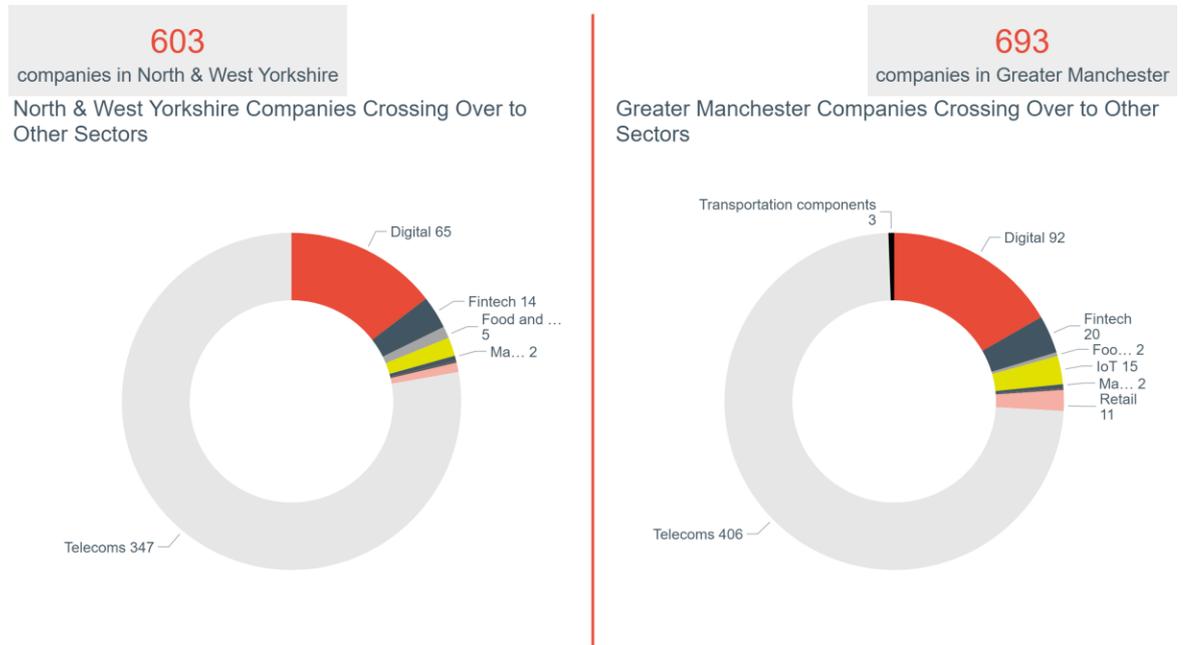
Source: Hatch Regeneris/DataCity (2019)

5.6   Figure 5.1 shows a pattern of interdependence between AI and other sectors which broadly matches the comparator economies of Greater Manchester and England. **This belies the notion that the North and West Yorkshire are in any way laggards in recognising the potential of transformative techniques and cross-sector opportunities**. A similar pattern is shown is we consider the Digital arena (Figure 5.2). Here, the North and West Yorkshire area shows a greater cross-over in transportation, Food and Drink and Creative.

Figure 5.2 Sector Map of Digital Activities
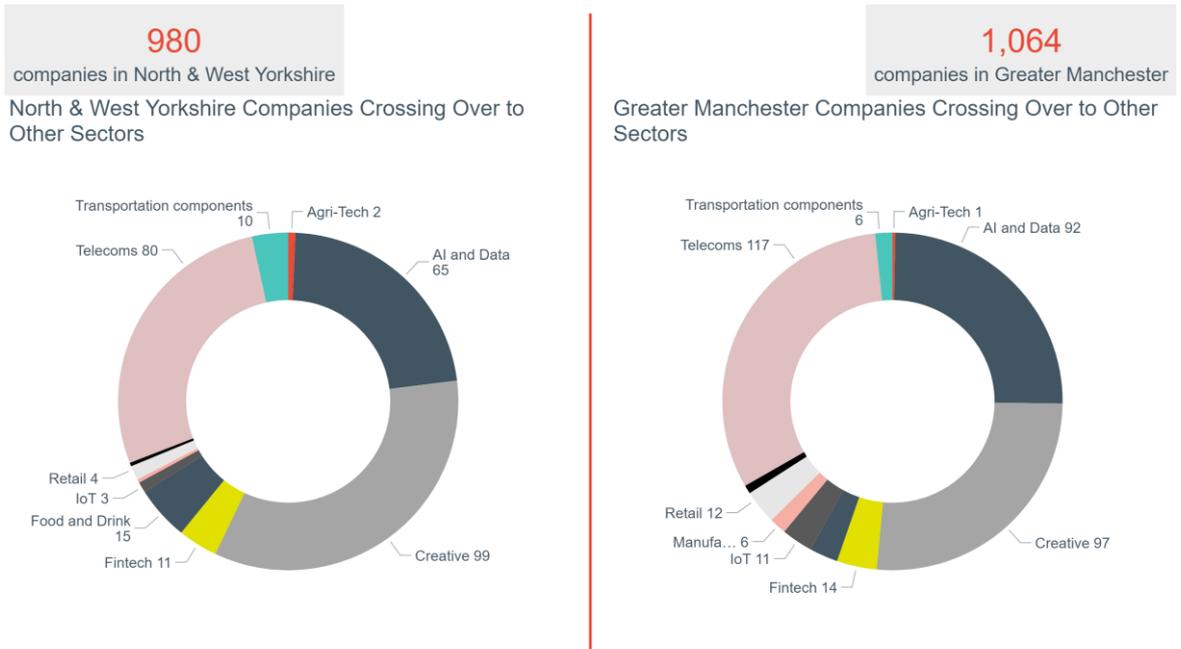
Source: Hatch Regeneris/DataCity (2019)

5.7 The Internet of Things (IOT) category (Figure 5.3) hints at a greater degree of digital integration and connectivity in West and North Yorkshire than in Greater Manchester. The IoT sector is itself likely to be more functionally attuned to other processes. This is because IoT is better regarded as a current and future embedded technology across all sectors.

5.8 In this respect, North and West Yorkshire appears to be more integrated across transportation, food and drink, and telecoms. Moreover, there appears to be a broader spread of 'connectiveness' across the economy as a whole.

Figure 5.3 Sector Map of Internet of Things
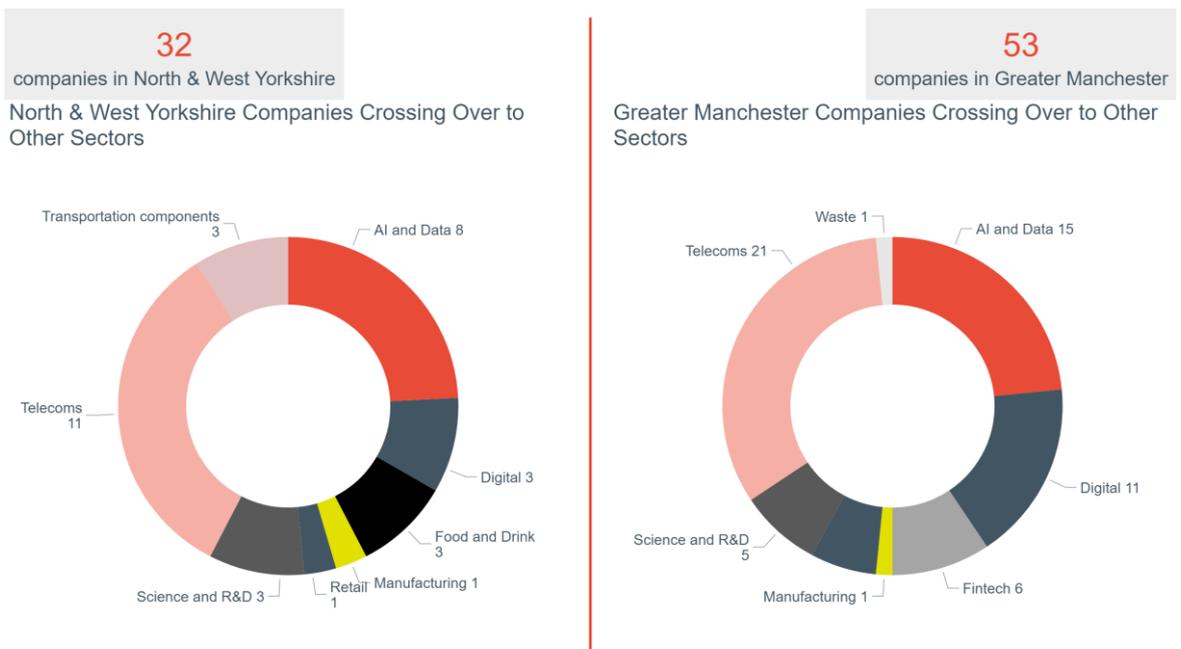
Source: Hatch Regeneris/DataCity (2019)

5.9 Our analysis also indicates this sector remains an urban focused activity, centred largely within and around the Leeds and York boundaries (see Figure 5.4).

Figure 5.4 Location of 'IoT' Defined Companies
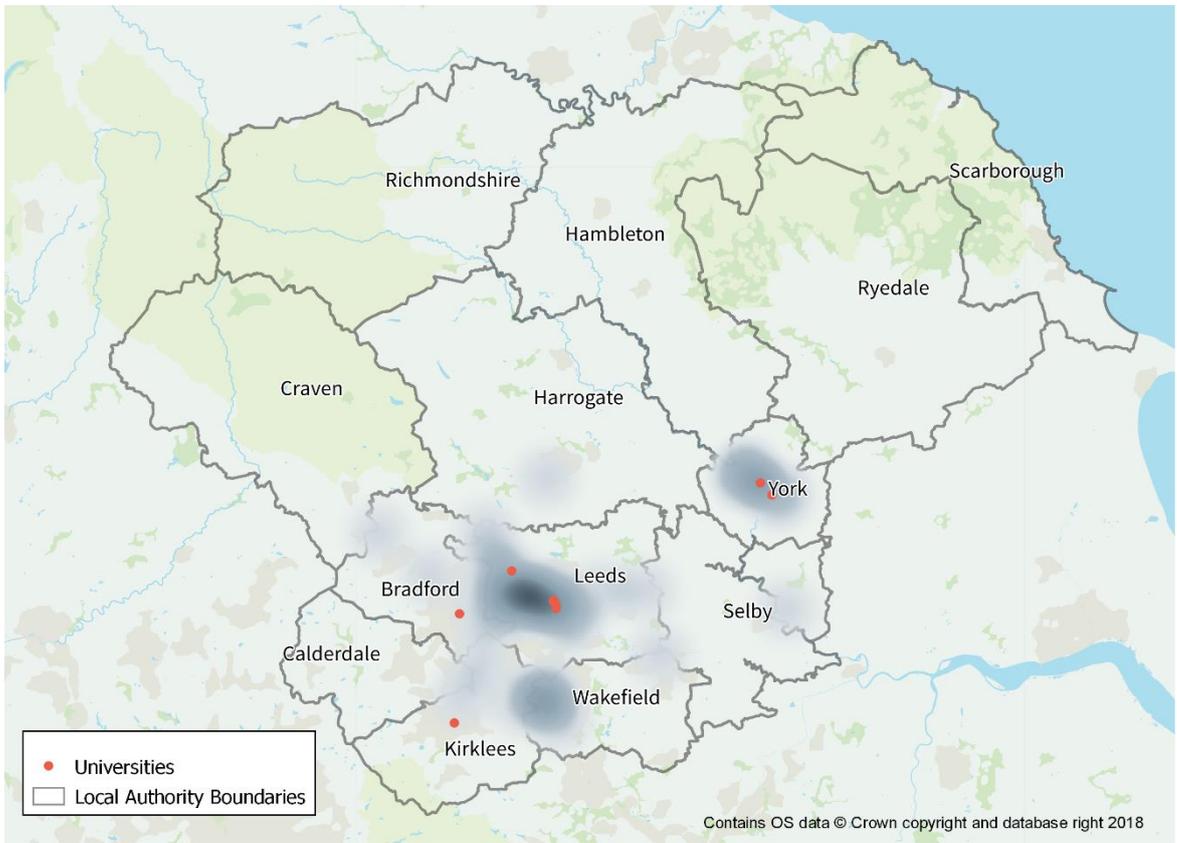
Source: Hatch Regeneris/DataCity (2019)

5.10 Integration and versatility come out strongly in a wider analysis of manufacturing activity (Figure 5.5). Relative strength here centres on energy, food and drink and transportation. By contrast, manufacturing seems more embedded in the science sector in Greater Manchester.

Figure 5.5 Sector Map of Manufacturing

176
companies in North & West Yorkshire

North & West Yorkshire Companies Crossing Over to Other Sectors

- AI and Data 2
- Digital 1
- Energy 14
- Food and Drink 16
- IoT 1
- Science an… 7
- Transportation components 13

175
companies in Greater Manchester

Greater Manchester Companies Crossing Over to Other Sectors

- AI and Data 2
- Clean Growth 3
- Digital 6
- Energy 8
- Fintech 2
- Food and Drink 4
- IoT 1
- Retail 2
- Science and … 13
- Transportation components 4

Source: Hatch Regeneris/DataCity (2019)

5.11   Manufacturing locations are shown in Figure 5.6, which illustrates trading locations of different undertakings. The distinction between trading and registered addresses is important, as the AI based method allows the analysis to focus on where economic activity is happening, rather where companies have headquarters functions.

Figure 5.6 Location of Manufacturing Activity
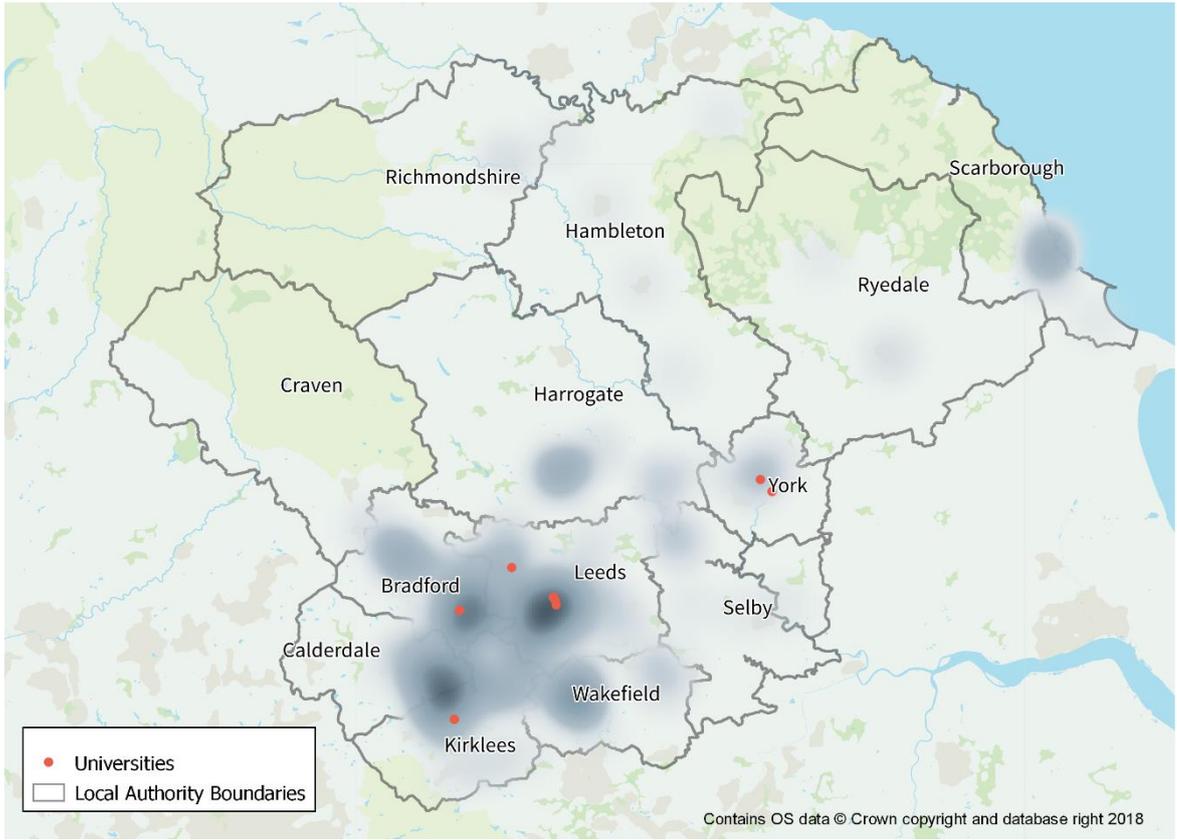
Source: Hatch Regeneris/DataCity (2019)

5.12   The Fintech sector's cross-over pattern is shown in Figure 5.7

Figure 5.7 Fintech sector cross-over
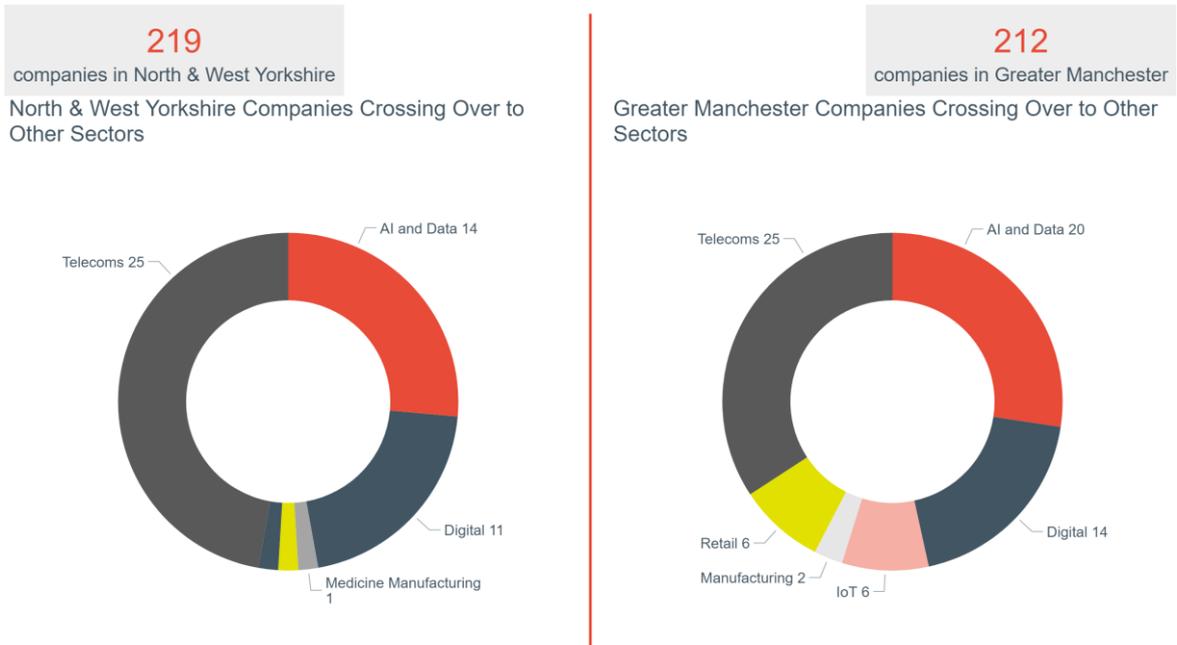
Source: Hatch Regeneris/DataCity (2019)

5.13   Here the pattern of interdependence in West and North Yorkshire is slightly narrower than in Greater Manchester. In particular, links with IoT, manufacturing and retail are absent. This suggests that Fintech is less well integrated across these other activities.

5.14   Full sector maps of all the AI defined areas are provided in Appendix E. It should be noted that for some sectors, the results are not entirely diagnostic. Agri-tech appears well-defined and self-contained. The only significant cross-over in the Creative Sector is with Digital technologies. Similarly, Clean Growth is dominated by Energy related cross-overs.

6. Results (2): Productivity Analysis and Related Questions

6.1 The basis of our research approach to 'productivity' is that the websites of sample firms in the target and comparator geographies contain certain keywords that can be regarded as 'high productivity' markers. These productivity markers were based on a simple review of management journals and Hatch Regeneris experience with working on similar assignments. The productivity markers were then tested with the client group and applied to the DataCity sample.

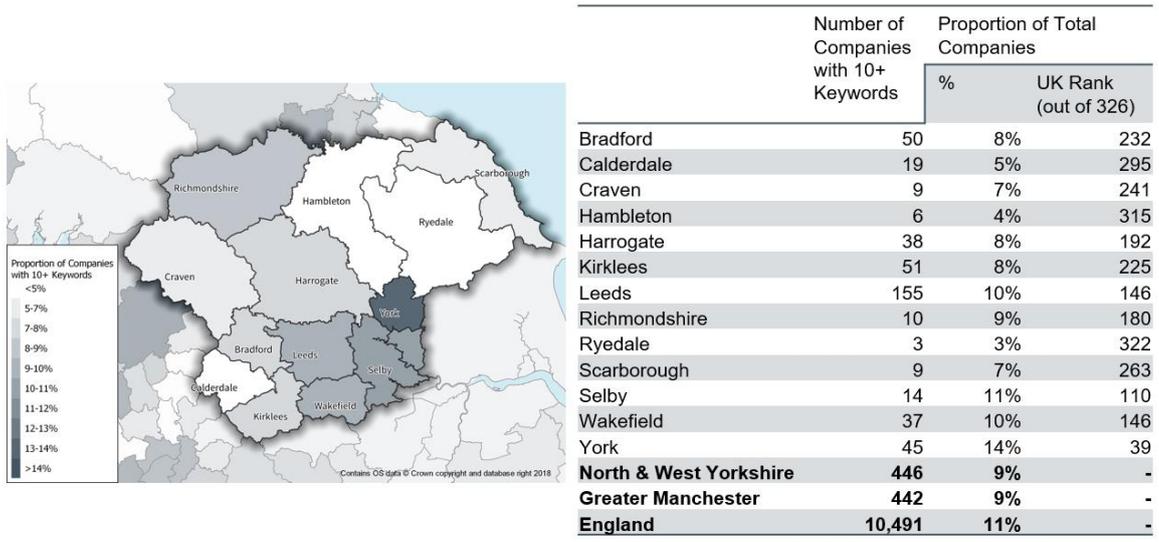6.2 A full description of the methodology underpinning the analysis provided in Appendix D. Appendix C also provides a note on the reliability of the estimates. In general, it is best to regard the results of our analysis as a pointer rather than strong quantitively tested theories.

6.3 The approach was designed to answer questions around productivity performance, within and between sectors and locations as well as distinct question surrounding the performance of family owned firms, the age profile of undertakings and so on.

6.4 The questions this section addresses are:

- Are businesses in the West and North Yorkshire area as productive as their counterparts in other areas?

- Is 'in sector' productivity performance more varied in West and North Yorkshire than in other areas?

- Are family-owned firms as productive as other types of firms?

- Is the business base in West and North Yorkshire older than elsewhere, and is there any association between age and productivity performance?

Are businesses in the West and North Yorkshire area as productive as their counterparts in other areas?

6.5 This question cannot be answered by an analysis of this type. The count of productivity markers provides a good indication of the likely presence of activities more associated with higher productivity outcomes, but this question is better addressed through top-down analysis based on standard National Statistics.

6.6 Through an area-based analysis of productivity keywords, the implication is a slight **underperformance relative to the England** – **but not Greater Manchester**.

Figure 6.1 Indicators of Area-Based Productivity Performance

	Number of Companies with 10+ Keywords	Proportion of Total Companies	
		%	UK Rank (out of 326)
Bradford	50	8%	232
Calderdale	19	5%	295
Craven	9	7%	241
Hambleton	6	4%	315
Harrogate	38	8%	192
Kirklees	51	8%	225
Leeds	155	10%	146
Richmondshire	10	9%	180
Ryedale	3	3%	322
Scarborough	9	7%	263
Selby	14	11%	110
Wakefield	37	10%	146
York	45	14%	39
North & West Yorkshire	**446**	**9%**	**-**
Greater Manchester	**442**	**9%**	**-**
England	**10,491**	**11%**	**-**

Source: Hatch Regeneris/DataCity (2019)

Is 'in sector' productivity performance more varied in West and North Yorkshire than in other areas?

6.7   We believe that there is compelling evidence to indicate that in North and West Yorkshire there is a greater disparity in productivity performance both within and between sectors. Figured 6.1 and 6.2 shows a keyword analysis of the businesses which we mapped to individual URLs.

Figure 6.2 Productivity Keyword Distribution: North and West Yorkshire v England
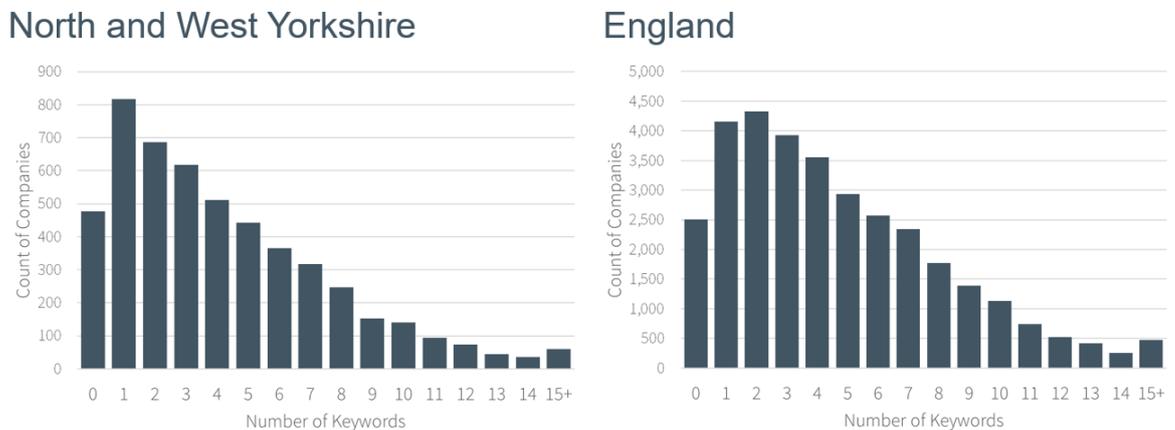
Source: Hatch Regeneris/DataCity (2019)

Figure 6.3 Productivity Keyword Distribution: North and West Yorkshire v Greater Manchester

Source: Hatch Regeneris/DataCity (2019)

6.8 Graphical representation of the distribution of keyword in companies highlights the possibility of a greater spread of outcomes in the North and West Yorkshire region, but this can only really be explored through statistical analysis.

6.9 In order to unpick this further, we have calculated the coefficient of variation (CoV) on the incidence of keywords in companies in th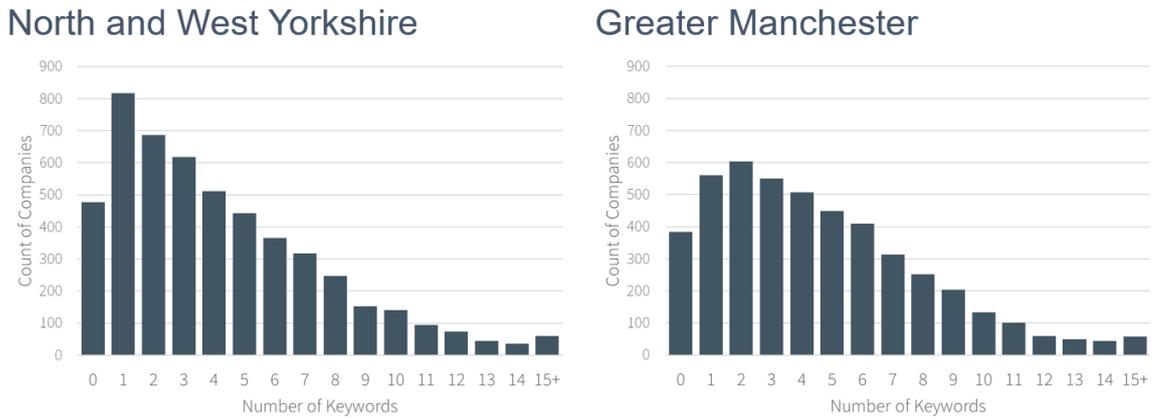e different geographies. The CoV provides an independent measure of dispersion. If the hypothesis that productivity performance was more varies in North and West Yorkshire was correct, then the coefficient of variation is expected to be higher than in the other geographies (Table 7.1). The findings highlighted in this table supports that hypothesis.

