Transport for the North

NPIER: Capabilities, Local Data and Narratives

Workstream 1: Reviewing the North's Capabilities

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1 Introduction

1.1 Background and Purpose

Transport for the North (TfN) has commissioned Cambridge Econometrics (CE) and SQW to undertake a preparatory stage of work to inform a potential refresh of the original Northern Powerhouse Independent Economic Review (NPIER). Published in 2016, the NPIER set out an analysis of the North's 'productivity gap', identified a series of key sector capabilities where the North was, or had the potential to be, internationally competitive, and set out a transformational vision for the North's economy by 2050.

The NPIER provided evidence which underpinned TfN's Strategic Transport Plan, helped to inform wider economic policy across the North, and led to an ongoing programme of economic research. Since 2016 there have been a number of structural economic changes which have impacted the North's economy and political landscape, including the vote to leave the EU, the creation of additional Metro Mayors across the Northern region, Climate Change and Net Zero, and most recently the Covid-19 pandemic.

In this context it has been agreed that now is the time to begin planning for a refresh of the NPIER in 2022. As part of this planning exercise, CE and SQW have been tasked with reviewing the key sector capabilities identified in the original NPIER; preparing a local area literature and evidence review; and to identify options for the development of scenarios to inform a refreshed Northern 'economic narrative'. This will result in an 'insights, issues and choices' paper, which will be completed in Spring 2022.

This technical paper has been produced to feed into this final 'insights, issues and choices' paper, and specifically seeks to use a data-driven approach to review and appraise the North's key sector capabilities, within the established framework of the four "Prime", and three "Enabling" Capabilities which were identified as vital for the overall growth and productivity of the North in the 2016 NPIER.

1.2 Approach and methodology

Our approach to reviewing the North's key sector capabilities builds on the strength and understanding of the original framework developed and applied during the 2016 NPIER, which also provides the additional advantage of ensuring the consistency and comparability of results.

However, to further strengthen our approach and address some of the lessons learned since the NPIER's publication, we have made some augmentations to this framework. In particular, we have sought to provide better coverage and understanding of the North's capabilities beyond those that are "Prime" and "Enabling", by drawing on a broader range of metrics to articulate the capacity and quality of the North's 'everyday' foundational economy.[1]

[1] As defined by the Foundational Economy Collective, the foundational economy helps to "*supply daily household essentials for safe and civilized living, including providential services like health, education and care, and material infrastructure like pipe and cable utilities, and food distribution*."

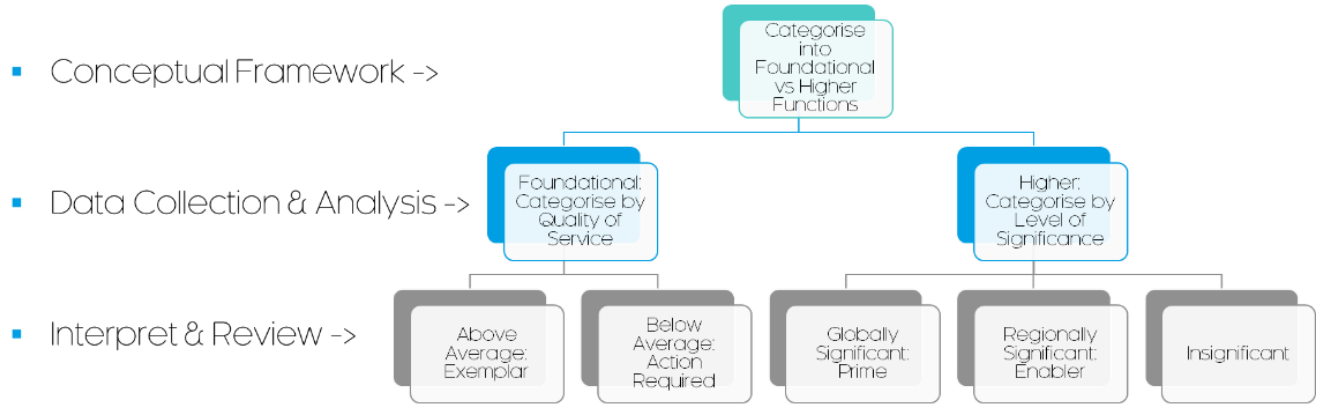
Likewise, we have also prioritised a broader range of data and metrics to review the North's non-foundational ("higher") capabilities, which has enabled additional, finer-grained insights to clarify the North's truly distinctive strengths. Such data has helped improve our understanding of capability productivity and output advantages and performance, research strengths and intensity, and international representation and competitiveness.

Finally, to supplement our review of the North's key capabilities, we have also aligned and incorporated insights and findings from a parallel study undertaken by The Data City, which has used innovative and novel industry data and classifications to provide insights into the definition and scale of the key capabilities of the North's economy.

This work has been undertaken in a logical, sequential manner, as summarised in Figure 1.2.1, which has also involved regular communication and consultation with the project client and steering group.

1. **Conceptual Framework**
    - Agreeing definitions, metrics and sources to create a conceptual framework that incorporates the entire Northern economy, including both foundational and non-foundational ("higher") economic functions, whilst retaining a means of defining and identifying "Primes" and "Enablers" in a rigorous manner.
2. **Data Collection and Analysis**
    - Collecting, processing and analysing a broad range of both traditional and innovative data sources, that are able to articulate and review the North's performance and capabilities across foundational and higher economic functions.
3. **Interpretation and Review**
    - Reflect on the findings and analysis, outlining any recommended changes to the existing "4+3" structure of the 2016 NPIER, with up to date, well-articulated and evidenced conclusions.

Figure 1.2.1: Our approach to reviewing the North's capabilities



1.3 Structure

This paper has the following structure:

i. The first section presents the conceptual framework for reviewing the North's capabilities, reflecting on the methodology applied to the original NPIER, lessons learned and feedback received, and outlining how these will be addressed in the review framework.

ii. The second section proceeds to outline the evidence and approach used to review the North's foundational capabilities, before presenting and analysing the results.

iii. The third sections then outlines the evidence and approach used to review the North's higher capabilities, including its "Primes" and "Enablers", before presenting and analysing the results, and outlining any recommended changes or points for consideration.

iv. The conclusion then summarises the key findings from the earlier sections, before reflecting on potential implications, opportunities, and any further work required.

An extensive data appendices also accompanies this paper, supplementing the detailed technical analysis presented throughout this paper.

2 Reviewing the North's Capabilities: A Conceptual Framework

2.1 Introduction

Here we present a conceptual framework which outlines our approach to reviewing the North's economic capabilities, across both its foundational and non-foundational ("higher") economic functions. Drawing heavily on the robust methodology applied to the original Northern Powerhouse Independent Economic Review (NPIER), we also reflect on the lessons learned and feedback received since the NPIER's publication in 2016.

In particular, we expand the remit of the framework to explore the role and importance of the foundational 'everyday economy' in the North. Additional layers of scrutiny and evidence have also been incorporated to try to identify which of the North's strengths and capabilities are truly distinctive, globally competitive, and pan-Northern.

2.2 The original NPIER's capabilities framework

The 2016 NPIER was given the clear remit to identify the most productive areas of the economy, where the North was or had the potential to be internationally competitive. It was framed to develop the evidence base around the international-class strengths of the North.

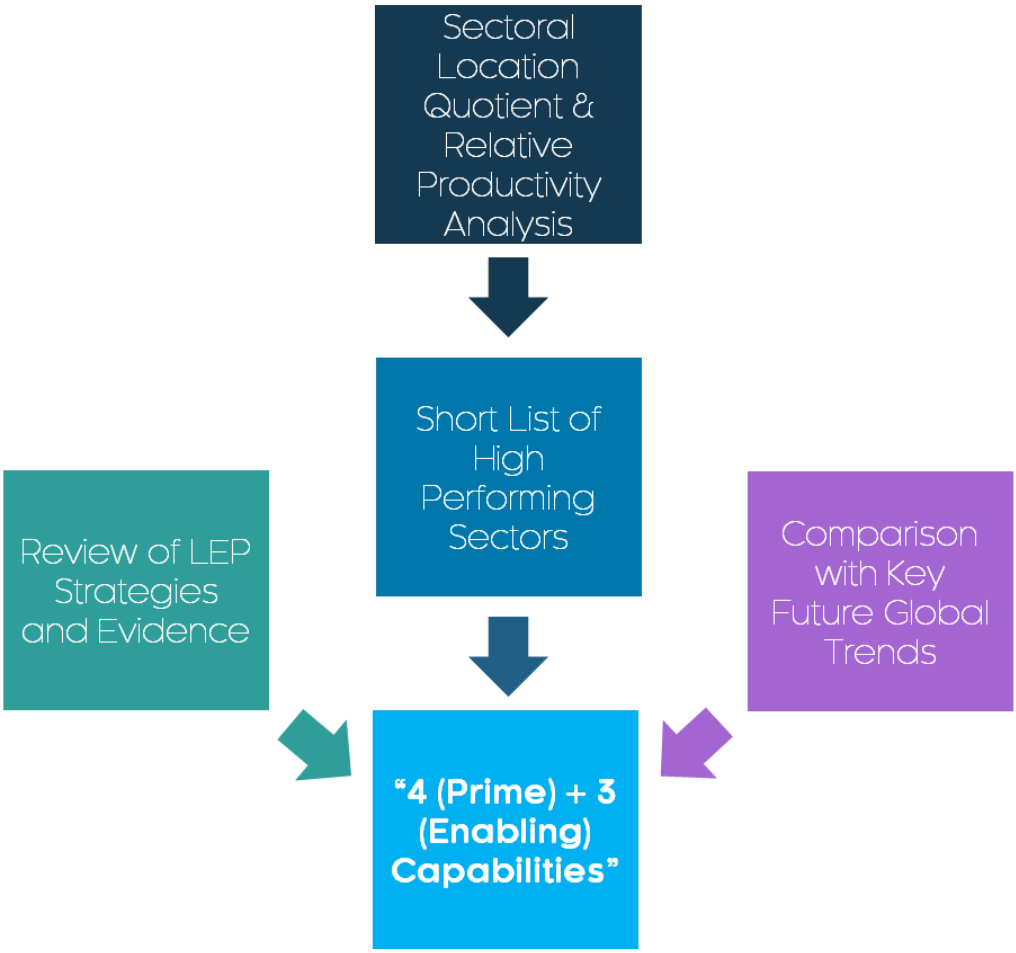
The Review produced five workstreams, which culminated to provide an up-to-date pan-Northern economic assessment, identifying opportunities for growth and investment. Workstream 3 provided analysis of distinctive competitive advantage and sectoral strengths, capabilities, and industrial potentials of pan-Northern significance. The Review took 'pan-Northern significance' as meaning:

- Existing and/or future potential sectoral and capability specialisms where the North is genuinely differentiated and distinctive and can compete at national and international scales. Exporting activities are a focus, to avoid intra-North displacement, as are market-led sectors, alongside assets and expertise of national and international standing.
- Sectors that are important in multiple city-regions/local areas across the North, avoiding simplistic 'one sector per area' thinking.
- Highly productive sectors, where the North can (or has the potential to) offer a comparative advantage in terms of productivity, and so help to close the North's productivity gap with the wider economy.
- Sectors and areas of economic activity where there is a robust economic rationale for, and added value from, collaboration/connectivity at the pan-Northern level.

Building on this rationale, Figure 2.2.1 summarises the original framework - and associated evidence inputs and processes - used to classify the North's capabilities. In the first stage, the latest economic data and forecasts were used to assess sectors in terms of relative labour productivity performance,

the degree of specialisation in the North (as measured by Location Quotient[2]), and the prospects for gross value added and employment growth.

Figure 2.2.1: Framework used to classify the North's "Prime" and "Enabling" Capabilities in the 2016 NPIER



Source: Cambridge Econometrics

This resulted in a preliminary, high-level shortlist of the North's current and potential sectoral strengths, as revealed by the then available economic data. This pan-Northern, data-driven exercise was then supplemented with an extensive 'bottom up' analysis of local area strategies, plans and evidence on sector strengths, specialisms and assets across the North.

Finally, the Review then sought to translate these sector strengths into a classification of the North's economic capabilities. This was achieved by applying Smart Specialisation principles to the earlier evidence, whilst also considering the latest global trends and disruptive technologies, to focus on what makes the economy of the North distinctive in national and international contexts. As a result:

> *"Four 'Prime' Capabilities have been identified by the Review as differentiated and distinctive at a pan-Northern level. These capabilities also perform well on productivity, and can compete at national and international scales."*

[2] Location Quotient's (LQ's) are a commonly used measure of the geographical specialisation of an industry.

> *"Three 'Enabling' Capabilities which, both in their own rights and through interactions with firms and organisations in the 'Prime' economic capabilities will exert significant influence over the North's long-term economic development."*

The four "Prime" and three "Enabling" (i.e. "4+3") Capabilities identified by the original framework, and regarded by the Review as being vital for the overall growth and productivity of the North, are outlined in more detail in Table 2.2.1 below.

Table 2.2.1: The North's "Prime" and "Enabling" Capabilities, according to the 2016 NPIER

Capability	Detail
"Prime" Capabilities	
Advanced Manufacturing (with a particular focus on materials and processes)	• A broad and deep sectoral specialisation across the North, based on historic strengths, and a very strong endowment of pure and applied knowledge assets and facilities in business and higher education.
Energy (in particular expertise around generation, storage, and low carbon technologies and processes)	• Based on the North's long-standing track record in Nuclear Energy, proven record in Offshore Wind Energy, and a growing expertise in battery technologies, alongside the opportunity for the North in Low/Zero Carbon energy, and Energy portability.
Health Innovation	• The North has long-established strengths in Life Sciences and Medical Technologies and Devices and a growing competence in new and efficient service delivery models brought about by e-health and the growing devolution of responsibilities for Health and Social Care.
Digital	• This includes the North's developing specialisms in high performance computing, cognitive computation, data analytics, simulation/modelling, and machine learning. Alongside existing strengths, such as Media, which provide a strong base from which the other 'Prime' economic capabilities to build.
"Enabling" Capabilities	
Financial and Professional Services	• This provides essential services to the 'Prime' capabilities, while also possessing the potential to generate employment via 're-shoring' activities currently out-sourced abroad, and 'north-shoring' where services move to the North from London and the South East.
Logistics	• With major port developments in the Liverpool and Hull and Humber City Regions, plus developments at Manchester and Robin Hood Airports, logistics

Capability	Detail
	are vital in allowing the "Prime "capabilities to realise their potential in overseas markets.
Education (primarily Higher Education)	• Education provides the research capability and knowledge excellence that underpins the 'Prime' capabilities above. It also offers potential for the internationalisation of activity through students, university-to-university links, and collaborations with global businesses.

Source: Cambridge Econometrics, Steer ED (adapted from the 2019 NPIER Review)

2.3 Reflections from the 2019 NPIER Review

In 2019, Steer ED, supported by CE, were commissioned by TfN to undertake a preliminary review of the 2016 NPIER, in order to inform a potential refresh and accompanying 5-year work programme. The emphasis was therefore forward looking, focussing primarily on identifying stakeholder's perspectives and requirements around the future of the NPIER.

In its initial assessment of the 2016 NPIER, the Steer Review highlighted the strength and understanding of the original framework used to identify and present the North's "Prime" and "Enabling" Capabilities, and its widespread adoption in Northern strategies and plans since 2016:

> *"The broad consensus from stakeholders consulted in our Review was that the framing of the [2016] review and its focus, namely on pan-Northern strengths, was the right thing to do at the time. It enabled consensus to be built around a package of commonalities and positive messages.*
>
> *This consensus building was regarded as a major achievement of the NPIER. The majority of consultees were very supportive of the 'Prime' and 'Enabling' Capabilities as a useful framing device and highlighted that the terms have become part of the policy-making lexicon in the North."*

This was further emphasised when Steer consulted local stakeholders on the potential terms and scope of a future refresh of the original NPIER and its capabilities framework:

> *"The vast majority of consultees indicated that a Productivity lens, and the "Prime" and "Enabling" Capabilities identified in the 2016 should be retained in a future NPIER. Consultees argued that the ambition to close the productivity gap and the challenges around increasing productivity were every bit as relevant today as they were in 2016."*
>
> *"The vast majority of consultees were also supportive of the current NPIER's Capabilities framework, advising that a future NPIER should 'refresh' not 'unpick' the Primes and "Enabler" s."*
>
> *"For some consultees the 'flexibility' of the capabilities framework was essential to consensus building and developing a coherent narrative."*

However, the Steer Review did acknowledge some concerns and shortcomings to the original framework, and areas to address if the exercise were to be repeated.

For instance, it reported stakeholders found the original NPIER had *"too narrow a sectoral/capability focus on the high-value end of the economy with insufficient emphasis on the 'everyday' economy."* Looking ahead, Steer found "*clear support, amongst consultees, for extending the focus of the NPIER, beyond the Capabilities to cover the wider economy."*

In addition to this, it also found some stakeholders reporting *"concerns as to whether all of the elements identified were sufficiently distinctive from the rest of the UK, e.g. parts of the report could have been written about other parts of the UK, especially parts relating to Advanced Manufacturing and Digital*."

Finally, the Review also reported a number of stakeholders reporting "*a lack of detail on the spatial implications of the operation of the Primes*", alongside "*too narrow a spatial focus on metropolitan areas*".

2.4 Reviewing the North's Capabilities: a conceptual framework

Our approach to defining a conceptual framework for reviewing and appraising the North's economic capabilities therefore seeks to address some of the concerns and shortcomings raised during the Steer Review, whilst still retaining the strength and understanding of the original framework applied to the 2016 NPIER.

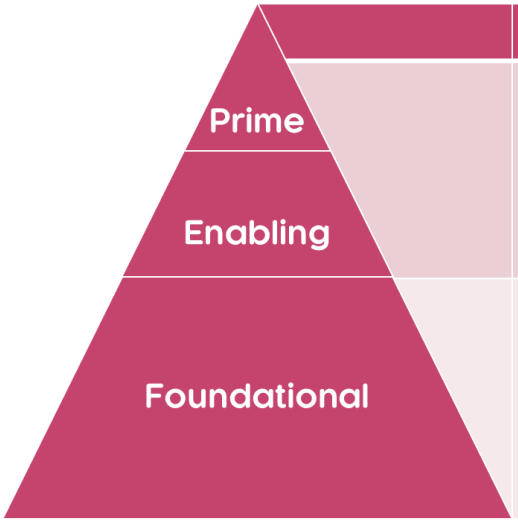
In particular we set out to:

- Augment the focus on globally competitive export-focused capabilities with an equally in depth look at the "everyday" or foundational sectors of the economy.
- Make use of newly available data sources in order to add Northern-specific detail to the existing "Prime" and "Enabling" Capabilities, including the extent to which they are or are not urban-focused.
- Identify if there are any additional emerging capabilities that might also benefit from being highlighted at this point.

We therefore require a simple, clear conceptual framework that encompasses all of the above. Figure 2.4.1 illustratively sets out our proposed framework for this review. This revised framework considers the North's capabilities not just as a 'zero-sum' set of small, high-performing sectors, but as an interrelated and interdependent network of 'building blocks', with each individual 'block' supporting and enabling those above and below it.

Capabilities therefore correspond to both the North's foundational non-foundational ("higher") economic functions – the former capturing 'everyday' sectors and activities that have a substantial impact on the economy and quality of life in the North – with a more targeted means of defining and identifying the "Primes" and "Enablers". In this review framework, capabilities are defined as follows:

Figure 2.4.1: Proposed conceptual framework for reviewing the North's economic capabilities



	Example of Sectors and Activities Captured	Proposed Performance Metrics	Proposed Performance Classifications
Prime / Enabling	Tradeables e.g. • Primary Sector • Manufacturing • Technical KIBS • Professional KIBS Non-Tradeables e.g. • Business Support • Consumer Services • Construction	• Research and innovation intensity • Exporting performance • Relative productivity • Specialisation (Location Quotients)	• Prime • Secondary Prime • Local Prime • Enabling • Secondary Enabling • Local Enabling

Foundational	• Public services e.g.
	  • Healthcare
	  • Social Care
	  • Emergency Services
	• Utilities e.g.
	  • Electricity
	  • Gas
	  • Water
	• Food and Consumer Essentials
	• Transport & Logistics
		• Coverage
		• Reliability
		• Service Quality
		• Value for Money
			• Above Average: Exemplar
			• Below Average: Action Required
			• Average: As Expected

Source: Cambridge Econometrics. Note: KIBS = knowledge intensive business services

- **Foundational Capabilities:** following the definition of the *Foundational Economy Collective*, foundational capabilities represent the 'everyday economy' of the North that help to "supply daily household essentials for safe and civilized living, including providential services like health, education and care, and material infrastructure like pipe and cable utilities, and food distribution."
- **Higher Capabilities:** therefore represent the distinctive, more outward looking parts of the North's economy. These capabilities contribute to the modern knowledge economy of the North, helping to drive innovation and productivity, and interact with global value chains. The higher capabilities continue to provide a means of defining, identifying and appraising the Norths "Prime" and "Enabling" Capabilities:
  - ***"Prime" Capabilities**:* as with the original NPIER, these are capabilities that have been identified as differentiated and distinctive at a pan-Northern level. These capabilities exhibit high performance across all metrics, serving a national or global market and interacting with global value chains, and are represented across multiple locations within the North.
  - ***"Enabling" Capabilities**:* similarly, as in the original NPIER, these are the capabilities that play a critical role in supporting the growth and development of the "Prime" Capabilities, primarily serving a regional market.

Reflecting these changes to the framework, and to better address some of the concerns and shortcomings raised during the Steer Review, we have reviewed the scale and quality of the evidence inputs and processes, placing a greater emphasis on novel and alternative datasets and sources, with a high degree of spatial and sectoral segmentation.

For instance, the inclusion of the foundational economy in the review framework requires the consideration of a broader range of metrics beyond the standard economic data, which often fail to capture the importance and

performance of the foundational economy. These metrics have been scrutinized to ensure they can assess and benchmark pan-Northern coverage, reliability, and quality.

Likewise, we have also prioritised a broader range of data and metrics to appraise the North's higher capabilities, which will enable us to clarify truly distinctive, pan-Northern strengths. This includes the use of firm-level microdata (to reveal productivity and output advantages and performance, and spatial distributions and strengths), patent and innovation grant data (to understand research strengths and intensity), and trade and export data (to explore international strengths and competitiveness).

Finally, to supplement the appraisal of the North's higher capabilities, we have also aligned and incorporated insights and findings from a parallel study undertaken by The Data City, which has sought to develop innovative business classifications to better understand the sectoral coverage and characteristics of the business base across the North.

The review framework also expands on how we monitor and assess the North's capabilities. For the North's foundational capabilities, the focus is less on standard specialisation and growth metrics, and more on service-based metrics (specifically, those that can identify relative coverage, reliability and quality). Therefore, we propose assessing the North's foundational capabilities are as follows:

- **Above Average – 'Exemplar':** these are the parts of the foundational economy where the North is outperforming the rest of the country, and are positively influencing the economy and quality of life of the North.
- **Below Average – 'Action Required':** these are the parts of the foundational economy where the North is underperforming the rest of the country, and may be negatively influencing the economy and quality of life of the North.
- **Average – 'As Expected':** these are the parts of the foundational economy where the North is performing in line with the rest of the country.

For the higher capabilities, the framework continues to provide a means of identifying and reviewing the "Prime" and "Enabling" Capabilities, but with the option of providing additional detail and nuances – by assessing a broader range of performance metrics - to further scrutinize and clarify truly high-performing, globally distinctive, pan-Northern strengths.

It should be noted that our approach **does not define the North's foundational and higher capabilities as two discrete or competing groups**. Instead, our approach intends to highlight the significant amount of synergy and overlap between the two. As such, any results referencing the value or scale of the North's foundational and higher economic functions are not directly comparable.

Additional detail on the definitions (including statistical classifications), evidence, and sources used to monitor and review the North's capabilities, across its foundational and higher economic functions, precedes the analysis presented over the following chapters.

3 The North's Foundational Capabilities

3.1 Introduction

The inclusion of the foundational economy in our conceptual framework allows us to consider the role and importance of the 'everyday economy' in our review of the North's economic capabilities.

Not included in the original NPIER framework, the foundational economy is a significant economic contributor in its own right – particularly in terms of employment and spending in the North – and through the provision of its goods and services it also has a critical role in determining the wellbeing and quality of life for residents in the North.

Drawing on a large and diverse evidence base, looking beyond just standard economic and growth metrics, we have been able review and benchmark the performance and effectiveness of the North's foundational capabilities. This has enabled us to uncover and remark on the relative strengths and areas of best practice in the North, as well as identify weaknesses and actions required, and reflect on potential opportunities and risks.

3.2 Foundational Capabilities: definitions and evidence

Our approach to defining the North's foundational capabilities draws heavily on the analysis and recommendations of the Foundational Economy Collective. The Collective is a group of academic researchers *"working together to develop a new way of thinking which challenges mainstream ideas about what economic policy should be."*

The Collective's concept of a 'foundational economy' was originally introduced in its 2013 'Manifesto for the foundational economy'. The Manifesto argued there was a "*large, neglected and sheltered economy with around 40% of the workforce engaged in providing households with basic goods and services*." It advocated a "*shift to a zonal way of thinking about multiple economies*", beyond just a focus on a singular, tradeable competitive economy.

The Collective defines the foundational economy as helping to "*supply daily household essentials for safe and civilized living*." It recommends a series of Standard Industrial Classification (SIC) codes that can be used to define the extent of the foundational economy - as well as its constituent parts, which include:

- 'The Material foundational economy': *"pipe and cable utilities, supermarkets etc. which through networks and branches continuously connect households to daily essentials."*
- 'The Providential foundational economy': *"a subset of (mainly) public sector welfare activities providing the universal services available to all citizens."*
- 'The Overlooked economy': *"goods and services culturally defined as essential and requiring occasional purchase, for example, consumer and household goods, holidays and travel etc."*

Building on and adapting these existing definitions and research, we have grouped the foundational economy into the following 18 foundational groupings – presented in Table 3.2.1 below – to review in the North of England, which sit under 4 distinct but interrelated foundational themes; Public Services, Utilities, Critical Transport and Logistics, and Food and Essentials.

Table 3.2.1: Foundational capabilities

Public Services	Utilities	Critical Transport and Logistics	Food and Consumer Essentials
Healthcare	Electricity	Roads and Public Realm	Wholesale and Supply Chains
Social Care	Gas	Public Transport	Non-specialised Retail (i.e. supermarkets)
Primary and Secondary Education	Water	Postal Service	Retail Banking and Finance
Emergency Services	Waste and Sewerage	Critical Freight Handling	
Public Administration	Digital Connectivity		
	Construction, Repair and Maintenance		

Source: Cambridge Econometrics

Inevitably, there is no established way of identifying and creating these groups, with inevitable debate as to whether a specific sector truly falls into a foundational or higher capability category.

These capabilities have been prioritised though as they represent recognised parts of the 'everyday' economy (as captured by the Foundational Economy Collective's definition), whilst avoiding duplication with the North's "Primes" and "Enablers" and - most importantly – given the available data, performance can be assessed and benchmarked at a sub-national/pan-Northern level.

By collating and processing a diverse range of direct and proxy metrics – ranging from A&E waiting times, to ultrafast broadband coverage, and public transport punctuality – we have been able to interpolate the performance of each of the North's foundational capabilities and benchmark this relative to the rest of the country. The performance of each capability has been benchmarked across the following service dimensions:

- **Coverage:** assesses how prevalent and accessible the service is across the North (and, where possible, accounting for rurality, mode/cost of transport etc.).
- **Reliability:** considers how reliable the service is, and the prevalence of disruptions, delays, or cancellations to that service.
- **Quality:** looks at the utility and value of the service or product being provided.

Across these three dimensions, for each individual metric a corresponding relative performance ratio has been calculated, which allows capabilities to be

assessed according to an experimental RAG criteria, as outlined in the conceptual framework, and presented in Table 3.2.2 below. A detailed, fully-sourced list of the metrics which have been used to assess the North's foundational capabilities, along with their calculated performance ratios, can be found in the data appendices.

Table 3.2.2: RAG criteria for reviewing the North's foundational capabilities

RAG code	RAG description	RAG performance ratio
Red	**Below Average – 'Action Required':** underperforming the rest of England	0.94 and below
Amber	**Average – 'As Expected':** performing broadly in line with the rest of England	0.95 to 1.05 (where 1.00 = identical performance to the rest of England)
Green	**Above Average – 'Exemplar':** outperforming the rest of England	1.06 and above
Grey	**Data Missing:** No currently available metric or reliable proxy	N/A

Source: Cambridge Econometrics

It should be noted that, **as a relative benchmarking exercise, our review of the North's foundational capabilities is not an absolute assessment of performance, and is instead a relative assessment** – in this case, relative to the rest of England[3]. Results should therefore be considered as such, and treated similarly to other relative performance measures, such as the Index of Multiple Deprivation (IMD).

Of course, any relative assessment is only 'point in time'. To address this we have prioritised metrics with time series to identify recent trends and relative trajectory. Capabilities have been assessed by additional RAG criteria given their relative direction of travel, as shown in Table 3.2.3. However, caution should be urged when interpreting these trends due to data limitations and the very short, often volatile time series available for most metrics.

In addition to this, where possible metrics have been appraised according to their pre-Covid pandemic performance (typically, no later than 2019). This is due to data becoming significantly distorted by the pandemic, alongside concerns relating to data quality issues (e.g. as a result of smaller sample sizes, less frequent collection etc.) meaning more recent data may not provide a true or reflective indication of a capabilities longer-term performance.

Finally, in addition to this relative benchmarking exercise, drawing on the SIC code definition provided by the Foundational Economy Collective, we also highlight the economic scale and importance of the North's foundational economy beyond the provision of its goods and services – in terms of employment and gross value added (GVA).

[3] Defined as England less the North. Note that for some metrics we benchmark the North relative to the rest of England less-London, due to the distortionary effect of the city region (particularly for transport-related metrics). More information can be found in the data appendices.

Table 3.2.3: RAG criteria for reviewing the recent trajectory of the North's foundational capabilities

RAG code	RAG description	RAG trend performance ratio
Red	Performance slowing relative to the rest of England	Below 0.95
Amber	Performance moving broadly in line with the rest of England	0.95 to 1.05 (where 1.00 = identical change to the rest of England)
Green	Performance improving relative to the rest of England	Above 1.05
Grey	No currently available or reliable time series	N/A

Source: Cambridge Econometrics. Trend performance has been calculated for the last 5 years, or closest available equivalent

3.3 Results summary

Table 3.3.1 presents the results of the benchmarking exercise used to review the North's foundational capabilities, according to the criteria outlined in the conceptual framework. Positively, the results show at a pan-Northern level the region has a number of capabilities that exhibit 'exemplar' levels of service – be it in terms of coverage, reliability or quality - relative to the rest of England.

Though evident across all themes, the North's 'exemplar' providers are largely concentrated in public services, such as health and social care, emergency services, and public administration, which score particularly well in terms of coverage and reliability. 'Exemplar' service is also observed in the remaining themes, notably digital connectivity in utilities, and wholesale and supply chains in food and essentials.

Across all capabilities, there is a notable trend of the North outperforming the rest of the country for coverage; of the 18 capabilities assessed in our framework, impressively the majority - 13 in total - exhibit 'exemplar' levels of coverage. However, this improved coverage does not always translate through to the service-related dimensions, with 7 capabilities in the North exhibiting 'exemplar' levels of reliability, and only 5 for quality.

For those that are not 'exemplar', the majority perform 'as expected' - in line with the national (rest of England) average. Given the characteristics of the foundational economy - including the provision of largely standardised, typically public, goods and services - it is no surprise this is the most widespread assessment. It does however emphasise the strength of those 'exemplar' capabilities, to go above and beyond the performance observed elsewhere in the country.

Of concern are capabilities in the North that exhibit service that 'requires action' - where performance lags the rest of the country. Though in the minority, this assessment is most common across the reliability and quality dimensions; of the 18 capabilities assessed, 4 'require action' in terms of

reliability, and 2 for quality. Though limited, for some capabilities this underperformance will have a discernible impact on the North's economy and quality of life.

Table 3.3.1: Performance of the North's foundational capabilities

Foundational Theme	Foundational Capability	Coverage	Reliability	Quality
Public Services	Healthcare			
	Social Care			
	Primary and Secondary Education			
	Emergency Services			
	Public Administration			
Utilities	Electricity			
	Gas			
	Water			
	Waste and Sewerage			
	Digital Connectivity			
	Construction, Repair and Maintenance			
Transport and Logistics	Roads and Public Realm			
	Public Transport			
	Postal Service			
	Critical Freight Handling			
Food and Consumer Essentials	Wholesale and Supply Chains			
	Non-specialised Retail			
	Retail Banking and Finance			

Source: Cambridge Econometrics. Key: **green = 'exemplar', amber "as expected", red "action required"**

The capabilities that exhibit service that 'require actions', and clearly warrant further attention in the North of England, are most evident across the utilities and transport and logistics themes. In particular, poor levels of reliability were observed across electricity, gas, and water provision, in addition to public transport (particularly for rail-related transport).

And despite exhibiting 'exemplar' coverage, the primary and secondary education and critical freight handling capabilities were the only ones to provide noticeably below average quality in the North of England, and warrant further attention.

In fact, the disconnect between the North's above average coverage and below average reliability and quality for some capabilities requires further investigation, beyond the scope of this paper. However, it is possible some coverage metrics may be bias upwards due to the larger public sector in the North, though effort was made to prioritise metrics which accounted for this.[4]

Of course, our assessment is by no means precise or exclusive; for instance, we have already seen how the performance of some capabilities varies across the multiple dimensions. Likewise, the above assessment assumes equal weighting across the three dimensions. Naturally, the ordering would change were greater weighting given to e.g. the quality dimension.

Moreover, it should be **emphasised that our benchmarking of the North's foundational capabilities is a relative benchmarking** – in this case for the North relative to the national average. As such, capability performance is not absolute; a capability may be 'exemplar' in the North relative to the rest of the country, but in an absolute sense may underperform, particularly relative to desired or targeted standards (e.g. the A&E waiting time target) or international comparators.

More detailed exploration and analysis of the performance of each of the foundational themes and capabilities across their respective coverage, reliability and quality metrics is provided below. The following hyperlinks can be used to jump to the findings for each respective theme:

- Public Services
- Utilities
- Critical Transport and Logistics
- Food and Essentials

The accompanying results, definitions and sources for each capability can be found in the data appendices.

3.4 Public Services

Capabilities, performance, and trajectory

Within the North's foundational economy, our review has found public services capabilities are by some distance its strongest performing, as the results in Table 3.4.1 show, overleaf.

Of the 5 foundational capabilities comprising the theme, impressively all of them display 'exemplar' coverage. In addition to this, 3 are 'exemplar' for reliability and a further 2 for quality (notably, healthcare and emergency services are 'exemplar' across all three dimensions). Only 1 capability, primary and secondary education 'requires action', in terms of quality.

[4] Not least, by prioritising 'frontline' public sector workers, and using per capita shares.

Table 3.4.1: Assessment of the North's foundational capabilities within the public services theme

Foundational Capability	Current performance (relative to rest of England)	Recent direction of travel (relative to rest of England)
Healthcare		
Coverage		
Reliability		
Quality		
Social Care		
Coverage		
Reliability		
Quality		
Primary and Secondary Education		
Coverage		
Reliability		
Quality		
Emergency Services		
Coverage		
Reliability		
Quality		
Public Administration		
Coverage		
Reliability		
Quality		

Source: Cambridge Econometrics

Looking at direction of travel, relative trend performance in the North has generally mirrored the national average over recent years, though the reduction in the quality of the primary and secondary education capability – which already 'requires action' – is of some concern.

Healthcare

- **Coverage – 'Exemplar':** the North consistently and strongly outperforms the rest of England on healthcare coverage metrics. On average, residents in the North have significantly higher accessibility to their nearest hospital or GP, even when accounting for non-private modes of transport.

  Likewise, on a per capita basis, the North has almost 20% more frontline health workers and hospital beds than the rest of England. The direction of travel for these metrics has generally been positive, although hospital bed coverage has increased at a relatively slower pace in the North.

- **Reliability – 'Exemplar':** the North also outperforms the rest of England on healthcare reliability metrics. Most notably, A&E waiting times in the North are some 7% lower than elsewhere in the country, whilst unplanned hospital readmission rates are 3% lower. Both metrics have outperformed the national average over recent years.

- **Quality – 'Exemplar':** in terms of quality, healthcare in the North continues to perform strongly, with metrics showing 79% of the North's population reside in 'good' or 'outstanding' NHS CCG areas, well above the national average of 64%. In patient surveys, respondents score the quality of hospitals in the North broadly in line with the rest of the country.

Social Care

- **Coverage – 'Exemplar':** as with healthcare, the North compares favourably to the rest of England on social care coverage metrics. On a per capita basis, the North has 81% more frontline care workers, and 11% more care beds than the rest of England. The North's social care workforce has also been growing strongly, although care bed coverage is declining faster than the national average.
- **Reliability – 'As Expected':** in terms of reliability, the North has a similar incidence of reported delayed transfers of care attributable to the social care sector, though these delays are increasing relative to the rest of the country. Positively, social care-related complaints (on a per capita basis) are 20% lower than the average, and stable.
- **Quality – 'As Expected':** metrics show 84% of the North's social care providers are scored 'good' or 'outstanding' by the CQC, identical to the national average, with the North closing its historic deficit. In patient surveys, respondents score the quality of social care in the North broadly in line with the rest of the country.

Primary and Secondary Education

- **Coverage – 'Exemplar':** the North also outperforms the rest of England on education coverage metrics. On average, school pupils in the North have much higher accessibility to their nearest school, whilst on a per capita basis, the North has 6% more in-classroom teaching staff than the rest of England. Recently, both of these metrics have moved in line with the national average.
- **Reliability – 'As Expected':** education reliability metrics show the North performs broadly in line with the rest of the country. Average classroom sizes in the North generally track the rest of England, although pupil absence rates are marginally higher, and increasing at a faster rate.
- **Quality – 'Action Required':** metrics show 80% of pupils in the North attend schools scored 'good' or 'outstanding' by Ofsted, below the national average of 86%, and this shortfall is widening. Pupil outcomes also lag the national average – PISA scores remain 3% below national benchmarks in the North, whilst educational attainment upon leaving school is on average 4% lower, and improving slower than the rest of the country.

Emergency Services

- **Coverage – 'Exemplar':** the North's emergency services coverage also compares favourably to the rest of England. On a per capita basis, the North has 14% more frontline emergency (police, fire, and ambulance) workers than elsewhere in the country. This aggregate measure is somewhat skewed by the North's notably higher police coverage, with fire and ambulance coverage closer to the national average.
- **Reliability – 'Exemplar':** positively, emergency service reliability metrics also outperform the rest of the country. Average response times are some 11% faster in the North than elsewhere in the country, with the North maintaining this performance gap over recent years. This assessment

does however exclude police response times, which are not publicly available.

- **Quality – 'Exemplar':** metrics show a significantly higher proportion of the North's population reside in areas with 'good' or 'outstanding' emergency services than elsewhere in the country. Likewise, in user surveys, respondents score the quality of emergency services in the North marginally above the national average.

  These aggregate quality measures require some important clarifications though. In particular, policing in the North lags the rest of the country across both metrics - 3 police forces in the North are rated 'inadequate' or 'requiring improvement', whilst only 55% of residents say the police do an excellent/good job. Independent of the fire and ambulance service, the quality of policing in the North could be assessed as 'requiring action'.

Public Administration

- **Coverage – 'Exemplar':** as with other public services, public administration also performs favourably in terms of coverage. On a per capita basis, the North has 22% more frontline public administration workers than elsewhere in the country. Despite this, the recent direction of travel has diverged from the national average.
- **Reliability – 'Exemplar':** public administration reliability metrics show a continued overperformance relative to the rest of the country. On a per capita basis, public administration-related complaints are more than 20% lower than the national average, but have been increasing at a faster rate in recent years.
- **Quality – 'As Expected':** in user surveys, respondents score the quality of public administration in the North marginally above the national average. Local authorities in the North perform in line with elsewhere in the country in terms of housing benefit and council tax processing efficiency.

3.5 Utilities

Capabilities, performance, and trajectory

The North's capabilities in utilities can be summarised by contrasting attributes and performance, as the results in Table 3.5.1 show, overleaf.

As with other themes, utilities in the North compares favourably in terms of coverage; of the 6 foundational capabilities comprising the theme, 3 of them display 'exemplar' coverage. Perhaps most interesting of these is digital connectivity, which is also 'exemplar' across the reliability and quality dimensions.

Of concern however is the prevalence of poor relative reliability, with 3 of the 6 capabilities - electricity, gas, and water – 'requiring action'. This poor reliability does not translate into lower quality however, with 5 of the 6 capabilities performing 'as expected', and the other 'exemplar'.

In terms of direction of travel, data limitations for this theme restrict clear and consistent observations. However, where data are available, relative trend performance appears similar to the rest of the country, with digital connectivity supplementing is 'exemplar' status with ongoing positive momentum.

Table 3.5.1: Assessment of the North's foundational capabilities within the utilities theme

Foundational Capability	Current performance (relative to rest of England)	Recent direction of travel (relative to rest of England)
Electricity:		
Coverage		
Reliability		
Quality		
Gas:		
Coverage		
Reliability		
Quality		
Water:		
Coverage		
Reliability		
Quality		
Waste and Sewerage:		
Coverage		
Reliability		
Quality		
Digital Connectivity:		
Coverage		
Reliability		
Quality		
Construction, Repair and Maintenance:		
Coverage		
Reliability		
Quality		

Source: Cambridge Econometrics

Electricity

- **Coverage – 'As Expected':** there is no currently available metric or reliable proxy to appraise the capability across this dimension. However, due to the nationwide standardisation of this particular utility, coverage is assumed to be in line with rest of England.
- **Reliability – 'Action Required':** electricity is one of three utilities to compare unfavourably in the North in terms of reliability. Interruptions to electricity supply are around 10% more prevalent than elsewhere in the country, and improving at a slower rate.
- **Quality – 'As Expected':** in customer surveys, respondents score the quality of electricity provision in the North broadly in line with the rest of the country. Satisfaction has been improving faster than the national average.

Gas

- **Coverage – 'Exemplar':** the North exhibits 'exemplar' coverage of gas provision. Only 9% of properties in the North are not connected to the gas

grid, which is almost half the national average of 16%. Relative trend performance has also been positive in recent years.

- **Reliability – 'Action Required':** as with electricity, gas provision in the North performs unfavourably in terms of reliability. Interruptions to the gas supply are around 14% more prevalent than elsewhere in the country, and improving at a slower rate.
- **Quality – 'As Expected':** in customer surveys, respondents score the quality of gas provision in the North broadly in line with the rest of the country. Improvements have been slowing relative to the national average.

Water

- **Coverage – 'As Expected':** there is no currently available metric or reliable proxy to appraise the capability across this dimension. However, due to the nationwide standardisation of this particular utility, coverage is assumed to be in line with rest of England.
- **Reliability – 'Action Required':** alongside electricity and gas, water provision in the North also performs unfavourably in terms of reliability. Interruptions to the water supply are around 9% more prevalent than elsewhere in the country.
- **Quality – 'As Expected':** in customer surveys, respondents score the quality of water provision in the North slightly higher than the rest of the country, and close to 'exemplar' levels of quality.

Waste and Sewerage

- **Coverage – 'As Expected':** there is no currently available metric or reliable proxy to appraise the capability across this dimension. However, due to the nationwide standardisation of this particular utility, coverage is assumed to be in line with rest of England.
- **Reliability – 'Exemplar':** the North compares favourably for waste and sewerage reliability. Sewerage incidents and interruptions are some 9% lower than elsewhere in the country, whilst waste and environmental incident complaints (per capita) are 20% lower.
- **Quality – 'As Expected':** in customer surveys, respondents score the quality of sewerage provision in the North slightly higher than the rest of the country, and close to 'exemplar' levels of quality. The proportion of waste that is recycled in the North is identical to the national average.

Digital Connectivity

- **Coverage – 'Exemplar':** in contrast to some narratives, the North outperforms the rest of England in terms of the coverage of its digital connectivity. The proportion of premises in the North with either superfast (97% of all premises), ultrafast (65%), or full-fibre (27%) coverage all exceed the average for the rest of the country.

  Likewise, 4G coverage in the North (be it indoor, outdoor, or on key roads or motorways) also outperforms the national average. The direction of travel for these metrics has also been positive, with the rollout of better broadband some 8% faster in the North relative to the rest of the country.
- **Reliability – 'Exemplar':** experimental data also highlight the North's digital advantage in terms of the reliability of its digital connectivity. Interruptions to broadband in the North are estimated to be some 50% less prevalent than elsewhere in the country.

- **Quality – 'Exemplar':** finally, the North also compares favourably in terms of the quality of its digital connectivity. Upload and download speeds are, on average, 6% quicker in the North relative to elsewhere in the country, and have also been improving at a faster rate.

Construction, Repair and Maintenance

- **Coverage – 'Exemplar':** on a per capita basis, the North has 40% more construction, repair and maintenance workers than elsewhere in the country. Trades with more than double the representation of the national average include floorers, scaffolders, roofers, plasterers, bricklayers, and glaziers.
- **Reliability – 'Data Missing':** there is no currently available metric or reliable proxy to appraise the capability across this dimension.
- **Quality – 'As Expected':** in terms of quality, 77% of the construction, repair and maintenance workforce in the North are 'suitably qualified' (holding at least an intermediate trade apprenticeship), in line with the national average of 78%.

3.6 Critical Transport and Logistics

Capabilities, performance, and trajectory

The North's capabilities in critical transport and logistics are highly varied in terms of attributes and performance, as the results in Table 3.6.1 show.

Table 3.6.1: Assessment of the North's foundational capabilities within the critical transport and logistics theme

Foundational Capability	Current performance (relative to rest of England)	Recent direction of travel (relative to rest of England)
Roads and Public Realm		
Coverage		
Reliability		
Quality		
Public Transport		
Coverage		
Reliability		
Quality		
Postal Service		
Coverage		
Reliability		
Quality		
Critical Freight Handling		
Coverage		
Reliability		
Quality		

Source: Cambridge Econometrics

As with other themes, the North's critical transport and logistics capabilities are strongest on the coverage dimension, with 2 of the 4 capabilities exhibiting 'exemplar' coverage – including public transport and critical freight handling. In

contrast, and somewhat surprisingly, roads and public realm coverage in the North 'requires action'.

The reliability and quality of the North's public transport and critical freight handling capabilities 'require action' respectively, though the other capabilities perform 'as expected' on these dimensions. The direction of travel has largely been aligned to the national average, though critical freight handling has trailed this comparator.

Roads and Public Realm

- **Coverage – 'Action Required':** the North lags the rest of England on metrics relating to roads and public realm coverage. Major road length miles per capita are 10% below the average for the rest of the country, though this gap is closing. Meanwhile, the coverage of EV charging points is some 14% below average.
- **Reliability – 'As Expected':** average journey delays on major roads in the North are some 17% longer than the national average, a level of performance that 'requires action'. Yet on a per capita basis, highways and public realm-related complaints remain 35% lower than the national average
- **Quality – 'Exemplar':** in terms of quality, the North's roads and public realm compare favourably to the rest of the country. 75% of the North's major roads are in 'good' condition, above the national average of 72%. And relative to the number of vehicle miles driven on major roads in the North, traffic accidents are some 30% below average. For both metrics, relative trend performance has also been positive.

Public Transport

- **Coverage – 'Exemplar':** the North exhibits 'exemplar' public transport coverage. On average, residents in the North have significantly higher accessibility to key services – such as employment centres, schools, hospitals and shopping centres – by public transport. This accessibility is also improving relative to the rest of England.

  Reflecting this better coverage, the number of public transport journey's per capita are some 23% higher in the North than elsewhere in the country. This rate has started to decline in recent years however, as relative private transport use in the North increases.
- **Reliability – 'Action Required':** despite this 'exemplar' coverage, public transport reliability compares unfavourably to the rest of England and 'requires action'. This is a particularly pertinent issue for rail; pre-Covid, only 55% of rail services in the North arrived 'on time', well below the national average of 66%. These delays have also become more prevalent over recent years.
- **Quality – 'As Expected':** even with these reliability issues, quality metrics remain 'as expected', and even close to 'exemplar' levels. In customer surveys, respondents score the quality of public transport in the North – even rail – slightly higher than the rest of the country. And relative to the rest of the country, public transport travel times in the North are closer to (though still above) private alternatives.

Postal Service

- **Coverage – 'As Expected':** in customer surveys, respondents in the North score the availability of postal branches and post boxes slightly

higher than the rest of the country, whilst relative trend performance has been positive.

- **Reliability – 'As Expected':** as with coverage, in customer surveys respondents score the speed and punctuality of postal delivery slightly higher than the rest of the country. Relative trend performance has also been positive.
- **Quality – 'As Expected':** finally, in customer surveys respondents score the quality of the postal service in the North slightly higher than the rest of the country, and close to 'exemplar' levels of quality, whilst relative trend performance has been positive.

Critical Freight Handling

- **Coverage – 'Exemplar':** the coverage of the North's critical freight handling capability compares favourably to the rest of England. On a per capita basis, total freight handled in the North – across road, rail, air, and water freight – is around 26% above the national average. This freight handling intensity has eased over recent years though, due to increasing freight capacity in the South and Midlands.
- **Reliability – 'Exemplar':** internationally comparable statistics show waiting times at major freight ports in the North are typically 18% shorter than elsewhere in the country.
- **Quality – 'Action Required':** the UN's Liner Shipping Connectivity Index (LSCI) provides an indication of freight port quality. Relative to those elsewhere in the country, major ports in the North underperform on the index. In addition to this, major freight port turnaround times are almost 30% slower in the North.

3.7 Food and Consumer Essentials

Capabilities, performance, and trajectory

The North's food and consumer essentials capabilities are some of its most consistently high performing, as

Table 3.7.1 shows, overleaf.

As with others, they are strongest on the coverage dimension; of the 3 capabilities comprising the theme, impressively all of them display 'exemplar' coverage. In terms of reliability and quality, the majority perform 'as expected', though 1 – wholesale and supply chains – scores 'exemplar' for both reliability and quality.

In terms of direction of travel, data limitations for this theme restrict clear and consistent observations. However, where data are available, relative trend performance appears similar to the rest of the country.