6.10 Additionally, analysis of the incidence of productivity key words within each sector and across all sectors highlights differences in the drivers of productivity/ the ways that productive behaviour is exhibited. For example, 'Management' is the most common key word across all sectors apart from Science and R&D, where 'process' is a more frequently used term.

6.11 There are certain keywords that are more prevalent in North and West Yorkshire than Greater Manchester across all sectors – knowledge, research, original, concept, cutting edge, work experience, apprenticeship scheme. A full sector by sector analysis is set out in **Appendix K**.

Table 6.1 Coefficient of variation- Productivity Markers			
Sectors	North and West Yorkshire	Greater Manchester	England
Accommodation and Food Services	1.42	1.32	1.25
Agri-Tech	1.11	1.06	1.18
Agriculture, Forestry and Fishing	1.15	1.38	0.96
AI and Data	0.68	0.69	0.67
Clean Growth	0.90	0.84	0.74
Construction	1.10	1.08	1.13
Creative	0.68	0.69	0.63
Digital	0.67	0.66	0.58
Energy	0.71	0.70	0.63
Fintech	0.73	0.70	0.55
Food and Drink	1.15	0.97	0.97
Health and Care	1.00	0.92	0.95
IoT	1.11	0.82	0.71
Manufacturing	0.65	0.67	0.52
Medicine Manufacturing	0.97	0.93	0.82
Retail	1.63	1.44	1.57
Science and R&D	0.80	0.76	0.74
Telecoms	0.64	0.63	0.59
Transport and Logistics	0.90	0.94	0.89
Transportation components	0.94	0.91	0.95
Waste	1.03	1.06	1.19
Whole sample	**0.80**	**0.71**	**0.69**

Source: Hatch Regeneris/DataCity (2019)

Are family-owned firms as productive as other types of business? Is the business base in West and North Yorkshire older than elsewhere, and is there any association between age and productivity performance?

6.12 We believe that there is compelling evidence to indicate that in North and West Yorkshire there is evidence to that suggest the businesses are older (based on year of incorporation), and that there are more family-run undertakings.

6.13 We find no evidence to suggest that family owned firms are less productive, and in-fact find compelling reasons to suggest that family run firms display greater signs of high productivity related behaviour than companies under other types of ownership.

Figure 6.4 Company Ownership and Age Analysis

Family-Run Companies

Proportion of Companies with 'Family-run' Keyword

Area	Number of Family-Run Companies
North & West Yorkshire	99
Greater Manchester	83
England	1,629

Average Number of Keyword by Company Type

● Family-run ● Not Family-run
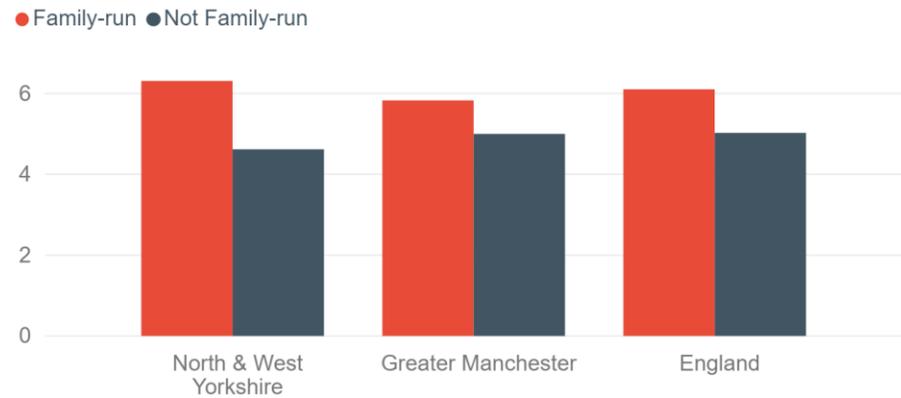
Average Age (Years) of Companies by Company Type

● Family-run ● Not Family-run
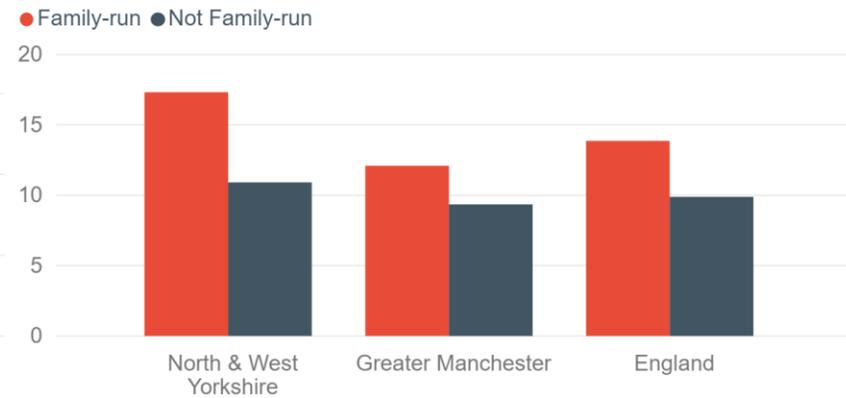
Source: Source: Hatch Regeneris/DataCity (2019)

7. Summary and Recommendations

7.1   This chapter summarises the headline findings from the report, together with a series of policy recommendations that centre on the delivery and design of a Local Inclusive Industrial Strategy for North and West Yorkshire.

- Differences in productivity across regions are more closely related to different firm level productivities within sectors and less impacted by local industrial structure

- Top-down analysis suggests that the wider Yorkshire and Humber region is home to a disproportionate number of firms in the bottom 10% of productivity performance

- Empirical evidence and academic research suggest that more could be achieved by focusing on improving productivity in existing higher performing firms rather than chasing the long tail of poor performers

- Productivity growth in knowledge intensive activities is at least twice that in more traditional sectors

- Firms in the bottom 10% of performance are more likely to be in the micro size band

- Companies trading internationally are 70% more productive than non-trading firms

- Firms who have benefited from FDI are over 70% more productive than firms who have never welcomed foreign capital

- The longer tail of productivity performance in the NWY area is supported by a bottom-up analysis of productivity markers

- The cross-sectoral reach of key techniques and technologies is at least as strong in the NWY area as in Manchester and the rest of England

- There is a core of well-performing companies to target. These tend to be **older** & **smaller** than in other areas, trading **internationally** and **cross-sectoral** in focus

- Family-owned and controlled firms show a greater openness to productivity building ideas and wider collaboration

- The pattern of business location across the region is complicated, and will make it difficult to devise a fully inclusive growth strategy if only focusing on sector specific interventions

Policy Implications and Recommendations

7.2   Policies should be designed to reward current success and augment existing productivity building behaviour. **This means designing interventions that target well performing companies in strategically important knowledge intensive activities**. In such circumstances, it is more important to focus on the technologies and types of intervention rather than pure sector definitions.

7.3   Because the area lacks the presence of leading Tier 1 manufacturers, the normal role of larger groups in spreading innovation and good practice through their supply chain needs to be replicated. In this area the role of Higher Education Institutions and other institutions could be crucial.

7.4   **The diversity of facilities and education assets in the region presents an opportunity for cross-sector manufacturers to operate in niche areas at Tiers 2 & 3 in the supply chain**. A number of regional facilities further bolster this cross-sector focus such as the

Centre for Precision Engineering and the 3M Buckley Innovation Centre which can contribute to innovation and collaboration in energy transport, health, medicine manufacturing etc. BioVale in York has begun to accelerate the growth of a bio-based cluster which will also serve multiple industries.

7.5   Leeds City Region has a network of well-established research centres of manufacturing excellence. Leeds City Region is home to 11 **Centres of Industrial Collaboration, which drive innovation in key growth sectors by bringing together research expertise in industry and higher education to develop new ideas, new materials, new products and services.** Local universities and higher education institutions work with organisations of all sizes across a wide range of industries, from SMEs to multi-nationals. Institutions like the 3M Buckley Innovation Centre in Huddersfield, the Bio-renewable Development Centre in York, Fab Lab in Keighley and innovation centres at the Universities of Bradford and Leeds show the collaborative and open approach the region takes to the future of manufacturing processes.

7.6   **Engagement of this type should not be focused on difficult to reach firms**. Previous interventions (for example the Manufacturing Advisory Service [MAS']) placed a premium on working with businesses that had never before engaged with the pubic-sector or business support services. Previous engagement with business support mechanisms can be regarded as an indication of openness to productivity enhancing activity.

7.7   Other markers of productivity enhancing activity should include **involvement in a Knowledge Transfer Network, involvement in apprenticeship training (especially higher level), openness to international trade,** and whether the company has received recent **foreign direct intervention.**

7.8   The analysis shows that the region is not dominated by a few big employers, instead, it is noticeable for being SME focussed and has a significant base of mid–sized businesses (so-called 'innovation generators'). Accordingly, **interventions should be designed to appeal to smaller family-based undertakings.** This means making it as easy as possible for smaller companies to benefit from support and upskilling. Interventions should not dilute share capital, control or autonomy. This is because smaller, family controlled firms are often resistant to any interventions that threaten to erode financial independence.

7.9   The top down analysis suggests that Brexit could pose a risk to the region. Local manufacturers source significant imports and intermediate product from the EU (especially Holland and Belgium). Awareness raising is needed amongst smaller businesses to better inform them about potential future challenges and the mitigations that may be needed.

7.10   In terms of skills, it should be remembered that people spread innovation and success. Brexit may make it more difficult for local businesses to attract talent from the EU. This will challenge sectors such as construction, healthcare and the visitor economy. However, Brexit may make it easier to attract skilled labour from outside the EU, especially those with skills more suitable to the digitisation of the economy.

7.11   There is a strong history and a large base of manufacturing across the region and a diverse range of skills being deployed across its sub-sectors. Leeds City Region has a larger number of entrants into STEM related higher education than Greater Manchester, Greater Birmingham & Solihull and Sheffield City Region. The Universities of York, Leeds, Huddersfield and others add to the density of innovation and higher skills support.

7.12   There is also depth in vocational education. For example, the new Leeds University Technical College, specialises in Advanced Manufacturing and Engineering led by local employers Siemens, Kodak and Agfa with educational expertise from The University of Leeds and Leeds City College, supported by Leeds City Council, EEF The Manufacturers Organisation, Leeds Chamber of Commerce, Grant Thornton and over 25 local businesses. York College is largest provider of apprenticeships in the region, the college offers Level 3

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Diplomas in Electrical, Manufacturing and Technical Engineering as well as an Engineering Apprenticeship. York College has partnered with the Yorkshire Rail Academy at the National Railway Museum to deliver a sustainable flow of trained staff into the industry through the delivery of a wide range of courses and use of the rail track and signalling simulation facility. Other important centres include Wakefield Collage, Bradford College, Kirklees College and Calderdale College.

7.13 **Enhancing links between and within these institutions and employers should remain a top priority for any local industrial strategy**.

7.14 Finally, our understanding of trading addresses suggests a degree of specialisation that may favour locations where certain activities are focused. To ensure social inclusivity, the design of interventions should recognise the spatial filters through which a sector based policy may operate.

7.15 The analysis above offers an interesting snapshot of a regional economy on the verge of a major transformation. The North and West Yorkshire area has the potential to provide the kind of flexibility required by future manufacturing technologies. In particular it gives the region a head-start in creating a granular mix of local manufacturers, providing customised components and services for diversified patterns of consumption and demanding foreign investors.

Appendix A - Data & Research Approach

A.1 Traditional methods of understanding economic and productive activity struggle to reflect the evolving nature of the world around us. Productivity is hard to measure and SIC codes are poorly-suited to understanding how the modern economy functions. Current datasets struggle to fairly reflect:

- Large companies that span many industrial sectors

- Technology companies which operate in small and frequently changing niches markets

- Companies that operate in emerging sectors that have not yet been classified

A.2 This data report is based on a new, experimental and evolving approach to understanding the economic structure and performance of the target geography. It draws on a novel approach to analysis and categorising large datasets. The data upon which the analysis is based has been generated by The Data City Limited.

A.3 This represents a new way of measuring economic activity and should not be used to compare specific numbers against official statistics. The process relies on rounds of iterative learning. A detailed description of the methods used can be found at The Data City Website Our Data & Industrial Sector Classification.

A.4 The approach uses machine learning to classify businesses based on the words they use to describe themselves. The first step is to manually classify a relatively small number of websites and businesses, which the team are confident represent a sector or area of interest. This initial dataset is then used to train a machine-learning algorithm to identify similar businesses. The dataset is then updated as examples of mis-categorised businesses are flagged up. This iterative approach over time generates much improved datasets on which more confident insights can be based.

A.5 Due to the incidence of false positives and mis-categorisations, the data is best used either:

- In aggregate (to compare the number of a certain type of business in one region or city with another). The noise caused by false positives and mis-categorisations is consistently distributed across the UK and should thus affect all areas similarly, allowing comparison.

- As a lead-generation process, and to identify companies of interest. Even with lower accuracy rates, the availability of suggestions of hundreds of companies to investigate further is of significant value.

- For a specific use or investigation, the data becomes more accurate with each iteration.

URL Matching

A.6 No directory exists for the 4.3 million UK companies with their website URLs included. Various strategies have been used to find websites for these companies. The DataCity approach is both legal (many others illegally scrape Google) and also of higher quality and more reproducible than many others currently in the market place.

A.7 But all approaches are imperfect. Specially, there is always a trade-off between accuracy (DataCity can match 50,000 companies with 99% accuracy by restricting analysis to companies that only include their registered company number and registered postcode on

their website) and coverage (DataCity can match 1,000,000 companies with about 70% accuracy).

A.8 Our quality assurance indicates an approximate sector classification of approximately 70% across the whole data set, in the second, and current iteration of the data, with a lower match of URL to a specific organisation.

A.9 In addition to our usual quality control testing we have manually checked the company-to-URL matching quality of the eCommerce sector and approximately 60 companies in the Hatch/North and West Yorkshire classifications. All companies which we checked are based in Leeds, UK, as familiarity with a city significantly speeds up manual verification.

A.10 These are the results of that QA exercise.

Table A.1 : DataCity QA Process		
Sector	**Companies tested**	**% URLs matched correctly**
eCommerce	60	72%

A.11 It should be noted that an incorrect URL match does not always mean that the company will be classified incorrectly. Companies with similar names often do similar things, for example The Open Data Institute Leeds and The Open Data Institute are separate organisations, but an incorrect company-to-URL match (as is quite likely in this case) would not incorrectly classify either as both organisations do similar things.

A.12 Similarly, a correctly matched URL does not guarantee correct classification using machine learning. Here, again, there is a trade-off between accuracy and coverage.

A.13 **Therefore, we expect with high confidence that the sector classification of the eCommerce sector will be greater than 72%.**

A.14 In addition, Hatch Regeneris **have completed an additional round of URL matching, using a random sample of approximately 100 larger companies across all sectors.** Our findings are broadly consistent with the DataCity quality assurance exercise.

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Appendix B - Sector Mapping

B.1   The sectors have been defined using keywords to search the data sources listed above and to generate profiles for each sector. The sector definitions were agreed with officials from WYCA and the approach was subject to the DataCity and Hatch Regeneris QA process. A full list of sector keyword is shown below.

B.2   For some sectors, despite repeated iterations of the model, it was not possible or practical to derive an AI keyword themed sector profile. In these circumstances, standard SIC code based definitions have been used.

Table B.1 Sector Definitions				
Data City Initial Proposition	Client Suggestions	Agreed Sector Definition	Notes	
AI and Data		AI and Data – to include cyber security	• Machine learning / Machine Intelligence • Data Science • Artificial Intelligence • Big Data • Data Analytics • Data Mining • Digital Forensics	• DSaaS (Data Science as a Service) • BDaaS (Big Data as a Service) • Advanced Data Management / Architecture • Metadata • Cyber- / Security / Intelligence
Clean Growth		Clean Growth	• Clean tech • Circular economy • Low carbon • Clean energy • Low carbon technology • Smart grid • Renewable energy • Precision agriculture • Resource efficiency • Green finance • Green bonds • Low carbon finance • Sustainability • Zero carbon • Hydrogen • Carbon capture and storage (CCS/CCUS) • Bio energy • BECCS • District heating	• Flood resilience • Flood risk • Ultra-low emission vehicles • Vehicle to grid • Solid wall insulation • Passivehaus • Energiesprong • Solar • CHP • Gasification • Energy from waste • Heat recovery • Natural capital • Ecosystems services • Heat pumps • Land manager / land management • Forestry • Land use, land use change and forestry (LULUCF) • Nature conservation

Data City Initial Proposition	Client Suggestions	Agreed Sector Definition	Notes
			- Climate change adaptation - Climate model / modelling - Flood defence - Clean vehicle technologies - Green and blue infrastructure - Peatland - Afforestation
Manufacturing		Manufacturing	Use standard SIC code definitions – Hatch to provide if necessary Keywords - Industry 4.0 - Industrial Digitalization - Digital manufacturing - Made smarter - Manufacturing technologies - Digital manufacturing enterprises
Energy		Energy	Standard SIC code definition to be used and sector specific key words: - Smart communities and/or connected communities - Demand Side response (DSR) - Aggregation - Smart Systems - Smart city - Whole Energy System - Generation - Storage - Hydrogen – Centre of Excellence - Energy House - Climate services - Carbon markets - Thermophilic composting - Building Technologies and Sustainable Construction - Alternative fuels - Carbon finance - Wind - Geothermal - Biomass - Photovoltaic - Heat Pumps - Low emission vehicles - Lighting - Hydropower (or key word hydro) - Renewable consultancy - Nuclear - Energy Management

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Data City Initial Proposition	Client Suggestions	Agreed Sector Definition	Notes	
			- Resilience and/or city resilience - Water treatment - Environmental management and/or consultancy - Natural capital - Clean energy - Energy intensive	- Carbon capture and storage - Air pollution - Contaminated Land / Land remediation - Environmental Consultancy / Renewable energy consultancy - Noise - Smart grid - Energy efficiency - Wave and tidal power - Pollution control - Heat Networks
Digital		Digital	- Machine Learning - Digital government - Fashion Tech - Computer programming - Management Consulting - Advertising - Retail tech - IT Services and Digital Transformation - Software and Data - Software as a Service SaaS - Data as a Serviced DaaS - Platform as a service PaaS - Cloud Computing - Everything-as-a-Service (EaaS) - AdTech - PropTech	- Asset Intelligence - Social Media / Social Computing - Enterprise Mobility - Automation / Autonomic Platforms - Cognitive Technology / Cognitive Data - Human Machine - Quantified Self - User experience - Identity / authentication - Biometrics - Data Centre - Rail tech - Immersive tech XR, - Virtual reality - Big tech and other companies using gaming – eg

Data City Initial Proposition	Client Suggestions	Agreed Sector Definition	Notes	
			- Blockchain - IoT 5G - Ecommerce - Software & Technology Development - Blockchain - Artificial Intelligence / Machine Learning / Big Data 'Edtech'	gamification for learning, EdTech? - Video Games - Mobile App Games - Sports/online betting - Massive multiplier online playing
Creative		Creative	DC process with clear keywords, see Industrial Sector Classification	
Fintech		Fintech	DC process with clear keywords, see Industrial Sector Classification	
Healthtech		Medtech	- Medtech - Health Innovation - Health tech - E-Health - Digital Health - Healthcare Analytics - Precision Medicine	- Biomarkers - Medical instruments - Medical technologies - Diagnostics - Healthcare records - NHS Spine - Telehealth
IoT		IoT	- Smart city - Data-intensive products - Data-intensive applications - Sensors - Data management Analytics	- Wearables - Mobility - Connected cities / devices / - Connected or autonomous vehicles / driverless cars - Internet of Business Things (IoBT)
Telecoms and Networks		Telecoms and Networks	DC process with clear keywords, see Industrial Sector Classification	
Waste		Waste	Use standard SIC code definitions – Hatch to provide if necessary	

Data City Initial Proposition	Client Suggestions	Agreed Sector Definition	Notes	
			Key words • Circular economy • Treatment and disposal of hazardous waste • Treatment and disposal of non-hazardous waste	
Construction		Construction	Use standard SIC code definitions	
	Agriculture forestry & Fishing	Agriculture forestry & Fishing	Use standard SIC code definitions	
	Transport and logistics	Transport and logistics	Use standard SIC code definitions	
	Accommodation and food services	Accommodation and food services	Use standard SIC code definitions	
	Health and care	Health and care	Use standard SIC code definitions	
	Retail	Retail	• E-commerce • Direct home shopping • Mail order house • Online trading • Multi-retailing • Link between ecommerce and other sectors like Fintech, • Retail Tech / Payments / user Experience/Customer Journey	• Online Payments / Authentication / Identity / Biometrics • Digital supply chain • Omni channel • AI. Powered personalization • Mobile Apps / payments • All-mode Transport Hub • Final Mile delivery

Appendix C - Sample Size & Confidence Intervals

C.1   Table C.1 shows the breakdown of the sample of websites obtained:

Table C.1 Sample of Company Websites				
	North and West Yorkshire	Greater Manchester	England	Total
Total Registered Companies	130,744	149,297	3,121,730	3,438,087
Websites Found	44,374	46,337	992,004	1,113,263
Total Scraped Companies	31,557	31,692	662,934	754,155
Scraped Companies Matched to Sector - First Run	19,085	20,014	410,602	466,294
Scraped Companies Matched to Sector - Second Run (post QA)	5,079	4,674	96,814	108,640

Source: Hatch Regeneris/DataCity (2019)

C.2   As indicated above, this exercise cannot be regarded as a randomised sample, and therefore the calculation of standard confidence intervals is problematic. The process only identifies those companies with a website presence and this creates the likelihood of sample bias. This means a normal probability distribution is unlikely to apply.

C.3   Nonetheless, we can estimate confidence intervals based on the hypothesis that the 5.079 sample is representative of the population of 131,000 registered companies. **At the 95% confidence level, this yields a confidence interval of +/- 0.5% for any observed data**. However, given that this data is not randomised and has been partly selected for the ease of analysis, we believe that these findings should cannot be regarded as statistically robust.

Appendix D - Keyword and Productivity Analysis

D.1 The foundation of our approach to productivity is that the websites of sample firm in the target and comparator geographies contain certain keywords that can be regarded as 'high productivity' markers.

D.2 These productivity markers were based on a simple review of management journals and the Hatch Regeneris experience with working on similar assignments. The following specific research questions were developed to provide a starting point for deriving the productive key words.

7.16 Specific research questions included:

- What roles and functions are undertaken within North and West Yorkshire's major sectors?

- What companies are driving productivity by adopting new technology?

  - What sector do they operate in?

  - Are there common technologies across sectors?

  - Do these firms cluster together?

  - Is there more process or product innovation?

  - Is there evidence of firms adopting automation?

- What firms have KTP's with universities?

- Is there evidence of firms using enterprise resource planning, customer relationship management and supply chain management technologies?

- What firms have benefitted from Foreign Direct Investment?

- Are there discernible differences between the firms that use this technology and those that do not?

- Are there differences in the size and age of firms and their productivity performance?

- Are there differences in where the firm is located?

- What is the pattern of family ownership?

- What firms run an apprenticeship scheme?

D.3   The agreed productivity markers were:

Table D.1 Productivity Markers		
Productivity Marker	**Key words**	
Innovation	Innovation Idea Innovation ecosystem Knowledge Cutting-edge Collaboration Design thinking New Research Fertilise Conceive Concept	Entrepreneur Process Automation Knowledge-transfer partnership/KTP Original Additive Digitisation Manufacturing by Design Lean Kaizan
Skills	Work experience Graduate scheme Degree Achievement Apprentice Apprenticeship scheme School-leavers	Recruitment Hiring Promotion Performance review Training Professional development Continuing Professional Development (CPD)
Business environment	Export Import International Overseas New market Growth	Global Worldwide Foreign direct investment Overseas investment Headquarters

Source: Hatch Regeneris/Data City

D.4   The hypothesis underlying our analysis was tested by randomly extracting over 150 companies from the sector list and determining their Return on Capital Employed (ROCE). This exercise was focused on the larger companies as it requires the provision of full company accounts. Under UK Company Law, smaller undertakings are now only required to file abbreviated or 'fileted' accounts. These accounts do not allow for calculations of annual profit and capital returns.

D.5   ROCE is a standard measure used to assess performance and productivity. It tells us what returns (profits) the business has made on the resources available to it. ROC is derived calculated by dividing operating profit by capital employed.

D.6   We correlated ROCE with the count of Productivity Markers across the sample businesses. We included a number of different sectors including manufacturing, energy and accommodation. It was not possible to undertake this analysis for the full sample, but we were able to test the proposition for a sub-set of the larger businesses (approx. 100). **Our analysis a revealed a moderate to weak positive correlation between the productivity markers and ROCE ($r = 0.36$).** Given the standard of data available for the work, we were satisfied that a positive relationship had been demonstrated, and that it fell within +/- 0.3 at the 85% confidence interval. However, given that this data is not randomised and has been partly selected for the ease of analysis, **we believe that these findings should cannot be regarded as statistically robust.**

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Appendix E - Results of Sector Mapping Exercise

E.1 The data below provides a full analysis of the bespoke sector definitions by reported SIC codes. For sectors marked with an asterisk, the DataCity sector definitions proved inaccurate, and further analysis was deemed unreliable.

Table E.1 Sector Profile			
Sector	Identified Companies	Proportion of Total Businesses	Total Number of Businesses
Agri-Tech	84	40%	210
AI and Data	603	NA	NA
Clean Growth	89	NA	NA
Creative	131	1%	12,605
Digital	980	13%	7,705
Energy	251	9%	2,925
Fintech	219	NA	NA
Food and Drink	1,626	17%	9,365
IoT	32	NA	NA
Manufacturing	177	2%	7,710
Medicine Manufacturing	93	30%	310
Retail	304	2%	18,200
Science and R&D	340	NA	NA
Telecoms	741	NA	NA
Transportation components	436	NA	NA
Waste	143	25%	565
Total	**5,079**	**4%**	**136,740**
Accommodation and Food Services*	1,193	12%	9,980
Agriculture, Forestry and Fishing*	225	3%	8,490
Construction*	3,675	27%	13,685
Health and Care*	1,591	20%	8,090
Transport and Logistics*	812	12%	6,720

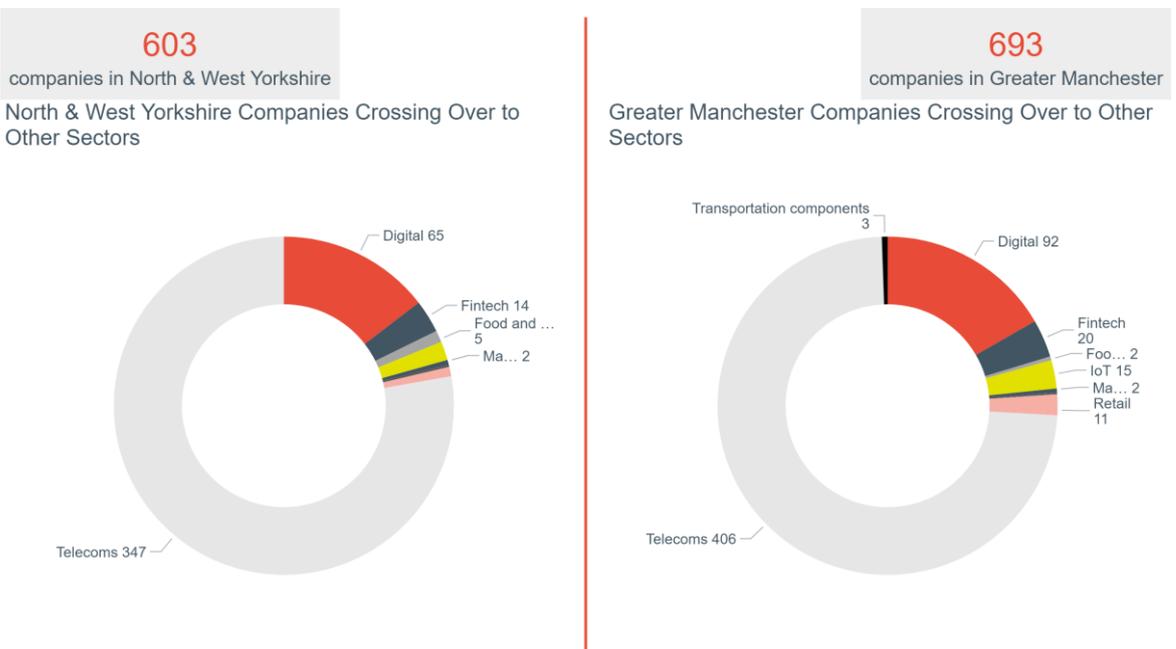* These sectors have not been defined using the Data City process. Instead they are based on SIC definitions

Source: Hatch Regeneris/DataCity

Figure E.1 Sector Map of the Agri-Tech Sector

84
companies in North & West Yorkshire

North & West Yorkshire Companies Crossing Over to Other Sectors

36
companies in Greater Manchester

Greater Manchester Companies Crossing Over to Other Sectors

Source: Source: Hatch Regeneris/DataCity (2019)

Figure E.2 Sector Map of the AI and Data Sector

603
companies in North & West Yorkshire

North & West Yorkshire Companies Crossing Over to Other Sectors

693
companies in Greater Manchester

Greater Manchester Companies Crossing Over to Other Sectors

Source: Source: Hatch Regeneris/DataCity (2019)

Figure E.3 Sector Map of the Clean Growth Sector

89	73
companies in North & West Yorkshire	companies in Greater Manchester

North & West Yorkshire Companies Crossing Over to Other Sectors

Greater Manchester Companies Crossing Over to Other Sectors

Manufacturing 2

Energy 78

Manufacturing 3

Energy 67

Source: Source: Hatch Regeneris/DataCity (2019)

Figure E.4 Sector Map of the Creative Sector

131	143
companies in North & West Yorkshire	companies in Greater Manchester

North & West Yorkshire Companies Crossing Over to Other Sectors

Greater Manchester Companies Crossing Over to Other Sectors

Food and Drink 2

Digital 99

Food and Drink 1

Digital 97

Source: Source: Hatch Regeneris/DataCity (2019)

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Figure E.5 Sector Map of the Digital Sector
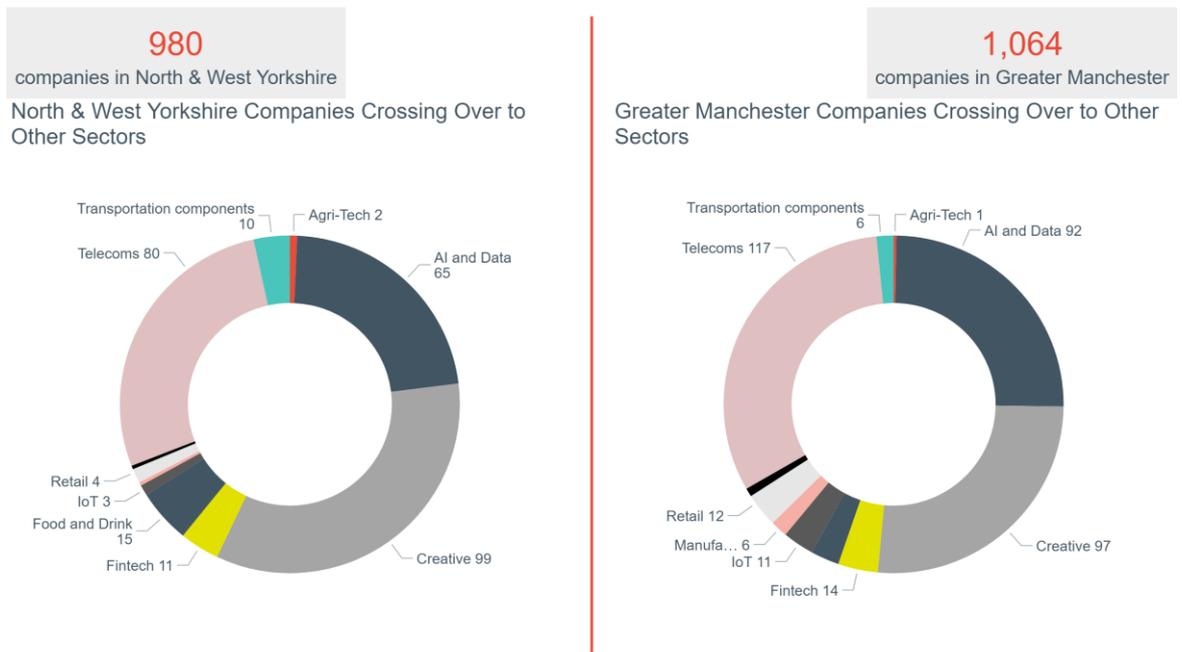
Source: Source: Hatch Regeneris/DataCity (2019)
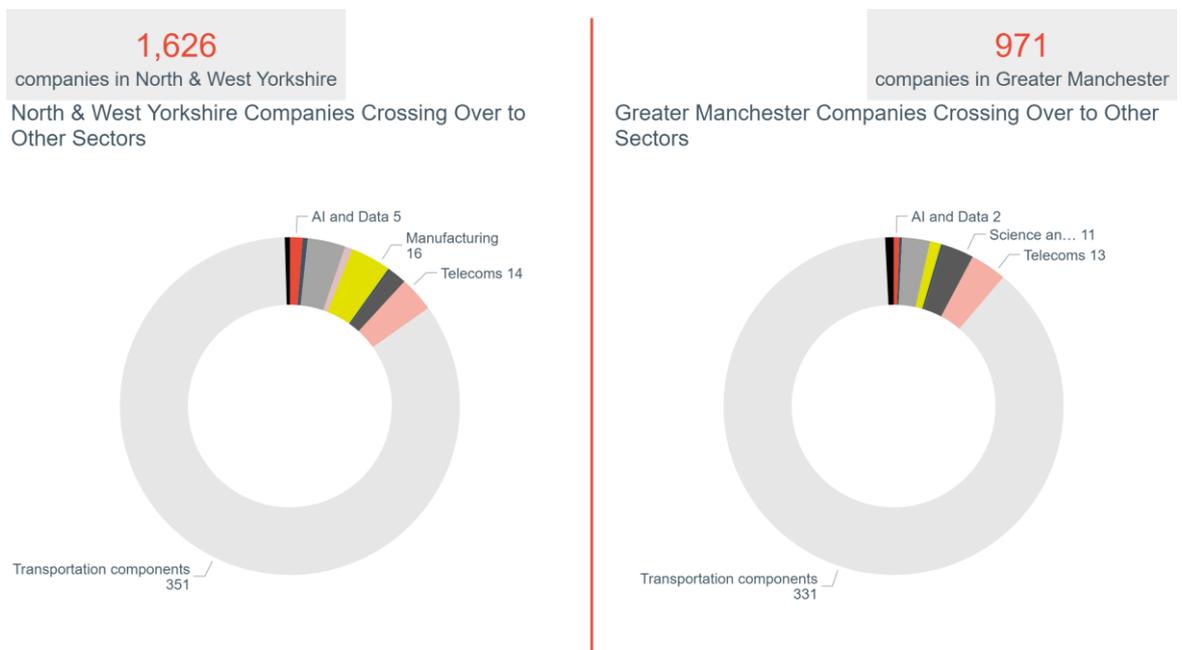
Figure E.6 Sector Map of the Energy Sector
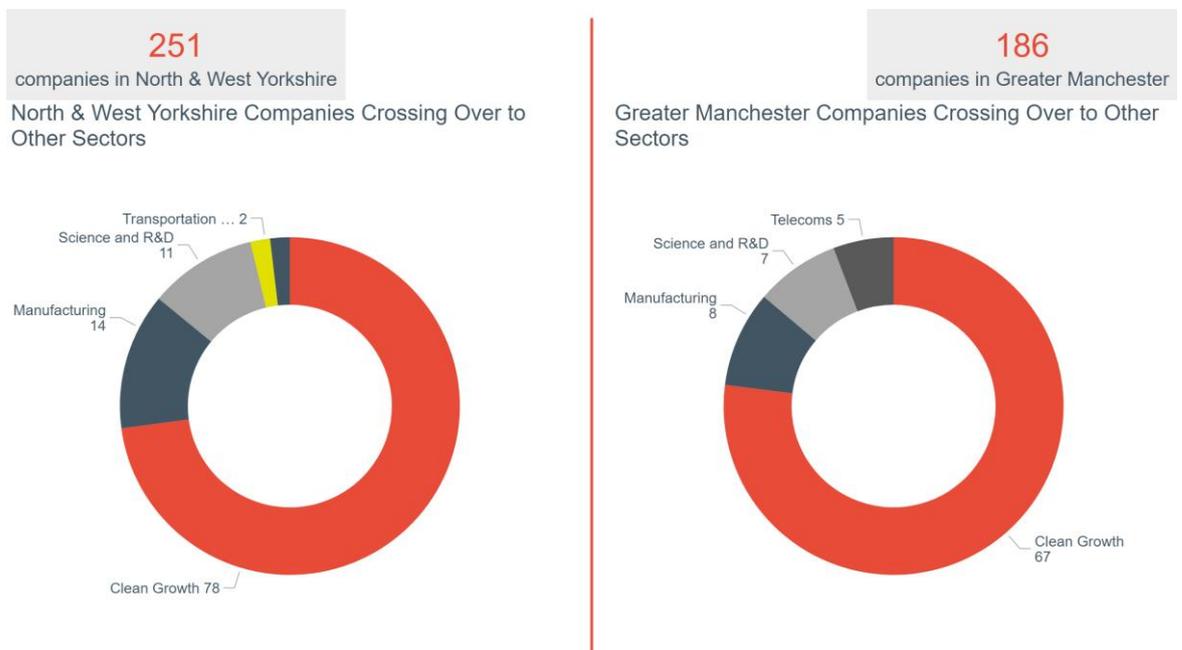
Source: Source: Hatch Regeneris/DataCity (2019)

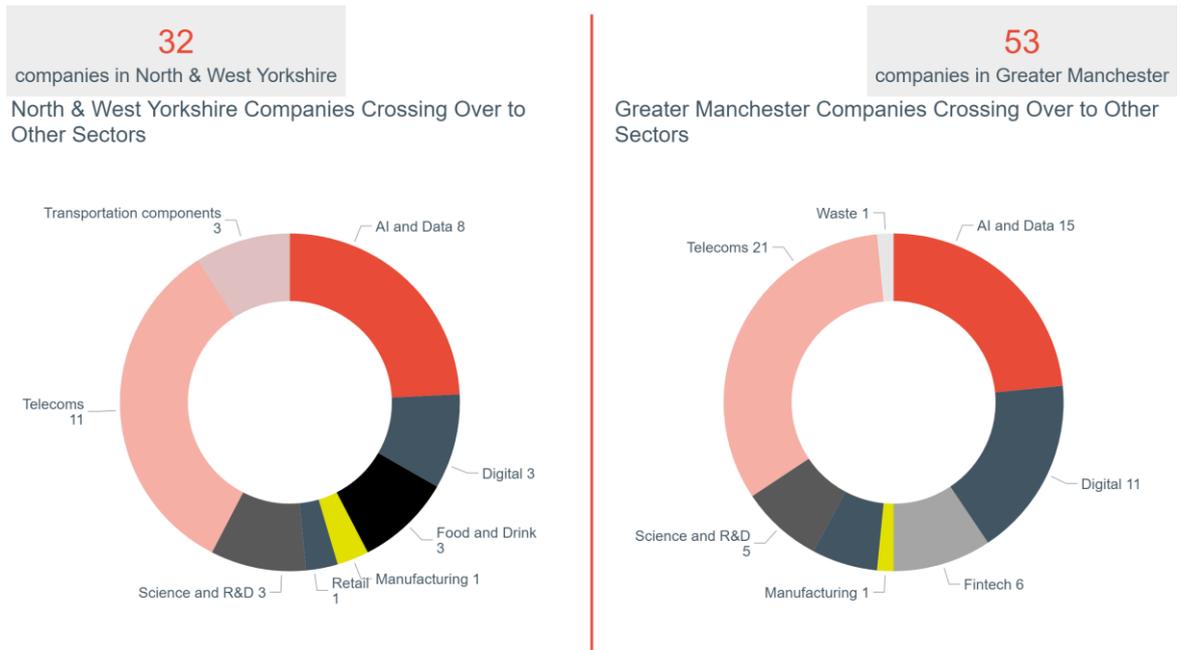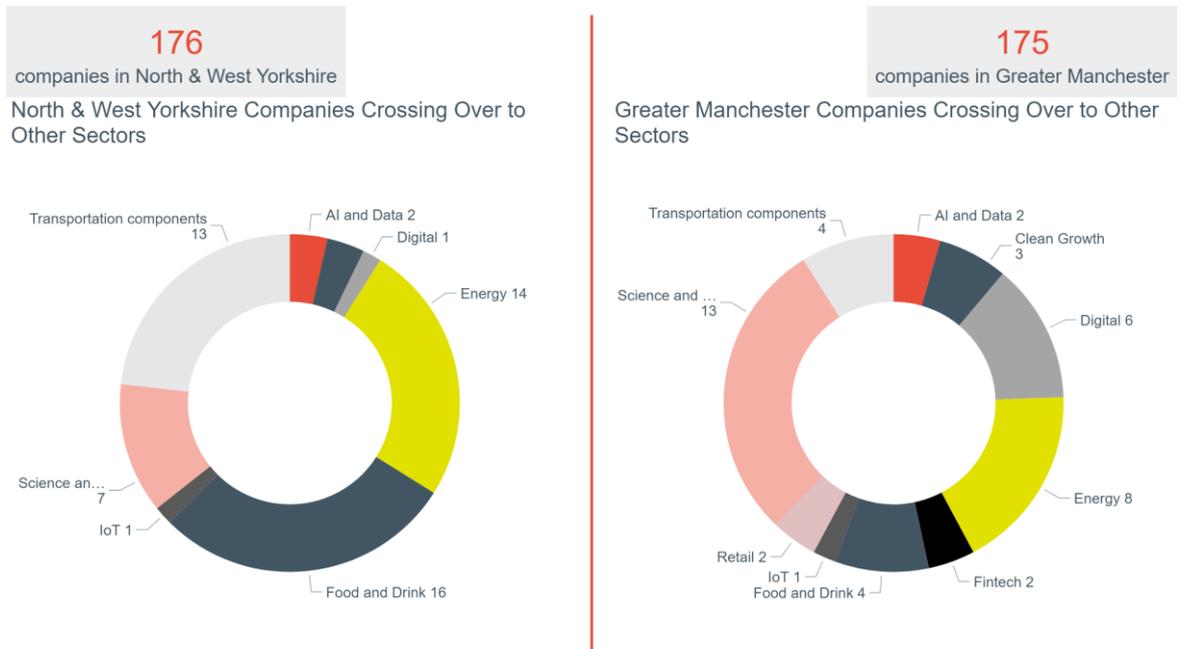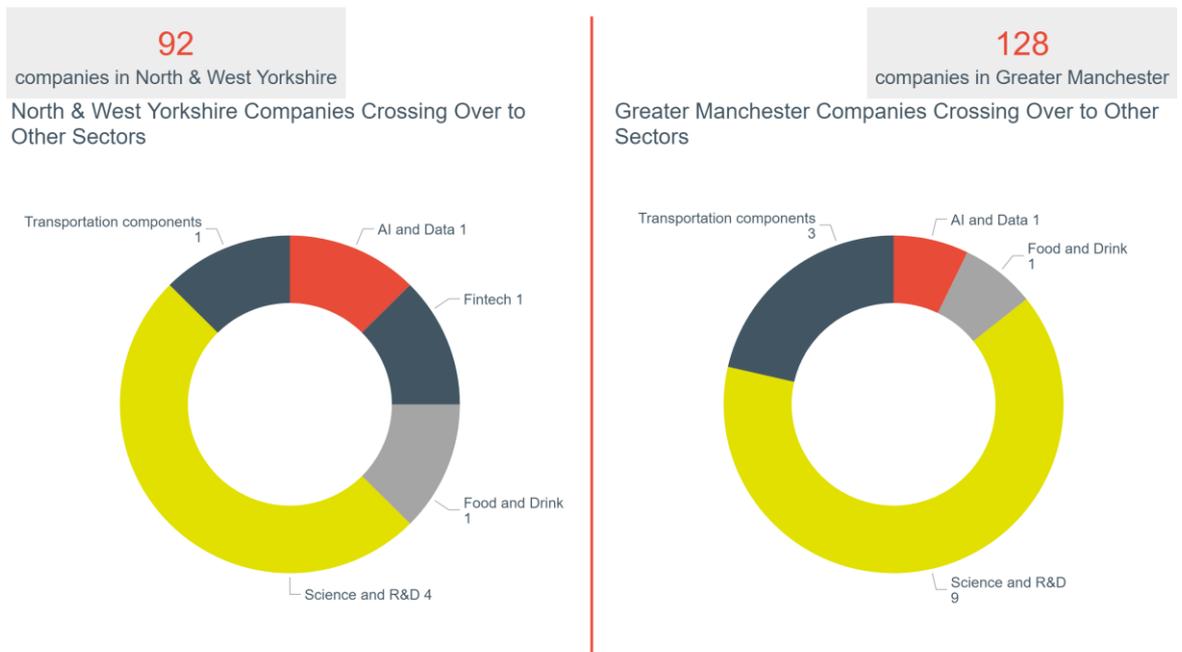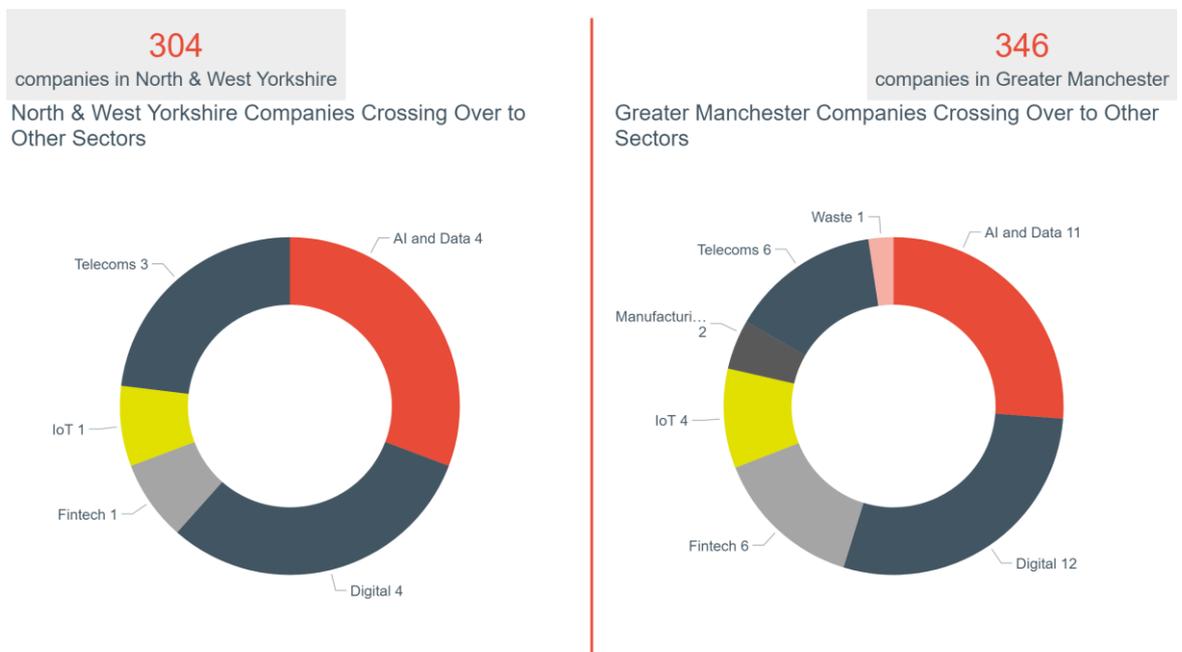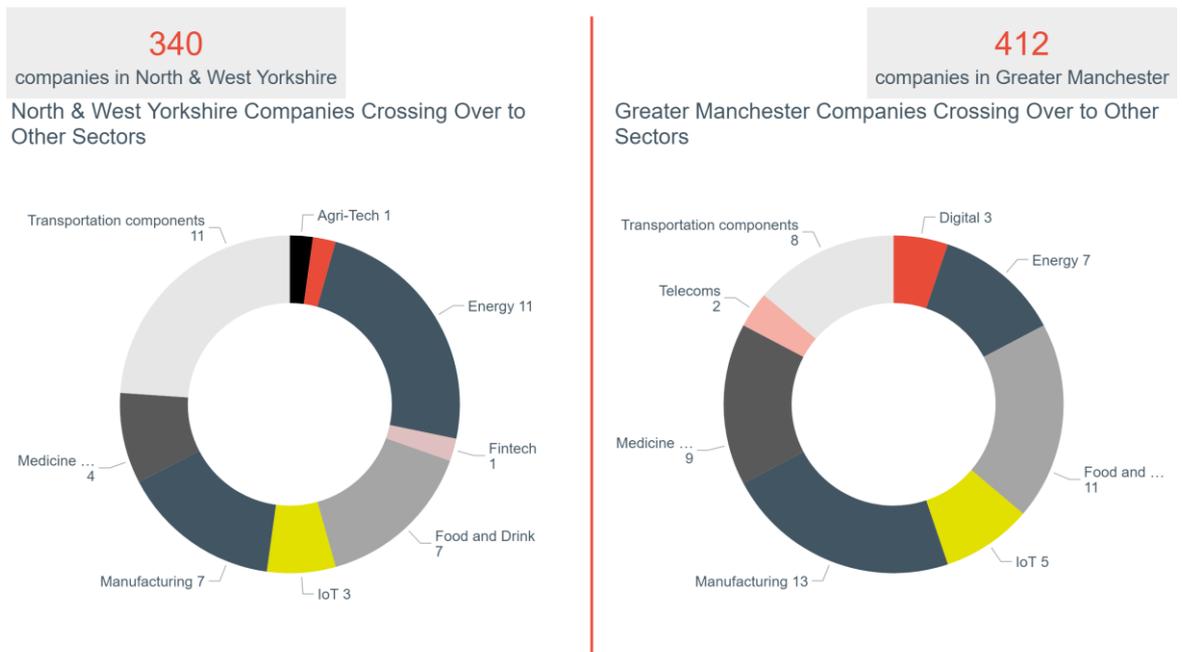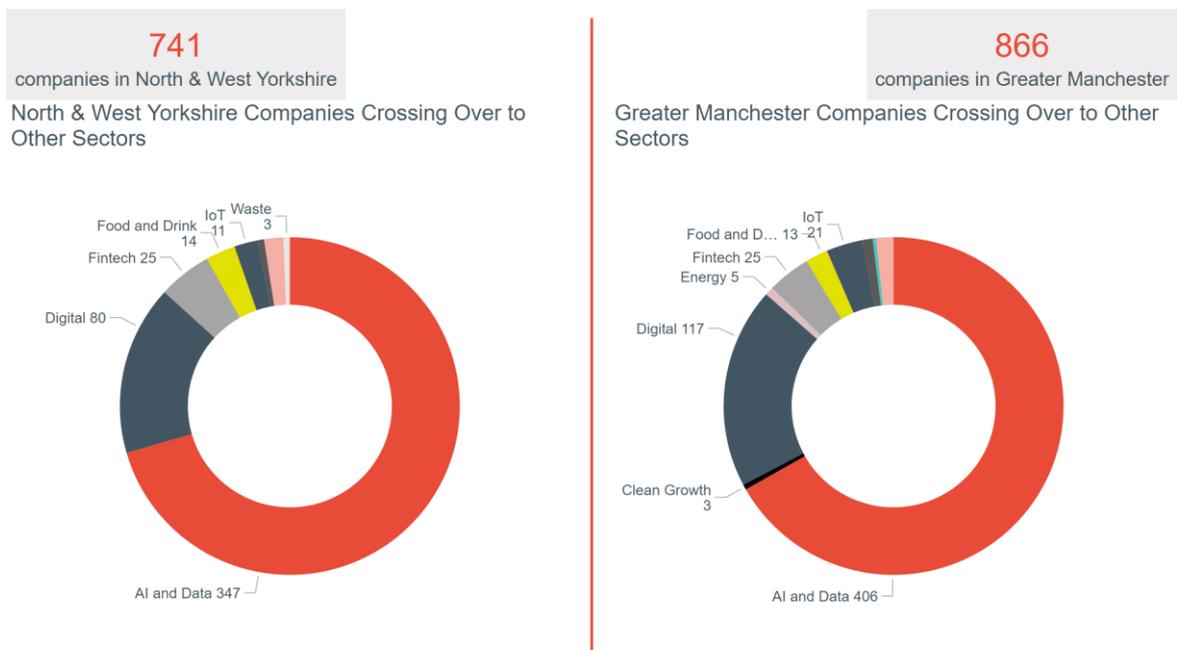## Figure E.7 Sector Map of the Fintech Sector

219
companies in North & West Yorkshire

North & West Yorkshire Companies Crossing Over to Other Sectors

- AI and Data 14
- Telecoms 25
- Digital 11
- Medicine Manufacturing 1

212
companies in Greater Manchester

Greater Manchester Companies Crossing Over to Other Sectors

- AI and Data 20
- Telecoms 25
- Digital 14
- Retail 6
- Manufacturing 2
- IoT 6
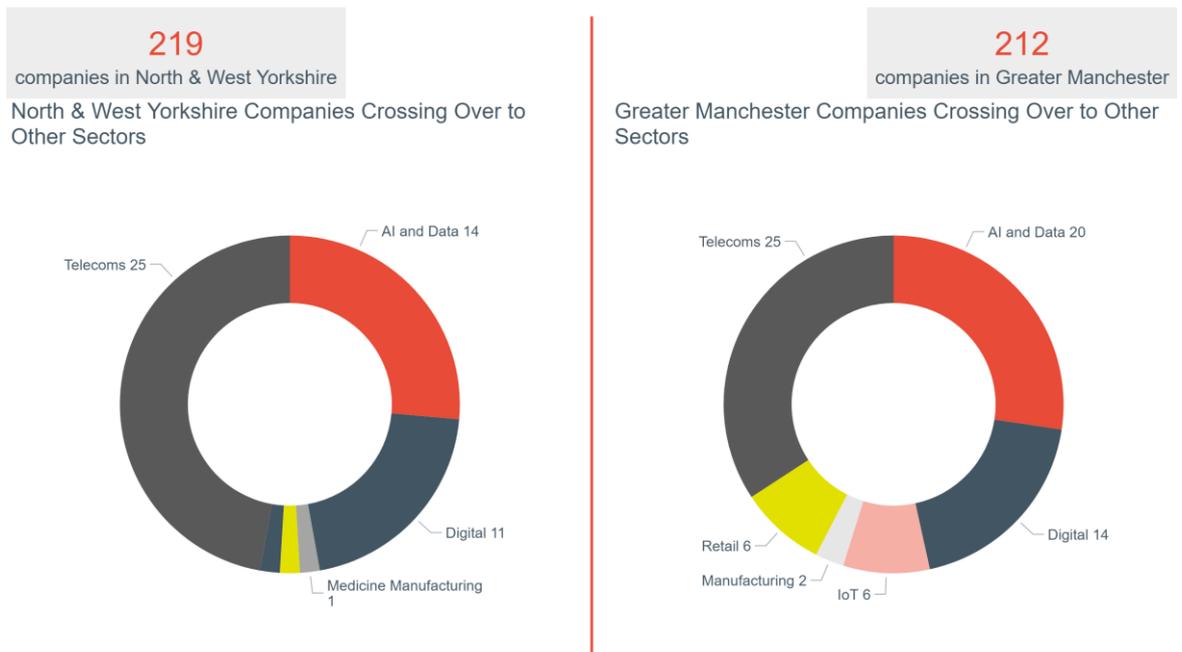
Source: Source: Hatch Regeneris/DataCity (2019)