Table 3.7.1: Assessment of the North's foundational capabilities within the Food and Consumer Essentials theme

Foundational Capability	Current performance (relative to rest of England)	Recent direction of travel (relative to rest of England)
Wholesale and Supply Chains		
Coverage		
Reliability		
Quality		
Non-specialised Retail		
Coverage		
Reliability		
Quality		
Retail Banking and Finance		
Coverage		
Reliability		
Quality		

Source: Cambridge Econometrics

Wholesale and Supply Chains

- **Coverage – 'Exemplar':** metrics show the North performs strongly on wholesale and supply chains coverage. On a per capita basis, the North has up to 28% more warehouse and logistics space than elsewhere in England.
- **Reliability – 'Exemplar':** though data are limited for this dimension, the results show the North exhibits 'exemplar' reliability in terms of wholesale and supply chains, with a lower incidence of reported fuel, food and other essentials shortages relative to elsewhere in the country.
- **Quality – 'Exemplar':** finally, metrics suggest the North also compares favourably for the quality of its wholesale and supply chain network, with warehouse and logistics facilities in the North typically larger and more modern than the national average.

Non-specialised Retail

- **Coverage – 'Exemplar':** relative to the rest of England, the coverage of non-specialised retail (i.e. supermarkets and other large food stores) in the North is high and improving. On average, residents in the North have much higher accessibility to their nearest supermarket or food store, even when accounting for non-private modes of transport.
- **Reliability – 'As Expected':** though data are limited for this dimension, the results show the North performs 'as expected' in terms of reliability, with an identical incidence of reported food shortages relative to elsewhere in the country.
- **Quality – 'Data Missing':** there is no currently available metric or reliable proxy to appraise the capability across this dimension.

Retail Banking and Finance

- **Coverage – 'Exemplar':** as with other food and essentials, metrics show the North performs strongly on retail banking and finance coverage. On a

per capita basis, the North has 15% more ATM's than the rest of England. Meanwhile, the per capita incidence of bank branches and building societies mirrors the national average but is declining at a faster rate.

- **Reliability – 'As Expected':** though data are limited for this dimension, the results show the North performs 'as expected' with a similar proportion of ATM's free to use as elsewhere in the country.
- **Quality – 'As Expected':** the Demos Good Credit Index provides an indication of the availability and quality of retail banking and finance. Relative to elsewhere in the country, the North performs 'as expected' on the index.

Summary

Following the analysis of the above metrics, three capabilities stood out as requiring further attention in the North of England. These included:

- Performance and direction of the Quality of Primary and Secondary Education
- Reliability performance of all three traditional Utilities (Electricity, Gas, and Water)
- Reliability performance of Public Transport

Furthermore, it is worth bearing in mind that these metrics are relative to the rest of the country: they identify regional areas of relative strength and weakness, rather than more systemic national issues.

3.8 Foundational Capabilities: additional metrics

As we have already seen, through the provision of its goods and services, the North's foundational capabilities have a vital role in determining the wellbeing and quality of life for residents in the North. This in itself has significant economic value, not least in terms of improving productivity, economic participation, and skills and human capital, amongst others.

Yet the foundational capabilities also have a much clearer and direct economic impact, particularly in terms of employment, spending and output. We apply the Foundational Economy Collective's SIC code definition to uncover and further highlight the economic scale and importance of the foundational economy in the North, and its constituent parts including:

- 'The Material foundational economy': *"pipe and cable utilities, supermarkets etc. which through networks and branches continuously connect households to daily essentials."*
- 'The Providential foundational economy': *"a subset of (mainly) public sector welfare activities providing the universal services available to all citizens."*
- 'The Overlooked economy': *"goods and services culturally defined as essential and requiring occasional purchase, for example, consumer and household goods, holidays and travel etc."*

As Table 3.8.1 shows, the total foundational economy accounts for some 4.7 million jobs in the North of England – equivalent to almost three-quarters

(approximately 67%) of all employment in the North's economy (marginally above the national average of 65%). This is also more than double the employment in other (i.e. non-foundational) parts of the economy.

It also generates some £204 billion of gross value added (GVA), which equates to more than two-thirds (63%) of all GVA produced in the North. Productivity in the sector is some 6% lower than the total economy-wide average, though this shortfall is smaller than elsewhere in the country, where the gap stands at 8%.

Table 3.8.1: Scale and performance of the foundational economy in the North of England, 2018-19

	Pan-Northern Totals					
	Employment (000's)	GVA (£, millions)	Productivity (GVA per job, £ 000's)	Employment % of total	GVA % of total	Productivity % of total
Material foundational economy	1,233	67,236	54.5	18%	21%	117%
Providential foundational economy	2,026	83,888	41.4	29%	26%	89%
Overlooked economy	1,420	53,223	37.5	20%	16%	80%
Total foundational economy	**4,679**	**204,347**	**43.7**	**67%**	**63%**	**94%**
Other (i.e. non-foundational) economy	*2,280*	*120,519*	*52.9*	*33%*	*37%*	*113%*
Total (i.e. foundational and non-foundational) economy	***6,959***	***324,866***	***46.7***	**-**	**-**	**-**

Source: Cambridge Econometrics, Foundational Economy Collective, ONS

Since 2013 the foundational economy has created some 275,000 additional jobs in the North, and during this time has grown by an average of 1.0% per annum. However, as Figure 3.8.1 shows, this pace of growth trails both the national average, and the 'other' (i.e. non-foundational) economy average (which grew at 2.5x the rate of the foundational economy).

Figure 3.8.1: Growth of the foundational economy in the North of England, 2013-19

Source: Cambridge Econometrics, Foundational Economy Collective, ONS

Particularly significant is the slow growth of the providential economy in the North. This part of the foundational economy includes many key public services, and its slower growth may reflect the reduction in public spending in the North. Also notable is the slower growth of the material economy – critical for infrastructure and utilities – in the North relative to the national average.

Figure 3.8.2 highlights how the scale of the North's foundational economy has changed since the publication of the original NPIER, in terms of employment share. After peaking in 2014, the share has declined slightly, settling at its current value of 67%. Though more recent data are unavailable, it is likely this share has since increased because of the Covid-19 pandemic, particularly given the reported employment growth in public (i.e. providential) services.[5]

Figure 3.8.2: Foundational economy employment share, 2013-19

Source: Cambridge Econometrics, Foundational Economy Collective, ONS

The foundational economy is well represented at a pan-Northern level, as Table 3.8.2 shows. The 11 Local Enterprise Partnership (LEP) areas comprising the North all exhibit foundational economy shares close to or above the national average. However, only 1 LEP area, Greater Manchester, has seen their foundational economy grow faster than the national average since 2013.

[5] See research here for instance.

Table 3.8.2: Scale and performance of the foundational economy by LEP area in the North of England, 2018-19

	North East	Tees Valley	Cheshire and Warrington	Cumbria	Greater Manchester	Lancashire	Liverpool City Region	Humber	Leeds City Region	Sheffield City Region	York, North Yorkshire and East Riding	**Total North**	***Rest of England***
Employment (000's)	573	197	299	170	846	447	441	277	752	392	285	**4,679**	***14,177***
GVA (£, millions)	27,195	8,398	14,115	7,071	38,477	19,622	17,710	11,215	32,088	16,801	11,655	**204,347**	***637,035***
Productivity (GVA per job, £ 000's)	47.4	42.7	47.2	41.6	45.5	43.9	40.2	40.5	42.7	42.9	40.9	**43.7**	***44.9***
Employment % of total	70%	71%	60%	70%	63%	69%	68%	71%	67%	69%	71%	**67%**	***66%***
GVA % of total	67%	65%	52%	67%	60%	68%	62%	57%	65%	66%	68%	**63%**	***60%***
Productivity % of total	96%	91%	87%	97%	95%	99%	90%	80%	96%	96%	95%	**94%**	***92%***
Growth per annum %	0.0%	0.0%	1.4%	1.0%	1.7%	0.9%	1.3%	0.9%	1.3%	1.2%	0.5%	**1.0%**	***1.9%***

Source: Cambridge Econometrics, Foundational Economy Collective, ONS

4 The North's Higher Capabilities

4.1 Introduction

The purpose of the non-foundational ("higher") capability review exercise is to use a novel, data-driven approach to provide fresh insights and knowledge into the performance and composition of the North's higher capabilities, including its "Primes" and "Enablers".

Our findings are not intended to supplant or refresh the original "Prime" and "Enabling" Capabilities identified in 2016, but instead offer an alternate point of view that challenges, nuances, and updates the original framework, drawing on new data and analytics.

4.2 Higher Capabilities: definitions and evidence

Our conceptual framework allows us to distinguish between the North's higher and foundational economic functions. If, as defined in the previous section, foundational capabilities represent the 'everyday economy' of the North, higher capabilities can be seen as representing the distinctive, more outward looking parts of the North's economy.

These higher capabilities typically contribute to the modern knowledge economy of the North, and help to drive innovation and productivity, whilst interacting with global value chains. Critically, their distinction provides a more targeted means of reviewing the North's "Prime" and "Enabling" Capabilities, drawing on a richer, more focussed evidence base.

Our understanding of the North's "Prime" and "Enabling" Capabilities remains the same as the original NPIER:

- **"Prime" Capabilities:** are capabilities that have been identified as differentiated and distinctive at a pan-Northern level. These capabilities exhibit high performance across all metrics, serving a global market and interacting with global value chains, and are represented across multiple locations within the North.
- **"Enabling" Capabilities:** are capabilities that play a critical role in supporting the growth and development of the "Prime" Capabilities, and primarily serve a regional market.

For the purpose of this study, we have split the non-foundational ("higher") part of the economy into 24 separate "capabilities". This degree of disaggregation allows for a slightly more detailed analysis than in the original NPIER, without being so specialised as to disallow the possibility of pan-Northern participation. These are presented in Table 4.2.1 below.

These 24 capabilities have been defined using a 'bottom-up' approach. We have drawn on analysis of functional relatedness between sectors to help allocate 5-digit SIC codes into the 24 groups. This is in contrast to the original NPIER, which used a 'top-down' approach to defining capabilities, which offered only 45 potential classifications. Details of the approach undertaken can be found in the data appendices.

Table 4.2.1: Higher capabilities to be reviewed

Capability	*Description*	Capability	*Description*
Accommodation and Hospitality	*Hotels; Pubs and Restaurants*	**Food and Agriculture**	*Agriculture; Food and Drink Manufacturing; Land Management; Agricultural Commodities (Raw and Semi Processed)*
Machinery and Processing	*Machinery and Machine Tools; Processing Techniques; Heavy and Industrial Manufacturing*	**Foundation Industries**	*Metals; Ceramics; Glass; Basic Chemicals; Paper; Cement*
Arts and Recreation	*Theatres; Golf Courses; Museums and Casinos; Leisure Centres*	**Information and Communications**	*Computing and Communications Technology; Digital Networks; Digital Infrastructure*
Transport Equipment	*Engines and Combustion; Vehicles and Transport Equipment Manufacturing (including Aerospace, Shipping)*	**Life Sciences**	*Medicine and Human Health Research; Veterinary*
Business Support Services	*Recruitment; Security; Cleaning; Call Handling; Admin*	**Media and Publishing**	*Broadcast Media; Books; Music*
Chemicals and Materials	*Pharmaceuticals; Advanced Chemical Products Manufacturing; Materials and Synthetic Materials Manufacturing; Chemical Treatment Of Metals; Chemical Analysis*	**Engineering and Construction**	*Buildings; Advanced Or Offsite Construction; Architecture and Engineering; Engineering Research;*
Wholesale and Retail	*Specialist Wholesale and Retail (i.e. excluding Supermarkets); Fashion, Luxury Goods*	**Management and Social Science**	*Economics; Management and Social Sciences Research; Consulting and Technical Services*
International Transport and Logistics	*Specialist Logistics; International Transport; Shipping; Ports and Airports; Maritime Services*	**Mining and Extraction**	*Mining; Oil and Gas Extraction; Minerals; Gems*
Higher and Further Education	*Higher and Further Education; Learning Technologies*	**Law and Accountancy**	*Real Estate Representation; Legal; Tax and Accounting*
Electronic Devices	*Electronic Hardware and Devices Manufacturing*	**Software and IT**	*Software Development and Publishing; IT Consultancy; IT Related Services*
Energy and Power	*Energy Generation, Distribution, and Storage (including Low Carbon sources); Heating and Electricity; Energy Efficiency*	**Textiles and Wood Products**	*Textiles; Clothing; Furniture; Wood Products*
Finance	*Finance; Insurance; Reinsurance; Banking*	**Water, Waste and Circular Economy**	*Refuse; Water Supply; Waste; Recycling; Circular Economy; Reservoirs*

Source: Cambridge Econometrics. Supporting statistical definitions for each capability can be found in the Data Appendices

We have therefore been able to map and define the North's higher capabilities at a level of detail some 16 times greater than before, providing for significantly more robust and functional definitions. A detailed overview of the SIC codes used to define each capability, and corresponding lookups for non-SIC code data, can be found in the data appendices.

In our assessment of the North's higher capabilities, we have prioritised a data-driven approach, and for each capability the following metrics have been produced (primarily at a pan-Northern level, but also for lower geographies for some metrics). Similarly, detailed overview of metric definitions and sources can also be found in the data appendices:

- Standard economic metrics:
    - Employment (i.e. jobs)
    - Gross Value Added (GVA)
    - Business base
    - Productivity (GVA per job)
- Trade metrics:
    - Goods exports
    - Services exports
- Innovation metrics:
    - Patent applications
    - Innovate UK project funding grants

A number of these metrics have also been interacted together, for instance to estimate exports as a proportion of GVA, or patent applications per job. Location quotients (LQ's[6]), which were used extensively in the original NPIER, have also been calculated for each metric. LQ's are a measure of the geographical specialisation of an industry - the higher the LQ the more an area has a specialisation in that industry relative to the national average.

As with the foundational capabilities, metrics have been appraised according to their pre-Covid pandemic performance (typically, no later than 2019). This is due to data becoming significantly distorted by the pandemic, alongside concerns relating to data quality issues (e.g. as a result of smaller sample sizes, less frequent collection etc.) meaning more recent data may not provide a true or reflective indication of a capabilities longer-term performance.

In line with the original NPIER, a capability is defined as high performing if – at a pan-Northern level - it exhibits a clear specialisation (as measured by LQ[7]) in terms of employment and/or GVA, as well as above average productivity

[6] To calculate LQ's, we have used the same definition as the ONS, provided here.

[7] As with the with the original NPIER, the benchmark for any LQ analysis presented here is the rest of England less London (i.e. England, less the North and London), which also ensures continuity with the foundational capabilities benchmarking.

(relative to either the national economy-wide average[8], and/or the national benchmark for that capability).

In addition to this, to better profile capability strengths and specialisms we assess capability innovation intensity and performance, which is included as an extra dimension in our conceptual framework. Specifically, we assess research intensity and specialisms in terms of patent applications and Innovate UK funding grants.

A capability is defined as operating in a global market if – at a pan-Northern level – it has a higher export intensity (either in terms of exports as a proportion of GVA, or exports per job) relative to the national, economy-wide average. If a capability is unable to or only partially fulfils these criteria, it is regarded as operating in a regional market.

Representation at the pan-Northern level is defined by assessing the specialisation (as measured by LQ[9]) of capabilities in LEP areas across the North. In order to identify capabilities where relative specialism is spread across the North (i.e. is 'pan-Northern'), we simply count the number of LEP geographies with a LQ of greater than 1.0 for each capability.

4.3 Results

Our approach to evaluating the North's higher capabilities, and reviewing the "Primes" and "Enablers", follows a similar process to that presented in the original NPIER, and can broadly be structured into following four distinctive phases:

i. *Economic specialisation and performance:* firstly, we start by considering the relative specialisation and economic performance of higher capabilities in the North. In the 2016 NPIER, this was the limits of the data exercise used to identify the North's "Prime" and "Enablers".

ii. *Research and innovation intensity and strengths:* here, drawing on novel and alternative data sources we progress the parameters of our review even further, firstly by incorporating and assessing relative innovation dynamics and performance.

iii. *Export intensity and global market representation:* export and trade data are then used to profile the representation and performance of the higher capabilities within global markets.

iv. *Pan-Northern distribution and representation:* finally, detailed spatial analysis is undertaken to determine the geographic representation and concentration of higher capabilities in the North.

[8] The national average is defined as above (the rest of England less London).

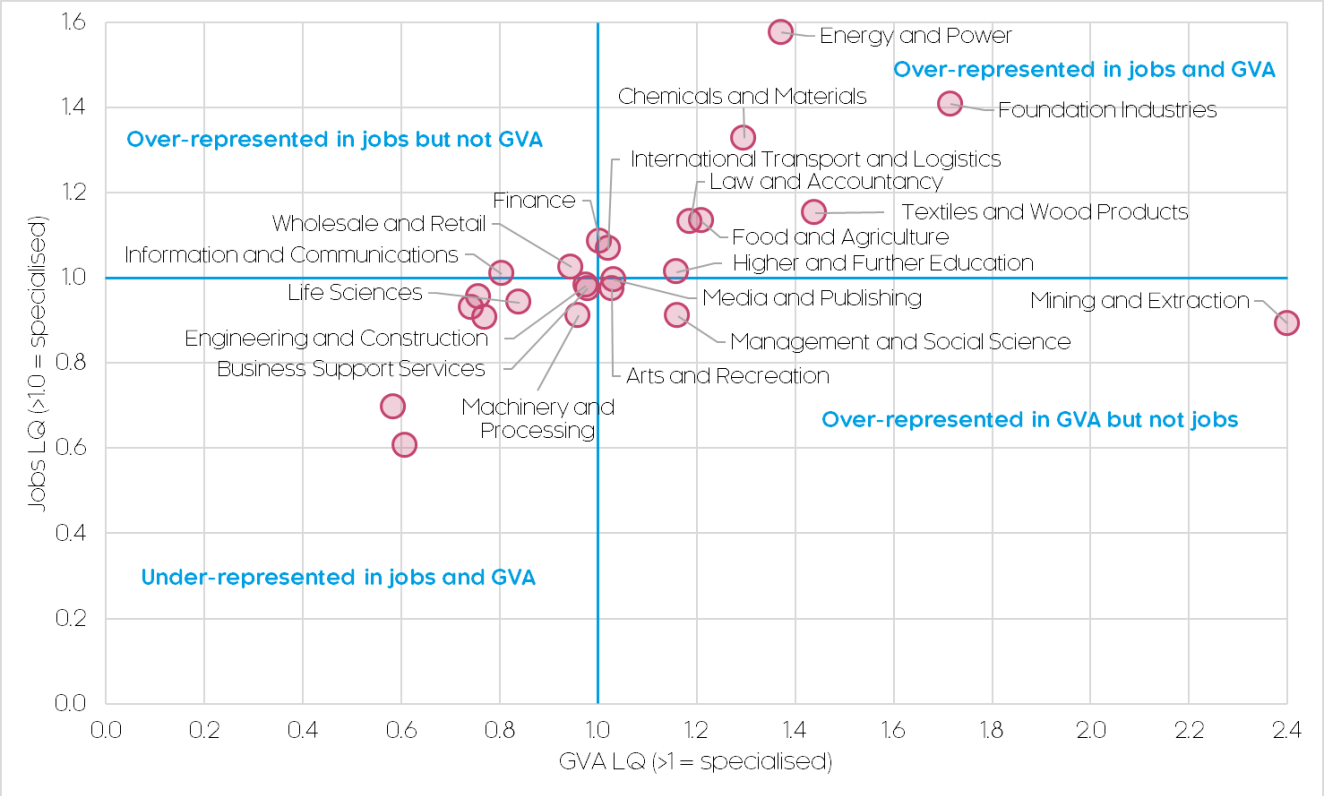
[9] As before, to calculate LEP area LQ's, we have used the same definition as the ONS, provided here.

i. Economic specialisation and performance

Specialisation

Figure 4.3.1 refreshes a visualisation presented in the original NPIER, which shows for each of the 24 higher capabilities in the North of England their specialisation and representation in terms of both jobs (y-axis) and GVA (x-axis) – as measured by LQ[10], relative to the rest of England less-London benchmark.

Figure 4.3.1: Higher capability specialisation in the North, 2018-19



Source: ONS, Cambridge Econometrics. Note: LQ's relative to the rest of England less-London average. Mining and extraction GVA LQ actually 3.6 but scaled to fit on chart

Capabilities in the top right quadrant show a clear specialisation and over-representation at a pan-Northern level, relative to the benchmark. This is dominated by the diversity of material and goods producing activities that the North is renowned for its strengths in, such as energy and power, food and agriculture, foundation industries, chemicals and materials, and textiles and wood products.

Some service-based capabilities also feature, notably law and accountancy, as well as higher and further education, finance, and international transport and logistics. Related services, including media and publishing, arts and recreation, and management and social science feature in the bottom right quadrant, demonstrating overrepresentation in GVA but not jobs. Wholesale and retail and information and communications meanwhile are relative anomalies in the top left quadrant, overrepresented in GVA but not jobs.

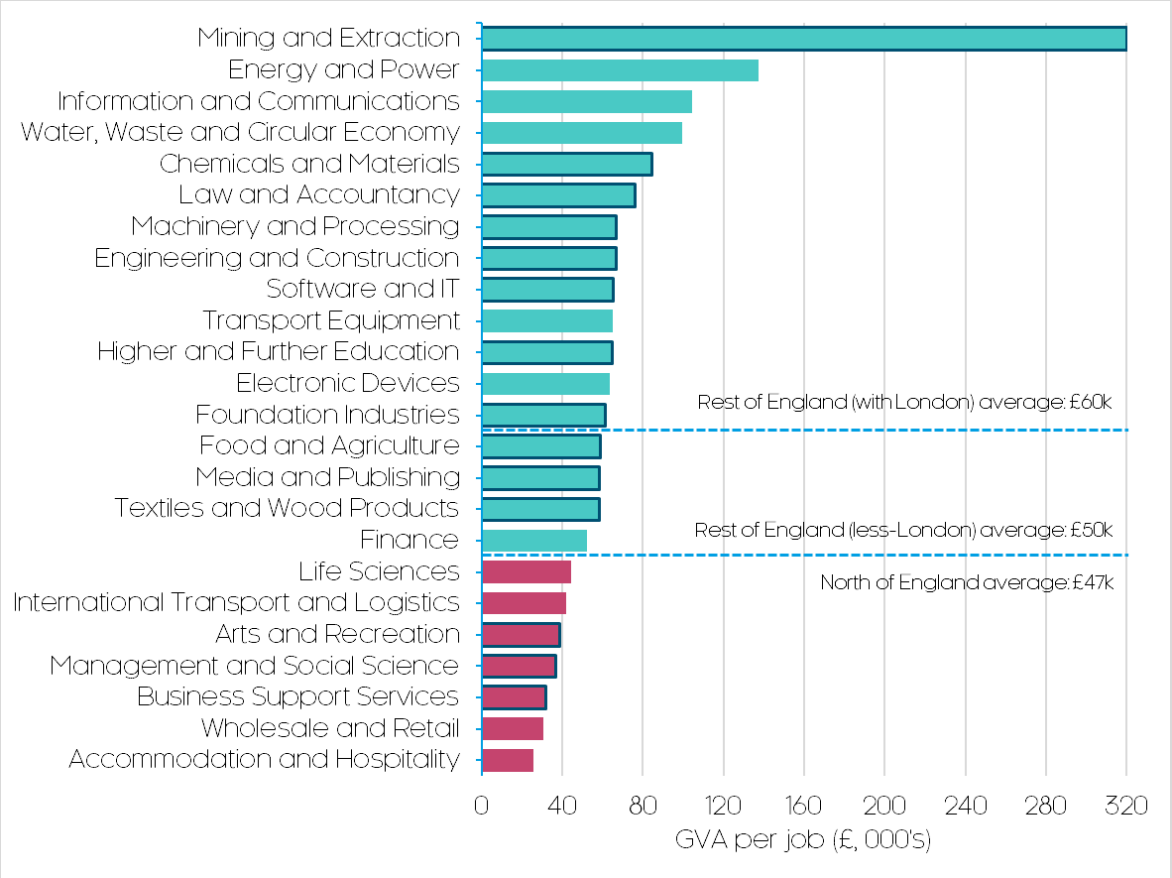
[10] LQ's are a measure of the geographical specialisation of an industry - the higher the LQ the more an area has a specialisation in that industry relative to the national average.

The remaining capabilities feature in the bottom left quadrant, suggesting no clear relative specialisation at a pan-Northern level. Yet some capabilities are located at the edge of this quadrant, indicating pan-Northern specialisation close to the national average, with the potential to match or even exceed this. This includes machinery and processing, life sciences, engineering and construction, and business support services.

Productivity

In keeping with the approach of the original NPIER, we then proceed to consider the relative productivity performance and dynamism of the higher capabilities. Figure 4.3.2 again refreshes NPIER analysis to look at the productivity of the North's capabilities relative to both the national economy-wide average, and national capability benchmarks.

Figure 4.3.2: Labour productivity of higher capabilities in the North, 2018-19



Source: ONS, Cambridge Econometrics. Note: capabilities with shaded borders exhibit productivity close to or above their national (rest of England less-London) capability benchmark

Capabilities have been colour-coded according to their relative performance on these metrics: turquoise if they exceed the national economy-wide average, and pink if they are below it, whilst any capability (both those turquoise or pink) with a shaded border exhibit productivity above or close to their respective national capability benchmark.[11]

A number of capabilities in the North exhibit both high productivity (in an absolute sense) and perform well against national capability benchmarks for

[11] As with the original NPIER, 'close to' is defined as at least 90% of the national capability benchmark. This definition of 'close to' is applied for the remainder of the capabilities analysis presented here.

productivity, suggesting areas of comparative advantage. Capabilities that perform well on both measures are typically those highly specialised and overrepresented in the North (as outlined in Figure 4.3.1 above).

This includes several material and goods-producing capabilities such as mining and extraction (the North's most productive capability), chemicals and materials, machinery and processing, foundation industries, and food and agriculture. Yet a similar number of service-based activities in the North also perform strongly against both benchmarks, notably law and accountancy, followed by software and IT, higher and further education, media and publishing, and engineering and construction.

A diverse range of capabilities including energy and power, information and communications, water, waste and circular economy, transport equipment, and electronic devices exhibit high productivity in an absolute sense, but below peers elsewhere in the country (i.e. there is a notable 'productivity gap' in the North), particularly relative to those in the wider South East.

In addition to these, some capabilities in the North have generally low levels of productivity (in an absolute sense) but outperform or are close to their peers elsewhere in the country for that respective capability. Within the North, this includes arts and recreation, business support services and management and social science.

Bringing them together

Bringing specialisation and productivity together, based on the above analysis and findings the 24 higher capabilities have been categorised into three broad groups (and sub-groups within these), in an approach adapted from the original NPIER. These groupings are presented in Table 4.3.1 overleaf.

First, the column on the left shows capabilities where the North is clearly specialised in terms of jobs and/or GVA, whilst productivity is very high (in an absolute sense i.e. when compared to the whole economy average for the rest of England less-London). Capabilities which perform well against this measure are largely material and goods-producing.

This includes chemicals and materials, energy and power, food and agriculture, foundation industries, mining and extraction, and textiles and wood products, where LQs are high, and productivity is very high. The North is also specialised in other high productivity capabilities, including law and accountancy, finance, and higher and further education.

Second, the central column shows a mixed basket of capabilities where the North:

- Has some specialisation (i.e. LQ's just above or close to 1), but productivity is high in general (e.g. information and communications, media and publishing, and engineering and construction).
- Exhibits limited specialisation (i.e. LQ's below 1), but productivity is high in general (e.g. transport equipment, electronic devices, software and IT).
- Is specialised (i.e. LQ's above 1), but productivity is lower than the whole economy average (e.g. management and social science, international transport and logistics).

Table 4.3.1: Specialisation and productivity of higher capabilities in the North

Clearly Specialised and High Productivity	Mixed Picture	Poor Performers
1. High productivity, very high specialisation: • Chemicals and Materials* • Energy and Power • Food and Agriculture* • Foundation Industries* • Mining and Extraction* • Law and Accountancy* • Textiles and Wood Products* **2. High productivity, high specialisation:** • Higher and Further Education* • Finance	**3. High productivity, some specialisation:** • Machinery and Processing* • Information and Communications • Media and Publishing* • Engineering and Construction* **4. High productivity, limited specialisation:** • Transport Equipment • Electronic Devices • Software and IT* • Water, Waste and Circular Economy **4. Low productivity, high specialisation:** • International Transport and Logistics • Management and Social Science*	**6. Low productivity, some/limited specialisation:** • Accommodation and Hospitality • Arts and Recreation* • Business Support Services* • Wholesale and Retail • Life Sciences

Source: Cambridge Econometrics. Note: capabilities marked * have productivity close to or above their national capability benchmark

Third, the column on the right includes sectors that perform less strongly against both benchmarks. This does include capabilities which exhibit some specialisation (e.g. wholesale and retail, arts and recreation, life sciences), but all have productivity below the national economy-wide benchmark.

Scale and recent trends

Finally, as with the original NPIER, we also give attention to the scale and trend performance of the higher capabilities. Unfortunately, due to data limitations, consistent and comparable time series data are only available for jobs, whilst forecasts are also unavailable (though past trends often provide an indication of future performance, particularly in the short-term).

Table 4.3.2 presents the share of GVA and jobs accounted for by capability in the North. It is evident that collectively some of the lower productivity capabilities referenced above, such as wholesale and retail, business support services, and accommodation and hospitality, account for a relatively large share - close to half - of the North's economy, particularly in terms of jobs.

Meanwhile, higher productivity sectors such as energy and power, information and communications, and chemicals and materials account for a lower share of the North's economy (especially in terms of jobs). Collectively though, these

capabilities still account for a relatively large share – around a third - of the North's GVA, given their high productivity.

Table 4.3.2: Higher capability scale and recent trends in the North

Capability	Share of Northern GVA (%)	Share of Northern jobs (%)	Northern jobs, 2013 (000's)	Northern jobs, 2019 (000's)	Northern growth p.a., 2013-19 (%)	National growth p.a., 2013-19 (%)
1. High productivity, very high specialisation:	*19.2%*	*12.0%*	*771.0*	*831.6*	*1.3%*	*2.2%*
Chemicals and Materials*	2.1%	1.2%	81.1	81.9	0.2%	-0.6%
Energy and Power	2.0%	0.7%	41.8	46.2	1.7%	3.7%
Food and Agriculture	3.3%	2.6%	172.0	179.7	0.7%	1.9%
Foundation Industries*	2.3%	1.8%	117.3	123.5	0.9%	0.6%
Mining and Extraction	0.9%	0.1%	9.6	9.5	-0.1%	0.7%
Law and Accountancy*	6.7%	4.1%	244.8	287.0	2.7%	3.0%
Textiles and Wood Products	1.9%	1.5%	104.5	103.6	-0.1%	4.1%
2. High productivity, high specialisation:	*8.7%*	*6.2%*	*392.8*	*430.3*	*1.5%*	*0.6%*
Higher and Further Education*	3.3%	2.4%	144.6	166.8	2.4%	2.5%
Finance*	3.1%	2.8%	190.8	192.4	0.1%	-0.1%
Information and Communications*	2.3%	1.0%	57.5	71.2	3.6%	-1.7%
3. High productivity, some specialisation:	*11.6%*	*8.2%*	*481.2*	*573.5*	*3.0%*	*2.4%*
Machinery and Processing	2.3%	1.6%	116.1	112.4	-0.5%	-0.1%
Media and Publishing*	1.1%	0.9%	52.6	63.4	3.2%	-1.1%
Engineering and Construction*	8.2%	5.7%	312.5	397.7	4.1%	3.9%
4. High productivity, limited specialisation:	*6.3%*	*4.2%*	*248.2*	*291.2*	*2.7%*	*1.7%*
Transport Equipment*	2.3%	1.6%	93.8	114.7	3.4%	2.6%
Electronic Devices	0.6%	0.5%	34.7	32.5	-1.1%	-2.3%
Software and IT*	2.0%	1.4%	76.6	99.5	4.4%	2.2%
Water, Waste and Circular Economy	1.4%	0.6%	43.1	44.4	0.5%	2.3%
5. Low productivity, high specialisation:	*5.1%*	*6.0%*	*324.7*	*414.8*	*4.2%*	*3.8%*
International Transport and Logistics*	3.3%	3.7%	200.7	254.6	4.0%	4.5%
Management and Social Science*	1.8%	2.3%	124.0	160.1	4.4%	2.9%
6. Low productivity, some/limited specialisation:	*27.4%*	*40.3%*	*2,505.6*	*2,801.5*	*1.9%*	*1.7%*
Accommodation and Hospitality	4.1%	7.5%	451.0	523.6	2.5%	3.2%
Arts and Recreation*	2.7%	3.3%	195.1	229.9	2.8%	1.6%
Business Support Services*	6.4%	9.5%	562.3	658.0	2.7%	2.2%
Wholesale and Retail*	11.0%	16.7%	1,085.6	1,161.8	1.1%	0.5%
Life Sciences	3.1%	3.3%	211.6	228.2	1.3%	3.5%
Total higher capabilites	***78.3%***	***76.8%***	***4,723.6***	***5,342.8***	***2.1%***	***1.9%***
Total North (i.e. economy-wide)	**100.0%**	**100.0%**	**6,323.6**	**6,958.6**	**1.6%**	**1.6%**

Source: ONS, Cambridge Econometrics. Note: capabilities marked * exhibit growth close to or above their national (rest of England less-London) capability benchmark

The final columns also highlight trends since 2013 for each capability in the North, and relative to the national average. A comparator year of 2013 has been chosen as this represents the latest reference year used in the classification of the capabilities in the 2016 NPIER. The analysis shows:

- Since 2013, the higher capabilities (averaging growth of 2.1% per annum) have led the growth of the Northern economy (1.6% per annum). This reconciles with findings in the previous section which showed slower growth for many of the North's foundational capabilities.
- Within the North, growth has been strongest in typically lower productivity capabilities; growth in business support services (2.7%), arts and recreation (2.8%), accommodation and hospitality (2.5%), management and social science (4.4%), and international transport and logistics (4.0%) have all outpaced the total Northern average.
- Likewise, all of these capabilities have grown close to or above their national (rest of England less-London) capability benchmark. Additional capabilities which have outpaced both benchmarks include software and IT (4.4%), transport equipment (3.4%), engineering and construction (4.1%), media and publishing (3.2%), and information and communications (3.6%).
- Only a handful of capabilities have exhibited slow or negative growth (in terms of jobs); machinery and processing (-0.5%), electronic devices (-1.1%), textiles and wood products (-0.1%), and mining and extraction (-0.1%). Besides electronic devices, these contractions have been larger than the national capability benchmark.

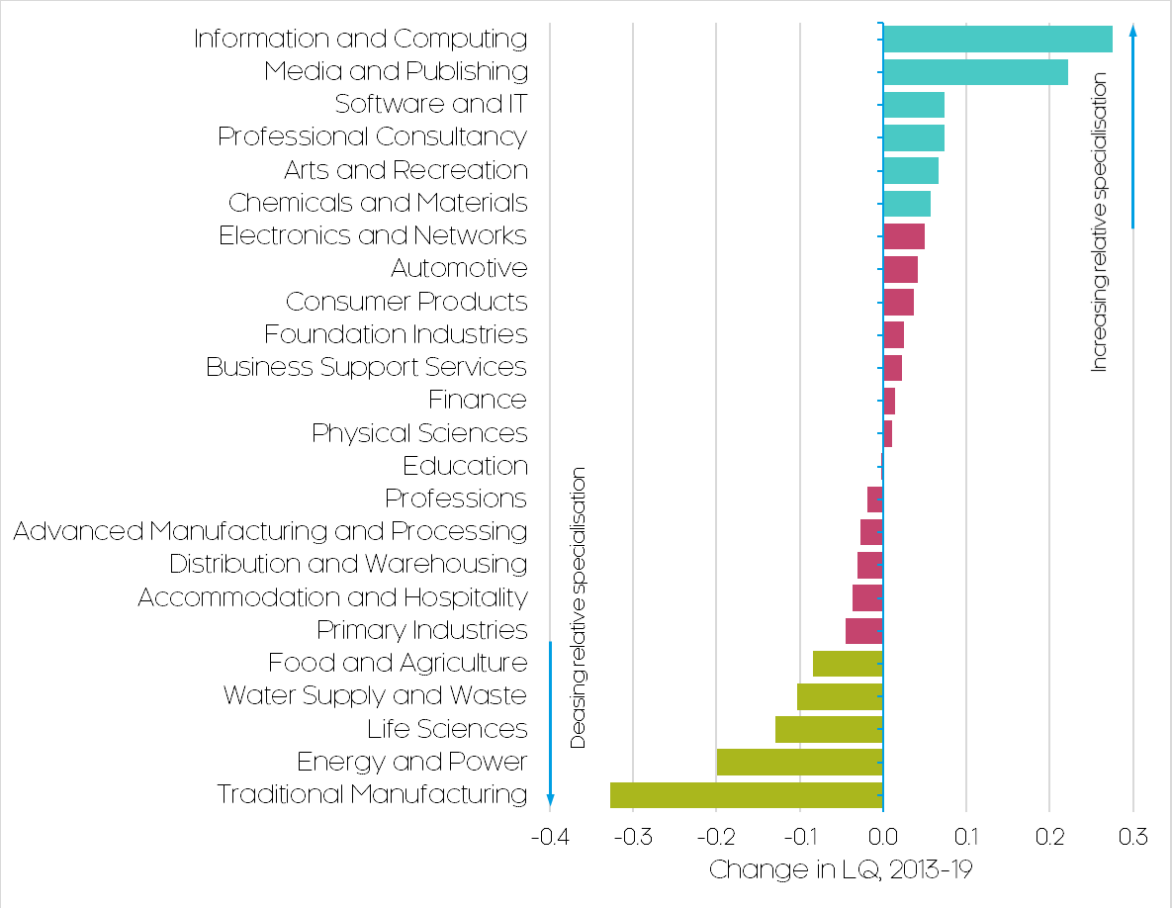
In addition to this, we are also able to calculate the change in capability specialisation (as measured by LQ, in terms of jobs) since 2013, as shown in Figure 4.3.3. A number of capabilities have increased their relative specialisation since 2013, the baseline for the assessment in the original NPIER, and can therefore be regarded as exhibiting emerging specialisms in the North.

This is led by the North's digital capabilities, with information and communications, media and publishing, and software and IT all notably increasing their relative specialisation in the North since 2013. Professional consultancy, chemicals and materials, and arts and recreation are other capabilities to exhibit emerging specialisms.

The majority of capabilities in the North have seen no significant change in their relative specialisation over this period. There are however a handful of capabilities in the North which have shown a decline - meaning they are less specialised now relative to their assessment in the 2016 NPIER.

This includes capabilities such as textiles and wood products, energy and power, life sciences, and food and agriculture. Life sciences is a notable feature here, as it was identified as a "Prime" capability in the 2016 NPIER. Since this assessment, its specialisation has declined, as performance in the North has trailed the rest of the country.

Figure 4.3.3: Changes to higher capability specialisation in the North since 2013



Source: ONS, Cambridge Econometrics. Change in LQ's measured in term of jobs

ii. Research and innovation intensity and strengths

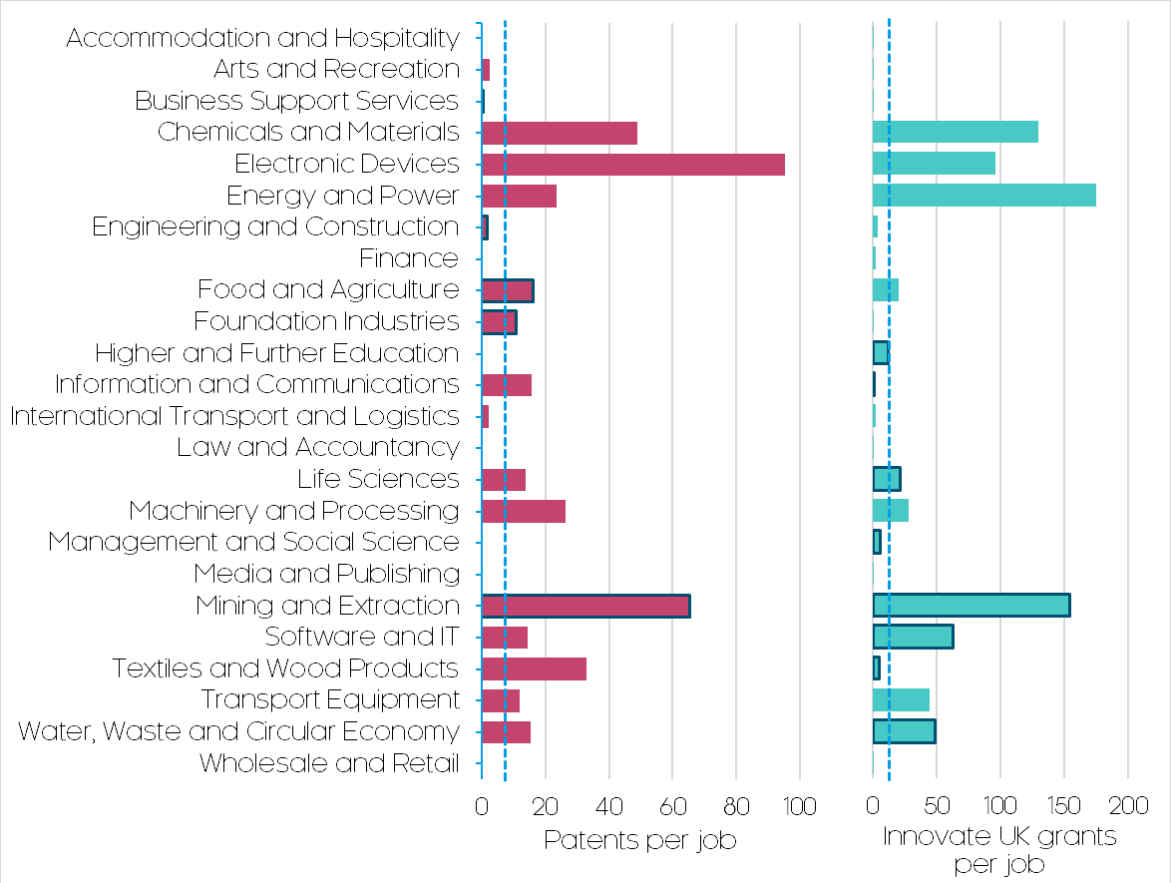
An extra step applied here, not considered in the original NPIER, is to assess the relative research and innovation (R&I) intensity and performance of the North's higher capabilities. This uses novel data on patent applications and Innovate UK project funding grants, which have been produced to a detailed technology and spatial classification and can thus be allocated to capabilities.

Adapted from a previous study looking at the R&I performance of the North, each metric can provide us with a more nuanced understanding of local R&I processes. In particular, the study found Innovate UK grant data can be regarded as capturing the 'discovery' phase of the innovation process, and patent applications the 'commercialisation' phase. Some capabilities will perform more strongly on one phase than the other.

Figure 4.3.4 shows for each of the 24 capabilities their R&I performance in terms of both patent applications (per 10,000 jobs, shaded in pink) and Innovate UK grants (per 10,000 jobs, shaded in turquoise). National economy-wide averages are shown by the dashed blue lines, whilst capabilities with a shaded border exhibit performance above or close to their respective national capability benchmark.

Four capabilities stand out as distinctive on these metrics and dominate the North's R&I landscape. Collectively, they represent two-fifths of all Innovate

Figure 4.3.4: Higher capability research and innovation performance, various timeframes*



Source: EPO, Innovate UK, Cambridge Econometrics. *Note: Patent data is aggregate of 2010-2015. Innovate UK data is aggregate of 2003-2019. Capabilities with shaded borders exhibit productivity close to or above their national (rest of England less-London) capability benchmark

UK project funding grants and a third of all patent applications in the North – all whilst accounting for only 3% of jobs. These are:

- electronic devices;
- mining and extraction;
- chemicals and materials, and;
- energy and power

Despite this strong performance, except for mining and extraction, relative R&I intensity for these capabilities trails benchmarks for the rest of the country. Yet there are a diverse range of capabilities where the North demonstrates both high R&I intensity and performs close to or above the national capability benchmark, including life sciences, information and communications, food and agriculture, water, waste and circular economy, and software and IT.

It should be noted that both R&I metrics (most notably patent data) are biased towards production and goods-producing capabilities, and services R&I is likely being mis/undercounted. When looking at R&I performance relative to capability benchmarks however, a number of service-based capabilities in the North stand out, with higher and further education, engineering and construction, management and social science, and business support services performing well against their national capability benchmarks.

Notwithstanding these data limitations, Table 4.3.3 reviews capabilities in the North according to their R&I status, defined as follows:

- **Research and innovation leaders:** these are capabilities that have clear and recognised R&I strengths and assets in the North and are at the forefront of the North's knowledge space. For these capabilities, R&I intensity (on one or both measures) exceeds *both* economy-wide and national capability benchmarks e.g. mining and extraction, information and communications, life sciences.
- **Research and innovation drivers:** this includes capabilities that exhibit similarly above-average R&I intensity (on one or both measures), but underperform relative to national capability benchmarks. Despite this, these capabilities are still driving the evolution of the North's knowledge space e.g. chemicals and materials, energy and power, transport equipment.
- **Research and innovation contributors:** typically services-based, these capabilities exhibit R&I intensity close to or below the economy-wide benchmark (on one or both measures), but are still important contributors to R&I in the North e.g. higher and further education, engineering and construction, international transport and logistics.

Table 4.3.3: Research and innovation performance of higher capabilities in the North

Research and innovation leaders	Research and innovation drivers	Research and innovation contributors
Mining and Extraction	Electronic Devices	Engineering and Construction
Textiles and Wood Products	Chemicals and Materials	Higher and Further Education
Food and Agriculture	Machinery and Processing	Management and Social Science
Information and Communications	Energy and Power	Finance
Water, Waste and Circular Economy	Transport Equipment	International Transport and Logistics
Software and IT		Media and Publishing
Life Sciences		Law and Accountancy
Foundation Industries		Wholesale and Retail
		Accommodation and Hospitality
		Business Support Services
		Arts and Recreation

Source: Cambridge Econometrics

iii. Export intensity and interaction with global markets

As outlined in our conceptual framework, the central purpose of the export intensity benchmarking is to identify whether higher capabilities serve a primarily global or regional market from the North of England. It also allows for additional profiling and understanding of capability strengths and advantages. The metrics used here account for both the export of goods and services.

Figure 4.3.5 shows for the capabilities their exporting performance in terms of both exports per jobs (shaded in pink) and their export to GVA ratio (shaded in turquoise). National economy-wide averages are shown by the dashed blue

lines, whilst capabilities with a shaded border exhibit performance above or close to their respective national capability benchmark.

Figure 4.3.5: Higher capability exporting performance, 2019

Source: ONS, Cambridge Econometrics. Note: Primary industries exports actually £381k per jobs, but scaled to fit on chart

As with research and innovation, a small and distinctive cluster of high performing capabilities stand out as driving the North's exporting performance. Once more these are largely materials and goods-producing capabilities, with the following capabilities accounting for more than half of the North's exports:

- mining and extraction;
- chemicals and materials;
- machinery and processing;
- electronic devices;
- transport equipment, and;
- foundation industries.

Interestingly, all of these capabilities - except machinery and processing – also perform well against national capability benchmarks for exporting, highlighting potential comparative advantages in the North. Finance is also a notable high performing exporter, exhibiting both very high export intensity (naturally, in terms of services) whilst also outperforming peers elsewhere in the country.

In addition to these, a diverse range of largely services-based capabilities exhibit above-average exporting intensity and interaction with global markets,

including textiles and wood products, information and communications, international transport and logistics, and arts and recreation.

Note that due to data limitations, some capabilities are not directly captured in our metrics and have been excluded from the above analysis. Therefore, for these capabilities, alternative national (UK-wide) data have been used to interpolate these results, as provided in Table 4.3.4.

Table 4.3.4: UK-wide exporting performance for higher capabilities with missing data, 2019

Capability	Exports per job (£, 000's)	Export-GVA ratio
Higher and Further Education	3.2	0.1
Energy and Power	4.1	0.0
Life Sciences	74.7	0.9
Management and Social Science	24.2	0.5
Media and Publishing	38.0	0.4
Software and IT	41.0	0.5
Water, Waste and Circular Economy	17.3	0.2
Whole Economy Average (UK-wide)	**21.3**	**0.4**

Source: ONS, Cambridge Econometrics. Note: data here not directly comparable Figure 4.3.3

Of course, some capabilities might not be major exporters *from* the UK, but can be significant exporters *to* the rest of the UK. Existing research has shown such 'internal' regional exports are particularly prevalent in activities relating to energy and power, higher and further education, and international transport and logistics.

From the data and analysis provided so far, we are able to assess capabilities in the North of England according to their exporting intensity and global market representation. These categories are shown in Table 4.3.5 below, and defined as follows:

- *Very high global market representation:* these are capabilities that – at a pan-Northern level - clearly exhibit consistently high exporting intensity and global market representation, and are therefore likely to have only a limited dependency on regional markets e.g. mining and extraction, chemicals and materials, transport equipment.

  These capabilities exhibit exporting intensity (on one or both measures) that is well above (more than 1.5x) the national economy-wide benchmark.

- *High global market representation:* these are capabilities that – at a pan-Northern level - exhibit above-average exporting intensity and global market representation, but are likely to have a similar if not higher dependency on regional markets e.g. information and communications, management and social science, international transport and logistics.

  These capabilities exhibit exporting intensity (on one or both measures) that is close to or above (but less than 1.5x) the national economy-wide benchmark.

- *Some global market representation:* these are capabilities that – at a pan-Northern level - exhibit limited exporting intensity and global market representation, and typically have a higher dependency on regional markets e.g. accommodation and hospitality, wholesale and retail, business support services.

  These capabilities exhibit exporting intensity (on one or both measures) that is below the national economy-wide benchmark.

Table 4.3.5: Global market interaction of higher capabilities in the North

Very high global market representation	High global market representation	Some global market representation
Transport Equipment	International Transport and Logistics	Wholesale and Retail
Textiles and Wood Products	Food and Agriculture	Law and Accountancy
Mining and Extraction	Arts and Recreation	Engineering and Construction
Machinery and Processing	Management and Social Science	Business Support Services
Information and Communications		Accommodation and Hospitality
Foundation Industries		Higher and Further Education
Finance		Energy and Power
Electronic Devices		Water, Waste and Circular Economy
Chemicals and Materials		
Life Sciences		
Media and Publishing		
Software and IT		

Source: Cambridge Econometrics

iv. Pan-Northern distribution and representation

Finally, as outlined in our conceptual framework, the remaining step to reviewing and assessing the North's higher capabilities is to explore the spatial distribution of capabilities across the North, and their representation at a 'pan-Northern' level.

In the 2016 IER, a key criteria for identifying the original "4+3" "Prime" and "Enabling" Capabilities was that they were differentiated and distinctive at a pan-Northern level i.e. their strengths and assets were well represented across the North, and not concentrated in one or a few areas.

Firstly, Table 4.3.6 looks at the 24 higher capabilities considered in our review and how specialised and overrepresented they are (as measured by LQ, in terms of jobs) across the North's 11 constituent LEP areas. LEP area LQ's have been shaded lighter if they are below the North of England average, and darker if above.