Figure E.8 Sector Map of the Food and Drink Sector

1,626
companies in North & West Yorkshire

North & West Yorkshire Companies Crossing Over to Other Sectors

- AI and Data 5
- Manufacturing 16
- Telecoms 14
- Transportation components 351

971
companies in Greater Manchester

Greater Manchester Companies Crossing Over to Other Sectors

- AI and Data 2
- Science an… 11
- Telecoms 13
- Transportation components 331

Source: Source: Hatch Regeneris/DataCity (2019)

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Figure E.9 Sector Map of the IoT Sector

32
companies in North & West Yorkshire

North & West Yorkshire Companies Crossing Over to Other Sectors

53
companies in Greater Manchester

Greater Manchester Companies Crossing Over to Other Sectors

Source: Source: Hatch Regeneris/DataCity (2019)

Figure E.10 Sector Map of the Manufacturing Sector

176
companies in North & West Yorkshire

North & West Yorkshire Companies Crossing Over to Other Sectors

175
companies in Greater Manchester

Greater Manchester Companies Crossing Over to Other Sectors

Source: Source: Hatch Regeneris/DataCity (2019)

Figure E.11 Sector Map of the Medicine Manufacturing Sector

92
companies in North & West Yorkshire

North & West Yorkshire Companies Crossing Over to Other Sectors

128
companies in Greater Manchester

Greater Manchester Companies Crossing Over to Other Sectors

Source: Source: Hatch Regeneris/DataCity (2019)

Figure E.12 Sector Map of the Retail Sector

304
companies in North & West Yorkshire

North & West Yorkshire Companies Crossing Over to Other Sectors

346
companies in Greater Manchester

Greater Manchester Companies Crossing Over to Other Sectors

Source: Source: Hatch Regeneris/DataCity (2019)

Figure E.13 Sector Map of the Science and R&D Sector

340
companies in North & West Yorkshire

North & West Yorkshire Companies Crossing Over to Other Sectors

- Agri-Tech 1
- Transportation components 11
- Energy 11
- Fintech 1
- Food and Drink 7
- IoT 3
- Manufacturing 7
- Medicine … 4

412
companies in Greater Manchester

Greater Manchester Companies Crossing Over to Other Sectors

- Digital 3
- Transportation components 8
- Energy 7
- Telecoms 2
- Food and … 11
- Medicine … 9
- IoT 5
- Manufacturing 13

Source: Source: Hatch Regeneris/DataCity (2019)

Figure E.14 Sector Map of the Telecoms Sector

741
companies in North & West Yorkshire

North & West Yorkshire Companies Crossing Over to Other Sectors

- IoT 11
- Waste 3
- Food and Drink 14
- Fintech 25
- Digital 80
- AI and Data 347

866
companies in Greater Manchester

Greater Manchester Companies Crossing Over to Other Sectors

- IoT 21
- Food and D… 13
- Fintech 25
- Energy 5
- Digital 117
- Clean Growth 3
- AI and Data 406

Source: Source: Hatch Regeneris/DataCity (2019)

Figure E.15 Sector Map of the Transportation Components Sector

436
companies in North & West Yorkshire

North & West Yorkshire Companies Crossing Over to Other Sectors

Medicine Ma… 1
IoT 3
Agri-Tech 8
Food and Drink 351

409
companies in Greater Manchester

Greater Manchester Companies Crossing Over to Other Sectors

Manufacturing 4
Agri-Tech 1
Food and Drink 331

Source: Source: Hatch Regeneris/DataCity (2019)

Figure E.16 Sector Map of the Waste Sector

143
companies in North & West Yorkshire

North & West Yorkshire Companies Crossing Over to Other Sectors

Telecoms 3
Energy 2
Food and Drink 2

160
companies in Greater Manchester

Greater Manchester Companies Crossing Over to Other Sectors

Transportation components 2
Food and Drink 3
Retail 1
IoT 1
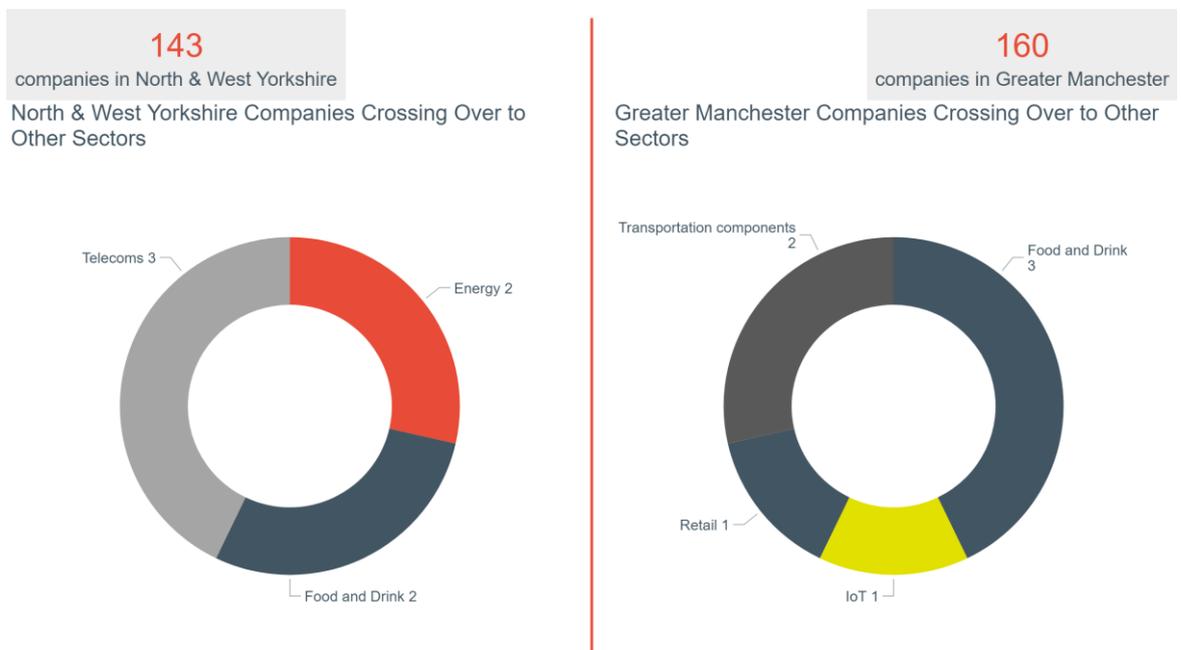
Source: Source: Hatch Regeneris/DataCity (2019)

Appendix F - Productivity Keyword Analysis

Productivity Keywords per Company (All Sectors)
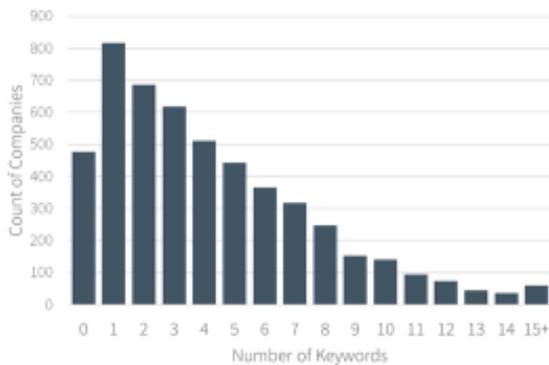
West and North Yorkshire

Greater Manchester
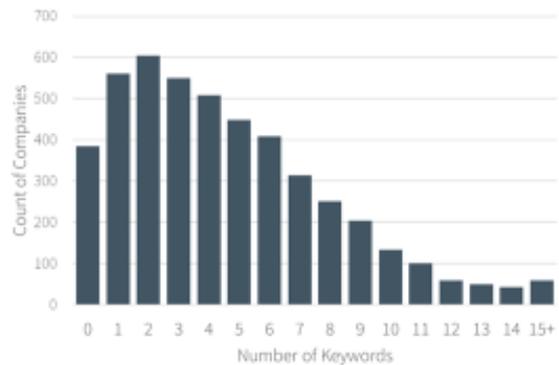
Productivity Keywords per Company (All Sectors)

West and North Yorkshire
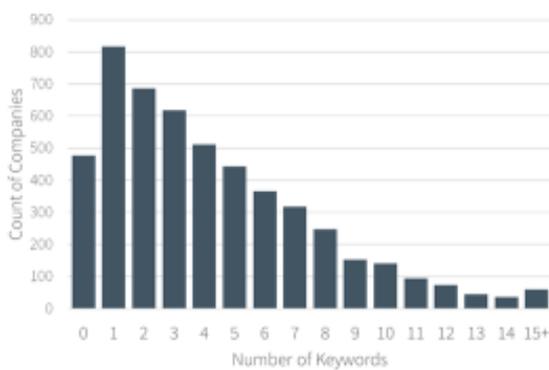
England
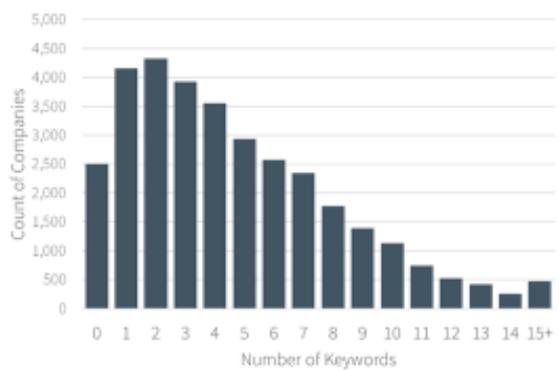
Productivity Keywords per Company (Accommodation and Food Services)
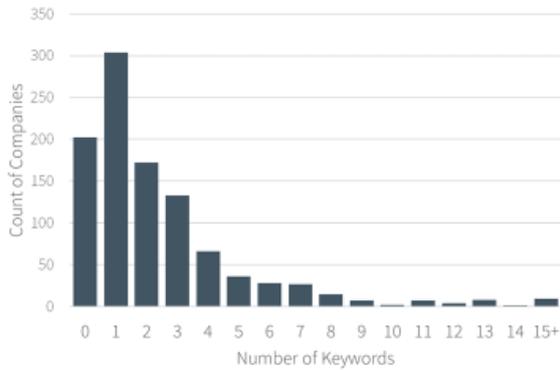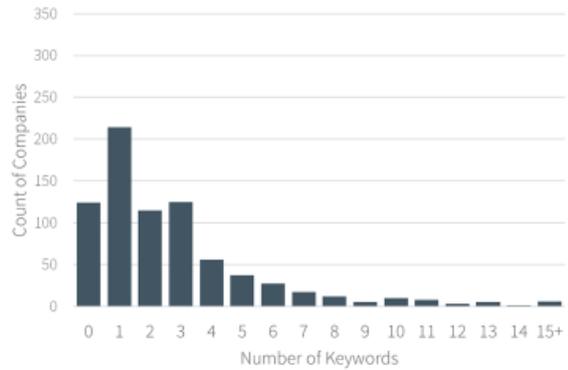
Productivity Keywords per Company (Agriculture, Forestry and Fishing)
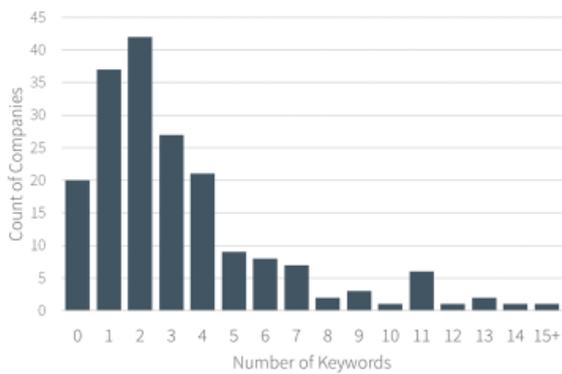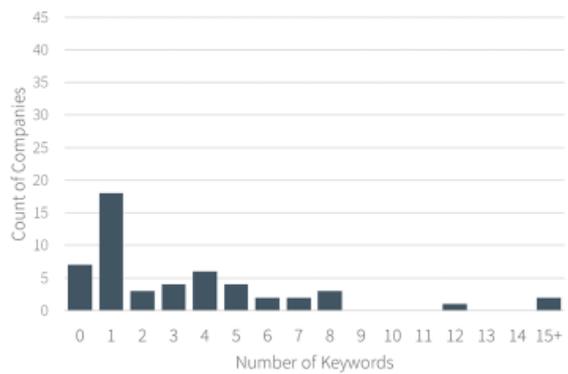
Productivity Keywords per Company (Agri-Tech)

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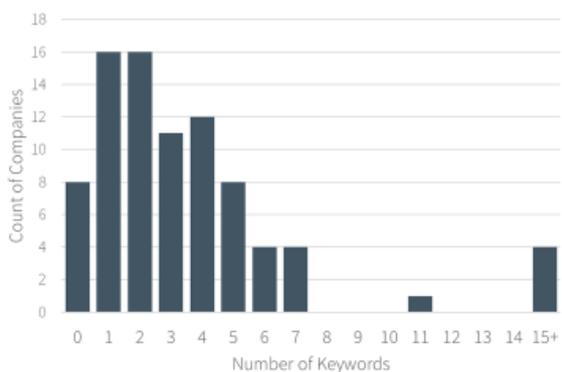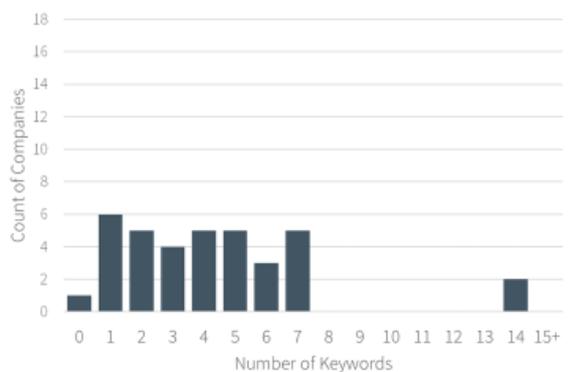
Productivity Keywords per Company (AI and Data)
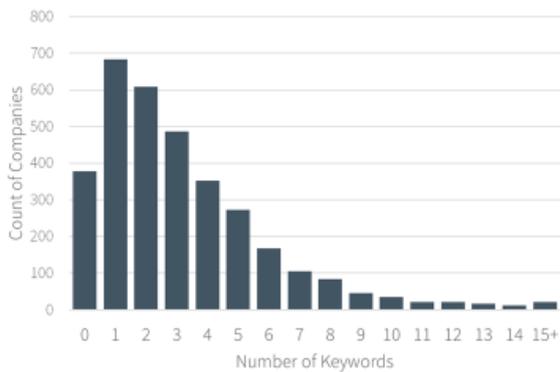
North and West Yorkshire
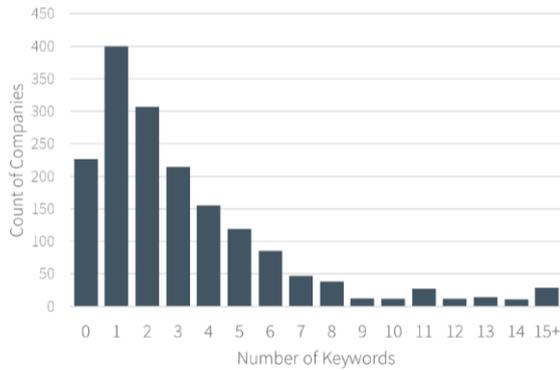
Greater Manchester
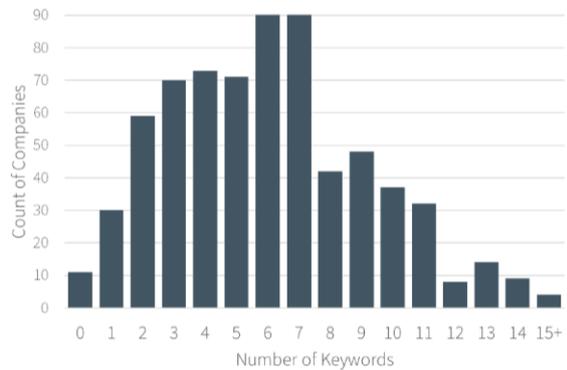
Productivity Keywords per Company (Construction)

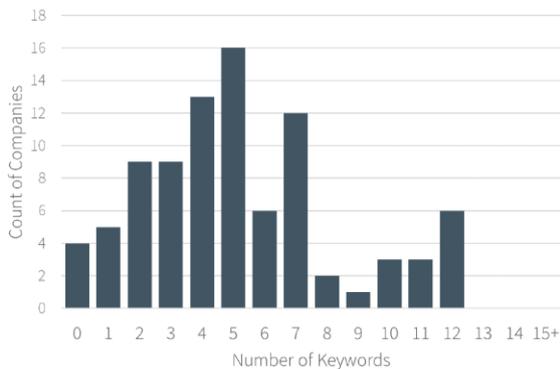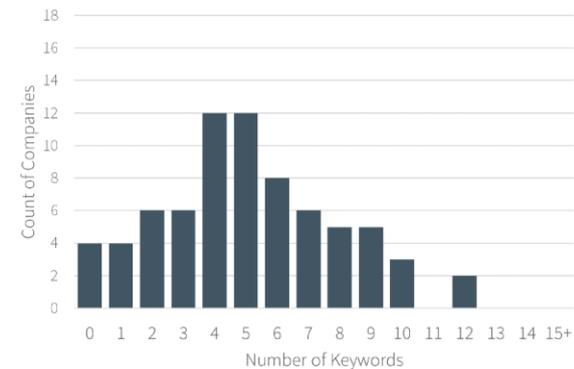## North and West Yorkshire

Greater Manchester
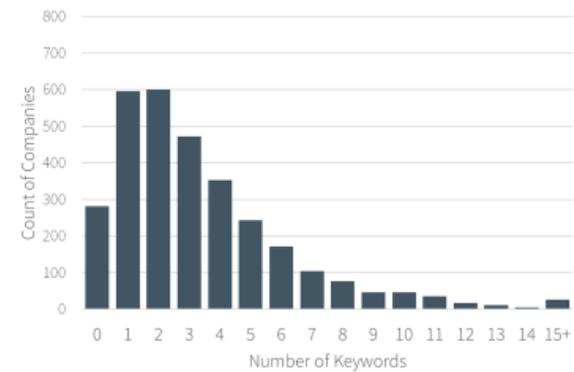
Productivity Keywords per Company (Clean Growth)
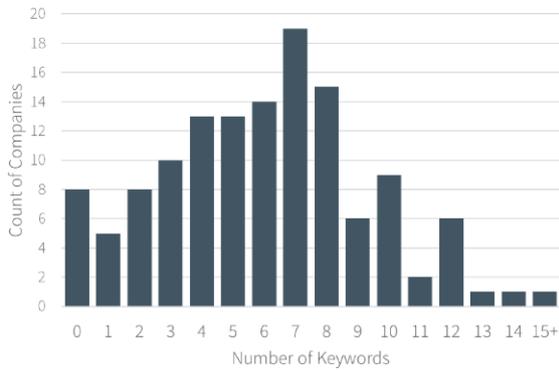
North and West Yorkshire
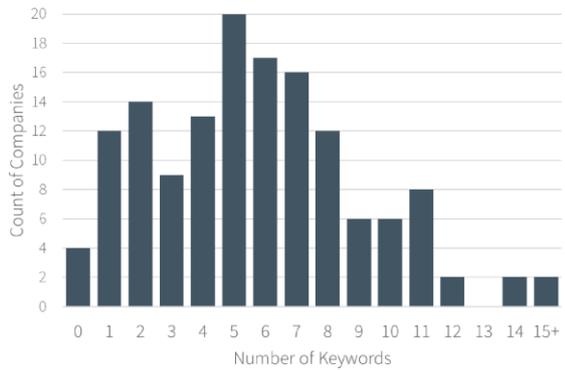

Greater Manchester

Productivity Keywords per Company (Creative)

North and West Yorkshire

Greater Manchester

Productivity Keywords per Company (Digital)

North and West Yorkshire

Greater Manchester

Productivity Keywords per Company (Energy)

North and West Yorkshire

Greater Manchester

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Productivity Keywords per Company (Fintech)

North and West Yorkshire

Greater Manchester
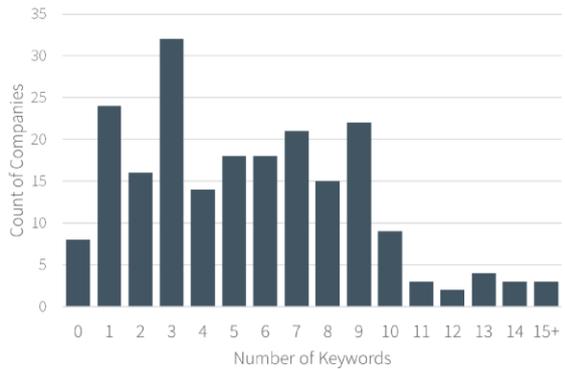
Productivity Keywords per Company (Food & Drink)

North and West Yorkshire

Greater Manchester
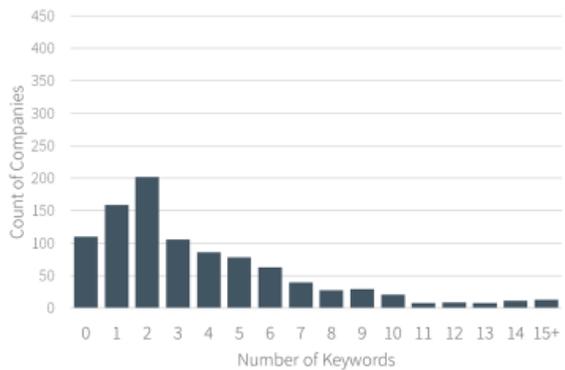
Productivity Keywords per Company (Health and Care)
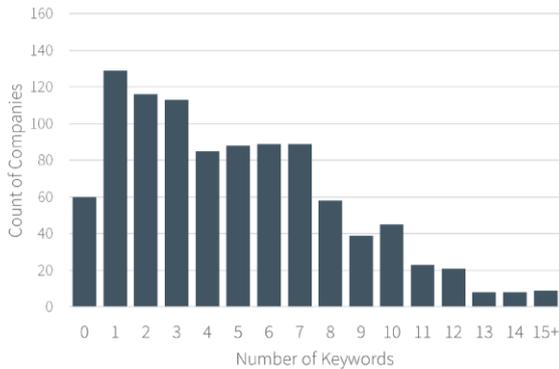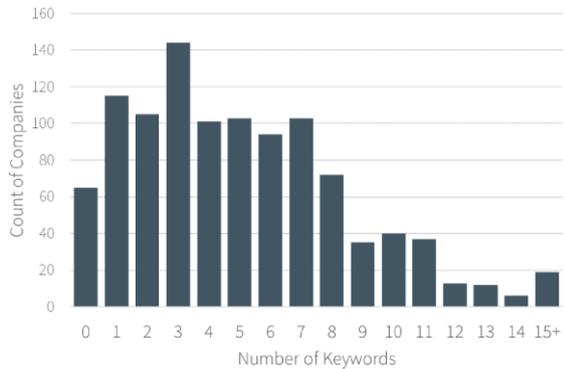
North and West Yorkshire

Greater Manchester
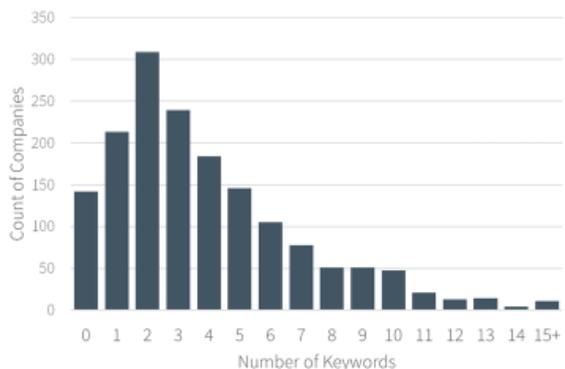
Productivity Keywords per Company (IoT)

North and West Yorkshire

Greater Manchester
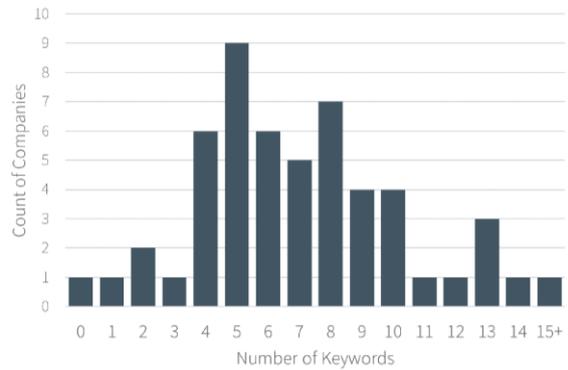
Productivity Keywords per Company (Manufacturing)

North and West Yorkshire
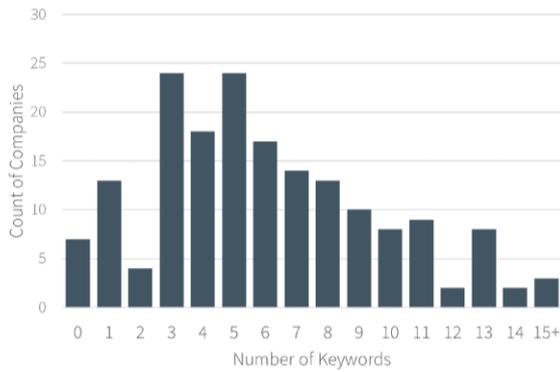
Greater Manchester
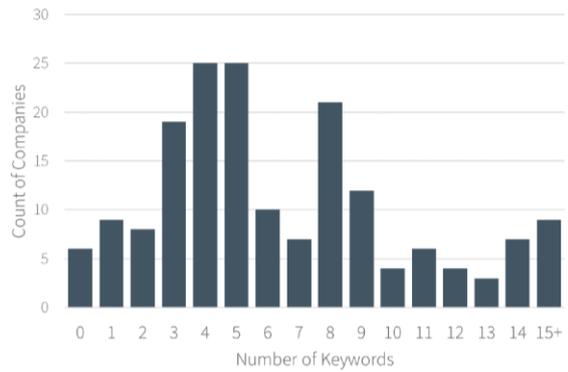
Productivity Keywords per Company (Medicine Manufacturing)