Table 4.3.6: Higher capability Location Quotient's (LQ's) by LEP area in the North, 2018-19

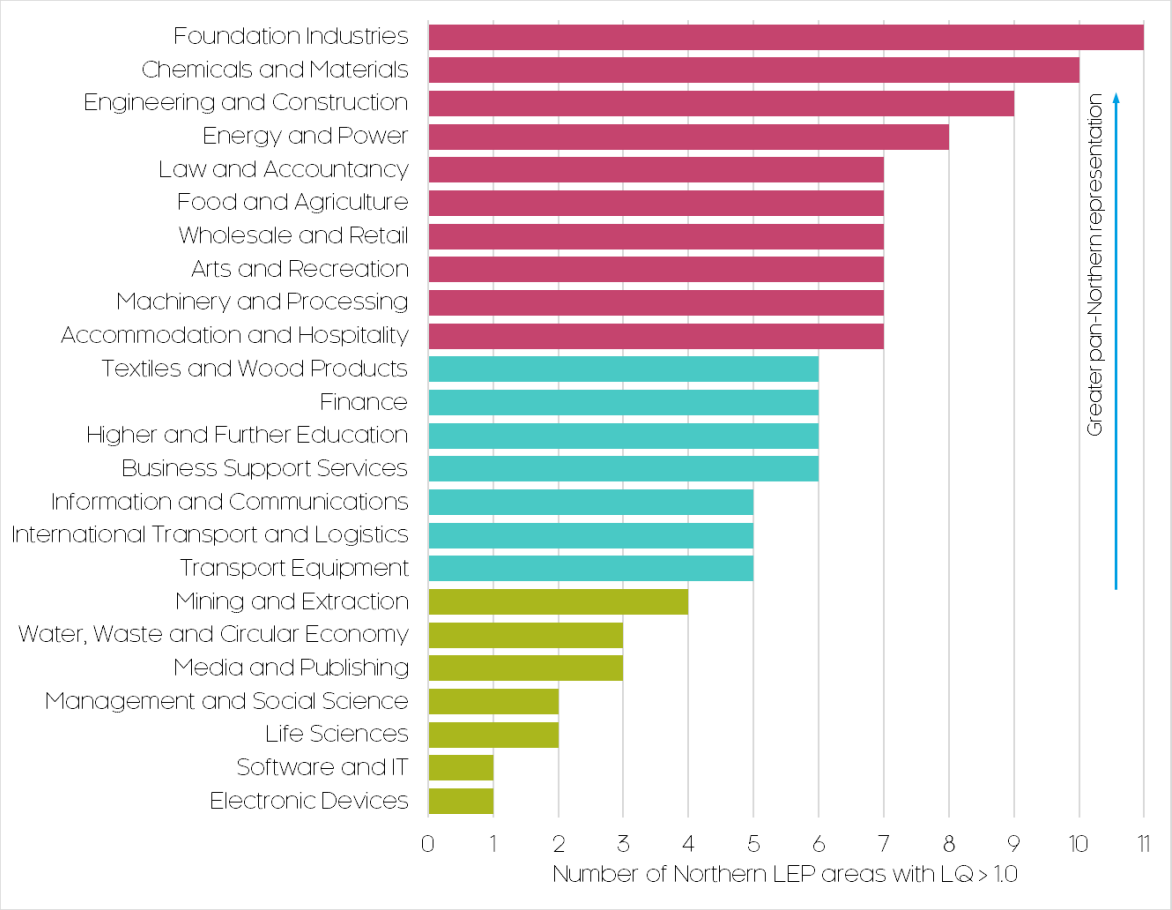
	Capability Location Quotient (>1 = Specialised)											
	North East	Tees Valley	Cheshire and Warrington	Cumbria	Greater Manchester	Lancashire	Liverpool City Region	Humber	Leeds City Region	Sheffield City Region	York, North Yorkshire and East Riding	**Total North of England**
Accommodation and Hospitality	1.2	0.9	1.2	1.7	1.1	1.1	1.1	1.0	0.9	1.0	1.7	**1.0**
Machinery and Processing	1.4	1.3	0.9	1.1	0.8	1.1	0.7	1.4	1.2	1.3	0.7	**0.9**
Arts and Recreation	1.1	1.1	1.3	1.0	1.1	1.1	1.3	1.0	0.9	1.0	1.3	**1.0**
Transport Equipment	1.3	0.6	1.1	2.0	0.4	1.8	1.1	0.8	0.4	0.7	0.7	**0.9**
Business Support Services	0.9	1.0	1.2	0.8	1.3	0.9	1.1	1.1	1.1	1.1	1.0	**1.0**
Chemicals and Materials	1.5	1.3	2.2	1.8	1.2	1.9	1.2	2.6	1.1	1.2	0.9	**1.3**
Wholesale and Retail	1.0	1.0	1.2	1.0	1.2	1.2	1.1	1.1	1.4	1.2	1.0	**1.0**
International Transport and Logistics	0.8	1.0	0.9	0.9	1.2	0.7	1.3	1.6	1.1	1.4	0.9	**1.1**
Higher and Further Education	1.4	0.6	0.6	0.6	1.2	1.1	1.2	0.6	1.0	1.6	1.1	**1.0**
Electronic Devices	0.9	0.3	0.7	0.8	0.9	0.5	0.4	0.4	0.7	1.2	1.0	**0.7**
Energy and Power	1.7	1.4	1.0	11.1	2.7	1.4	0.2	1.2	1.3	0.6	1.5	**1.6**
Finance	0.9	0.9	1.6	0.5	1.2	0.6	1.1	0.4	1.5	1.1	1.2	**1.1**
Food and Agriculture	1.2	1.0	1.7	4.2	0.9	2.1	0.9	3.4	1.3	1.0	5.0	**1.1**
Foundation Industries	1.8	2.1	1.1	1.5	1.1	1.5	1.3	3.1	1.5	2.3	1.2	**1.4**
Information and Communications	1.4	0.8	0.8	0.4	1.4	1.1	1.1	0.6	1.0	1.3	0.5	**1.0**
Life Sciences	0.8	0.7	0.8	0.7	0.9	0.8	1.4	1.1	0.9	0.9	0.9	**0.9**
Media and Publishing	0.9	0.4	0.7	0.7	1.6	0.7	0.9	1.1	1.5	0.8	0.7	**1.0**
Engineering and Construction	1.1	1.4	1.6	1.4	1.2	1.3	1.0	1.2	1.0	1.1	1.3	**1.0**
Management and Social Science	0.7	0.6	1.6	0.8	1.1	0.6	0.9	0.5	0.8	0.5	1.0	**0.9**
Mining and Extraction	0.7	3.7	2.8	1.3	0.2	0.5	0.6	7.0	0.5	0.5	0.7	**0.9**
Law and Accountancy	1.1	0.8	1.8	0.9	1.9	1.2	1.4	0.8	1.3	1.0	1.1	**1.1**
Software and IT	0.8	0.6	1.3	0.3	1.0	0.7	0.6	0.5	1.0	0.7	0.8	**0.6**
Textiles and Wood Products	0.9	0.6	0.7	1.2	1.2	1.9	0.7	1.9	2.0	1.4	0.8	**1.2**
Water, Waste and Circular Economy	1.0	1.2	0.9	0.7	0.6	0.7	1.0	0.9	1.2	1.3	0.6	**0.9**

Source: ONS, Cambridge Econometrics. Note: LQ's are for jobs only, which is the most reliable metric at a detailed spatial level. LQ's are a measure of the geographical specialisation of an industry - the higher the LQ the more an area has a specialisation in that industry relative to the national average

For the majority of capabilities, LEP area LQ's show relatively limited deviation from the North of England average, reflecting the relative spatial uniformity of most capabilities in the North.

In order to formally assess and identify the capabilities where relative specialism is spread across the North (i.e. where a capability is 'pan-Northern', we simply count the number of LEP geographies with a LQ of greater than 1.0. This is shown in Figure 4.3.6.

Figure 4.3.6: Higher capability specialisation by Northern LEP areas, 2018-19



Source: ONS, Cambridge Econometrics

Using this information, we are able to assess how evenly capabilities are distributed across LEP areas in the North, and categorise them according to the following identity, as shown in Table 4.3.7:

- *Clear pan-Northern representation:* these are capabilities in which 7 or more LEP areas have a relative specialisation. Shaded pink, this includes foundation industries, chemicals and materials, and energy and power.
- *Partial pan-Northern representation:* these are capabilities in which approximately half (5 or 6) of the LEP areas have a relative specialisation. Shaded turquoise, this includes finance, higher and further education, and information and communications.
- *Lower pan-Northern representation:* these are capabilities in which 4 or fewer LEP areas have a relative specialisation. Shaded green, this includes software and IT, life sciences and media and publishing.

Table 4.3.7: Spatial representation of higher capabilities in the North

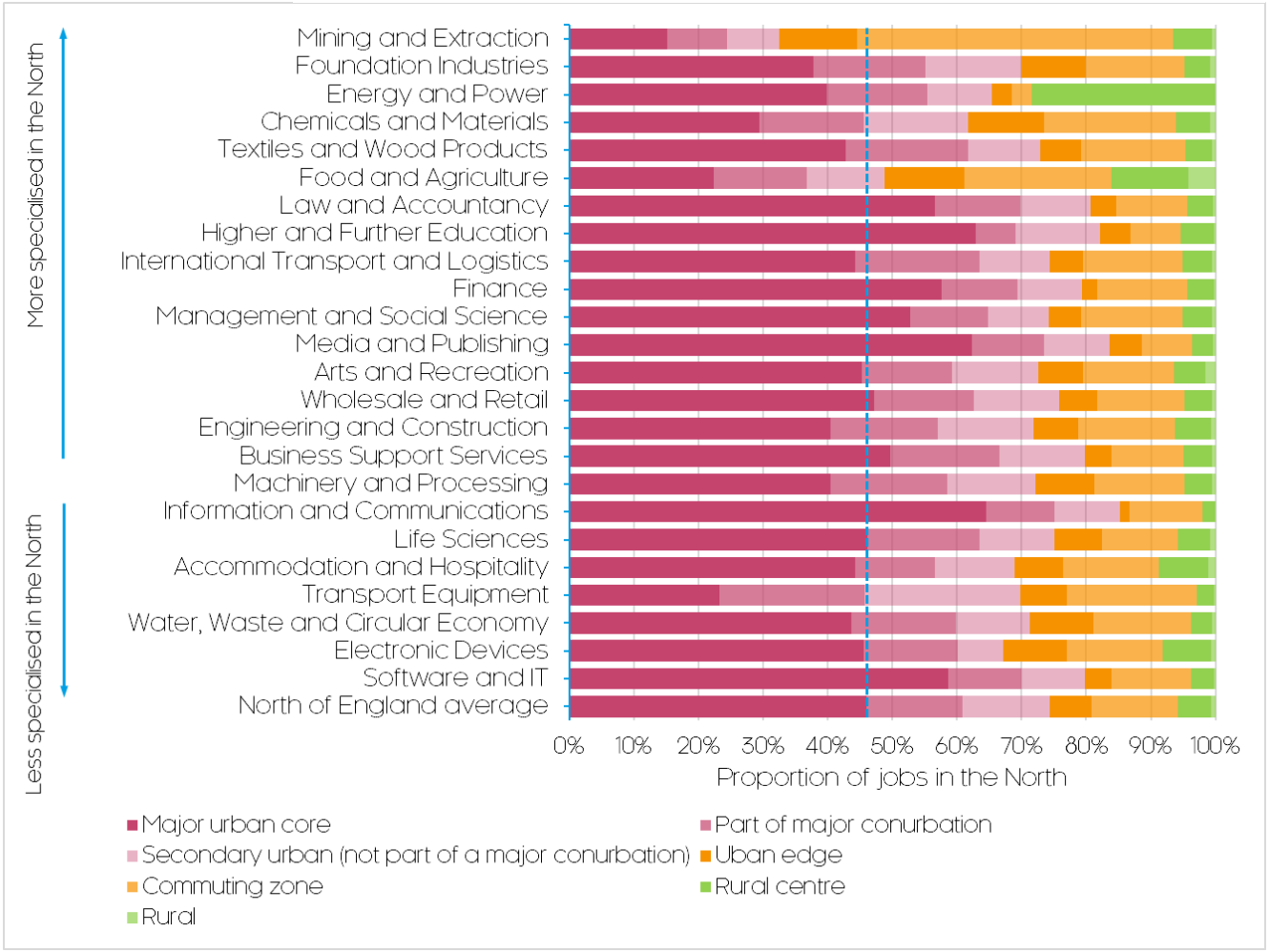
Clear pan-Northern representation	Partial pan-Northern representation	Lower pan-Northern representation
Foundation Industries Chemicals and Materials Engineering and Construction Energy and Power Accommodation and Hospitality Machinery and Processing Arts and Recreation Wholesale and Retail Food and Agriculture Law and Accountancy	Business Support Services Higher and Further Education Finance Textiles and Wood Products Transport Equipment International Transport and Logistics Information and Communications	Mining and Extraction Media and Publishing Water, Waste and Circular Economy Life Sciences Management and Social Science Electronic Devices Software and IT

Source: ONS, Cambridge Econometrics

Urban vs. Non-urban

In addition to these spatial categorisations, Figure 4.3.7 looks in extra detail at the spatial distribution and representation of higher capabilities in the North, particularly in terms of urban vs. non-urban representation, using an experimental, UK-specific local area typology developed by CE.[12]

Figure 4.3.7: Higher capability employment distribution by local area typology in the North, 2018-19



Source: Cambridge Econometrics

[12] Developed as part of research for the Productivity Insights Network, accessible here.

Interestingly, when ordering capabilities by their relative specialisation in the North (according to the LQ's presented in Figure 4.3.1 above), we see the North's most specialised (and typically, most productive) capabilities exhibit a strong bias to low-density semi-urban and periphery urban locations, rather than high-density, major urban centres.

This is of course unsurprising given many of the North's most specialised capabilities tend to be goods-producing and more capital, resource, and – importantly - land intensive. For instance, only a third of the North's activity in mining and extraction is in urban areas, less than half the average for the North of England (shown by the dashed blue line).

Other high performing capabilities in the North, including foundation industries, energy and power, chemicals and materials, textiles and wood products, and food and agriculture, are all significantly underrepresented in high-density, major urban centres relative to the economy-wide average in the North.

Naturally, this raises questions over the role and importance of urbanisation agglomeration mechanisms for the North's economy. There is to some extent a 'chicken and egg' question here: does the North's relative specialisation in industries that tend to locate away from urban areas, go some way to explaining the recent relative underperformance of the North's large cities, or is it that the lack of investment in Northern urban areas that has prevented the North from developing comparative specialisations in urban-based service industries?

Summary of higher capability performance

Table 4.3.8 provides a visual overview of the performance of the 24 higher capabilities, scored against five criteria: absolute productivity performance, specialisation, innovation intensity, global integration, and the degree of pan-Northern coverage.

This summarises capability performance against the metrics presented in the detailed analysis provided above. For innovation intensity and global integration, capability scores are not absolute but relative to the national economy-wide benchmark. For each criteria, capability performance has been shaded using a red-amber-green (RAG) system.

Table 4.3.8: Overview of higher capability performance against key criteria

	Specialisation	Productivity	Innovation intensity	Global integration	Pan-Northern coverage
	Employment LQ	*Absolute GVA per job (£, 000's)*	*Average of Relative patent/ Innovate UK grants per job*	*Relative exports per job*	*Number of LEP areas with LQ>1.0*
Accommodation and Hospitality	0.9	25.5	30%	55%	7
Arts and Recreation	0.9	38.5	48%	105%	7
Business Support Services	0.9	31.8	60%	73%	6
Chemicals and Materials	1.7	84.6	60%	83%	10

Electronic Devices	0.9	63.7	88%	81%	1
Energy and Power	1.7	137.3	35%	0%	8
Engineering and Construction	1.0	66.7	74%	133%	9
Finance	0.7	52.3	35%	117%	6
Food and Agriculture	1.3	59.0	108%	98%	7
Foundation Industries	1.8	61.3	75%	98%	11
Higher and Further Education	1.0	64.7	62%	0%	6
Information and Communications	0.9	104.4	52%	31%	5
International Transport and Logistics	1.1	42	65%	75%	5
Law and Accountancy	0.9	76.1	23%	58%	7
Life Sciences	1.0	44.2	86%	0%	2
Machinery and Processing	1.2	67.0	62%	51%	7
Management and Social Science	0.7	36.8	48%	40%	2
Media and Publishing	0.6	58.6	11%	0%	3
Mining and Extraction	0.9	323	85%	227%	4
Software and IT	0.5	65.3	89%	0%	1
Textiles and Wood Products	1.4	58.4	89%	109%	6
Transport Equipment	1.1	65.2	37%	74%	5
Water, Waste and Circular Economy	1.1	99.6	76%	0%	3
Wholesale and Retail	1.1	30.7	70%	105%	7

Source: various (see previous analysis), Cambridge Econometrics

4.4 Implications for the 2016 NPIER "Prime" and "Enablers"

Bringing together our findings on the North's higher capabilities, as presented over the previous four phases of analysis, we are now in a position to review and reflect on the implications for the 4 "Prime" and 3 "Enabling" Capabilities from the 2016 NPIER.

As emphasised earlier in our review, the intention of our analysis is not to supplant or refresh the original "Prime" and "Enabling" Capabilities identified

and adopted in 2016 – that would be for a future commission, such as a NPIER refresh, to decide.

However, our review has provided an alternate point of view that challenges, nuances and updates the original IER framework. As such, we have drawn out and summarised several recommendations and points of consideration for each of the original NPIER's "Prime" and "Enabling" Capabilities below.

"Prime" Capabilities

Advanced Manufacturing (2016 Prime)

Corresponding higher capabilities (from this review):

- Machinery and Processing
- Transport Equipment
- Chemicals and Materials
- Electronic Devices

Discussion: the 2016 Advanced Manufacturing Capability is a broad category, covering four of our more disaggregated groupings. All four exhibit high levels of labour productivity. Of these, *Chemicals and Materials* is the strongest performer, highly specialised, with genuine pan-Northern coverage, and with high scores across all metrics. *Machinery and Processing* is also a significant asset, with consistently above-average performance; *Electronic Devices* is less of a pan-Northern specialisation, however it performs well on innovation metrics, whereas *Transport Equipment* has a lower innovation score, but is more evenly distributed and has high exporting intensity.

Conclusion: our analysis confirms that Advanced Manufacturing is a clear "Prime" Northern capability, with *Chemicals and Materials* as the stand-out subsector. However the variety of industrial activities and potential synergies between them also provide potential future benefits. Manufacturing is clearly a critical sector and major growth opportunity moving forward, not just in its ability to drive innovation, exports and high levels of productivity growth, but also in its role in developing the infrastructure and equipment required for tackling the climate crisis.

Energy (2016 Prime)

Corresponding higher capabilities (from this review):

- Energy and Power

Discussion: *Energy and Power* is a strong specialisation of the North, highly productive, and with a high level of pan-Northern coverage; however, it does not perform strongly on the innovation metrics, which warrants further investigation. Its low score on exports may be misleading; although the data suggests a low level of international exports, it is likely still 'exporting' energy out of the region to the rest of the UK.

Conclusions: the Energy sector is in the middle of a major global transformation, and the North's existing specialisation is an important regional strength. Energy should retain its designation as a "Prime" Northern Capability and key regional priority moving forward.

Health Innovation (2016 Prime)

Corresponding higher capabilities (from this review):

- Life Sciences

Discussion: *Life Sciences* does not stand out as a regional strength in this data analysis, with low – and declining - levels of specialisation other than in Liverpool City Region, and limited evidence of exporting activity. However, crucially, it does perform well on innovation metrics.

Conclusions: As a 2016 "Prime" Capability, the nature and strength of the Health Innovation Capability clearly requires further analysis. The data suggests that it is more of a localised niche strength than the North's more dominant pan-regional strengths in Manufacturing and Energy, and the way it is factored into future strategy should consider this relationship in more detail.

Digital (2016 Prime)

Corresponding higher capabilities (from this review):

- Information and Communication
- Software and IT

Discussion: both *Information and Communication* and *Software and IT* have strong productivity and innovation figures, but employment location quotients suggest that they are not yet pan-Northern relative specialisations of the region, although the recent direction of travel is positive.

Conclusions: as with Health Innovation, the 2016 Digital "Prime" Capability appears to represent more of a group of localised high-performing niche sectors than an undeniable pan-Northern strength. Moving forward, it may be more fruitful to conceive of digital, and digitalisation, as a cross-cutting opportunity involving all sectors, or alternatively as an enabling sector, given the role of digital technology in helping all sectors reach new markets.

"Enabling" Capabilities

Financial and Professional Services (2016 Enabler)

Corresponding higher capabilities (from this review):

- Finance
- Management and Social Science
- Law and Accountancy

Discussion: Financial and Professional Services is another broad category of activities. Despite their reputation, these activities are not always the most highly productive sectors of an economy, and their productivity performance within the North is only slightly higher than the wider economy. They are not a specialisation of the North as a whole, although they do appear to be reasonably evenly distributed. Their performance on innovation metrics is below average, as is their export intensity, with the notable exception of the Finance sector.

Conclusions: in contrast to the "Prime" Capabilities, the 2016 "Enabling" Capabilities were selected as much for their importance to the wider economy as for their strength within the North, and as such, based on our analysis Finance and Professional Services clearly deserve to retain the descriptor.

Logistics (2016 Enabler)

Corresponding higher capabilities (from this review):

- International Transport and Logistics

Discussion: *International Transport and Logistics* shows above average performance across the majority of metrics. It's a small relative specialisation of the region, with average productivity.

Conclusions: international transport should begin to recover from the Covid-19 pandemic over the coming years, whilst logistics has been boosted by the switch to online retail and services. Both are important facilitators of both domestic and international trade and tourism. It is appropriate that Logistics should retain its position as an "Enabling" Capability.

Higher Education (2016 Enabler)

Corresponding higher capabilities (from this review):

- Higher and Further Education

Discussion: *Higher and Further Education* is relatively high-productivity, regionally-focused sector with above average productivity. As with Energy, its low score on exports may be misleading, with the sector an important 'exporter' of educational services to the rest of the UK

Conclusions: *Higher and Further Education* have a critical role to play in the higher functions of an economy, maintaining and increasing the skill levels of the population, producing and attracting graduates and other skilled workers, and providing critical research and innovation. Our analysis suggests it is correctly categorised as a crucial "Enabling" Capability.

Other Emerging Strengths

A number of additional higher capabilities emerged from the data as particular Northern strengths, that do not correspond to a 2016 "Prime" or "Enablers". We would suggest that the data considered here shows there performance is such that these are worth consideration for categorisation as additional "Prime" or "Enabling" Capabilities.

Firstly, a number of other manufacturing sectors, such as ***Foundational Industries*** and ***Textiles and Wood Products*** that are not typically included in the "Advanced Manufacturing" bracket, clearly show up in the data as major existing strengths within the North.

Whether currently designated as being "advanced" or not, all manufacturing sectors have the potential to partake in global supply chains, benefit from increased levels of product and process innovation and technology adoption, and contribute directly to the decarbonisation agenda, both in terms of the products they produce and the decarbonisation of the industries themselves.

Although unfashionable, the strength of these sectors within the North should not be underplayed. These are highly productive, innovative, export-focused strengths, represented right across the region.

Engineering and Construction also emerges as a genuine pan-regional strength, particularly with regards to innovation, and is a large a vital sector for the North, particular in terms of employment.

Other typically non-urban sectors that emerge from the data also have with a key role to play in decarbonisation and sustainability are ***Food and Agriculture***, which is particularly strong on innovation and exports, and to a lesser extent ***Water, Waste and Circular Economy***, which although scoring well on productivity and innovation, does not have strong pan-regional coverage.

4.5 Higher Capabilities: additional metrics

Concurrent to our work presented here, TfN commissioned The Data City (TDC) to undertake a separate study to provide insight into the definition and scale of the key capabilities of the North's economy, starting with the "Prime" and "Enabling" Capabilities identified in the original NPIER. As with CE and SQW's work, the outputs from the project will also support TfN's evidence base and analytical framework moving forwards.

Due to the related nature of the two projects (not least given our own technical, data-driven review of the North's economic capabilities), CE has worked closely and collaboratively with TDC and TfN to ensure complimentary outcomes between the two projects. Working with TDC and their novel dataexplorer platform, we have therefore been able to explore additional data for the "Prime" and "Enabling" Capabilities.

This has a two-fold purpose: firstly 1) by drawing on alternative definitions and data from TDC we are able to sense-check our assessment and review of the North's "Primes" and "Enablers", particularly in terms of non-SIC code derived definitions and measures of economic specialisation, productivity, and growth.

Secondly 2) it allows us to consider emerging trends and innovation capabilities related to the North's "Primes" and "Enablers" that are not captured by conventional data or SIC codes, particularly in terms of three key modernising drivers: decarbonisation, automation and digitisation.

1. Economic specialisation and performance

Data and definitions

The Data City (TDC) have built a platform, dataexplorer, that presents UK company-level financial data from Companies House and CreditSafe using innovative Real Time Industrial Classifications (RTICs). RTICs classify businesses using language patterns within the website text of individual companies to understand their key activities and operations.

The RTIC classification method can offer some distinct advantages from the traditional hierarchical SIC classification approach, with SIC codes becoming increasingly inflexible to the way in which modern, high growth businesses operate (with some of the critical issues explored in this article). However, it is also important to acknowledge the drawbacks of the RTIC approach.

For example, RTICs are constructed using information from company websites, but not every company has a website. The dataexplorer platform consists of some 5 million UK companies, and though all of these are available for analysis, only 1.65 million companies are matched to a website, and are therefore included in the RTICs. This represents less than 10% of all UK companies.

Due to the data collection method, one would expect a strong selection bias towards firms in the digital sector. Unfortunately, we have no way of correcting for or even quantifying the extent this bias. Results should therefore be interpreted with extreme caution.

There are other concerns with the data that should be taken into account. Many UK firms operate across multiple sites, and undertake a range of different activities. Unlike SIC-code based analysis, in which separate data is collected on the level and nature of activity of different local units, the RTIC method used is unable to identify what activity is undertaken in what location and at what capacity. Therefore, all activities are allocated to all sites equally. We have no means of quantifying the extent to which this distorts the results.

In total, 44 RTICs were defined by TDC for the purpose of this commission, as shown in Table 4.5.1 below, providing detailed performance data for 27,422 registered companies in the North of England, covering the period 2020-21.

Table 4.5.1: RTICs covered by The Data City's dataexplorer platform

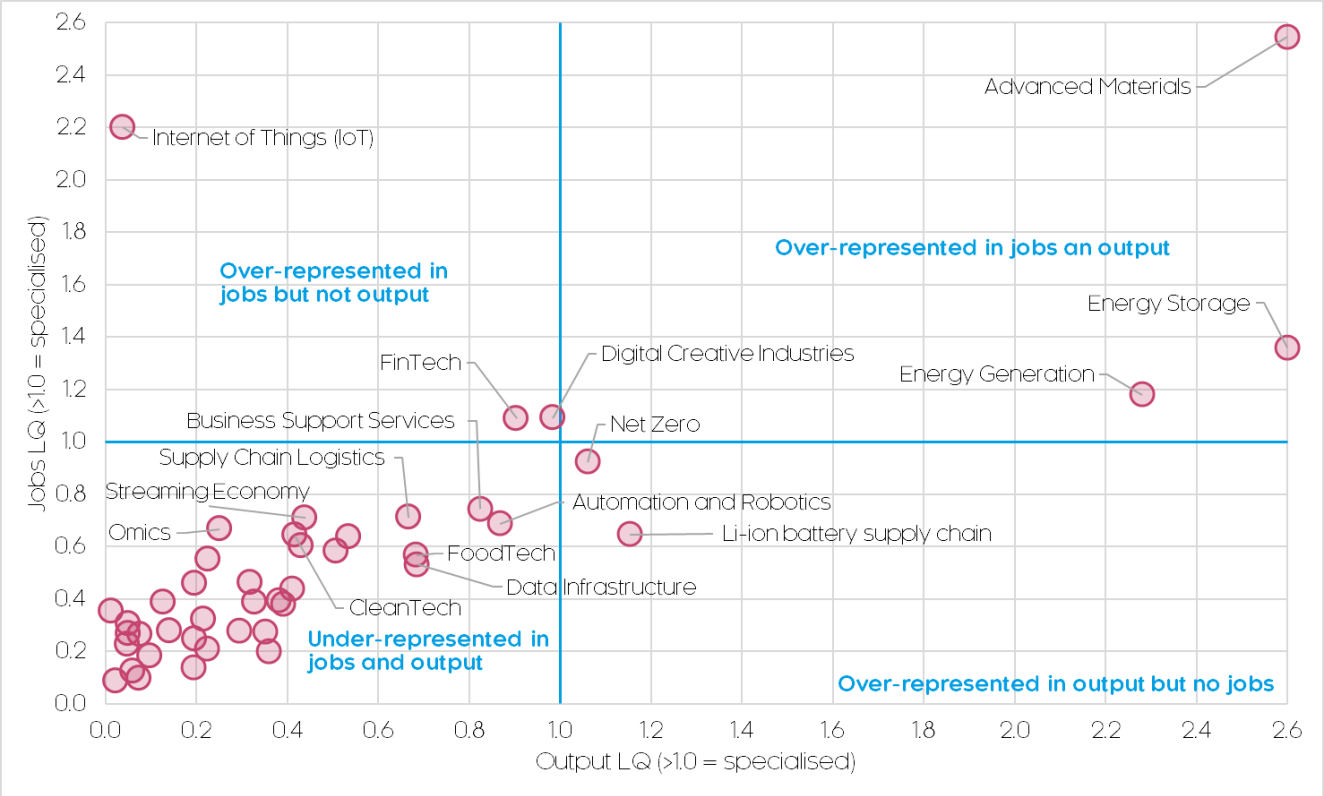
The Data City RTICs (dataexplorer v2)			
Adtech	Cyber	FoodTech	Pharma
Advanced manufacturing	Data Infrastructure	Gaming	Photonics
Advanced Materials	Data Landscape	Geospatial Economy	Quantum Economy
AgriTech	Design and Modelling Technologies	Immersive Technologies	Research and Consulting - Physical Sciences and Engineering
Artificial Intelligence	Digital Creative Industries	Internet of Things (IoT)	Sensors
Automation and Robotics	EdTech	Li-ion battery supply chain	Software as a Service (SaaS)
Autonomous vehicles	Electronics Manufacturing	Media and Publishing	Space Economy
Business Support Services	Energy Generation	MedTech	Streaming Economy
CleanTech	Energy Management	Modular Construction	Supply Chain Logistics
Computer Hardware	Energy Storage	Net Zero	Telecommunications
Cryptocurrency Economy	FinTech	Omics	Wearables and Quantified Self

Source: The Data City

Specialisation

Using this data, in a similar approach to our earlier analysis, Figure 4.5.1 shows for each of the 44 RTICs defined by TDC their specialisation and representation in the North of England, in terms of both jobs (y-axis) and output[13] (x-axis) – as measured by LQ, relative to the rest of England less-London benchmark.

Figure 4.5.1: RTIC specialisation in the North, 2020-21



Source: The Data City, Cambridge Econometrics. Note: LQ's relative to the rest of England less-London average. Energy storage output LQ actually 8.9 but scaled to fit on chart.

Interestingly, RTICs that exhibit a clear specialisation and over-representation at a pan-Northern level (relative to the England-less London benchmark) largely relate to some of the original NPIER's "Prime" and "Enablers", including:

- **Energy**: with the North displaying clear strengths and specialisations in RTICs such as energy storage, energy generation, and net zero.
- **Advanced manufacturing**: with RTICs including advanced materials and li-ion battery supply clearly over-represented in the North.
- **Digital and financial and professional services**: a range of digital RTICs are highly specialised in the North, notably internet of things, digital creative industries, and – spanning both the North's digital and financial capabilities - fintech.

There is no obvious reason to suspect a strong data bias towards energy and manufacturing sectors, hence these results are likely credible and meaningful. Some RTICs also exhibit specialisation close to the national benchmark, and again capture activities related to the NPIER's capabilities, including supply

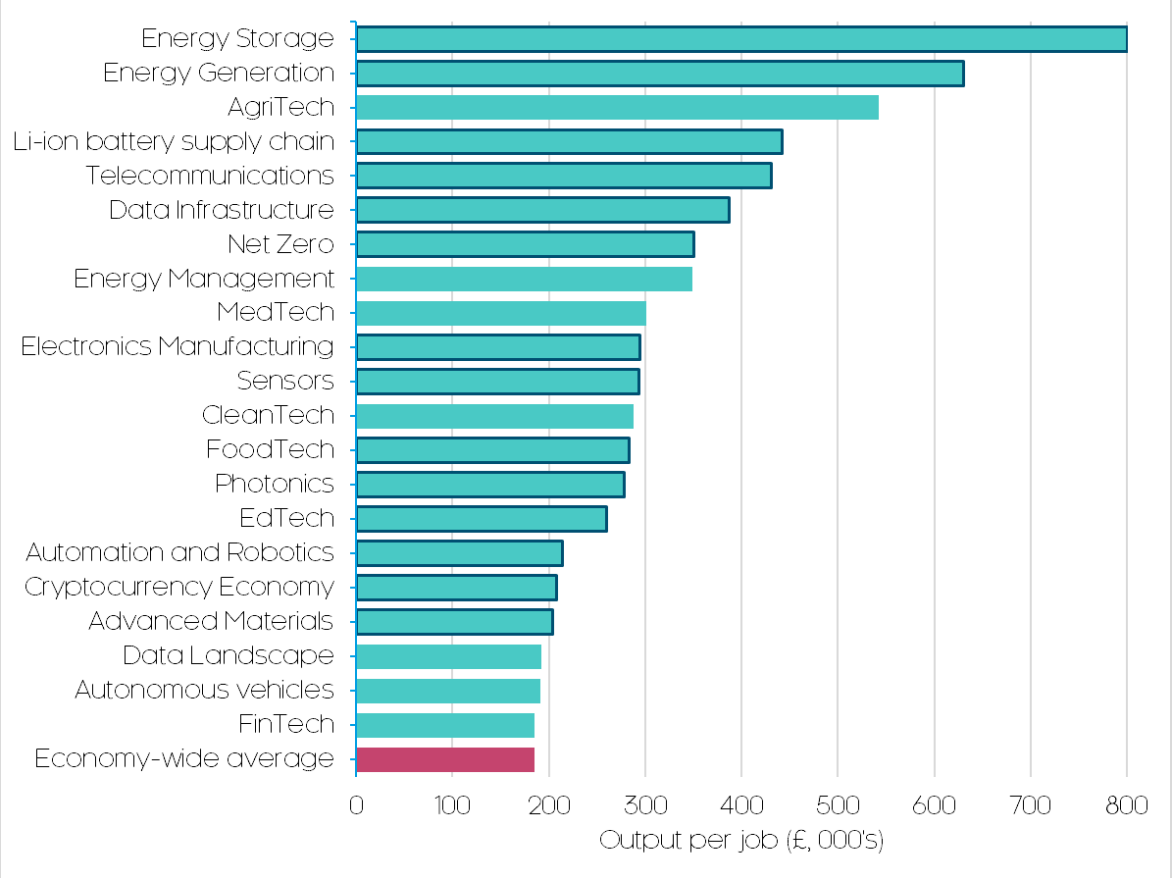
[13] Defined as gross turnover, or sales, in TDC's dataexplorer.

chain logistics, automation and robotics, foodtech, data infrastructure, cleantech, and omics.

Productivity

Given they focus on larger firms with Companies House registrations and easily accessible websites, it is unsurprising that the majority of RTICs in the North of England exhibit productivity (output per job[14]) above the national (England less-London) economy-wide average, as shown in Figure 4.5.2.

Figure 4.5.2: High productivity RTICs in the North, 2020-21



Source: The Data City, Cambridge Econometrics. Note: Energy storage productivity actually £1,443k per job but scaled to fit on chart.

There are a number of RTICs in the North that outperform both this economy-wide average and the national RTIC benchmark (as indicated by a shaded border in Figure 4.5.2), suggesting potential areas of comparative advantage. Once more, these reflect activities related to the NPIER's "Primes" and "Enablers", notably:

- **Energy**: the energy storage, energy generation, and net zero RTICs complement their over-representation in the North with above-average productivity, reiterating their local competitiveness.
- **Advanced manufacturing**: a wide range of RTICs including li-ion battery supply, electronics, sensors, foodtech, automation and robotics, and advanced materials all exhibit industry leading productivity in the North.

[14] Output per job is not a preferred measure of productivity, as it inflates the productivity of sectors with high value intermediate consumption. However it has been used here in the absence of other measures.

- **Digital, financial and professional services, and education**: several digital RTICs are more productive in the North than elsewhere in the country, including telecommunications and data infrastructure.

Scale and recent trends

Finally, with a full-time series providing at least a decade of industry data, we are also able to observe the scale and growth of RTICs[15] in the North of England, as presented in Table 4.5.2.

Given that they represent agile and emerging parts of the economy, the majority of RTICs are relatively small in scale in the North, rarely representing more than 5,000 jobs or £1bn or output (turnover).

Some are significant economic contributors though, with advanced manufacturing, advanced materials, business support services, data infrastructure, energy generation, li-ion battery supply and net zero all £10bn+ turnover industries in the North.

In fact, net zero is the North's most valuable RTIC, worth some £25bn in terms of turnover, highlighting the scale and strength of the net zero opportunity for the region. Business support services meanwhile, with almost 150,000 employees, is the largest RTIC in employment terms.

In terms of growth, which TDC measures in terms of new company registrations[16], all RTICs have exhibited relatively strong growth over the past decade, typically outpacing the national average (though this has often been from a lower base).

RTICs which have seen faster growth than the economy-wide average *and* their national benchmark in the North once more relate to strengths identified by the original "Primes" and "Enablers", for instance:

- **Digital:** a diverse range of digital RTICs within the North are exhibiting above average growth including wearables and quantified self (32% growth per annum), immersive technologies, edtech, digital creative industries, cyber, and artificial intelligence.
- **Energy:** the energy storage (26% growth per annum), energy management, net zero, and cleantech RTICs supplement their above average representation and productivity in the north with above average growth.
- **Health Innovation:** the pharma (24% growth per annum), medtech, and omics RTICs are all growing faster in the North than elsewhere in the country.
- **Financial and professional services:** has seen some of the fastest growth in related RTICs, fintech, adtech, business support services, and research and consulting.

[15] Given RTICs only cover a small part of the overall economy (see *data and definitions* above) the data presented in Table 4.5.2 are likely undercounting true scale and performance.

[16] It should be emphasised, this is not a preferred or recognised measure of assessing sector growth, but is the only growth related metric available on TDC.

Table 4.5.2: RTIC scale and recent trends in the North

RTIC	Share of Northern RTIC turnover (%)	Share of Northern RTIC jobs (%)	Northern turnover (£m's)	Northern jobs (000's)	Northern growth p.a. (%)	National growth p.a. (%)
Adtech	0.2%	0.3%	237.6	2.0	27.8%	24.3%
Advanced manufacturing	9.4%	10.9%	11,045.6	68.1	17.9%	17.8%
Advanced Materials	12.4%	11.6%	14,679.6	72.1	13.7%	15.0%
AgriTech	0.6%	0.2%	672.5	1.2	22.6%	22.8%
Artificial Intelligence	1.9%	1.9%	2,211.2	12.0	22.0%	18.8%
Automation and Robotics	0.7%	0.6%	793.5	3.7	17.3%	17.1%
Autonomous vehicles	0.5%	0.5%	551.3	2.9	19.7%	16.8%
Business Support Services	11.8%	24.0%	13,887.6	149.5	25.6%	24.1%
CleanTech	1.1%	0.7%	1,314.2	4.6	21.3%	20.2%
Computer Hardware	0.6%	0.8%	713.4	5.0	16.8%	14.3%
Cryptocurrency Economy	0.1%	0.1%	147.1	0.7	46.3%	39.0%
Cyber	1.8%	1.9%	2,066.5	12.1	22.3%	20.2%
Data Infrastructure	11.7%	5.7%	13,787.2	35.6	16.4%	16.0%
Data Landscape	4.7%	4.6%	5,514.5	28.7	18.4%	17.1%
Design and Modelling Technologies	0.3%	0.5%	342.7	3.0	19.6%	17.7%
Digital Creative Industries	1.9%	3.4%	2,221.7	20.9	22.4%	20.3%
EdTech	0.6%	0.4%	679.4	2.6	28.1%	20.0%
Electronics Manufacturing	4.6%	2.9%	5,402.1	18.3	18.8%	17.7%
Energy Generation	10.4%	3.1%	12,290.1	19.5	21.4%	22.4%
Energy Management	2.6%	1.4%	3,027.4	8.7	22.0%	16.8%
Energy Storage	3.4%	0.4%	4,022.1	2.8	25.7%	23.6%
FinTech	7.7%	7.9%	9,121.5	49.2	30.6%	25.1%
FoodTech	1.8%	1.2%	2,103.3	7.4	17.2%	18.7%
Gaming	0.3%	0.3%	303.3	1.9	25.7%	27.8%
Geospatial Economy	0.4%	0.8%	504.9	4.7	21.8%	18.4%
Immersive Technologies	0.1%	0.1%	91.1	0.8	29.9%	23.9%
Internet of Things (IoT)	0.9%	1.5%	1,088.3	9.5	21.9%	22.4%
Li-ion battery supply chain	11.7%	5.0%	13,781.9	31.2	15.6%	16.6%
Media and Publishing	1.2%	1.8%	1,381.6	11.0	18.8%	18.1%
MedTech	2.5%	1.5%	2,905.7	9.7	21.9%	19.4%
Modular Construction	1.0%	1.1%	1,182.4	6.7	20.2%	21.7%
Net Zero	21.0%	11.4%	24,779.7	70.7	21.7%	21.3%
Omics	0.3%	0.5%	410.1	2.9	21.3%	17.4%
Pharma	0.9%	1.1%	1,085.1	7.0	24.3%	20.1%
Photonics	0.7%	0.5%	868.0	3.1	20.4%	15.9%
Quantum Economy	0.1%	0.2%	133.6	1.1	19.4%	16.6%
Research and Consulting	4.6%	6.4%	5,399.3	40.2	21.4%	21.0%
Sensors	0.9%	0.6%	1,053.7	3.6	16.0%	14.9%
Software as a Service (SaaS)	1.8%	2.0%	2,137.4	12.3	19.3%	18.3%
Space Economy	0.4%	0.5%	515.8	3.3	18.8%	18.3%
Streaming Economy	0.1%	0.2%	113.6	1.0	19.1%	19.2%
Supply Chain Logistics	4.8%	6.2%	5,709.2	38.6	23.2%	24.7%
Telecommunications	4.5%	2.0%	5,264.7	12.2	16.3%	15.4%
Wearables and Quantified Self	0.1%	0.1%	70.5	0.7	31.8%	24.8%
Total RTICs	**100.0%**	**100.0%**	**117,992.6**	**622.9**	**21.0%**	**19.8%**

Source: The Data City, Cambridge Econometrics

2. Emerging trends and modernising drivers

Emerging trends are often combinations of existing 'traditional' sectors with some combination of modernising drivers. Three key modernising drivers are of particular relevance and prominence over the next few decades will be:

Decarbonisation – the process of removing or reducing climate critical emissions across the entire product life cycle

Automation – the process of replacing or augmenting human physical or cognitive input in order to improve efficiency, productivity, or product quality,

Digitisation – the process of adapting the system to be able to be monitored and controlled remotely via computer or mobile device

These three cross-cutting drivers can represent both product and process innovation, and are already responsible for driving change across a wide range of different sectors. For instance:

- Finance + Digitisation = Fintech
- Energy and Power + Decarbonisation = Low Carbon Energy
- Manufacturing + Automation = Advanced Manufacturing

Rather than occurring randomly or independently, these trends often emerge organically from existing sectors, and can provide a useful indication of future specialisms and growth potential within a sector.

Here, we draw on the dataexplorer's sector keywords enrichment measure, which captures emerging key terms that are over-represented among companies within that sector compared to the average UK company, providing an indication of emerging trends and specialisms.

Using this measure, we are able to better understand how well-placed certain aspects of the "Prime" and "Enabling" Capabilities are in the North in terms of engaging with emerging trends and modernising drivers.

For instance, trending keywords that are more apparent in a sector in the North (relative to elsewhere in the country) may suggest areas of potential advantage and future transition, and a 'first-mover' advantage for the North.

In addition to this, we have also utilised the dataexplorer's new 'Innovation Score' feature, which enables us to assess how 'innovation active' firms in the North are with regards to certain capabilities.[17]

A summary of the results is provided in Table 4.5.3 on the following page, accompanied by a more detailed analysis for each capability further below.

The accompanying charts from the dataexplorer platform showing the underlying keyword enrichment data is provided in the data appendices.

[17] To be defined as 'innovation active' a firm must have at least a one star 'Innovation Score' on dataexplorer

Table 4.5.3: Sector keywords relating to the NPIER capabilities

	NPIER "Primes"				NPIER "Enablers"		
	Advanced Manufacturing	**Energy**	**Health Innovation**	**Digital**	**Financial and Professional Services**	**Logistics**	**Education**
Sector keywords (top 15, in order of prevalence. **Bold** = more prevalent in North)	**additive manufacturing**	**beccs**	**adme**	**beccs**	**precision medicine**	final mile delivery	mixed reality
	manufacturing technologies	**low carbon technology**	**small molecule**	ccus	adme	digital supply chain	gamification
	human machine	**demand side response**	**precision medicine**	hydroelectricity	small molecule	**telematics**	**virtual reality**
	3d printing	non-hazardous waste	**biologic**	**daas**	**environmental consultancy**	**internet of things**	augmented reality
	cognitive technology	**renewable energy consultancy**	**biomarkers**	**platform as a service**	medical affairs	**e-commerce**	vr
	digital manufacturing	**energy storage**	medical affairs	**connected devices**	**psd2**	**pharma**	**animation**
	composites	**smart grid**	orphan drug	**demand side response**	**biomarkers**	digital transformation	ar
	smart factory	**clean growth**	biosimilar	mixed reality	**flood risk**	machine learning	content creation
	advanced materials	**heat networks**	bioequivalence	enterprise mobility	orphan drug	industry 4.0	**platforms**
	integrated manufacturing	energy generation	**regenerative medicine**	**paas**	biosimilar	iot	digital transformation
	industry 4.0	gasification	**biotech**	broadcast and media	**open banking**	data analytics	machine learning
	advanced manufacturing	**carbon capture and storage**	**medical technologies**	**data centre**	**contaminated land**	**artificial intelligence**	artificial intelligence
	autonomous vehicles	vehicle to grid	**glp**	internet of things	bioequivalence	big data	data analytics
	robotics	energy from waste	bioscience	**digital forensics**	biometrics	**blockchain**	mobile apps
	diode	**low emission vehicles**	cmc	cyber security	**materials science**	**pharmaceuticals**	software development
Proportion of firms 'innovation active'	30% (national average 37%)	31% (national average 32%)	78% (national average 85%)	45% (national average 49%)	33% (national average 35%)	25% (national average 29%)	51% (national average 54%)

Source: The Data City, Cambridge Econometrics. Note: sector keywords highlighted **bold** appear with a prevalence in the North close to or above than the national (England less-London) average. 'Innovation active' shares are also relative to the England less-London average

"Prime" Capabilities

Advanced manufacturing

Analysis of the sector keywords enrichment for the North's advanced manufacturing capability shows a strong interaction with a large number of emerging trends, some of which encompass the modernising drivers.

Generally, this is at a rate in line with or below the national (i.e. rest of England less-London) capability benchmark. Some trending terms are more apparent in the North however - with a strong focus on materials - including 'additive manufacturing', 'manufacturing technologies', '3d printing', 'composites' and 'advanced materials'.

Meanwhile, more process-driven terms such as 'digital manufacturing', 'smart factory', 'integrated manufacturing', and 'industry 4.0' are trending terms which are all significantly overrepresented in the capability relative to other sectors, but are seeing slower uptake in the North.

In the North, a third (30%) of all firms in the sector are 'innovation active', which is the lowest proportion of all "Primes", and below the national benchmark for the sector (37%).

Energy

Analysis of the sector keywords enrichment for the North's energy capability shows very high interaction with several emerging trends and modernising drivers, often at rates exceeding the national average.

For instance, a number trending terms – many linked to decarbonisation – are prevalent in the capability and more apparent in the North relative to the national capability benchmark, suggesting areas of potential advantage and future transition, including 'beccs[18]', 'low carbon technology', 'renewable energy consultancy', 'smart grid', 'carbon capture and storage' and 'heat networks'.

These findings point towards a rapidly emerging and nationally significant expertise in 'clean growth'/'low-carbon' in the North, with the region more successfully transitioning away from traditional opportunities in energy to those provided by the modernising driver of decarbonisation.

In the North, just over a third (31%) of all firms in the sector are 'innovation active', only marginally below the national benchmark for the sector (32%), highlighting local energy-related innovation strengths and capacity.

Health innovation

Analysis of the sector keywords enrichment for the North's health innovation capability shows a strong interaction with a large number of emerging trends, some of which encompass the modernising drivers.

Generally, these are at rates exceeding the national capability benchmark, with trending terms overrepresented in the North – often related to life sciences and medicine - including 'adme[19]', 'precision medicine', 'biologic', 'biomarkers' and 'regenerative medicine'.

[18] Bioenergy with Carbon Capture and Storage

[19] Absorption, Distribution, Metabolism and Excretion

In the North, given its innovation focus the vast majority – more than three quarters (78%) - of all firms in the sector are 'innovation active', which is the highest of all capabilities, but tracking below the national benchmark for the sector (85%).

Digital

For the North's digital capabilities, the sector keywords enrichment reveals interaction with a broad range of emerging trends, which – unsurprisingly – are largely related to the digitisation driver.

Trending terms for the capability that are overrepresented in the North relative to the national capability benchmark, suggesting areas of potential advantage and future transition, include 'desktop as a service', 'platform as a service', 'connected devices', 'data centre' and 'data forensics'.

Meanwhile, terms such as 'mixed reality', 'broadcast and media, and 'cybersecurity' are trending terms which are all significantly overrepresented in the capability relative to other sectors, but are seeing slower uptake in the North.

In the North, almost half (45%) of all firms in the sector are 'innovation active', close to the national benchmark for the sector (49%), reflecting local innovation strengths and capacity relating to digital.

"Enabling" Capabilities

Financial and Professional Services

Most apparent from the sector keywords enrichment for this capability is the sheer breadth and diversity of activities and specialisms captured in the North.

Looking specifically at finance, the sector keywords enrichment shows very high interaction with several emerging trends and modernising drivers, often at rates exceeding the national average.

For instance, a number trending terms – many linked to digitisation – are prevalent in the capability and more apparent in the North relative to the national capability benchmark, suggesting areas of potential advantage and future transition, including 'psd2'[20], 'open banking', and 'mobile payments'.