North and West Yorkshire

Greater Manchester

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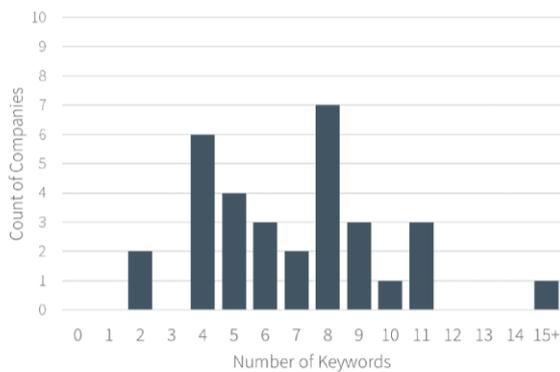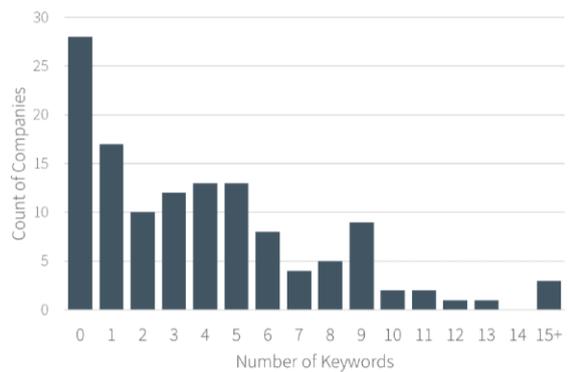
Productivity Keywords per Company (Retail)

North and West Yorkshire
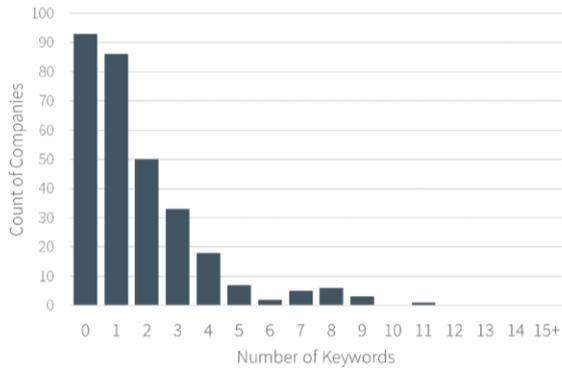
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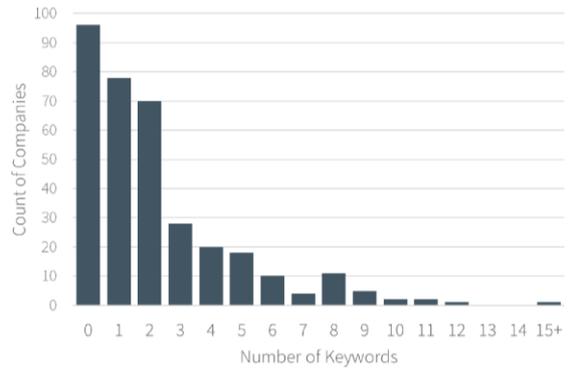
Productivity Keywords per Company (Science and R&D)

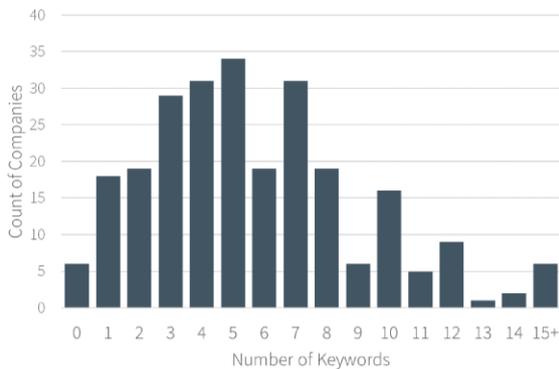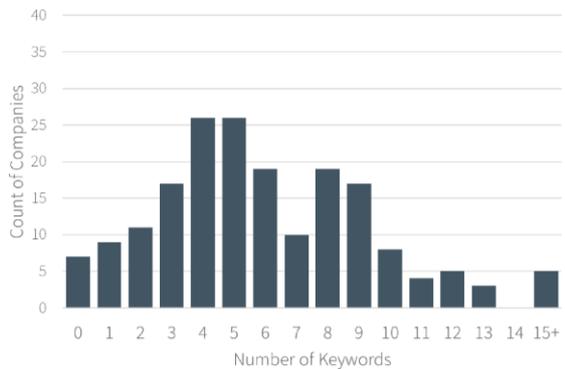## North and West Yorkshire
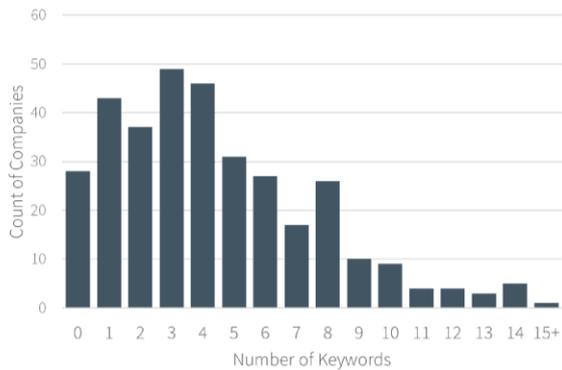
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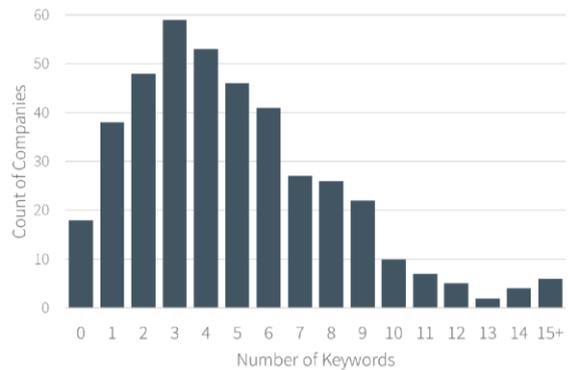
Productivity Keywords per Company (Telecoms)

North and West Yorkshire

Greater Manchester

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REGENERIS
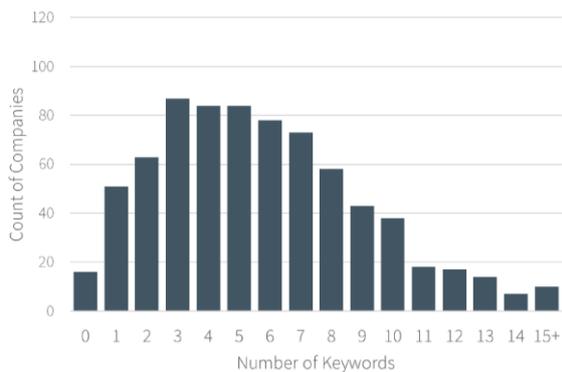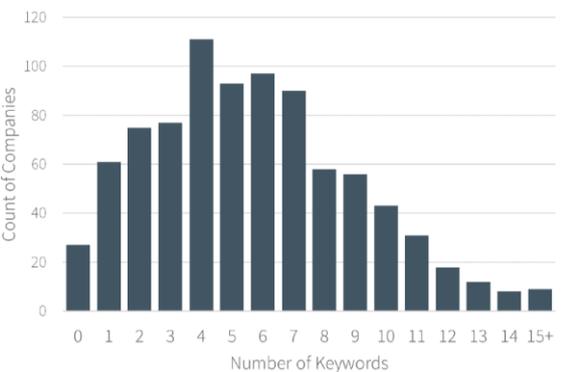
Productivity Keywords per Company (Transport and Logistics)

North and West Yorkshire
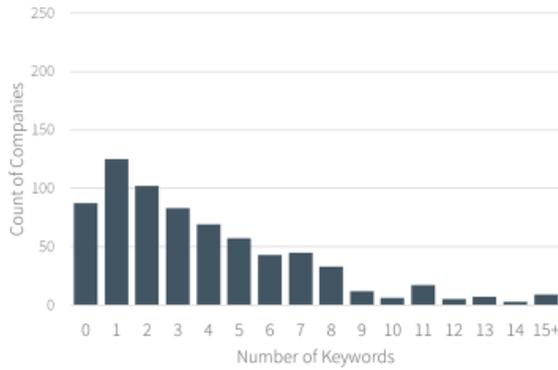
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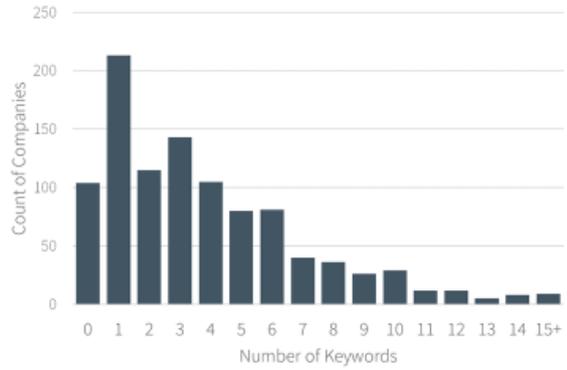
Productivity Keywords per Company (Transportation Components)

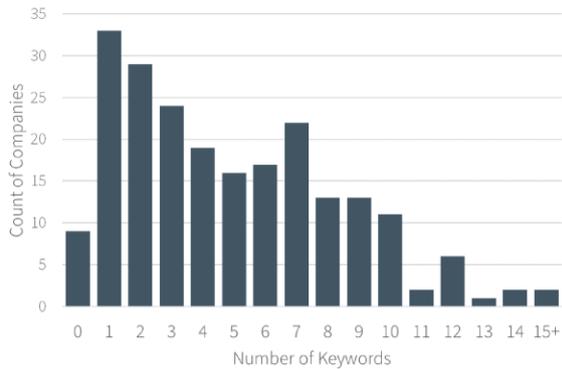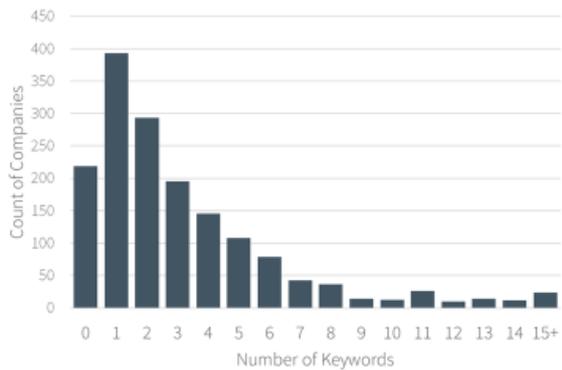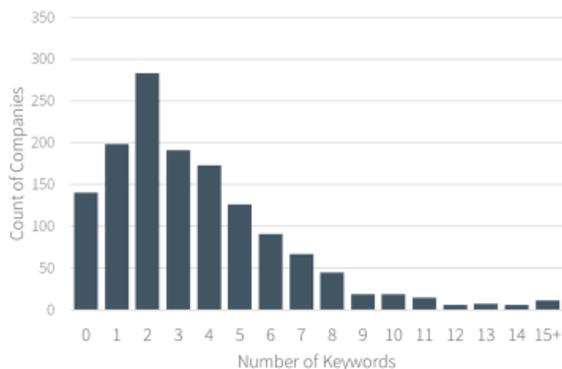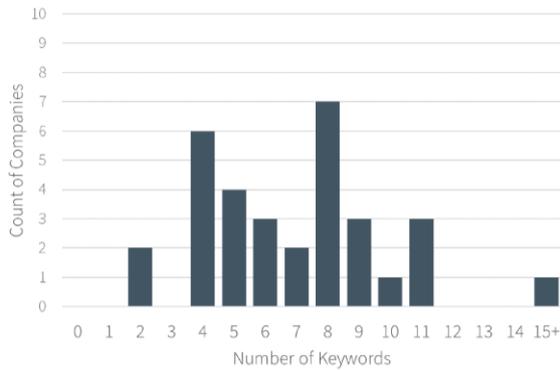### North and West Yorkshire
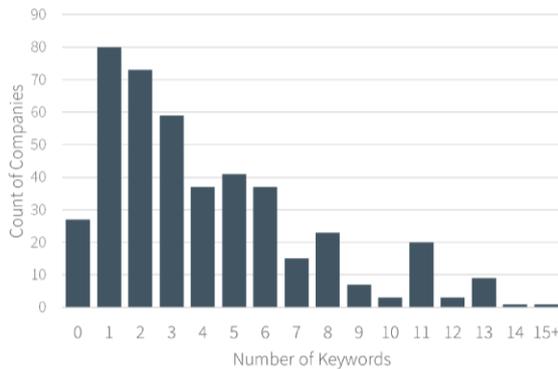
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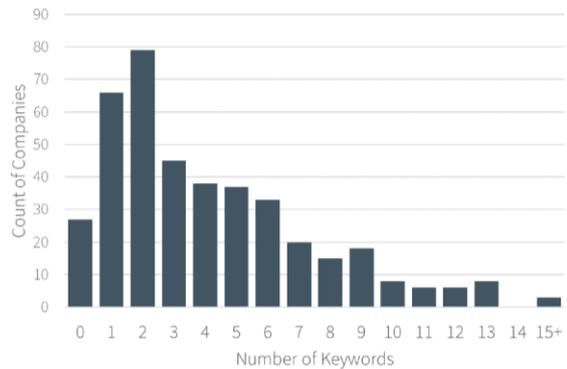
Productivity Keywords per Company (Waste)

North and West Yorkshire
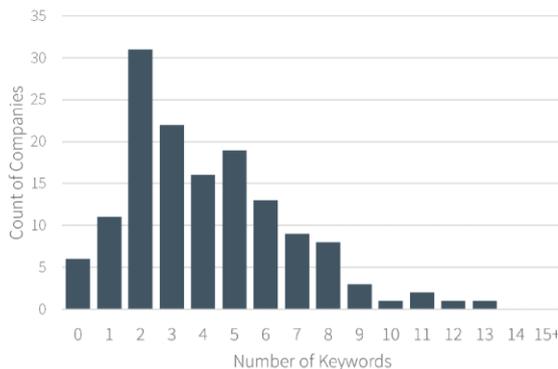
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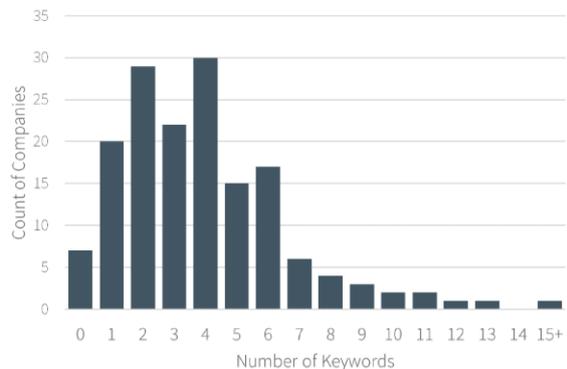
Appendix G - Age Analysis

All Companies

Share Founded in Last 2 Years

	North & West Yorkshire	Greater Manchester	England
	19%	25%	22%

Share Founded in Last 5 Years

	North & West Yorkshire	Greater Manchester	England
	38%	44%	40%

Share Founded in Last 10 Years

	North & West Yorkshire	Greater Manchester	England
	60%	65%	62%

Average Age (Years)

North & West Yorkshire	Greater Manchester	England
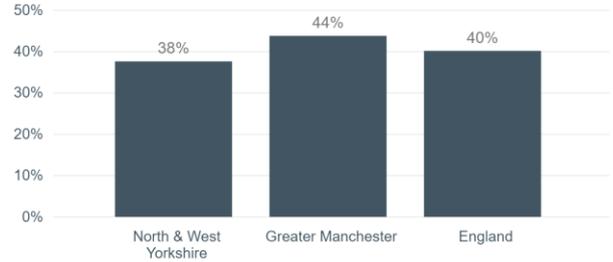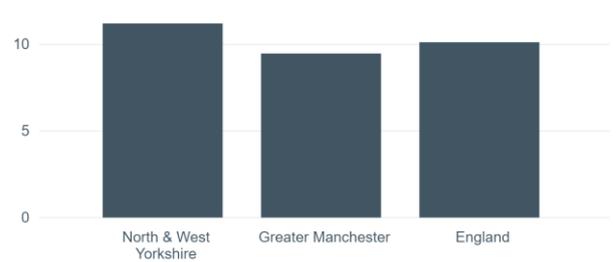
Accommodation and Food Services

Share Founded in Last 2 Years

	North & West Yorkshire	Greater Manchester	England
	40%	47%	38%

Share Founded in Last 5 Years

	North & West Yorkshire	Greater Manchester	England
	65%	70%	60%

Share Founded in Last 10 Years

	North & West Yorkshire	Greater Manchester	England
	82%	84%	78%

Average Age (Years)

North & West Yorkshire	Greater Manchester	England

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Agriculture, Forestry and Fishing

Share Founded in Last 2 Years

Region	Value
North & West Yorkshire	14%
Greater Manchester	30%
England	15%

Share Founded in Last 5 Years

Region	Value
North & West Yorkshire	27%
Greater Manchester	46%
England	28%

Share Founded in Last 10 Years

Region	Value
North & West Yorkshire	45%
Greater Manchester	64%
England	48%

Average Age (Years)

Region	Value
North & West Yorkshire	~17
Greater Manchester	~10.5
England	~16

Agri-Tech

Share Founded in Last 2 Years

Region	Value
North & West Yorkshire	15%
Greater Manchester	3%
England	12%

Share Founded in Last 5 Years

Region	Value
North & West Yorkshire	27%
Greater Manchester	25%
England	27%

Share Founded in Last 10 Years

Region	Value
North & West Yorkshire	49%
Greater Manchester	39%
England	53%

Average Age (Years)

Region	Value
North & West Yorkshire	~20
Greater Manchester	~28
England	~18

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AI and Data

Share Founded in Last 2 Years
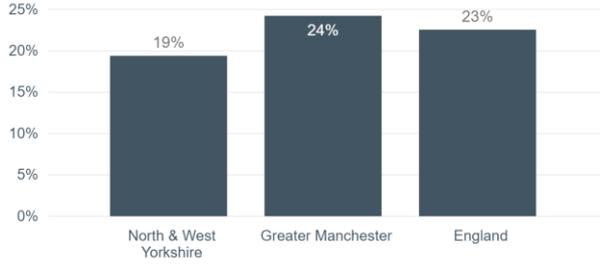
Region	Value
North & West Yorkshire	19%
Greater Manchester	24%
England	23%

Share Founded in Last 5 Years

Region	Value
North & West Yorkshire	38%
Greater Manchester	42%
England	42%

Share Founded in Last 10 Years

Region	Value
North & West Yorkshire	61%
Greater Manchester	68%
England	65%

Average Age (Years)

Region	Value
North & West Yorkshire	~9.6
Greater Manchester	~8.4
England	~8.6
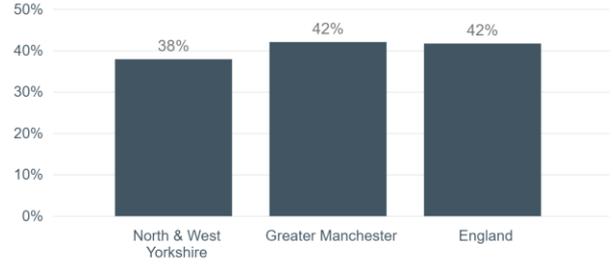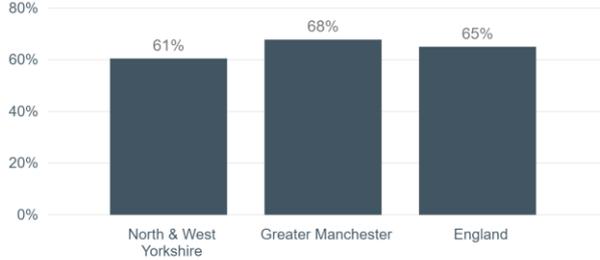
Clean Growth

Share Founded in Last 2 Years
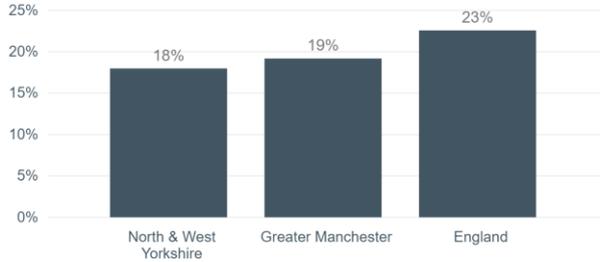
Region	Value
North & West Yorkshire	18%
Greater Manchester	19%
England	23%

Share Founded in Last 5 Years

Region	Value
North & West Yorkshire	28%
Greater Manchester	42%
England	42%

Share Founded in Last 10 Years

Region	Value
North & West Yorkshire	69%
Greater Manchester	73%
England	73%

Average Age (Years)

Region	Value
North & West Yorkshire	~8.8
Greater Manchester	~6.9
England	~7.8
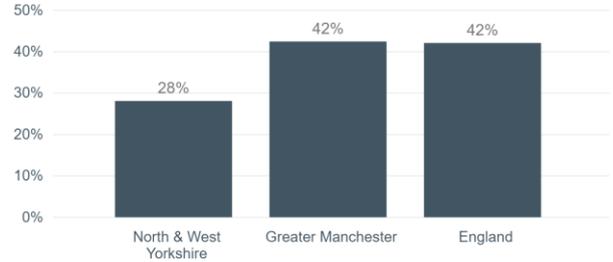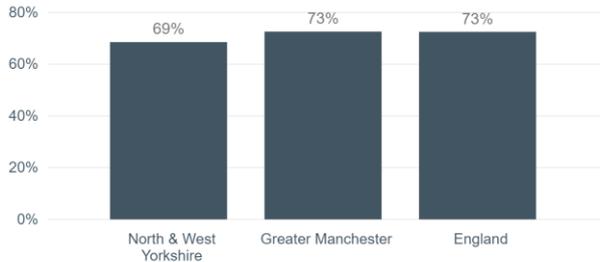
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Construction

Share Founded in Last 2 Years

Region	Value
North & West Yorkshire	20%
Greater Manchester	24%
England	22%

Share Founded in Last 5 Years

Region	Value
North & West Yorkshire	38%
Greater Manchester	42%
England	42%

Share Founded in Last 10 Years

Region	Value
North & West Yorkshire	59%
Greater Manchester	62%
England	62%

Average Age (Years)

Region	Value
North & West Yorkshire	~11
Greater Manchester	~10
England	~10
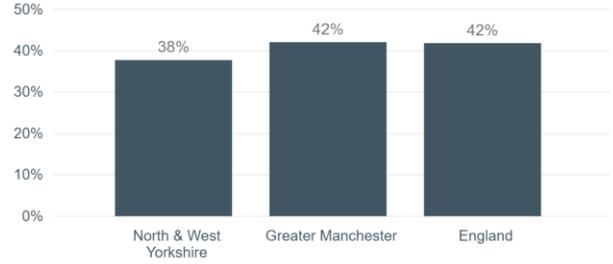
Creative

Share Founded in Last 2 Years
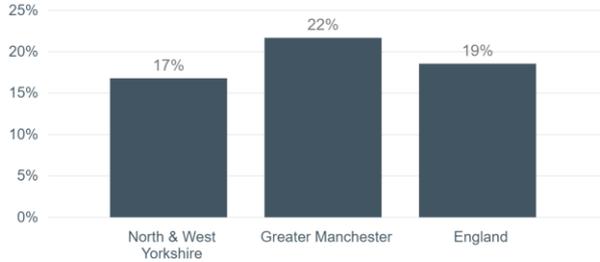
Region	Value
North & West Yorkshire	17%
Greater Manchester	22%
England	19%

Share Founded in Last 5 Years

Region	Value
North & West Yorkshire	41%
Greater Manchester	46%
England	38%

Share Founded in Last 10 Years

Region	Value
North & West Yorkshire	66%
Greater Manchester	69%
England	65%

Average Age (Years)

Region	Value
North & West Yorkshire	~8
Greater Manchester	~7
England	~8
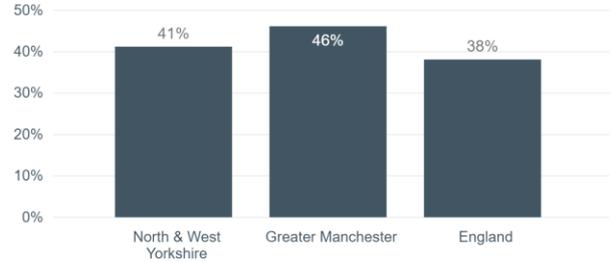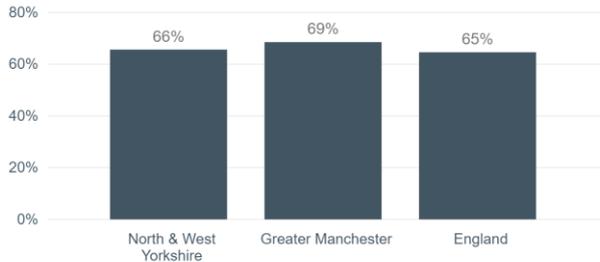
HATCH REGENERIS

Digital

Share Founded in Last 2 Years
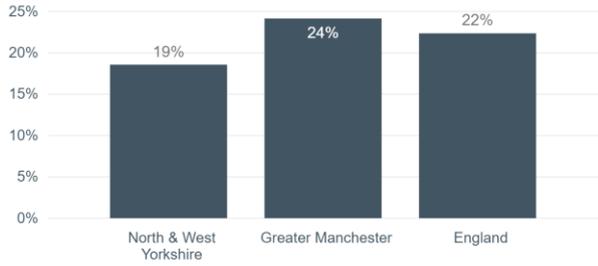
Region	Value
North & West Yorkshire	19%
Greater Manchester	24%
England	22%

Share Founded in Last 5 Years

Region	Value
North & West Yorkshire	39%
Greater Manchester	46%
England	43%

Share Founded in Last 10 Years

Region	Value
North & West Yorkshire	63%
Greater Manchester	68%
England	66%

Average Age (Years)

Region	Value
North & West Yorkshire	~11
Greater Manchester	~8.5
England	~8.5
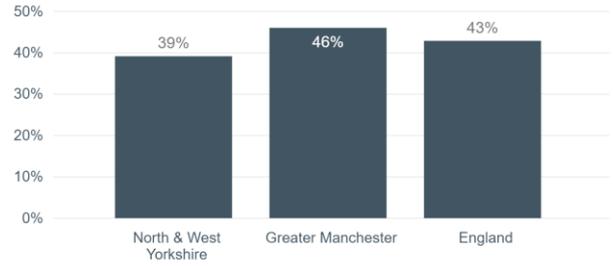
Energy

Share Founded in Last 2 Years
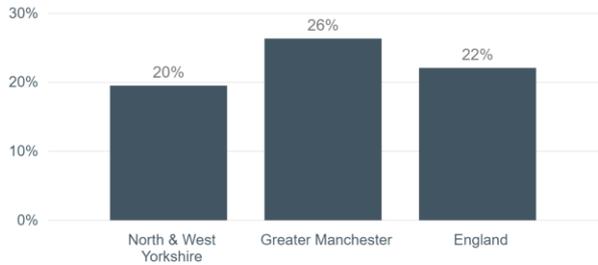
Region	Value
North & West Yorkshire	20%
Greater Manchester	26%
England	22%

Share Founded in Last 5 Years

Region	Value
North & West Yorkshire	35%
Greater Manchester	44%
England	41%

Share Founded in Last 10 Years

Region	Value
North & West Yorkshire	61%
Greater Manchester	65%
England	65%

Average Age (Years)

Region	Value
North & West Yorkshire	~11.5
Greater Manchester	~8
England	~9.5

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Fintech

Share Founded in Last 2 Years

	North & West Yorkshire	Greater Manchester	England
	24%	25%	24%

Share Founded in Last 5 Years

	North & West Yorkshire	Greater Manchester	England
	44%	41%	44%

Share Founded in Last 10 Years

	North & West Yorkshire	Greater Manchester	England
	63%	70%	66%
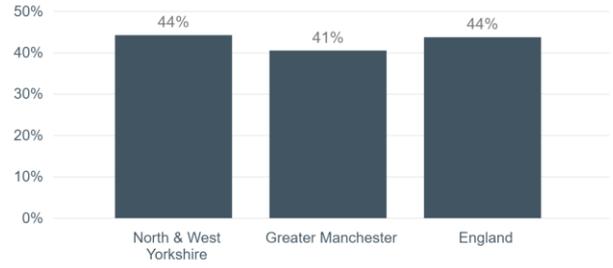
Average Age (Years)