These findings point towards a fast-emerging and nationally significant expertise in 'fintech' in the North, with the region moving away from traditional opportunities in finance to those provided by the modernising driver of digitisation.

For the general professional services sector, reflecting the breadth of the sector in the North, the sector keywords enrichment reveals interaction with a broad range of emerging trends, across a diverse range of modernising drivers, notably decarbonisation and digitisation.

Trending terms for the capability that are overrepresented in the North relative to the national capability benchmark, suggesting areas of potential advantage and future transition, include 'environmental consultancy', 'flood risk', 'biomarkers', 'contaminated land' and 'materials science'.

[20] Refers to the EU Payment Services Directive 2.

In the North, just over a third (33%) of all firms in the sector are 'innovation active', close to the national benchmark for the sector (35%), reflecting local innovation strengths and capacity.

Logistics

Analysis of the sector keywords enrichment for the North's logistics capability shows a strong interaction with a large number of emerging trends, some of which encompass the modernising drivers.

Generally, this is at a rate in line or below the national (i.e. rest of England less-London) capability benchmark. Some trending terms are more apparent in the North however, suggesting areas of potential advantage and future transition for the capability - with a strong preference to digitisation - including 'telematics', 'internet of things', 'e-commerce', and 'blockchain'.

Meanwhile, 'final mile delivery', 'digital supply chain', and 'machine learning', are all significantly overrepresented for the national capability benchmark, but are seeing slower uptake in the North.

In the North, a quarter (25%) of all firms in the sector are 'innovation active', which is the lowest proportion of all capabilities, and below the national benchmark for the sector (29%).

Education

Only a small number of trending terms are proposed by the sector keywords enrichment for the North's education capability. These overwhelmingly lean towards the digitisation driver, suggesting a transition towards 'edtech' in the North, with trending terms including 'virtual reality', 'animation', 'platforms', 'digital transformation' and 'mobile apps'.

These are however often underrepresented in the North relative capability benchmarks. In the North, impressively more than half (51%) of all firms in the sector are 'innovation active', the highest of all "Enablers" and close to the national benchmark for the sector (54%).

5 Conclusions

This closing section summarises the key findings to date and highlights some of the early considerations and recommendations to be carried over into the final 'insights, issues and choices' paper and future related Northern Powerhouse Independent Economic Review (NPIER) commissions.

5.1 Summary of findings

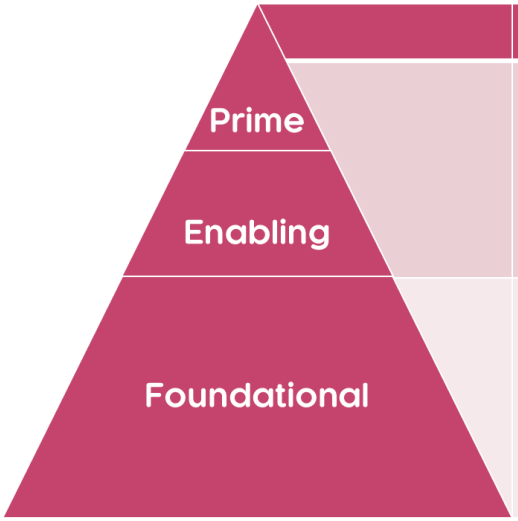
Developing a conceptual framework

Our approach to reviewing the North's economic capabilities has been outlined in our conceptual framework. Drawing heavily on the robust methodology applied to the original NPIER, our framework also reflected on the lessons learned and feedback received since it's publication in 2016.

In particular, we sought to address some of the critical feedback on the original IER's capability framework. Notably, we expanded the remit of the framework to explore the role and importance of the foundational 'everyday economy' in the North. Additional layers of scrutiny and evidence were also incorporated to identify truly distinctive, globally competitive, pan-Northern strengths and capabilities.

Figure 5.1.1 illustratively sets out our conceptual review framework, which considers the North's capabilities not just as a 'zero-sum' set of small, high-performing sectors, but as an interrelated and interdependent network of 'building blocks', with each individual 'block' supporting and enabling those above and below it.

Figure 5.1.1: Conceptual framework for reviewing the North's economic capabilities



	Example of Sectors and Activities Captured	Proposed Performance Metrics	Proposed Performance Classifications
Prime / Enabling	Tradeables e.g. • Primary Sector • Manufacturing • Technical KIBS • Professional KIBS Non-Tradeables e.g. • Business Support • Consumer Services • Construction	• Research and innovation intensity • Exporting performance • Relative productivity • Specialisation (Location Quotients)	• Prime • Secondary Prime • Local Prime • Enabling • Secondary Enabling • Local Enabling

Foundational	• Public services e.g.
	  • Healthcare
	  • Social Care
	  • Emergency Services
	• Utilities e.g.
	  • Electricity
	  • Gas
	  • Water
	• Food and Consumer Essentials
	• Transport & Logistics
		• Coverage
		• Reliability
		• Service Quality
		• Value for Money
			• Above Average: Exemplar
			• Below Average: Action Required
			• Average: As Expected

Source: Cambridge Econometrics. Note: KIBS = knowledge intensive business services

Capabilities therefore correspond to both the North's foundational and non-foundational ("higher") economic functions – the former capturing 'everyday' sectors and activities that have a substantial impact on the economy and quality of life in the North – with a more targeted means of defining and identifying the "Primes" and "Enablers". In this framework, capabilities have been defined as follows:

- **Foundational Capabilities:** following the definition of the Foundational Economy Collective, foundational capabilities represent the 'everyday economy' of the North that help to "supply daily household essentials for safe and civilized living, including providential services like health, education and care, and material infrastructure like pipe and cable utilities, and food distribution."
- **Higher Capabilities:** therefore represent the distinctive, more outward looking parts of the North's economy. These capabilities contribute to the modern knowledge economy of the North, helping to drive innovation and productivity, and interact with global value chains. The higher capabilities continue to provide a means of defining and identifying the Norths "Prime" and "Enabling" Capabilities:
    - ***"Prime" Capabilities**:* as with the original NPIER, these are capabilities that have been identified as differentiated and distinctive at a pan-Northern level. These capabilities exhibit high performance across all metrics, serving a global market and interacting with global value chains, and are represented across multiple locations within the North.
    - ***"Enabling" Capabilities**:* similarly, as in the original NPIER, these are the capabilities that play a critical role in supporting the growth and development of the "Prime" Capabilities, and also exhibit high performance across multiple locations within the North but primarily serve a regional market.

Our approach purposely sought not to define the North's foundational and higher capabilities as two discrete or competing groups, rather to highlight the significant amount of synergy and overlap between them.

Reviewing the North's foundational capabilities

The inclusion of the foundational economy in our conceptual framework enabled us to consider the role and importance of the 'everyday economy' in our review of the North's economic capabilities.

Not included in the original NPIER framework, we found the foundational economy is a significant economic contributor in its own right, accounting for some 4.7 million jobs in the North of England – equivalent to almost three-quarters (approximately 67%) of all employment – and generating approximately £204 billion of gross value added (GVA).

Yet through the provision of its goods and services it also has a critical role in determining the wellbeing and quality of life for residents in the North. Drawing on a large and diverse evidence base, we defined, reviewed and benchmarked the performance and effectiveness of the North's foundational capabilities across three service dimensions: coverage, reliability, and quality.

Table 5.1.1 shows the results of the benchmarking exercise used to review the North's foundational capabilities. Positively, the results show at a pan-Northern level the region has a number of capabilities that exhibit 'exemplar' levels of service – be it in terms of coverage, reliability or quality – relative to the rest of England.

Though evident across all themes, the North's 'exemplar' providers are largely concentrated in public services, such as health and social care, emergency

services, and public administration, which score particularly well in terms of coverage and reliability. 'Exemplar' service is also observed in the remaining themes, notably digital connectivity in utilities, and wholesale and supply chains in food and essentials.

Table 5.1.1: Performance of the North's foundational capabilities

Foundational Theme	Foundational Capability	Coverage	Reliability	Quality
Public Services	Healthcare			
	Social Care			
	Primary and Secondary Education			
	Emergency Services			
	Public Administration			
Utilities	Electricity			
	Gas			
	Water			
	Waste and Sewerage			
	Digital Connectivity			
	Construction, Repair and Maintenance			
Transport and Logistics	Roads and Public Realm			
	Public Transport			
	Postal Service			
	Critical Freight Handling			
Food and Consumer Essentials	Wholesale and Supply Chains			
	Non-specialised Retail			
	Retail Banking and Finance			

Source: Cambridge Econometrics. Key: **green = 'exemplar'**, **amber "as expected"**, **red "action required"**

For those that are not 'exemplar', the majority perform 'as expected' - in line with the national (rest of England) average. Of concern though are capabilities in the North that exhibit service that 'requires action' - where performance lags the rest of the country.

Though in the minority, this assessment is most common across the reliability and quality dimensions; of the 18 capabilities assessed, 4 'require action' in terms of reliability, and 2 for quality. Though limited, for some capabilities this underperformance will have a discernible impact on the North's economy and quality of life.

The capabilities that exhibit service that 'require actions', and clearly warrant further attention in the North of England, are most evident across the utilities and transport and logistics themes. In particular, poor levels of reliability were observed across electricity, gas, and water provision, in addition to public transport (particularly for rail-related transport).

And despite exhibiting 'exemplar' coverage, the primary and secondary education and critical freight handling capabilities were the only ones to provide noticeably below average quality in the North of England and warrant further attention.

Reviewing the North's higher capabilities

The purpose of the higher capabilities review exercise was to use a novel, data-driven approach to provide fresh insights and knowledge into the performance and composition of the North's "Prime" and "Enabling" Capabilities.

As emphasised throughout our review, the intention of our analysis was not to supplant or refresh the original "Prime" and "Enabling" Capabilities identified in the 2016 NPIER – that would be for a future commission, such as an NPIER refresh, to decide, though our body of evidence presented here can help to shape and inform that.

Our approach was broadly structured into four distinct phases:

i. *Economic specialisation and performance:* firstly, considered the relative specialisation and economic performance of the higher capabilities. In the 2016 NPIER, this was the limits of the data used in the exercise to identify the North's "Prime" and "Enablers".

ii. *Research and innovation intensity and strengths:* here, drawing on novel and alternative data sources we progressed the parameters of our review even further, firstly by incorporating and assessing relative innovation dynamics and performance.

iii. *Export intensity and global market representation:* export and trade data were then used to profile the representation and performance of the higher capabilities within global markets.

iv. *Pan-Northern distribution and representation:* finally, detailed spatial analysis was undertaken to determine the geographic representation and concentration of higher capabilities in the North.

Bringing together the findings and analysis of these four phases, we were able to review the North's higher capabilities, in line with the definitions and categories presented in our conceptual framework and reflect on the implications for the original NPIER's Prime" and "Enabling" Capabilities, as shown in Table 5.1.2.

Table 5.1.2: Summary of findings and recommendations from the higher capability analysis

Status of the 2016 "Prime" Capabilities	
Advanced Manufacturing	Pan-Northern High Performer
Energy	Pan-Northern High Performer
Health Innovation	Requires Attention
Digital	Requires Attention
Status of the 2016 "Enabling" Capabilities	
Financial and Professional	Appropriate Focus
Logistics	Appropriate Focus
Higher Education	Appropriate Focus
Other higher capabilities worth consideration	
Foundational Industries	Pan-Northern High Performer
Textiles and Wood Products	Pan-Northern High Performer
Engineering and Construction	Pan-Northern High Performer
Agriculture and Food	Pan-Northern High Performer
Water, Waste and Circular Economy	Worth Consideration

Source: Cambridge Econometrics

In the original NPIER, the 2016 "Prime" Capabilities were identified as being genuine pan-Northern specialisations and strengths: highly productive, innovative, and outward-looking. Upon concluding the data analysis, we found that two of the 2016 "Prime" Capabilities were clearly both still existing, distinctive strengths: Advanced Manufacturing and Energy. If anything the importance of these sectors to the North has only increased in the past five years, in light of the need to accelerate progress towards net zero.

The other two 2016 "Prime" Capabilities were not so clear cut: neither emerged from the data analysis as a genuine existing pan-Northern strength. Health Innovation could be considered as a potential future growth opportunity but is currently a niche sector within the North. The Digital capability may be best understood as one of three key cross-cutting drivers. Both suffered from comparisons with the Greater South East, which specialises strongly in these two areas (even when excluding London from the analysis). Whilst they don't

technically fulfil the definition of the "Prime" Capability, they are both still key growth sectors and opportunities moving forward.

The 2016 "Enabling" Capabilities all had average or above average performance but were chosen for their important role in supporting the wider growth across the economy. Our analysis concluded that these sectors remained critical regional enabling capabilities and building on this performance is an appropriate focus for them going forward.

The data also identified five additional sectors worthy of consideration. Four of these are already performing at the level of pan-Northern "Prime" Capabilities. This includes Agriculture and Food, Engineering and Construction, Textiles and Wood Products, and Foundational Industries.

Water, Waste and Circular Economy is not yet strongly represented across the entire region; however it may be worth consideration as a key component in the Green Economy. We would recommend considering these sectors as additional "Prime" Capabilities in future strategy, not least because of their synergistic overlap with the net zero agenda.

5.2 Consequences for consideration

The analysis and findings presented in this paper show that, in terms of its higher economic functions, the North's comparative strengths and high performance areas are in a range of "Prime" or emerging capabilities that, by and large:

- Tend to be goods producing, rather than service sectors
- As a result, tend to be capital, resource, and land intensive, rather than labour intensive
- Tend to experience and benefit from localisation ("clustering") benefits, more than more generalised urbanisation benefits
- As a result, don't tend to cluster in high density urban areas as much as service sectors - this is in contrast to the North's enabling sectors, which do tend to be more labour intensive and urban focused
- Are export focused, compete in international markets and partake in international supply chains, and are therefore the sectors of interest in moving the UK "up the global value chain"
- Have above-average tendency to both drive and benefit from innovation, particularly around the three key modernising trends of digitisation, automation and decarbonisation
- Have high employment multipliers – every additional job in manufacturing typically brings more money into the local economy, and hence produces further employment demand, than a job in a typical service sector
- Opportunely, happen to be the sectors most directly involved in driving a climate transition, both in terms of requiring technological change, and providing the resources for technological change of other sectors

Making the necessary investments to drive these high performing capabilities forward is of critical importance both to the performance of the North and the

ability of the UK to both meet its climate crisis obligations and make the desired transition to an outward-facing, globally competitive, high-wage, high-skill economy.

However, there is a secondary narrative here. That these relative strengths are largely confined to a series of non-urban activities is both a result of, and potentially a contributing factor to, the North's relatively underinvested and underdeveloped core cities.

City regions within the North have received insufficient public funding over the past four decades, and their infrastructure, housing and commercial property stock, and public realm are not as developed as equivalent sized cities across Europe and the US.[21] Despite this, we have seen parts of the foundational economy in the North – largely reliant on public funding – exhibit high performance and best practice relative to the rest of the country.

This lack of public investment, and the subsequent private investment it inevitably crowds in, has however constrained their ability to develop the critical mass of knowledge-based firms and graduate workers necessary to catalyse the process of urbanisation agglomeration required to compete in a modern knowledge-based economy. Whilst schools and universities within the North do produce highly skilled graduates, retention rates have historically proven insufficient to support the growth of a high-performing knowledge economy.

One particular issue is the dispersed and polycentric nature of many of the North's major city regions, with limited levels of economic integration between urban cores and their surrounding towns and suburbs. This reduces the ability of both the surrounding areas to benefit from agglomeration spill overs from the core (for example, access to specialised services), and the core to benefit from agglomeration spill overs from surrounding geographies (for example, access to a deeper labour market).

Some have explained the relative success of the Greater South East in terms of the emergence of a 'diverse core and specialised satellite' structure, that combine to provide a regional related variety of industries, knowledge spaces, and foundational drivers that is greater than the sum of its parts. This structure is reliant upon a steady inward flow of graduate workers (often displaced from the North), specialised and targeted capital investments, and high levels of connectivity, both physical and digital, between satellite and core.

For the North to be successful at replicating the success of the Greater South East, this combination of high levels of connectivity and economic integration, sectorally-targeted capital investment, and graduate retention and attraction, are a pre-requisite. A key question moving forward for Northern policy makers and analysts is how possible it is to replicate this highly innovative and productive diverse core and specialised satellite structure in the more polycentric North.

Critically, this analysis showed that existing spatial patterns of "Prime" and "Enabling" sectoral activity would mean that any targeted improvement in connectivity between urban cores and their hinterlands not only increase the

[21] See for instance Centre for Cities analysis here and here

level of economic integration within that city region but would also have the effect of better connecting the more urban-centric enabling sectors to the more dispersed "Prime" Capabilities that they are intended to support.

This synergy between sectoral and spatial development is a key insight of this analysis: it appears that two different problems - that of better integrating the cities of the North to their hinterlands in order to spread economic opportunity more widely, and the necessity to better connect the rural based "Primes" to the "Enabling" sectors located in city centres - would both benefit from the same package of policy interventions. This would, hopefully, also move the discussion beyond a simplistic and divisive "cities vs towns" discourse, into a more constructive "cities and towns, together" approach.

5.3 Next steps and further work

The findings and analysis presented in this technical paper will be used to inform the final 'insights, issues and choices' paper for this commission, which will outline a refreshed 'economic narrative' for the North. This final 'insights' paper is due to be completed Spring 2022.

During this process, our findings here will be supplemented with the wider work of the commission, including the local area literature and evidence reviews (undertaken by SQW), and the appraisal of options for scenario development (undertaken by CE).

Though the data and analysis provided here has been robust and extensive, our findings have raised additional questions and flagged potential knowledge gaps, which are beyond the scope of this technical paper. Therefore, these could benefit from inclusion in future research and commissions in the North.

For instance, given the spatial attributes of the North's "Prime" and "Enabling" Capabilities, the role and interaction of agglomeration in supporting the North's economy requires further exploration and understanding, particularly if agglomeration is to remain a central component of the NPIER moving forwards.

And though our assessment of the North's foundational economy is (to our understanding) unprecedented, it has also posed additional questions. For instance, the disconnect between the North's above average coverage and below average reliability and quality for some capabilities warrants further attention.

In addition to this, there is a worthwhile justification in trying to better understand the performance of the North's foundational capabilities relative to global – rather than just national – comparators, particularly for capabilities where performance in the North significantly diverges from the national average.

Finally, the purpose of our foundational analysis was to provide an assessment of the North's foundational economy. There would be significant value in building on this to draw out and better understand the linkages and dependencies between the North's foundational and higher capabilities.

6 Data Appendices

This appendix provides supporting information clarifying our approach to reviewing the North's economic capabilities. This includes an overview of data used, sources, definitions, and detailed results.

6.1 Foundational Capabilities metrics

The following tables outline the metrics used to review the North's foundational capabilities, in addition to their source, performance ratios, and accompanying RAG rating. Each table refers to the constituent capabilities within that theme.

Public Services

Capability	Coverage metrics	Relative performance (latest available year)	Change in relative performance (last 5 years, or equivalent)	Reliability metrics	Relative performance (latest available year)	Change in relative performance (last 5 years, or equivalent)	Quality metrics	Relative performance (latest available year)	Change in relative performance (last 5 years, or equivalent)
Healthcare	Proximity to hospital and GPs (Source: DfT)	1.19	0.04	A&E waiting times (Source: NHS)	1.07	0.06	Population covered by 'good' and 'outstanding' NHS CCG's (Source: CQC)	1.23	N/A
	Frontline* health workers per capita (Source: NHS)	1.19	-0.02	Unplanned hospital re-admission rates (Source: NHS)	1.03	0.02	Patient experience of health care (Source: NHS)	0.99	N/A
	Hospital beds per capita (Source: NHS)	1.19	-0.05						
Social Care	Frontline** care workers per capita (Source: NHS)	1.81	0.03	Delayed transfer of care attributable to social care (Source: NHS)	0.97	-0.42	Proportion of care providers rated 'good' and 'outstanding' (Source: CQC)	1.00	0.04
	Social care beds per capita (Source: CQC)	1.11	-0.03	Social care complaints per capita (Source: LGO)	1.20	0.02	Patient experience of social care (Source: NHS)	1.04	-0.01
Primary and Secondary Education	Proximity to schools (Source: DfT)	1.10	0.02	Average classroom size (Source: DfE)	1.01	0.00	Students covered by 'good' and 'outstanding' schools (Source: Ofsted)	0.93	-0.01
	Classroom teaching staff per capita (Source: ONS)	1.06	0.00	Pupil absence rates (Source: DfE)	0.96	-0.03	PISA scores in sciences, reading and math (Source: OECD)	0.97	N/A
							Educational attainment upon completing secondary education (Source: DfE)	0.96	-0.03
Emergency Services (Police, Fire, Ambulance)	Frontline*** emergency workers per capita (Source: ONS)	1.14	-0.01	Average response times (Source: CQC, HMICFRS)	1.11	0.01	User experience/satisfaction (Source: ONS, CQC, HMICFRS)	1.03	N/A
							Population covered by 'good' and 'outstanding' emergency services (Source: CQC, HMICFRS)	1.39	N/A
Public Administration	Frontline**** public administration workers per capita (Source: ONS)	1.22	-0.08	Public service complaints per capita (Source: LGO)	1.27	0.04	User experience/satisfaction (Source: LGA)	1.05	N/A
							Housing Benefit and Council Tax processing efficiency (Source: LGA)	1.02	0.01

Note: * refers to those providing direct care (notably medical doctors, nurses and midwives, dentists, pharmacists and physiotherapists). ** refers to those providing direct care. *** refers to those providing a direct service (notably police officers, firefighters and ambulance staff). **** refers to those providing a direct service (so excludes central government/civil service roles. Emergency services and the armed forces also excluded)

Utilities

Capability	Coverage metrics	Relative performance (latest available year)	Change in relative performance (last 5 years, or equivalent)	Reliability metrics	Relative performance (latest available year)	Change in relative performance (last 5 years, or equivalent)	Quality metrics	Relative performance (latest available year)	Change in relative performance (last 5 years, or equivalent)
Electricity	N/A - assumed to be in line with rest of England		N/A	Supply interruptions (Source: Ofgem)	0.90	-0.02	Customer satisfaction (Source: Ofgem)	0.99	0.02
Gas	Properties not connected to the gas network (Source: BEIS)	1.45	0.02	Supply interruptions (Source: Ofgem)	0.86	-0.04	Customer satisfaction (Source: Ofgem)	1.01	-0.03
Water	N/A - assumed to be in line with rest of England		N/A	Supply interruptions (Source: Ofwat)	0.91	N/A	Customer satisfaction (Source: Ofwat)	1.05	N/A
Waste and Sewerage	N/A - assumed to be in line with rest of England		N/A	Sewerage incidents and interruptions (Source: Ofwat)	1.05	N/A	Customer satisfaction (Source: Ofwat)	1.05	N/A
				Waste and environment complaints per capita (Source: LGO)	1.20	0.02	Proportion of waste recycled (Source: MHCLG)	1.00	-0.01
Digital Connectivity	Broadband coverage, and by type (Source: Ofcom)	1.06	0.08	Supply interruptions (Source: Ofcom)	1.52	N/A	Broadband speeds (Source: Ofcom)	1.06	0.10
	4G coverage (Source: Ofcom)	1.05	N/A						
Construction, Repair and Maintenance	Construction and R&M workforce per capita (Source: Construction Skills Network)	1.40	-0.01	N/A - no available metric	N/A	N/A	Proportion of construction and R&M workforce 'suitably qualified'* (Source: UKCES)	0.99	-0.01

Note: * 'suitably qualified' defined as holding at least an intermediate trade apprenticeship

Critical Transport and Logistics

Capability	Coverage metrics	Relative performance (latest available year)	Change in relative performance (last 5 years, or equivalent)	Reliability metrics	Relative performance (latest available year)	Change in relative performance (last 5 years, or equivalent)	Quality metrics	Relative performance (latest available year)	Change in relative performance (last 5 years, or equivalent)
Roads and Public Realm	Major road length miles per capita (Source: DfT)	0.90	0.02	Journey delays on major roads (Source: DfT)	0.83	-0.01	Condition of major roads (Source: DfT)	1.03	0.01
	EV charging points per capita (Source: DfT)	0.86	-0.11	Highways and public realm complaints per capita (Source: LGO)	1.35	-0.15	Road traffic accidents on major roads, relative to vehicle miles (Source: DfT)	1.30	0.03
Public Transport	Accessibility of key services by public transport (Source: DfT)	1.14	0.03	Public transport punctuality/delays (Source: DfT, ORR, Transport Focus)	0.93	-0.02	Public transport travel times relative to private (Source: DfT)	1.06	0.01
	Public transport journey's per capita (Source: DfT, ORR)	1.23	-0.08				User satisfaction (Source: Transport Focus)	1.02	N/A
Postal Service	Availability of post boxes and postal branches (Source: Ofcom)	1.04	0.02	Speed of delivery (Source: Ofcom)	1.03	0.01	User satisfaction (Source: Ofcom)	1.04	0.01
Critical Freight Handling	Total freight handled per capita (Source: Eurostat)	1.26	-0.14	Port waiting times (Source: FourKites)	1.18	N/A	Port LCSI score (Source: UNCTAD)	0.37	-0.04
							Port turnaround times (Source: FourKites)	0.71	N/A

Food and Consumer Essentials

Capability	Coverage metrics	Relative performance (latest available year)	Change in relative performance (last 5 years, or equivalent)	Reliability metrics	Relative performance (latest available year)	Change in relative performance (last 5 years, or equivalent)	Quality metrics	Relative performance (latest available year)	Change in relative performance (last 5 years, or equivalent)
Wholesale and Supply Chains	Warehouse and logistics space per capita (Source: CoStar)	1.28	N/A	Incidence of fuel, food and other essentials shortages (Source: Urbantz)	1.28	N/A	Average size of warehouse and logistics premises (Source: CoStar)	1.08	N/A
Non-specialised Retail	Proximity to supermarkets (Source: DfT)	1.10	0.02	Incidence of essential food shortages (Source: Urbantz)	1.00	N/A	N/A - no available metric	N/A	N/A
Retail Banking and Finance	Bank branches and building societies per capita (Source: ONS)	0.99	-0.03	Proportion of ATMs free to use (Source: Link)	0.97	-0.02	Good Credit Index score (Source: Demos)	0.98	0.00
	ATMs per capita (Source: Link)	1.15	0.03		-				

6.2 Higher Capabilities metrics

The following metrics were used to review the North's higher capabilities. Provided here is additional information on metric sources, methods, and spatial and sectoral coverage.