Food and Drink

Share Founded in Last 2 Years
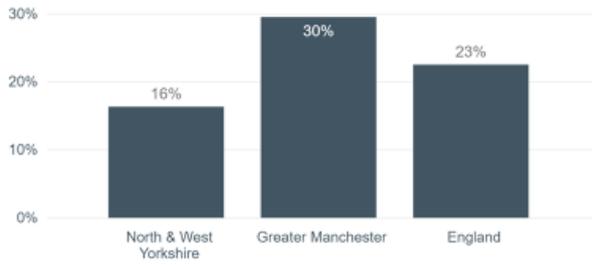
	North & West Yorkshire	Greater Manchester	England
	16%	30%	23%

Share Founded in Last 5 Years

	North & West Yorkshire	Greater Manchester	England
	32%	44%	39%

Share Founded in Last 10 Years

	North & West Yorkshire	Greater Manchester	England
	56%	63%	59%
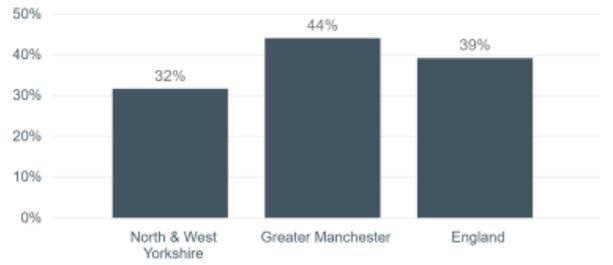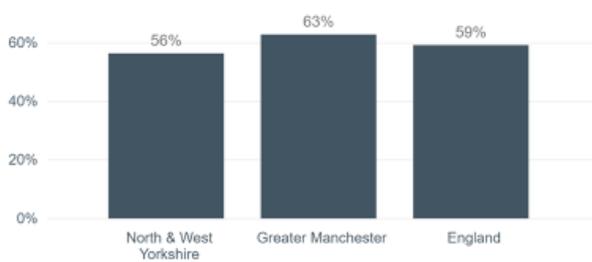
Average Age (Years)

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Health and Care

Share Founded in Last 2 Years
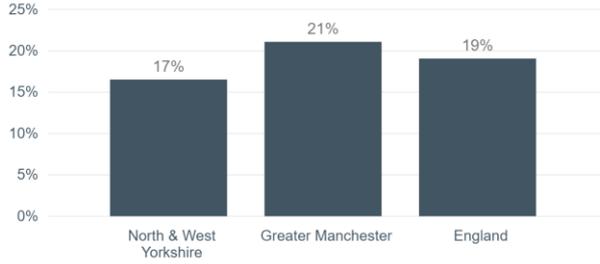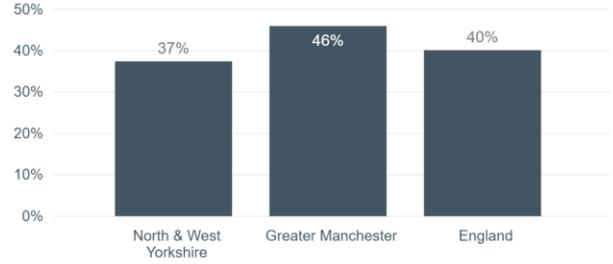
North & West Yorkshire	17%
Greater Manchester	21%
England	19%

Share Founded in Last 5 Years

North & West Yorkshire	37%
Greater Manchester	46%
England	40%

Share Founded in Last 10 Years

North & West Yorkshire	65%
Greater Manchester	71%
England	66%

Average Age (Years)

North & West Yorkshire	~9
Greater Manchester	~8
England	~9

IoT

Share Founded in Last 2 Years

North & West Yorkshire	19%
Greater Manchester	28%
England	22%

Share Founded in Last 5 Years

North & West Yorkshire	25%
Greater Manchester	45%
England	40%

Share Founded in Last 10 Years

North & West Yorkshire	56%
Greater Manchester	62%
England	60%

Average Age (Years)

North & West Yorkshire	~12
Greater Manchester	~9
England	~10

Manufacturing

Share Founded in Last 2 Years

	North & West Yorkshire	Greater Manchester	England
	15%	20%	18%

Share Founded in Last 5 Years

	North & West Yorkshire	Greater Manchester	England
	30%	33%	36%

Share Founded in Last 10 Years

	North & West Yorkshire	Greater Manchester	England
	45%	54%	53%
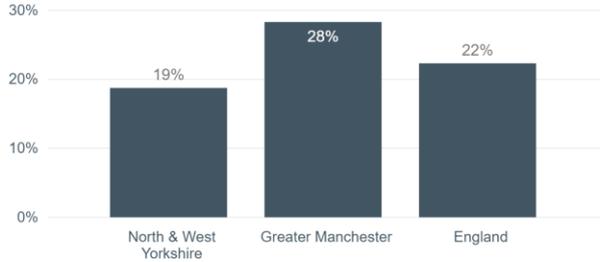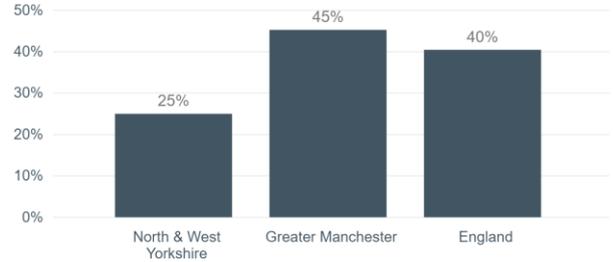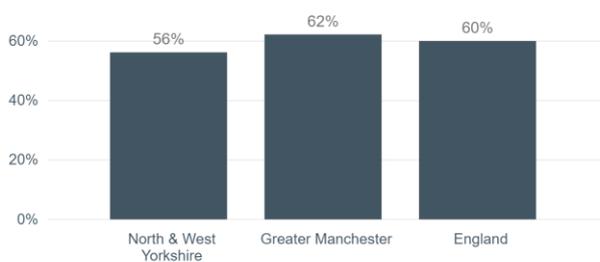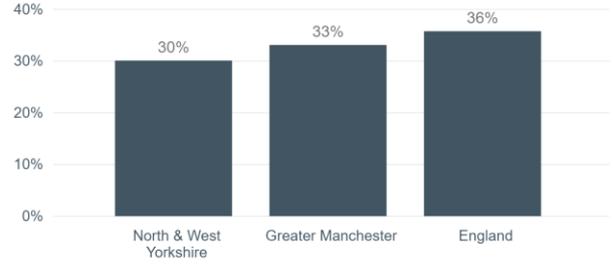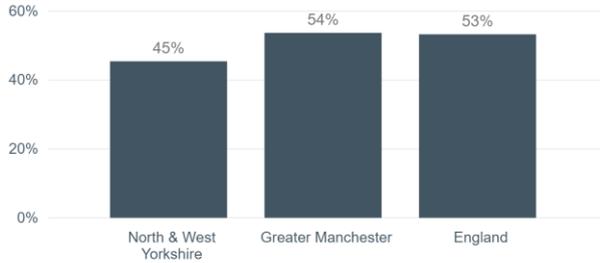
Average Age (Years)

Medicine Manufacturing

Share Founded in Last 2 Years
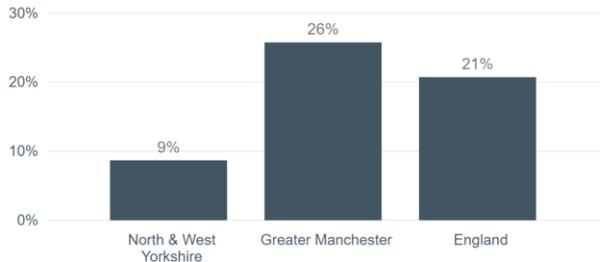
	North & West Yorkshire	Greater Manchester	England
	9%	26%	21%

Share Founded in Last 5 Years

	North & West Yorkshire	Greater Manchester	England
	39%	51%	41%

Share Founded in Last 10 Years

	North & West Yorkshire	Greater Manchester	England
	63%	70%	63%
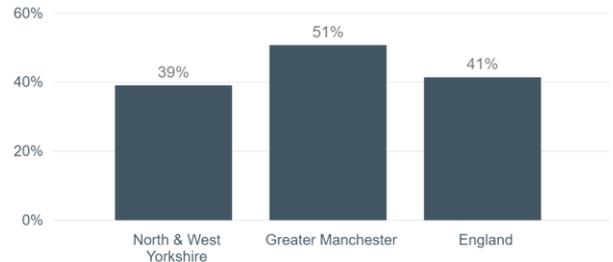
Average Age (Years)

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Retail

Share Founded in Last 2 Years
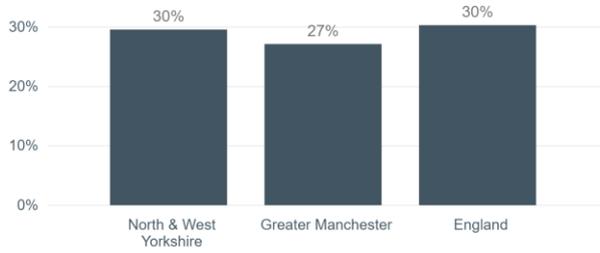
North & West Yorkshire: 30%
Greater Manchester: 27%
England: 30%

Share Founded in Last 5 Years

North & West Yorkshire: 51%
Greater Manchester: 51%
England: 53%

Share Founded in Last 10 Years

North & West Yorkshire: 73%
Greater Manchester: 71%
England: 73%

Average Age (Years)

North & West Yorkshire, Greater Manchester, England
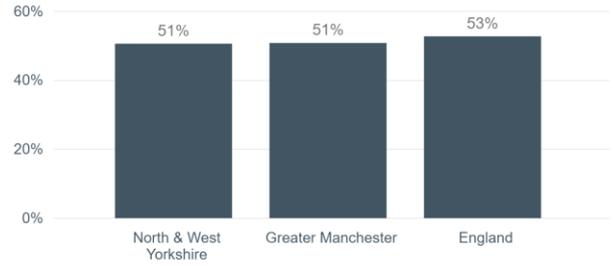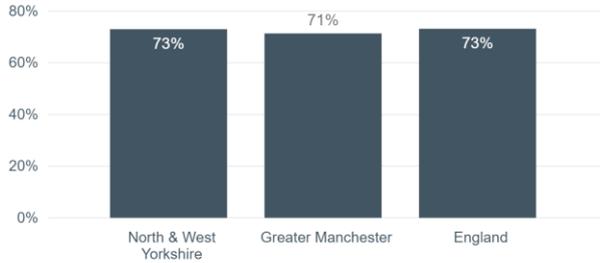
Science and R&D

Share Founded in Last 2 Years
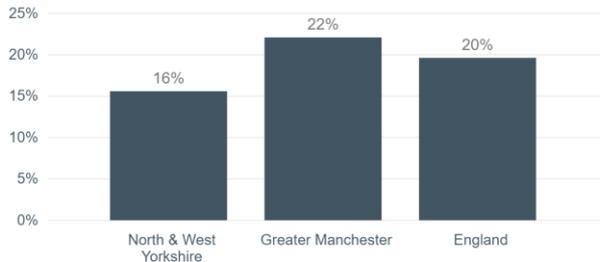
North & West Yorkshire: 16%
Greater Manchester: 22%
England: 20%

Share Founded in Last 5 Years

North & West Yorkshire: 31%
Greater Manchester: 35%
England: 36%

Share Founded in Last 10 Years

North & West Yorkshire: 47%
Greater Manchester: 53%
England: 54%

Average Age (Years)

North & West Yorkshire, Greater Manchester, England
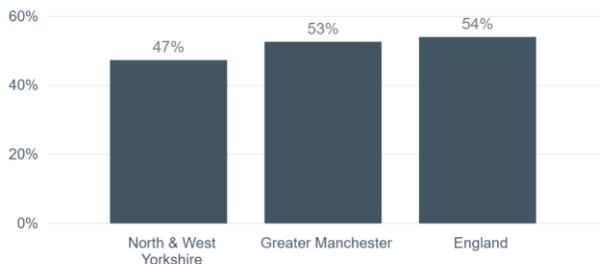
HATCH REGENERIS

Telecoms

Share Founded in Last 2 Years
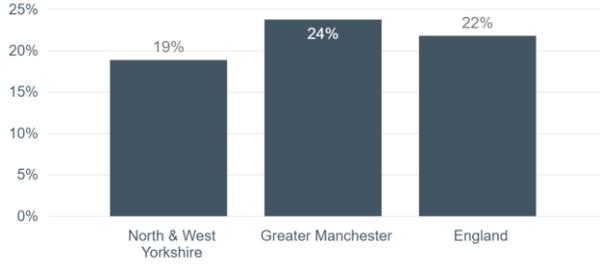
North & West Yorkshire: 19%	Greater Manchester: 24%	England: 22%

Share Founded in Last 5 Years

North & West Yorkshire: 36%	Greater Manchester: 42%	England: 40%

Share Founded in Last 10 Years

North & West Yorkshire: 59%	Greater Manchester: 67%	England: 63%

Average Age (Years)

North & West Yorkshire	Greater Manchester	England
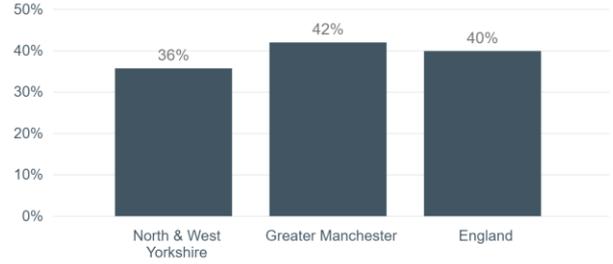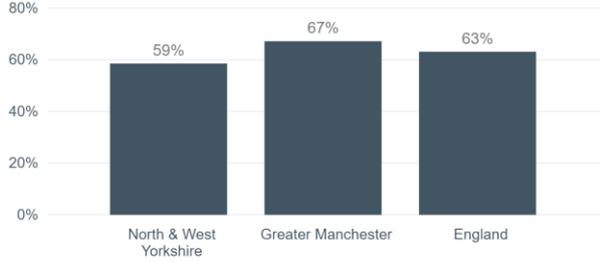
Transport and Logistics

Share Founded in Last 2 Years
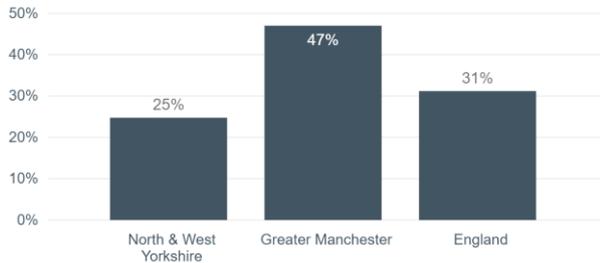
North & West Yorkshire: 25%	Greater Manchester: 47%	England: 31%

Share Founded in Last 5 Years

North & West Yorkshire: 46%	Greater Manchester: 65%	England: 50%

Share Founded in Last 10 Years

North & West Yorkshire: 62%	Greater Manchester: 76%	England: 66%

Average Age (Years)

North & West Yorkshire	Greater Manchester	England

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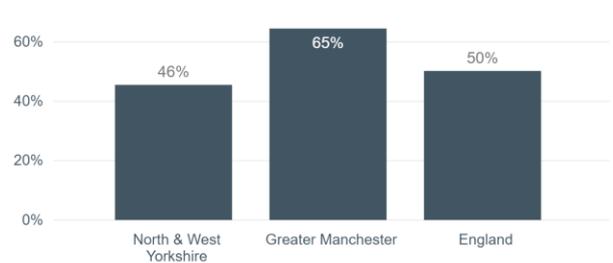
Transportation components

Share Founded in Last 2 Years
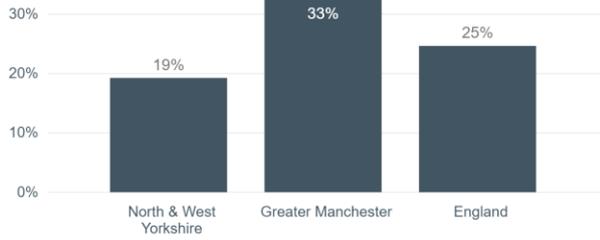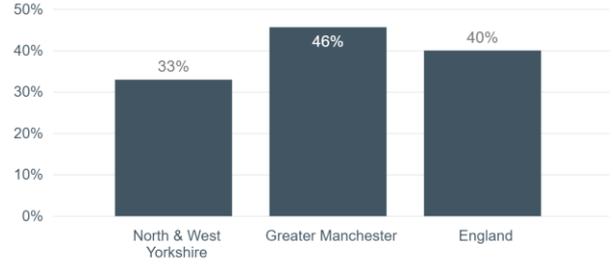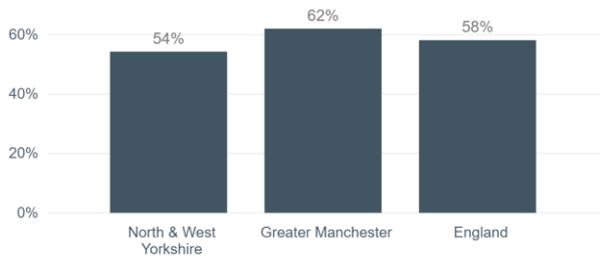
North & West Yorkshire	Greater Manchester	England
19%	33%	25%

Share Founded in Last 5 Years

North & West Yorkshire	Greater Manchester	England
33%	46%	40%

Share Founded in Last 10 Years

North & West Yorkshire	Greater Manchester	England
54%	62%	58%

Average Age (Years)

North & West Yorkshire	Greater Manchester	England

Waste

Share Founded in Last 2 Years

North & West Yorkshire	Greater Manchester	England
20%	15%	20%

Share Founded in Last 5 Years

North & West Yorkshire	Greater Manchester	England
31%	36%	36%

Share Founded in Last 10 Years

North & West Yorkshire	Greater Manchester	England
59%	58%	58%

Average Age (Years)

North & West Yorkshire	Greater Manchester	England
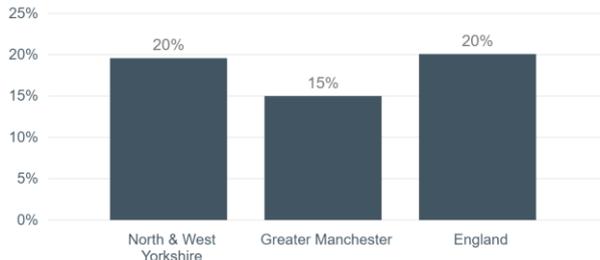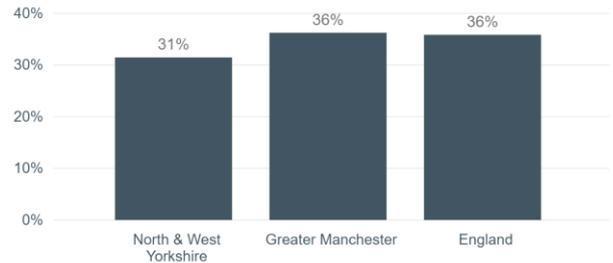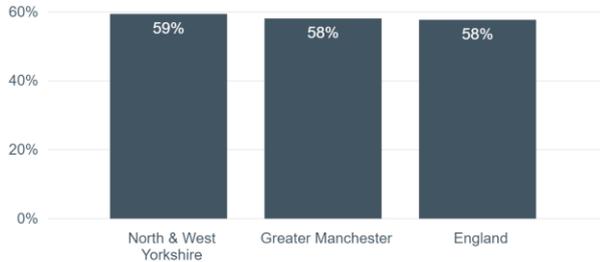
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Appendix H - Selected Alternative Cross-over analysis

H.1   This appendix provides an alternative way of assessing sector cross-over. Here we take the AI derived sector definition and look to the individual SIC code definitions of particular businesses. This provides both a check of AI definitions, and a way to investigate the interdependencies between sectors and activities.

H.2   As an example of the type of insight this analysis can provide, please note the wide spread of activities in Manufacturing in North and West, reinforcing earlier assumptions about the number, lower tier undertakings feeding into a potentially wider customer base.

Sector Breakdown of the AI and Data Sector

Industry	Number of Companies	NWY Share	GM Share	England Share
62020 : Computer consultancy activities	189	23%	20%	22%
62090 : Other information technology and computer service activities	109	13%	12%	14%
62012 : Business and domestic software development	50	6%	7%	7%
62030 : Computer facilities management activities	24	3%	3%	2%
61900 : Other telecommunications activities	19	2%	2%	2%
95110 : Repair of computers and peripheral equipment	18	2%	1%	2%
63110 : Data processing, hosting and related activities	17	2%	3%	2%
74909 : Other professional, scientific and technical activities (not including environmental consultancy or quantity surveying)	16	2%	3%	2%
63990 : Other information service activities nec	15	2%	1%	2%
61100 : Wired telecommunications activities	10	1%	1%	1%
78109 : Activities of employment placement agencies (other than motion picture, television and other theatrical casting) nec	10	1%	2%	1%
43210 : Electrical installation	9	1%	1%	1%
86900 : Other human health activities	7	1%	0%	1%
26200 : Manufacture of computers and peripheral equipment	6	1%	0%	0%
43290 : Other construction installation	6	1%		0%
63120 : Web portals	6	1%	1%	1%
47910 : Retail sale via mail order houses or via Internet	5	1%	1%	1%
47990 : Other retail sale not in stores, stalls or markets	5	1%	1%	0%
73110 : Advertising agencies	5	1%	1%	1%
46510 : Wholesale of computers, computer peripheral equipment and software	4	0%	1%	0%
58290 : Other software publishing	4	0%	1%	1%
47410 : Retail sale of computers, peripheral units and software in specialised stores	3	0%	1%	0%
47530 : Retail sale of carpets, rugs, wall and floor coverings in specialised stores	3	0%	0%	0%

Sector Breakdown of the Clean Growth Sector

Industry	Number of Companies	NWY Share	GM Share	England Share
74909 : Other professional, scientific and technical activities (not including environmental consultancy or quantity surveying)	10	9%	4%	7%
35110 : Production of electricity	8	7%	7%	9%
35140 : Trade of electricity	8	7%	3%	4%
74901 : Environmental consulting activities	7	6%	4%	6%
36000 : Water collection, treatment and supply	4	3%	3%	2%
62020 : Computer consultancy activities	4	3%	3%	2%
27510 : Manufacture of electric domestic appliances	3	3%		0%
27900 : Manufacture of other electrical equipment	3	3%	1%	1%
43999 : Specialised construction activities (other than scaffold erection) nec	3	3%	2%	3%
35230 : Trade of gas through mains	2	2%	1%	1%
43220 : Plumbing, heat and air-conditioning installation	2	2%	1%	2%
43290 : Other construction installation	2	2%	1%	1%
62090 : Other information technology and computer service activities	2	2%		1%
74100 : Specialised design activities	2	2%		0%
86210 : General medical practice activities	2	2%	1%	0%
16290 : Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials	1	1%	1%	0%
25990 : Manufacture of other fabricated metal products nec	1	1%		0%
27200 : Manufacture of batteries and accumulators	1	1%		0%
35130 : Distribution of electricity	1	1%	1%	2%
35220 : Distribution of gaseous fuels through mains	1	1%		1%
39000 : Remediation activities and other waste management services	1	1%		0%
42910 : Construction of water projects	1	1%		0%
43210 : Electrical installation	1	1%		3%

Sector Breakdown of the Creative Sector

Industry	Number of Companies	NWY Share	GM Share	England Share
73110 : Advertising agencies	37	18%	16%	14%
62090 : Other information technology and computer service activities	30	15%	10%	10%
74100 : Specialised design activities	26	13%	9%	12%
62012 : Business and domestic software development	14	7%	3%	5%
62020 : Computer consultancy activities	12	6%	7%	8%
73120 : Media representation	9	4%	4%	3%
59112 : Video production activities	8	4%	7%	6%
90030 : Artistic creation	7	3%	2%	4%
74909 : Other professional, scientific and technical activities (not including environmental consultancy or quantity surveying)	5	2%	2%	2%
18129 : Printing (other than printing of newspapers and printing on labels and tags) nec	4	2%	1%	1%
63110 : Data processing, hosting and related activities	3	1%	0%	1%
63120 : Web portals	3	1%	1%	2%
63990 : Other information service activities nec	3	1%	0%	2%
78109 : Activities of employment placement agencies (other than motion picture, television and other theatrical casting) nec	3	1%	0%	0%
18130 : Pre-press and pre-media services	2	1%		0%
59113 : Television programme production activities	2	1%	2%	1%
74202 : Other specialist photography (not including portrait photography)	2	1%	0%	1%
90020 : Support activities to performing arts	2	1%	1%	1%
14131 : Manufacture of men's outerwear, other than leather clothes and workwear	1	0%		0%
14132 : Manufacture of women's outerwear, other than leather clothes and workwear	1	0%		0%
14190 : Manufacture of other wearing apparel and accessories	1	0%		0%
43290 : Other construction installation	1	0%		0%
47890 : Retail sale via stalls and markets of other goods	1	0%		0%

Sector Breakdown of the Digital Sector

Industry	Number of Companies	NWY Share	GM Share	England Share
62090 : Other information technology and computer service activities	104	8%	6%	7%
62020 : Computer consultancy activities	81	6%	7%	9%
73110 : Advertising agencies	59	4%	4%	4%
62012 : Business and domestic software development	50	4%	5%	4%
74100 : Specialised design activities	38	3%	1%	3%
41100 : Development of building projects	23	2%	1%	1%
47910 : Retail sale via mail order houses or via Internet	23	2%	2%	2%
86900 : Other human health activities	22	2%	1%	1%
62011 : Ready-made interactive leisure and entertainment software development	21	2%	1%	1%
18129 : Printing (other than printing of newspapers and printing on labels and tags) nec	18	1%	0%	1%
63990 : Other information service activities nec	17	1%	1%	1%
73120 : Media representation	17	1%	1%	1%
74909 : Other professional, scientific and technical activities (not including environmental consultancy or quantity surveying)	17	1%	2%	2%
63110 : Data processing, hosting and related activities	16	1%	1%	1%
47990 : Other retail sale not in stores, stalls or markets	13	1%	1%	1%
43210 : Electrical installation	12	1%	0%	1%
43999 : Specialised construction activities (other than scaffold erection) nec	11	1%	1%	1%
90030 : Artistic creation	11	1%	1%	1%
41202 : Construction of domestic buildings	10	1%	2%	1%
59112 : Video production activities	10	1%	1%	1%
25990 : Manufacture of other fabricated metal products nec	9	1%	0%	0%
47190 : Other retail sale in non-specialised stores	9	1%	0%	0%
63120 : Web portals	9	1%	1%	1%

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Sector Breakdown of the Energy Sector

Industry	Number of Companies	NWY Share	GM Share	England Share
74909 : Other professional, scientific and technical activities (not including environmental consultancy or quantity surveying)	14	4%	4%	5%
36000 : Water collection, treatment and supply	13	4%	3%	4%
35110 : Production of electricity	11	3%	2%	4%
35140 : Trade of electricity	10	3%	2%	2%
62020 : Computer consultancy activities	9	3%	1%	3%
74901 : Environmental consulting activities	9	3%	2%	4%
32990 : Other manufacturing nec	8	3%	1%	1%
42910 : Construction of water projects	7	2%		1%
43220 : Plumbing, heat and air-conditioning installation	6	2%	1%	2%
27900 : Manufacture of other electrical equipment	5	2%	1%	1%
47990 : Other retail sale not in stores, stalls or markets	5	2%	1%	1%
27110 : Manufacture of electric motors, generators and transformers	4	1%		0%
28990 : Manufacture of other special-purpose machinery nec	4	1%		0%
35130 : Distribution of electricity	4	1%	0%	1%
42990 : Construction of other civil engineering projects nec	4	1%	2%	1%
43290 : Other construction installation	4	1%	0%	1%
27510 : Manufacture of electric domestic appliances	3	1%		0%
43110 : Demolition	3	1%		0%
43210 : Electrical installation	3	1%	2%	2%
43999 : Specialised construction activities (other than scaffold erection) nec	3	1%	2%	2%
47910 : Retail sale via mail order houses or via Internet	3	1%	0%	1%
49410 : Freight transport by road	3	1%		0%
62012 : Business and domestic software development	3	1%	2%	1%

Sector Breakdown of the Fintech Sector

Industry	Number of Companies	NWY Share	GM Share	England Share
62020 : Computer consultancy activities	22	8%	6%	11%
62012 : Business and domestic software development	19	7%	9%	8%
62090 : Other information technology and computer service activities	12	4%	2%	6%
56103 : Take away food shops and mobile food stands	7	2%	2%	1%
74909 : Other professional, scientific and technical activities (not including environmental consultancy or quantity surveying)	5	2%	4%	2%
63110 : Data processing, hosting and related activities	3	1%	1%	2%
78109 : Activities of employment placement agencies (other than motion picture, television and other theatrical casting) nec	3	1%	0%	1%
41202 : Construction of domestic buildings	2	1%	0%	0%
43999 : Specialised construction activities (other than scaffold erection) nec	2	1%		0%
56102 : Unlicensed restaurants and cafes	2	1%		0%
56302 : Public houses and bars	2	1%		0%
63990 : Other information service activities nec	2	1%	1%	2%
73110 : Advertising agencies	2	1%	1%	0%
74100 : Specialised design activities	2	1%	0%	0%
01629 : Support activities for animal production (other than farm animal boarding and care) nec	1	0%		0%
26200 : Manufacture of computers and peripheral equipment	1	0%		0%
41201 : Construction of commercial buildings	1	0%	0%	0%
42110 : Construction of roads and motorways	1	0%		0%
43310 : Plastering	1	0%		0%
43342 : Glazing	1	0%		0%
47610 : Retail sale of books in specialised stores	1	0%		0%
47782 : Retail sale by opticians	1	0%		0%
47910 : Retail sale via mail order houses or via Internet	1	0%	2%	1%

Sector Breakdown of the Food & Drink Sector

Industry	Number of Companies	NWY Share	GM Share	England Share
47910 : Retail sale via mail order houses or via Internet	65	3%	4%	4%
45200 : Maintenance and repair of motor vehicles	60	3%	1%	1%
56302 : Public houses and bars	60	3%	1%	1%
41202 : Construction of domestic buildings	44	2%	1%	2%
43999 : Specialised construction activities (other than scaffold erection) nec	41	2%	2%	2%
41100 : Development of building projects	38	2%	1%	2%
49410 : Freight transport by road	38	2%	1%	1%
86900 : Other human health activities	34	2%	1%	1%
47990 : Other retail sale not in stores, stalls or markets	33	2%	3%	2%
56101 : Licensed restaurants	32	2%	1%	1%
74909 : Other professional, scientific and technical activities (not including environmental consultancy or quantity surveying)	32	2%	2%	2%
62020 : Computer consultancy activities	27	1%	2%	2%
43210 : Electrical installation	24	1%	2%	1%
43390 : Other building completion and finishing	24	1%	1%	1%
47789 : Other retail sale of new goods in specialised stores (other than by opticians or commercial art galleries), nec	24	1%	1%	1%
47190 : Other retail sale in non-specialised stores	23	1%	2%	1%
25990 : Manufacture of other fabricated metal products nec	20	1%	1%	1%
43220 : Plumbing, heat and air-conditioning installation	20	1%	1%	1%
47710 : Retail sale of clothing in specialised stores	20	1%	1%	1%
32990 : Other manufacturing nec	19	1%	1%	1%
43290 : Other construction installation	19	1%	0%	1%
43320 : Joinery installation	19	1%	0%	1%
55100 : Hotels and similar accommodation	19	1%	0%	0%

Sector Breakdown of the IoT Sector

Industry	Number of Companies	NWY Share	GM Share	England Share
62020 : Computer consultancy activities	9	21%	11%	19%
62090 : Other information technology and computer service activities	7	17%	12%	13%
62012 : Business and domestic software development	4	10%	14%	13%
52290 : Other transportation support activities	3	7%		0%
61900 : Other telecommunications activities	3	7%	4%	3%
49410 : Freight transport by road	2	5%	1%	1%
61200 : Wireless telecommunications activities	2	5%	1%	2%
26511 : Manufacture of electronic instruments and appliances for measuring, testing, and navigation, except industrial process control equipment	1	2%		0%
26512 : Manufacture of electronic industrial process control equipment	1	2%		0%
32990 : Other manufacturing nec	1	2%	1%	0%
47110 : Retail sale in non-specialised stores with food, beverages or tobacco predominating	1	2%		0%
47410 : Retail sale of computers, peripheral units and software in specialised stores	1	2%	3%	1%
47620 : Retail sale of newspapers and stationery in specialised stores	1	2%		0%
62030 : Computer facilities management activities	1	2%	5%	2%
63110 : Data processing, hosting and related activities	1	2%		2%
71112 : Urban planning and landscape architectural activities	1	2%		0%
71121 : Engineering design activities for industrial process and production	1	2%		1%
72110 : Research and experimental development on biotechnology	1	2%		0%
72190 : Other research and experimental development on natural sciences and engineering	1	2%	3%	1%
74909 : Other professional, scientific and technical activities (not including environmental consultancy or quantity surveying)	1	2%	4%	3%
86210 : General medical practice activities	1	2%	1%	0%
86900 : Other human health activities	1	2%		0%
01250 : Growing of other tree and bush fruits and nuts				0%

Sector Breakdown of the Manufacturing Sector

Industry	Number of Companies	NWY Share	GM Share	England Share
25620 : Machining	19	9%	3%	5%
25990 : Manufacture of other fabricated metal products nec	16	8%	4%	5%
28990 : Manufacture of other special-purpose machinery nec	12	6%	2%	2%
71121 : Engineering design activities for industrial process and production	9	4%	4%	3%
62020 : Computer consultancy activities	8	4%	4%	6%
32990 : Other manufacturing nec	7	3%	2%	4%
22290 : Manufacture of other plastic products	6	3%	1%	1%
25110 : Manufacture of metal structures and parts of structures	6	3%	6%	2%
74909 : Other professional, scientific and technical activities (not including environmental consultancy or quantity surveying)	6	3%	4%	3%
25610 : Treatment and coating of metals	5	2%	0%	1%
62090 : Other information technology and computer service activities	5	2%	4%	3%
71122 : Engineering related scientific and technical consulting activities	5	2%	3%	3%
28490 : Manufacture of other machine tools	4	2%	1%	1%
62012 : Business and domestic software development	4	2%	3%	3%
72190 : Other research and experimental development on natural sciences and engineering	4	2%	2%	2%
28290 : Manufacture of other general-purpose machinery nec	3	1%	1%	1%
33120 : Repair of machinery	3	1%	1%	1%
43220 : Plumbing, heat and air-conditioning installation	3	1%	2%	1%
25500 : Forging, pressing, stamping and roll-forming of metal; powder metallurgy	2	1%		0%
26511 : Manufacture of electronic instruments and appliances for measuring, testing, and navigation, except industrial process control equipment	2	1%	0%	0%
27900 : Manufacture of other electrical equipment	2	1%	1%	1%
28910 : Manufacture of machinery for metallurgy	2	1%		0%
33190 : Repair of other equipment	2	1%		0%

Sector Breakdown of the Medicine Manufacturing Sector

Industry	Number of Companies	NWY Share	GM Share	England Share
86900 : Other human health activities	11	7%	13%	10%
86210 : General medical practice activities	8	5%	7%	4%
74909 : Other professional, scientific and technical activities (not including environmental consultancy or quantity surveying)	6	4%	2%	3%
47910 : Retail sale via mail order houses or via Internet	5	3%	1%	2%
62012 : Business and domestic software development	5	3%	4%	2%
47749 : Retail sale of medical and orthopaedic goods (other than hearing aids) nec, in specialised stores	4	3%		0%
62020 : Computer consultancy activities	4	3%	3%	4%
62090 : Other information technology and computer service activities	4	3%	1%	2%
46750 : Wholesale of chemical products	3	2%		0%
86101 : Hospital activities	3	2%	2%	3%
87100 : Residential nursing care activities	3	2%		1%
87200 : Residential care activities for learning disabilities, mental health and substance abuse	3	2%	2%	1%
32990 : Other manufacturing nec	2	1%	1%	1%
43210 : Electrical installation	2	1%		0%
43910 : Roofing activities	2	1%	0%	0%
56101 : Licensed restaurants	2	1%	0%	1%
71122 : Engineering related scientific and technical consulting activities	2	1%	0%	0%
72110 : Research and experimental development on biotechnology	2	1%	1%	1%
74100 : Specialised design activities	2	1%	0%	1%
78109 : Activities of employment placement agencies (other than motion picture, television and other theatrical casting) nec	2	1%	0%	1%
87900 : Other residential care activities	2	1%	1%	1%
88990 : Other social work activities without accommodation nec	2	1%	0%	1%

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Sector Breakdown of the Retail Sector

Industry	Number of Companies	NWY Share	GM Share	England Share
62020 : Computer consultancy activities	26	4%	6%	5%
74909 : Other professional, scientific and technical activities (not including environmental consultancy or quantity surveying)	17	3%	3%	2%
43999 : Specialised construction activities (other than scaffold erection) nec	14	2%	2%	2%
62012 : Business and domestic software development	14	2%	4%	3%
41202 : Construction of domestic buildings	13	2%	0%	2%
32990 : Other manufacturing nec	11	2%	1%	1%
62090 : Other information technology and computer service activities	10	2%	2%	3%
56101 : Licensed restaurants	9	2%	1%	1%
86900 : Other human health activities	9	2%	1%	2%
45200 : Maintenance and repair of motor vehicles	8	1%	0%	1%
47910 : Retail sale via mail order houses or via Internet	8	1%	2%	2%
43210 : Electrical installation	7	1%	2%	1%
56102 : Unlicensed restaurants and cafes	7	1%	0%	1%
90020 : Support activities to performing arts	7	1%	0%	1%
25990 : Manufacture of other fabricated metal products nec	6	1%	0%	0%
41100 : Development of building projects	6	1%	1%	2%
43220 : Plumbing, heat and air-conditioning installation	6	1%	1%	1%
43290 : Other construction installation	6	1%	1%	1%
43390 : Other building completion and finishing	6	1%	1%	1%
49410 : Freight transport by road	6	1%	1%	1%
42990 : Construction of other civil engineering projects nec	5	1%		0%
47190 : Other retail sale in non-specialised stores	5	1%	1%	1%
55100 : Hotels and similar accommodation	5	1%		0%

Sector Breakdown of the Science and R&D Sector

Industry	Number of Companies	NWY Share	GM Share	England Share
32990 : Other manufacturing nec	23	5%	4%	3%
86900 : Other human health activities	19	4%	3%	2%
62020 : Computer consultancy activities	16	3%	3%	5%
74909 : Other professional, scientific and technical activities (not including environmental consultancy or quantity surveying)	14	3%	3%	3%
22290 : Manufacture of other plastic products	12	2%	1%	1%
72190 : Other research and experimental development on natural sciences and engineering	12	2%	1%	2%
25990 : Manufacture of other fabricated metal products nec	9	2%	1%	1%
47910 : Retail sale via mail order houses or via Internet	9	2%	5%	2%
72110 : Research and experimental development on biotechnology	9	2%	1%	2%
32500 : Manufacture of medical and dental instruments and supplies	7	1%	2%	1%
46750 : Wholesale of chemical products	7	1%	1%	1%
62090 : Other information technology and computer service activities	7	1%	1%	2%
86210 : General medical practice activities	7	1%	1%	1%
41202 : Construction of domestic buildings	5	1%	1%	0%
47749 : Retail sale of medical and orthopaedic goods (other than hearing aids) nec, in specialised stores	5	1%	0%	0%
20130 : Manufacture of other inorganic basic chemicals	4	1%	0%	0%
20140 : Manufacture of other organic basic chemicals	4	1%	0%	0%
20590 : Manufacture of other chemical products nec	4	1%	2%	1%
28990 : Manufacture of other special-purpose machinery nec	4	1%	1%	1%
43999 : Specialised construction activities (other than scaffold erection) nec	4	1%	0%	1%
56103 : Take away food shops and mobile food stands	4	1%		0%
62012 : Business and domestic software development	4	1%	2%	2%
10890 : Manufacture of other food products nec	3	1%		0%

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Sector Breakdown of the Telecoms Sector

Industry	Number of Companies	NWY Share	GM Share	England Share
62020 : Computer consultancy activities	197	19%	17%	20%
62090 : Other information technology and computer service activities	113	11%	10%	12%
61900 : Other telecommunications activities	48	5%	5%	5%
62012 : Business and domestic software development	47	5%	5%	5%
61100 : Wired telecommunications activities	33	3%	2%	2%
62030 : Computer facilities management activities	31	3%	2%	2%
95110 : Repair of computers and peripheral equipment	26	3%	1%	2%
61200 : Wireless telecommunications activities	21	2%	1%	2%
63110 : Data processing, hosting and related activities	18	2%	2%	2%
63990 : Other information service activities nec	18	2%	1%	2%
74909 : Other professional, scientific and technical activities (not including environmental consultancy or quantity surveying)	18	2%	3%	2%
49410 : Freight transport by road	8	1%	0%	1%
73110 : Advertising agencies	8	1%	1%	1%
86900 : Other human health activities	8	1%	0%	1%
26200 : Manufacture of computers and peripheral equipment	7	1%	0%	0%
43210 : Electrical installation	7	1%	1%	1%
43220 : Plumbing, heat and air-conditioning installation	6	1%	0%	0%
74100 : Specialised design activities	6	1%	0%	0%
78109 : Activities of employment placement agencies (other than motion picture, television and other theatrical casting) nec	6	1%	1%	1%
43290 : Other construction installation	5	0%	0%	0%
46520 : Wholesale of electronic and telecommunications equipment and parts	5	0%	0%	0%
88990 : Other social work activities without accommodation nec	5	0%	0%	0%
46510 : Wholesale of computers, computer peripheral equipment and software	4	0%	0%	0%

## Sector Breakdown of the Transportation Components Sector

Industry	Number of Companies	NWY Share	GM Share	England Share
47910 : Retail sale via mail order houses or via Internet	27	5%	4%	4%
47190 : Other retail sale in non-specialised stores	12	2%	2%	1%
86900 : Other human health activities	12	2%	1%	1%
47789 : Other retail sale of new goods in specialised stores (other than by opticians or commercial art galleries), nec	11	2%	0%	1%
45200 : Maintenance and repair of motor vehicles	10	2%	1%	1%
56101 : Licensed restaurants	10	2%	0%	1%
62020 : Computer consultancy activities	10	2%	2%	3%
25990 : Manufacture of other fabricated metal products nec	9	2%	1%	1%
43210 : Electrical installation	9	2%	3%	2%
49410 : Freight transport by road	9	2%	1%	1%
32990 : Other manufacturing nec	8	1%	1%	1%
43999 : Specialised construction activities (other than scaffold erection) nec	8	1%	2%	2%
43220 : Plumbing, heat and air-conditioning installation	7	1%	1%	1%
47990 : Other retail sale not in stores, stalls or markets	7	1%	3%	2%
63990 : Other information service activities nec	7	1%	0%	1%
22290 : Manufacture of other plastic products	6	1%		0%
25620 : Machining	6	1%	0%	0%
41100 : Development of building projects	6	1%	1%	1%
41202 : Construction of domestic buildings	6	1%	2%	1%
45320 : Retail trade of motor vehicle parts and accessories	6	1%	1%	1%
47110 : Retail sale in non-specialised stores with food, beverages or tobacco predominating	6	1%	0%	1%
56103 : Take away food shops and mobile food stands	6	1%	2%	1%
31090 : Manufacture of other furniture	5	1%		0%

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Sector Breakdown of the Waste Sector

| Industry	Number of Companies	NWY Share	GM Share	England Share
38110 : Collection of non-hazardous waste	38	23%	19%	18%
38210 : Treatment and disposal of non-hazardous waste	14	8%	6%	8%
38320 : Recovery of sorted materials	12	7%	12%	9%
39000 : Remediation activities and other waste management services	11	7%	6%	6%
38120 : Collection of hazardous waste	7	4%	5%	3%
62020 : Computer consultancy activities	4	2%	1%	2%
41100 : Development of building projects	3	2%	1%	1%
62090 : Other information technology and computer service activities	3	2%	3%	1%
13990 : Manufacture of other textiles nec	2	1%		0%
25990 : Manufacture of other fabricated metal products nec	2	1%	1%	0%
38220 : Treatment and disposal of hazardous waste	2	1%	4%	3%
46750 : Wholesale of chemical products	2	1%		0%
49410 : Freight transport by road	2	1%	3%	3%
49420 : Removal services	2	1%		0%
74901 : Environmental consulting activities	2	1%	2%	3%
78109 : Activities of employment placement agencies (other than motion picture, television and other theatrical casting) nec	2	1%		0%
01410 : Raising of dairy cattle	1	1%		0%
01450 : Raising of sheep and goats	1	1%		0%
17219 : Manufacture of paper and paperboard containers other than sacks and bags	1	1%		0%
24410 : Precious metals production	1	1%		0%
33200 : Installation of industrial machinery and equipment	1	1%	1%	0%
35110 : Production of electricity	1	1%		1%
41202 : Construction of domestic buildings	1	1%		0%

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Appendix I - Location of Companies
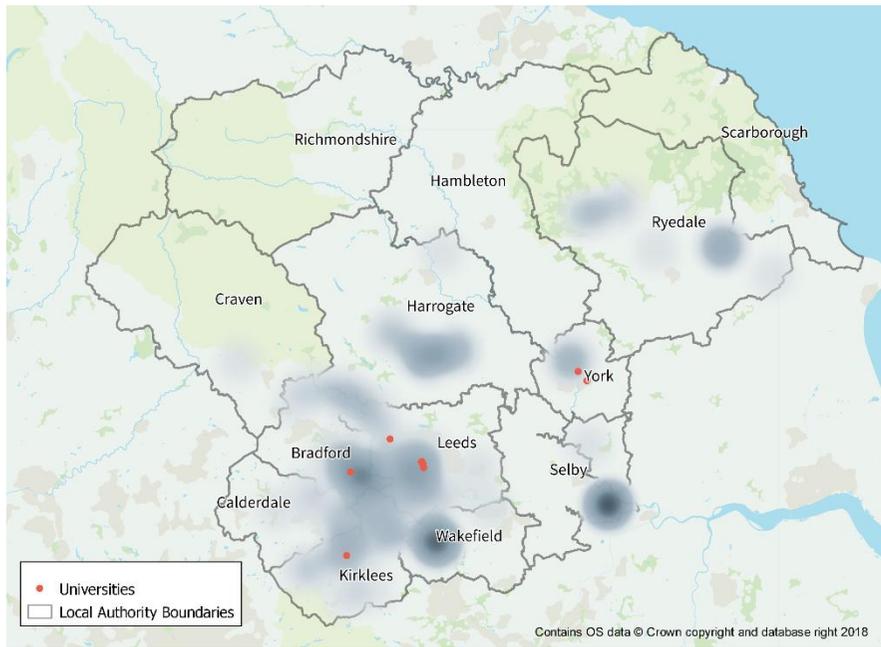
Figure I.1 Location of Agri-Tech Companies
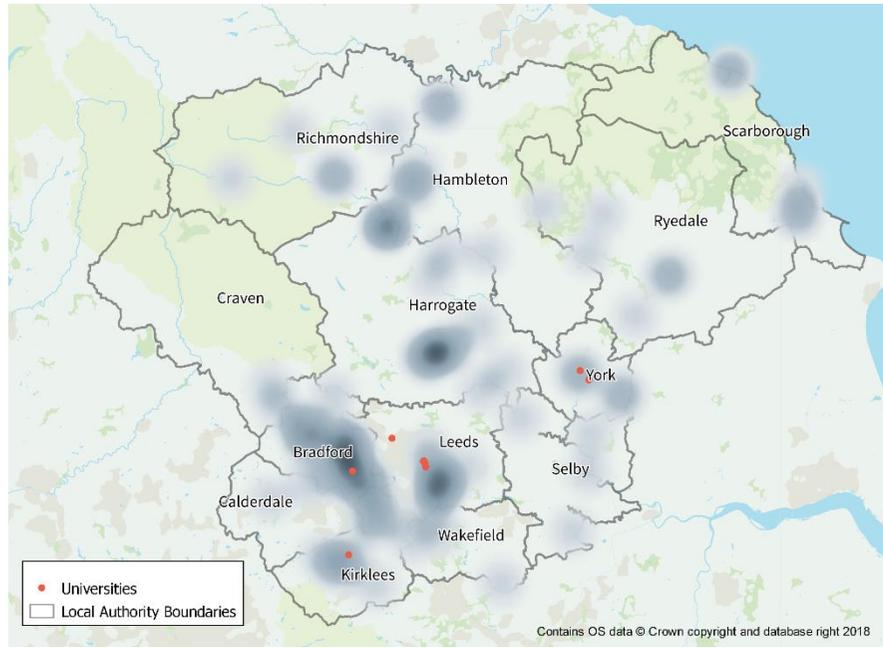
Source: Hatch Regeneris/DataCity (2019)
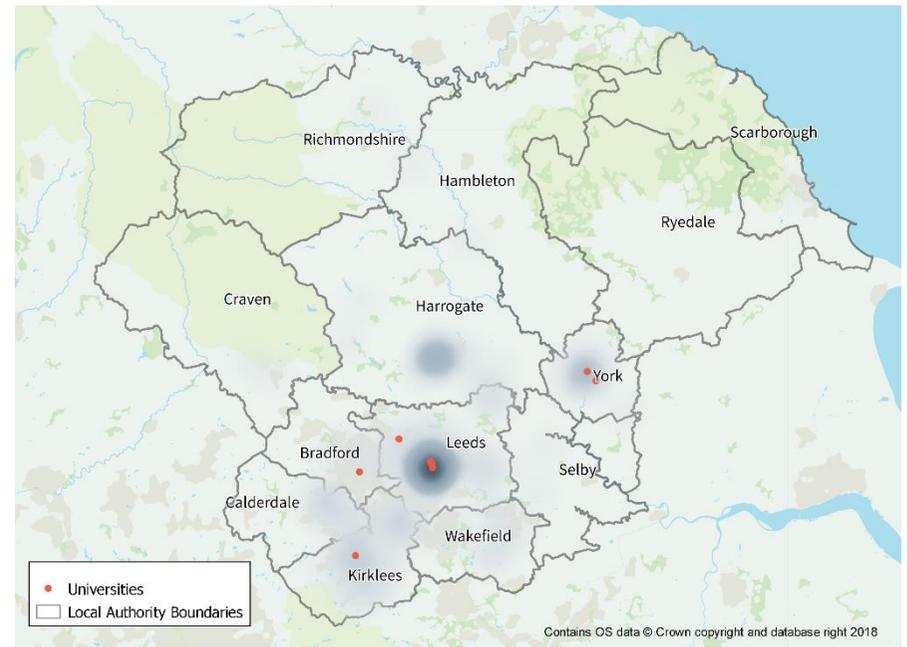
Figure I.2 Location of AI and Data Companies
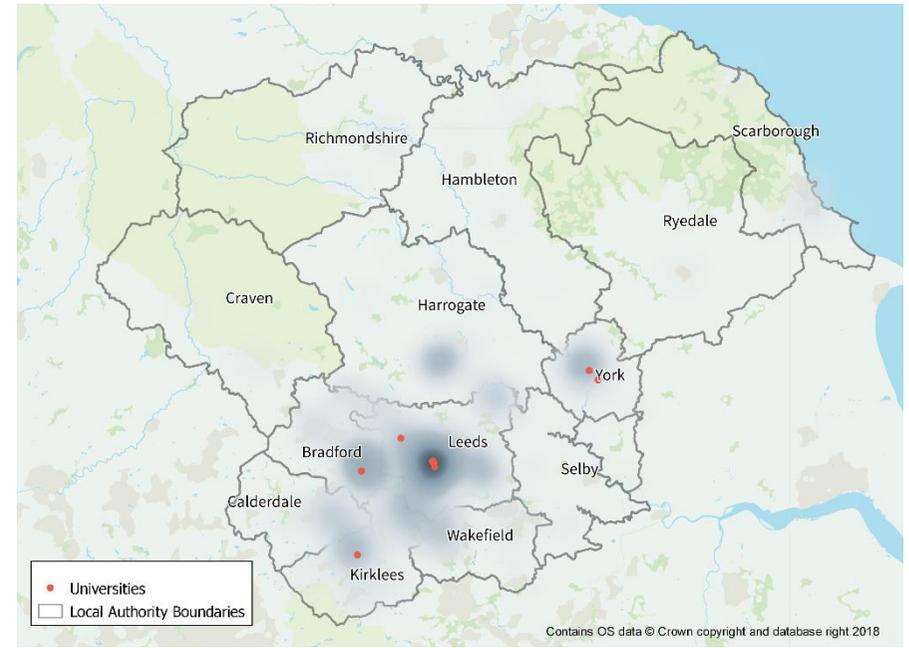
Source: Hatch Regeneris/DataCity (2019)
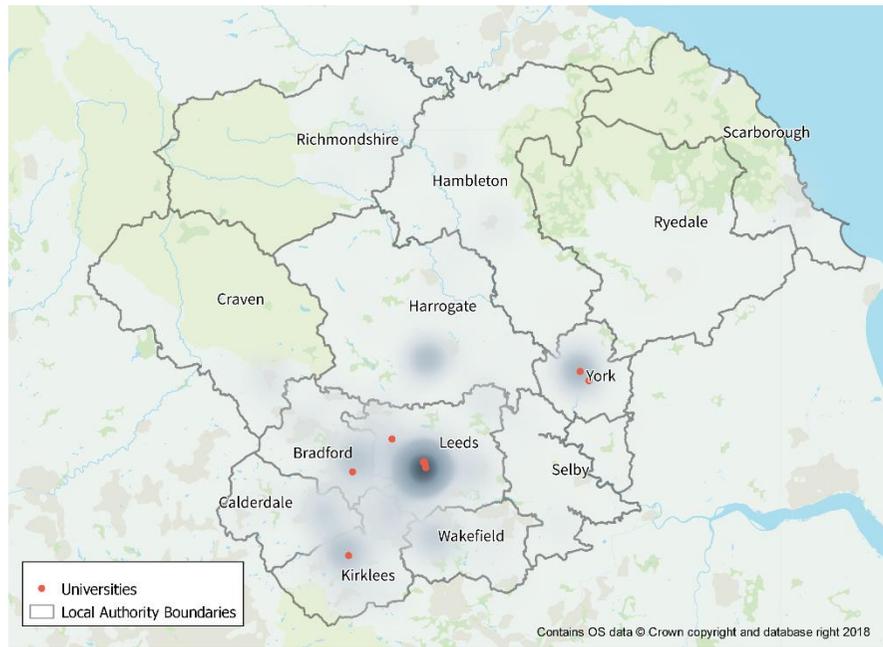
Figure I.3 Location of Clean Growth Companies

Source: Hatch Regeneris/DataCity (2019)

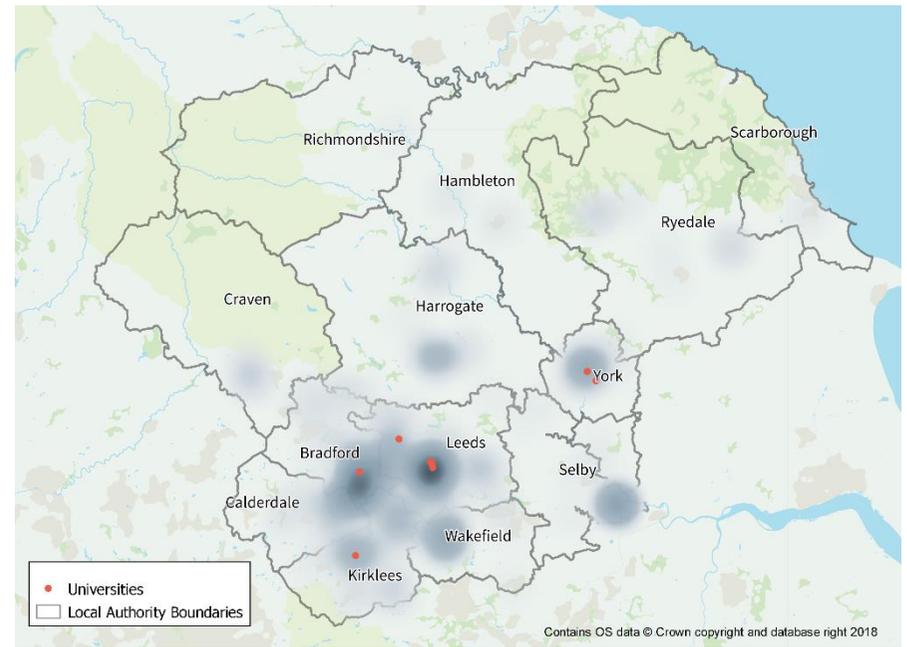## Figure I.4 Location of Creative Companies

Source: Hatch Regeneris/DataCity (2019)

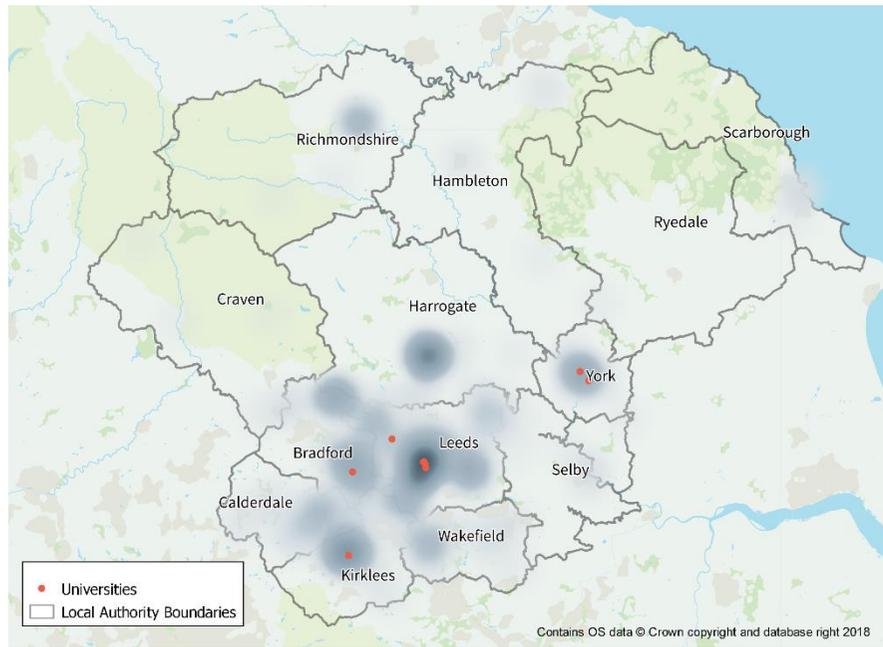## Figure I.5 Location of Digital Companies

Source: Hatch Regeneris/DataCity (2019)

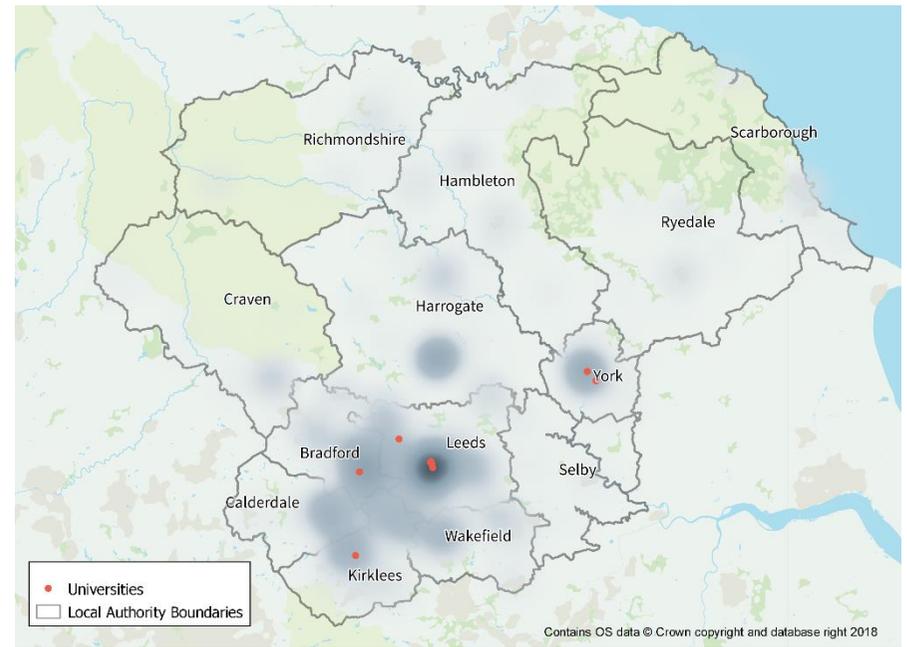## Figure I.6 Location of Energy Companies

Source: Hatch Regeneris/DataCity (2019)
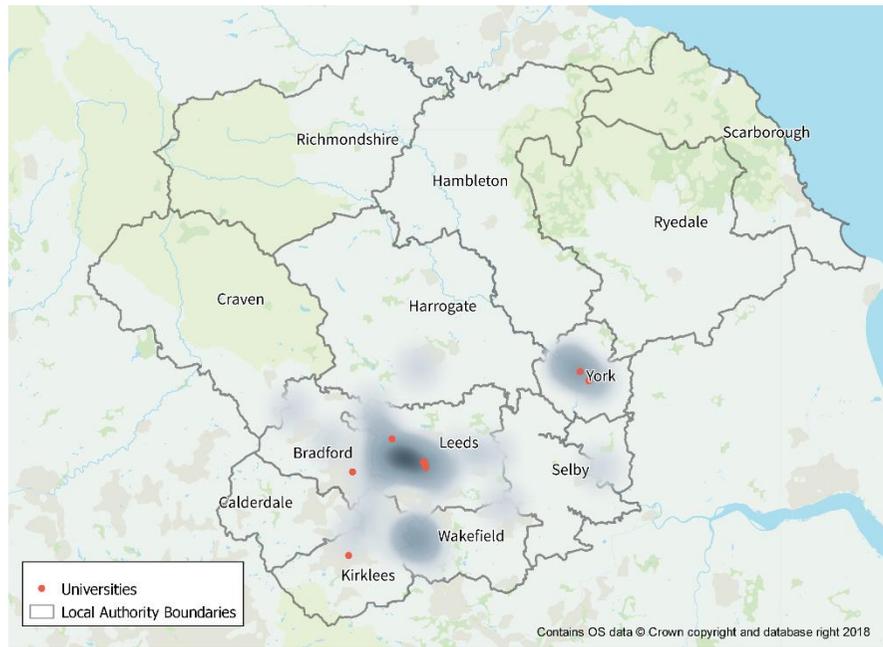
Figure I.7 Location of Fintech Companies

Source: Hatch Regeneris/DataCity (2019)

Figure I.8 Location of Food and Drink Companies

Source: Hatch Regeneris/DataCity (2019)

Figure I.9 Location of IoT Companies

Source: Hatch Regeneris/DataCity (2019)

Figure I.10 Location of Manufacturing Companies

Source: Hatch Regeneris/DataCity (2019)

Figure I.11 Location of Medicine Manufacturing Companies

Source: Hatch Regeneris/DataCity (2019)

Figure I.12 Location of Retail Companies

Source: Hatch Regeneris/DataCity (2019)

Figure I.13 Location of Science and R&D Companies
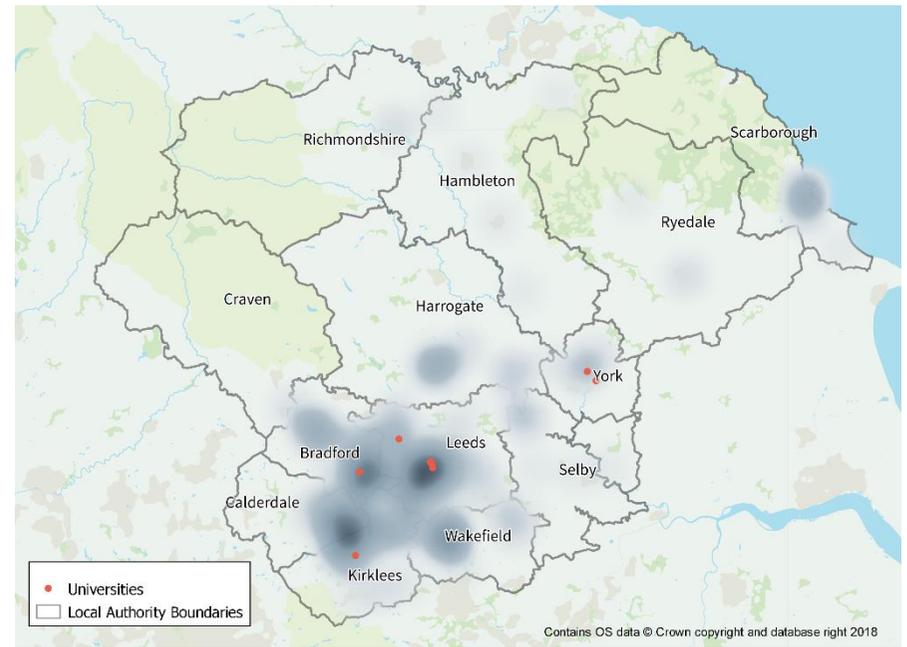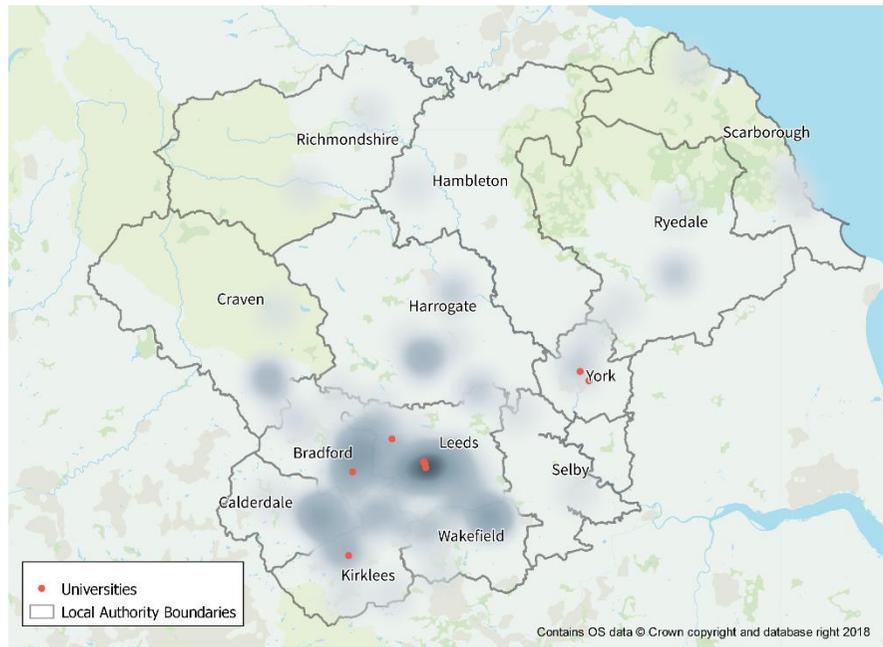

Source: Hatch Regeneris/DataCity (2019)

Figure I.14 Location of Telecoms Companies

Source: Hatch Regeneris/DataCity (2019)

Figure I.15 Location of Transportation Components Companies
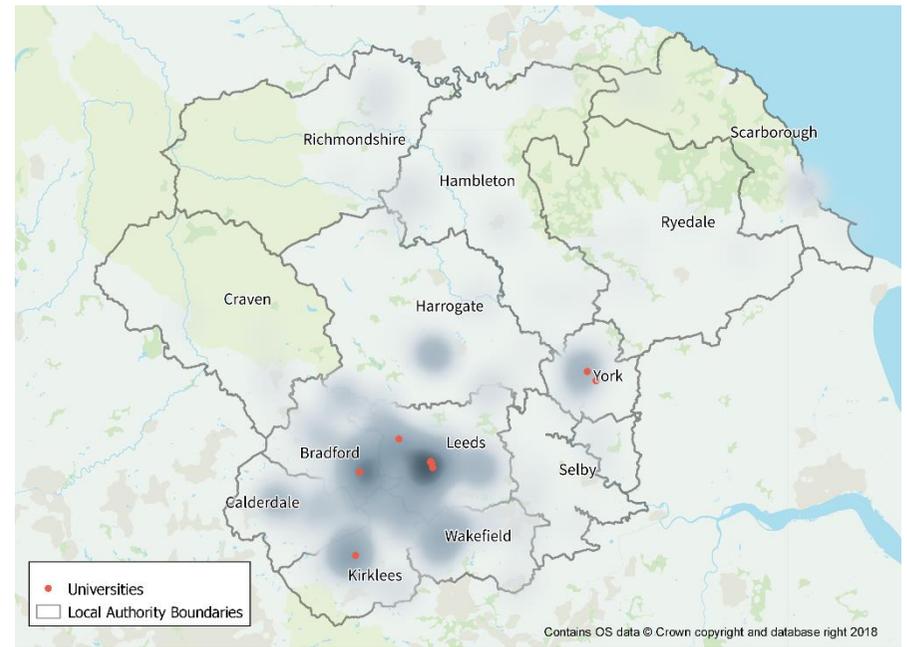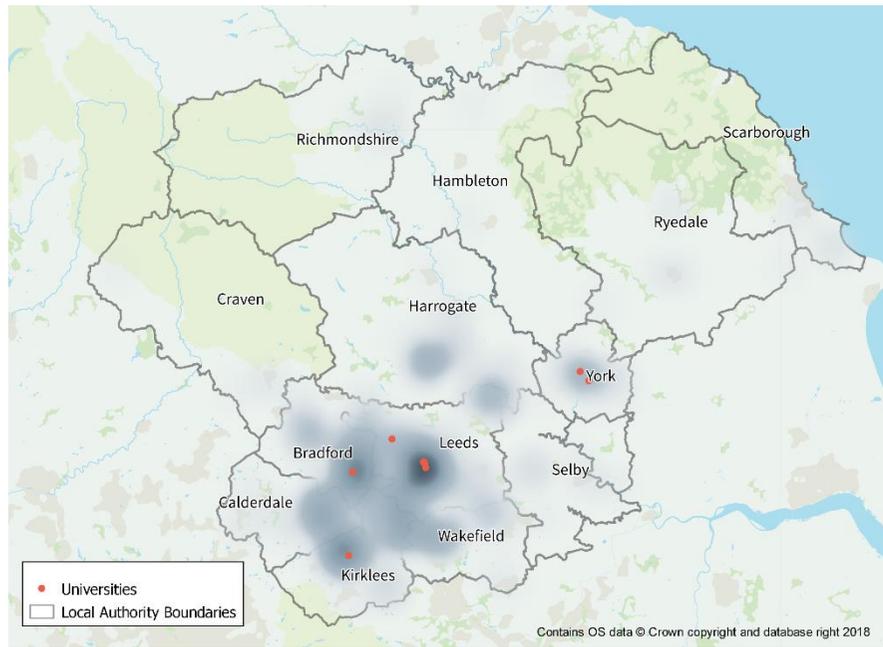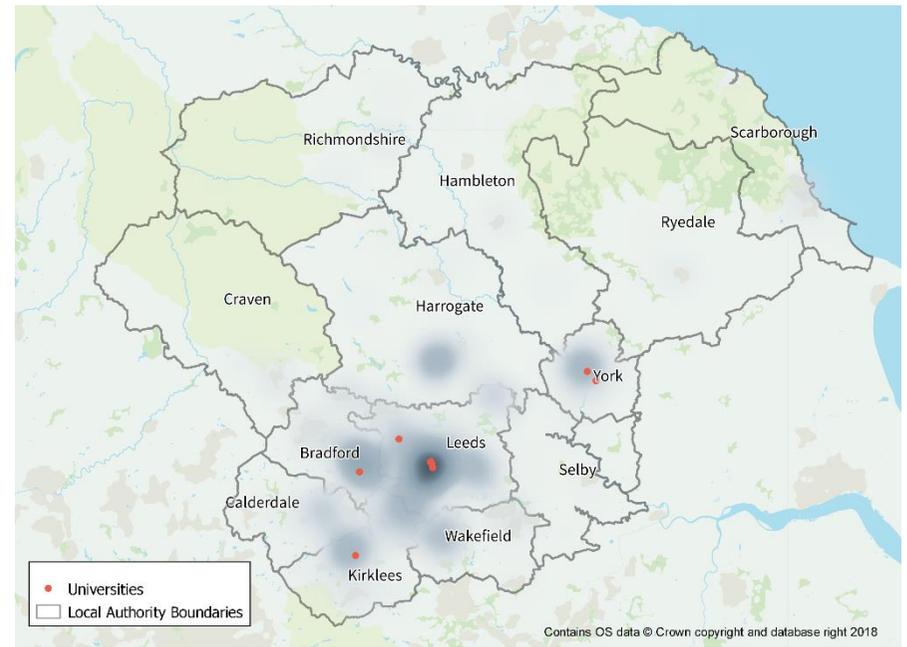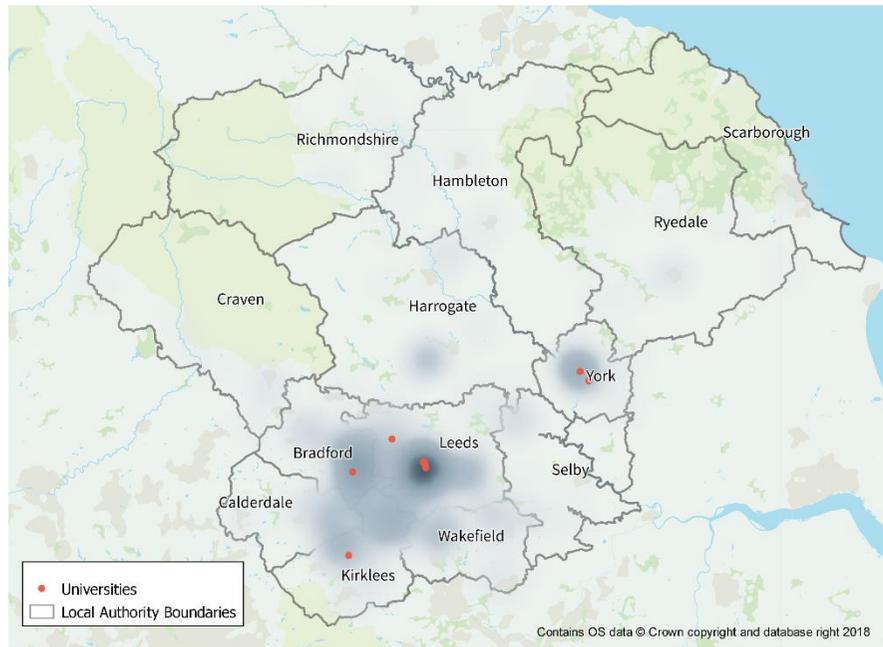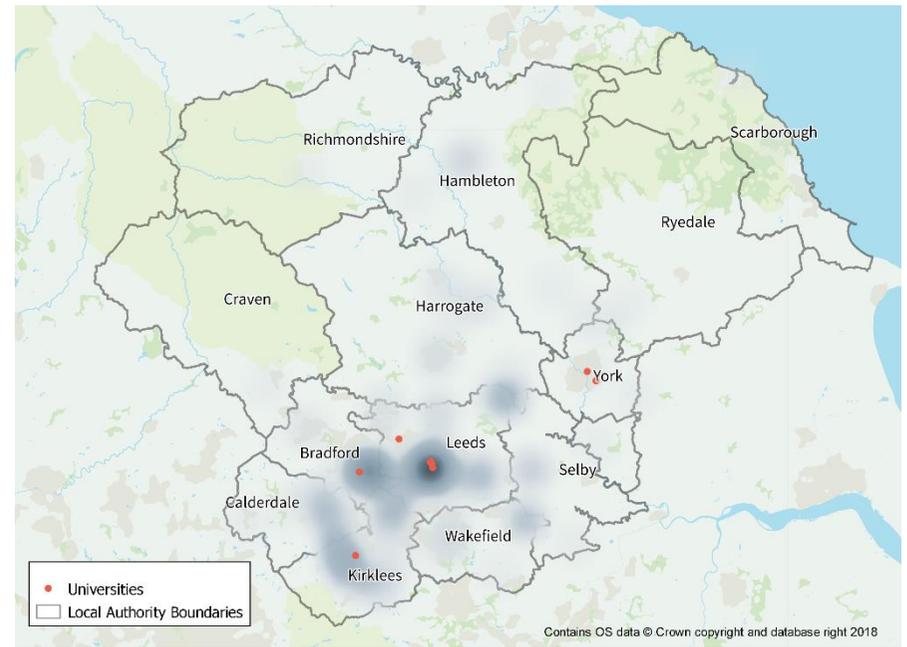

Source: Hatch Regeneris/DataCity (2019)

Figure I.16 Location of Waste Companies

Source: Hatch Regeneris/DataCity (2019)

Appendix J - Productivity by Sector

Sector	Digital			AI and Data			Clean Growth			IoT			Fintech			Science and R&D		
Productivity Keyword	NWY No.	NWY %	GM %	NWY No.	NWY %	GM %	NWY No.	NWY %	GM %	NWY No.	NWY %	GM %	NWY No.	NWY %	GM %	NWY No.	NWY %	GM %
Management	498	51%	53%	477	79%	80%	60	67%	63%	28	88%	92%	168	77%	77%	112	33%	38%
Process	379	39%	41%	318	53%	54%	47	53%	56%	18	56%	55%	110	50%	52%	119	35%	37%
Knowledge	364	37%	38%	350	58%	54%	44	49%	32%	16	50%	43%	102	47%	49%	101	30%	31%
Training	312	32%	31%	295	49%	47%	38	43%	29%	19	59%	45%	50	23%	28%	62	18%	22%
Growth	252	26%	24%	232	38%	38%	9	10%	30%	13	41%	38%	54	25%	29%	49	14%	21%
International	244	25%	26%	169	28%	26%	33	37%	18%	11	34%	26%	53	24%	32%	125	37%	36%
Research	238	24%	23%	129	21%	19%	23	26%	33%	9	28%	34%	87	40%	35%	87	26%	31%
Global	227	23%	27%	186	31%	31%	23	26%	32%	18	56%	55%	49	22%	28%	118	35%	37%
Innovation	169	17%	19%	121	20%	18%	14	16%	30%	17	53%	38%	23	11%	14%	93	27%	29%
Original	137	14%	13%	53	9%	9%	12	13%	12%	3	9%	15%	18	8%	11%	38	11%	11%
Recruitment	136	14%	12%	118	20%	20%	1	1%	4%	4	13%	9%	22	10%	10%	23	7%	6%
Concept	134	14%	13%	52	9%	6%	10	11%	15%	3	9%	15%	13	6%	8%	33	10%	10%
Idea	122	12%	14%	83	14%	13%	9	10%	3%	0	0%	17%	25	11%	13%	10	3%	3%

Table J.1 Productivity Keywords by Sector

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Sector	Digital			AI and Data			Clean Growth			IoT			Fintech			Science and R&D		
Productivity Keyword	NWY No.	NWY %	GM %	NWY No.	NWY %	GM %	NWY No.	NWY %	GM %	NWY No.	NWY %	GM %	NWY No.	NWY %	GM %	NWY No.	NWY %	GM %
Collaboration	106	11%	13%	94	16%	18%	9	10%	12%	6	19%	19%	12	5%	12%	30	9%	9%
Degree	87	9%	10%	64	11%	10%	9	10%	4%	2	6%	13%	39	18%	21%	29	9%	7%
Worldwide	86	9%	10%	64	11%	12%	8	9%	4%	9	28%	17%	7	3%	4%	44	13%	21%
Automation	69	7%	7%	70	12%	14%	0	0%	4%	6	19%	28%	15	7%	8%	18	5%	7%
Promotion	50	5%	6%	24	4%	4%	2	2%	3%	1	3%	2%	2	1%	3%	6	2%	1%
Hiring	38	4%	5%	43	7%	6%	0	0%	3%	0	0%	6%	9	4%	7%	3	1%	0%
Achievement	42	4%	3%	22	4%	4%	0	0%	4%	1	3%	2%	8	4%	3%	9	3%	2%
Headquarters	41	4%	4%	29	5%	4%	4	4%	3%	3	9%	19%	5	2%	5%	15	4%	10%
Export	24	2%	3%	28	5%	5%	4	4%	11%	0	0%	0%	5	2%	4%	37	11%	12%
Cutting-edge	36	4%	4%	21	3%	4%	1	1%	4%	1	3%	6%	11	5%	2%	13	4%	3%
Apprentice	33	3%	3%	22	4%	4%	5	6%	0%	1	3%	0%	2	1%	2%	4	1%	2%
Overseas	30	3%	4%	30	5%	3%	1	1%	1%	0	0%	4%	6	3%	4%	11	3%	6%
Entrepreneur	20	2%	3%	22	4%	3%	1	1%	3%	0	0%	4%	4	2%	2%	5	1%	1%
Professional development	15	2%	3%	17	3%	2%	2	2%	3%	0	0%	2%	9	4%	5%	3	1%	1%
Work experience	17	2%	2%	10	2%	1%	6	7%	1%	0	0%	0%	7	3%	0%	3	1%	1%

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Source: Hatch Regeneris/DataCity (2019)

| Table J.2 Productivity keywords across all sectors | | | |
Productivity Keyword	North & West Yorkshire Number	NWY Share	GM Share
Management	1254	58%	59%
Process	927	43%	45%
Knowledge	915	42%	41%
Training	716	33%	33%
International	589	27%	28%
Global	566	26%	30%
Growth	558	26%	27%
Research	544	25%	24%
Innovation	397	18%	20%
Recruitment	272	13%	13%
Original	251	12%	11%
Idea	236	11%	12%
Concept	231	11%	10%
Collaboration	229	11%	13%
Degree	216	10%	10%
Worldwide	203	9%	12%
Automation	152	7%	9%
Export	94	4%	5%
Headquarters	89	4%	5%
Hiring	86	4%	5%
Cutting-edge	77	4%	3%
Promotion	77	4%	4%
Overseas	74	3%	4%
Achievement	71	3%	3%
Apprentice	63	3%	3%
Entrepreneur	50	2%	2%
Import	46	2%	3%
Professional development	43	2%	2%
Work experience	42	2%	1%
Lean	37	2%	2%
Apprenticeship scheme	17	1%	0%
Graduate scheme	13	1%	1%
New market	11	1%	1%
Additive	8	0%	1%
Design thinking	6	0%	0%
Digitisation	6	0%	0%
Performance review	6	0%	0%
Conceive	4	0%	0%
Foreign direct investment	0	0%	0%

Source: Hatch Regeneris/DataCity (2019)

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