Standard economic metrics

The primary source for these metrics is a snapshot of the Office for National Statistics Inter-Departmental Business Register (IDBR). A highly detailed firm-level dataset, we have aggregated data to the North's corresponding geographies and capabilities.

An advantage of using the IDBR is that it allows us to understand output and productivity performance at a much more detailed spatial and sectoral level, without having to use extrapolation. Unfortunately, as a snapshot of the register, we are unable to assess time series trends. Firm-level data in our snapshot covers the years 2018 and 2019.

Metric	Source	Sectoral detail	Spatial detail	Comments
Employment (i.e. jobs)	ONS (IDBR)	To 5-digit SIC	To LSOA	Note that this is a measure of jobs, not workers/people
Gross Value Added (GVA)	ONS (IDBR)	To 5-digit SIC	To LSOA	GVA has been estimated from IDBR turnover, using a sectorally detailed GVA-turnover convertor
Business base	ONS (IDBR)	To 5-digit SIC	To LSOA	Includes enterprises and local units
Productivity (GVA per job)	ONS (IDBR)	To 5-digit SIC	To LSOA	

Trade metrics

Using ONS data on both goods and services exports at the ITL 1 regional level, we were able to convert trade classifications to SIC codes, and allocate exports to capabilities. Due to volatility and a lack of consistently defined data over a reasonable time period, we are unable to assess time series trends. The latest available year of data is 2019.

Metric	Source	Sectoral detail	Spatial detail	Comments
Goods Exports	ONS	To 2-digit SITC code	To ITL1 region	SITC codes have been converted to SIC codes
Services Exports	ONS	To 2-digit SIC	To ITL1 region	

Innovation metrics

To compile innovation and research data, we drew on an existing study looking at the research and innovation performance of the North. This study provided data on European Patent Office (EPO) applications for patents and the allocation of Innovate UK project funding grants.

Metric	Source	Sectoral detail	Spatial detail	Comments
Patent applications	EPO	To 4-digit IPC code	To LEP area	IPC codes have been manually allocated to capabilities
Innovate UK funding grants	Innovate UK	N/A	To LEP area	No sectoral classification is provided, so data has been allocated to capabilities using a text classification algorithm

With the lack of a standardised SIC convertor, we allocated projects and patent codes to their relevant capabilities using the following:

Allocating IPC codes: there were 662 IPC names at the 4-digit level. These were categorised manually by comparing them to the 24 higher capabilities' intended coverage activates. Where an IPC description could have fitted into more than one capability, discretion was used, and the capabilities' activities also became more defined through this thought process.

*Allocating Innovate UK project funding grants: t*here were over 38,000 projects that applied for innovate UK funding grants, which was too many to classify manually as with the IPC codes, so classifying each of these into one of the 24 higher capability categories was achieved using a text classification algorithm, coded in Python. First, random samples of projects were drawn from the list, categorised manually by reading titles their titles and descriptions, and then identifying key words and terms in these that guided the choice. These terms were added to a list of terms associated with the chosen category.

In this way, a list of keywords and terms was devised for each of the 24 higher capabilities categories. Automatic classifying then took place: the algorithm counted occurrences of keywords in each of the projects' titles and descriptions and classed a project into the higher capabilities category for whose keywords and terms it had the most occurrences, provided that a minimum threshold of term 'hits' was achieved for that category. Through an iterative process of manually sampling and categorising, growing the search terms lists, and then classifying via algorithm, the projects were categorised.

6.3 Higher Capabilities definitions

We base our system of classification around the propensity for localisation economies to occur between individual industries. Localisation economies refer to the benefits accrued from the spatial concentration of firms within the same or similar industries, which occur due to the positive externalities related to sharing knowledge, specialised inputs, outputs and labour markets. Very different sectors, in terms of SIC classifications, could form clusters and co-locate, based on their similarly qualified workforce, strong input-output relations or other factors. The following analysis tries to find industry-clusters based on such traits using network-based analysis.

Based on the literature (see Graham and Gibbons, 2018) and data availability two defining characteristics are used as defining factors of clustering in this analysis:

1. **Skill relatedness, to study which industries use similar workforce.** Data assembled by Neffke et al. (2017) is used to capture skill relatedness across industries. This analysis builds on the work of Froy (2019), who uses the same data to study industry relatedness in the Greater Manchester area. Neffke et al. (2017) measures labour flows from one industry to another to assess whether different sectors use workforce with similar skill set and technologies. Although, their analysis refers to German labour flows, Froy (2019) argues that the same skill relatedness measure could be applied to the UK too, as it is driven by the production technology. Following this argument and in absence of similar data set for the UK, this analysis also builds on German labour flows. Based on the data set of Neffke et al. (2017), an industry-industry skill relatedness matrix is used here to learn which sectors use similar workforce to each other. Hiring from a similar pool of workers could be a strong determinant for firms in different sectors to operate at the same location.
2. **Input-Output relationships**, to study supply chain links across industries. Based on the ONS intermediate consumption table for the UK (2016), this analysis built a matrix to capture supply chain relationships across industries. If firms within one sector use the intermediate product of another, it could drive those firms to move closer to each other and minimize transport costs.

To model how these drivers could form industry groups, which then could tend to co-locate, we applied a network science-based analysis. For 78 industry sectors (following the NACE-2 based classification of Neffke et al., 2017), adjacency matrices were created which reflect the links across sectors. To follow the simplest possible method, we considered an undirected and unweighted network of the sectors. This means that the direction of labour flows and the direction of input-output links across sectors were not considered. The average strength of directed links captures well enough their importance. To keep the analysis as simple as possible, an unweighted network was created for both type of relationships. This means that instead of adding weights to industry-industry connections we focused on the information

whether they are connected or not.[22] Using these restrictions, three binary and symmetrical adjacency matrices were created to form networks. The first two creates networks based on skill-relatedness and IO relationship across industries. Combining their information, a third matrix is formed as a sum of the two other matrices.

For identifying communities within these networks, community detection algorithms were used (R: igraph packages). First, the networks were partitioned into their connected components, subnetworks, within industries are closely related to each other. Second, in the giant connected component of the networks, which are the largest linked subsets, communities were identified. Within these communities, industries are more strongly related to each other than to the rest of the network. There are several community detection algorithms, which rely on different logics of finding groups. Naturally, some are designed to work better in larger networks while other are tailored to sparse structures. Based on the size of our networks, their sparseness and the number of groups identified in them, the communities found by the *walktrap* algorithm are presented here. This algorithm tries to partition the network to groups so that it maximizes the modularity score of the network, by scanning it with short random walks (for more technical details see Csardi, 2015).

Figure 6.3.1 shows the network based on the skill-relatedness data and the communities which the algorithm finds in them, illustrated by the different colouring of the nodes.[23] The algorithm identifies eight different groups in the main component and finds some unconnected sectors as well. Some groups are in line with NACE-1 level classifications such as grouping the main manufacturing sectors together or the consulting services. Other groups, such as grouping RD, engineering services, computer production and pharmaceuticals together is more in line with Malmberg (2002) who suggests clustering based on the knowledge intensity of sectors.

Figure 2 shows the network and sectoral clustering based on input-output relationships across sectors. Nine groups are identified within the main component. In this network, the algorithm finds some smaller and closely related groups such as the textile-clothes sector and the forestry and wood product sectors. It also identifies broader groups as entertainment sectors, services and manufacturing in the large component.

Figure 6.1.3 shows the network which combines information from both skills and input output relations. The algorithm finds eleven communities within the main component and has properties similar to both networks. It preserves some of the small communities from the second graph, connecting textile and wearing apparels and food manufacturing with agriculture. On the other hand, it reflects more the grouping of the first network in the way it divides the larger

[22] We considered two industries as connected if the strength of their link was higher or equal in strength than 90th percentile of the link-strength distribution in the network. This rather strict definition of links proved the best in terms of capturing most important links and not including many unimportant connections in our networks.

[23] Please note that the colour of the nodes outside the main connected component has no meaning in terms of group membership.

group. It separates education and social care, engineering and chemicals, manufacturing and the services sectors.

Overall, this analysis provided industry groupings based on labour flows and input-output production relations. Firms belonging to these groups could co-locate with higher chances with each other than with other industries, which is to be tested within our main framework.

Figure 6.1.1. Clusters of Skill Relatedness (left) and Input-Output Relationships (right)

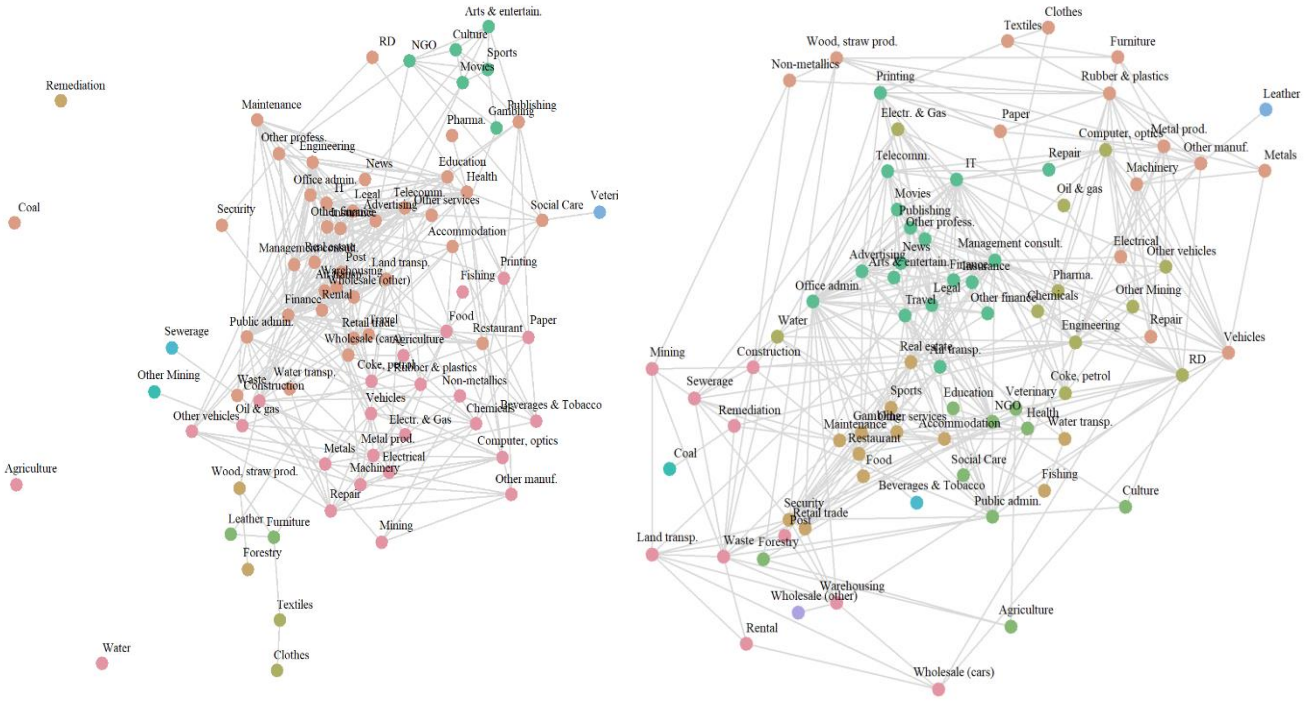
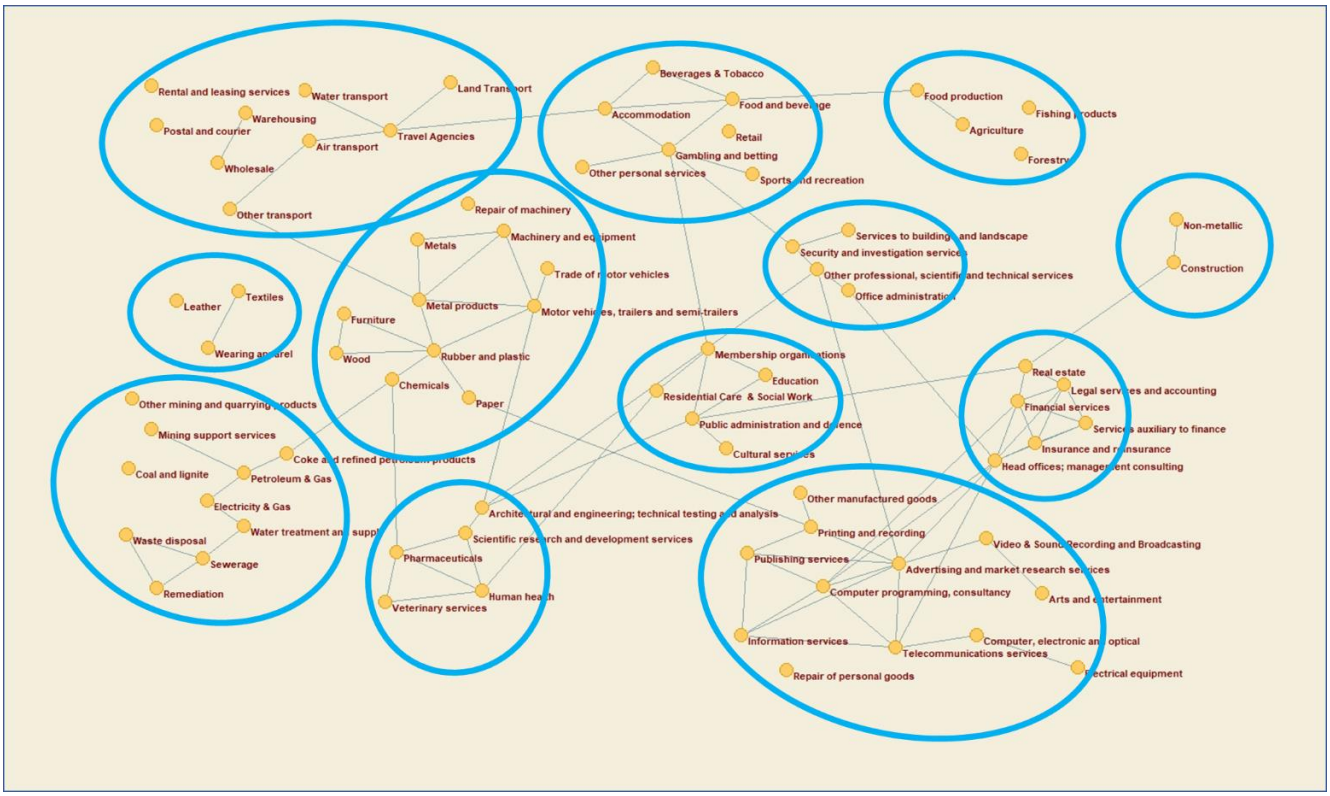


Figure 6.1.2. Simplified Groupings derived from combined dataset, using normalised data (0 to 1) with edge cut-off value of 0.35 (network displayed using Pajek software).



The sub-sectors featured in the network graph above are restricted to those covered by our two source datasets. However, we wished to carry out our analysis at the five-digit SIC level. A degree of professional judgement is therefore required as to which sectors are allocated to which categories.

There is no perfect way of doing this, however but using the relationships depicted above to help determine the approximate boundaries of functionally-related sub-sectors, this procedure should still produce a system of categorisation that is significantly more closely derived from reality than arbitrary SIC-code boundaries.

The below matrix shows how the 24 higher capabilities reviewed in this paper were defined using official classifications across the various metrics used.

Capability	SIC codes (standard metrics)	SITC codes (trade metrics)	SIC codes (trade metrics)	IPC codes (innovation metrics)
Accommodation and Hospitality	55.10 55.20 55.20.1 55.20.2 55.20.9 55.30 55.90 56.10 56.10.1 56.10.2		I	

	56.10.3 56.21 56.29 56.30 56.30.1 56.30.2 79.11 79.12 79.90 79.90.1 79.90.9		
Machinery and Processing	25.12 25.21 25.29 25.30 25.40 25.62 25.71 25.72 25.73 25.91 25.92 25.93 25.94 26.51 26.51.3 26.51.4 26.52 26.70 26.70.1 26.70.2 26.80 27.20 27.31 27.52 28.11 28.12 28.13 28.13.1 28.13.2 28.14 28.15 28.21 28.22 28.23 28.24 28.25 28.29 28.30 28.30.1	71 72 73 74 75 87 88 89 98	B06 B23 B24 B30 B33 B41 B66 B67 B81 B82 C21 F25 F41 F42

	28.30.2 28.41 28.49 28.91 28.92 28.92.1 28.92.2 28.92.3 28.93 28.94 28.95 28.99 33.11 33.12 33.19 33.20			
Arts and Recreation	74.20 74.20.1 74.20.2 74.20.9 90.01 90.02 90.03 90.04 91.01 91.01.1 91.01.2 91.02 91.03 91.04 92.00 93.11 93.12 93.13 93.19 93.19.1 93.19.9 93.21 93.29 96.02 96.04 96.09		O-T	A63 B44 Y10
Transport Equipment	29.10 29.20 29.20.1 29.20.2 29.20.3 29.31 29.32 30.11	78 79		B60 B61 B62 B63 B64 F01 F02 F03

	30.12 30.20 30.30 30.40 30.91 30.92 30.99 33.15 33.16 33.17 49.10 49.31 49.39 51.22		F04 F15 F23
Business Support Services	49.32 53.10 53.20 53.20.1 53.20.2 74.30 77.11 77.12 77.21 77.22 77.29 77.29.1 77.29.9 77.31 77.32 77.33 77.34 77.34.1 77.34.2 77.35 77.35.1 77.35.2 77.39 77.40 78.10 78.10.1 78.10.9 78.20 78.30 80.10 80.20 80.30 81.10 81.21 81.22 81.22.1	N	

	81.22.2 81.22.3 81.22.9 81.29 81.29.1 81.29.9 81.30 82.11 82.19 82.20 82.30 82.30.1 82.30.2 82.91 82.91.1 82.91.2 82.92 82.99 84.25 97.00			
Chemicals and Materials	20.11 20.16 20.17 20.30 20.41 20.42 20.51 20.52 20.53 20.59 20.60 21.10 21.20 22.11 22.19 22.21 22.22 22.23 22.29 28.96 38.12	23 51 52 54 56 57 58 59 62		B01 B04 B22 C01 C05 C06 C07 C08 C12 C22 C23 C25 C30 C40 F17
Wholesale and Retail	45.11 45.11.1 45.11.2 45.19 45.20 45.31 45.32 45.40 46.21	55	45 46 47	

46.22
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46.24
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	47.23 47.24 47.25 47.26 47.29 47.30 47.41 47.42 47.42.1 47.42.9 47.43 47.51 47.52 47.53 47.54 47.59 47.59.1 47.59.9 47.61 47.62 47.63 47.64 47.65 47.71 47.72 47.72.1 47.72.2 47.73 47.74 47.74.1 47.74.9 47.75 47.76 47.77 47.78 47.78.1 47.78.2 47.78.9 47.79 47.79.1 47.79.9 47.81 47.82 47.89 47.91 47.99			
International Transport and Logistics	49.20 49.31.1 49.31.9 49.41	91	H	B65

	49.42 49.50 50.10 50.20 50.30 50.40 51.10 51.10.1 51.10.2 51.21 52.10 52.10.1 52.10.2 52.10.3 52.21 52.21.1 52.21.2 52.21.3 52.21.9 52.22 52.23 52.24 52.24.1 52.24.2 52.24.3 52.29		
Higher and Further Education	85.41 85.42 85.42.1 85.42.2 85.51 85.52 85.53 85.59 85.60		
Electronic Devices	26.11 26.12 26.40 26.51.1 26.51.2 26.60 27.11 27.12 27.32 27.33 27.40 27.51 27.90 32.40.1 33.13	76 77	G07 G08 G09 H01 H03 H04 H05

	33.14 95.21		
Energy and Power	24.46 35.11 35.12 35.13 35.14 35.21 35.22 35.23		F22 F24 G21 H02 Y02
Finance	64.11 64.19 64.19.1 64.19.2 64.20 64.20.1 64.20.2 64.20.3 64.20.4 64.20.5 64.20.9 64.30 64.30.1 64.30.2 64.30.3 64.30.4 64.30.5 64.30.6 64.91 64.92 64.92.1 64.92.2 64.92.9 64.99 64.99.1 64.99.2 64.99.9 65.11 65.12 65.20 65.20.1 65.20.2 65.30 66.11 66.12 66.19 66.21 66.22 66.29 66.30	K	

	70.22.1 96.03		
Food and Agriculture	1.11 1.12 1.13 1.14 1.15 1.16 1.19 1.21 1.22 1.23 1.24 1.25 1.26 1.27 1.28 1.29 1.30 1.41 1.42 1.43 1.44 1.45 1.46 1.47 1.49 1.50 1.61 1.62 01.62.1 01.62.9 1.63 1.64 1.70 3.11 3.12 3.21 3.22 10.11 10.12 10.13 10.20 10.31 10.32 10.39 10.41 10.42 10.51 10.51.1	00 01 02 03 04 05 06 07 08 09 11 12 21 22 29 41 42 43	A01 A21 A22 A23 B02 C13

	10.51.2	
	10.51.9	
	10.52	
	10.61	
	10.61.1	
	10.61.2	
	10.62	
	10.71	
	10.72	
	10.73	
	10.81	
	10.82	
	10.82.1	
	10.82.2	
	10.83	
	10.83.1	
	10.83.2	
	10.84	
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	10.92	
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	46.11	
	46.12	
	46.13	
	46.14	
	46.15	
	46.16	
	46.17	
	46.18	
	46.19	
Foundation Industries	2.10	24
	2.30	25
	2.40	26
	9.90	27
	16.10	28
	16.21	53
	17.11	64
	17.12	66
	17.21	67
	17.21.1	68

17.21.9	69
17.22	93
17.23	96
17.24	
17.29	
20.12	
20.13	
20.14	
20.15	
20.20	
20.30.1	
20.30.2	
20.41.1	
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24.45	
24.51	

	24.52 24.53 24.54 25.11 25.50 25.61 25.99		
Information and Communications	26.20 26.30 26.30.1 26.30.9 61.10 61.20 61.30 61.90 63.11 63.12 63.99 95.11 95.12	J	
Life Sciences	72.11 72.19 75.00 86.21 86.22 86.23 86.90		A61
Media and Publishing	18.11 18.12 18.12.1 18.12.9 18.13 18.14 18.20 18.20.1 18.20.2 18.20.3 58.11 58.12 58.13 58.14 58.14.1 58.14.2 58.19 59.11 59.11.1 59.11.2 59.11.3 59.12 59.13		

	59.13.1 59.13.2 59.13.3 59.14 59.20 60.10 60.20 63.91 74.20.3 74.90			
Engineering and Construction	41.10 41.20 41.20.1 41.20.2 42.11 42.12 42.13 42.21 42.22 42.91 42.99 43.11 43.12 43.13 43.31 43.32 43.33 43.34 43.34.1 43.34.2 43.39 43.91 43.99 43.99.1 43.99.9 71.11 71.11.1 71.11.2 71.12 71.12.1 71.12.2 71.12.9 71.20 74.90.2 74.90.9	81	C F	B03 B07 E01 E02 E04
Management and Social Science	70.10 70.21 70.22 70.22.9 72.20			

	73.11 73.12 73.20 84.13 94.11 94.12			
Mining and Extraction	2.20 5.10 05.10.1 05.10.2 5.20 6.10 6.20 7.10 7.21 7.29 8.11 8.12 8.91 8.92 8.93 8.99 9.10 19.10 19.20 19.20.1 19.20.9	32 33 34	A B D E	C10 C11 C14 E21
Professions	68.10 68.20 68.20.1 68.20.2 68.20.9 68.31 68.32 69.10 69.10.1 69.10.2 69.10.9 69.20 69.20.1 69.20.2 69.20.3		L M	
Software and IT	58.21 58.29 62.01 62.01.1 62.01.2 62.02 62.03 62.09			D10 F05 G06 G11 G16 Y04

Textiles and Wood Products	13.10	61	A24
	13.20	63	A41
	13.30	65	A42
	13.91	82	A43
	13.92	83	A44
	13.92.1	84	A45
	13.92.2	85	A46
	13.92.3		A47
	13.93		B05
	13.93.1		B21
	13.93.9		B25
	13.94		B26
	13.95		B27
	13.96		B28
	13.99		B29
	14.11		B31
	14.12		B32
	14.13		B42
	14.13.1		B43
	14.13.2		B68
	14.14		C03
	14.14.1		C04
	14.14.2		C09
	14.19		D01
	14.20		D02
	14.31		D03
	14.39		D04
	15.11		D05
	15.12		D06
	15.20		D07
	16.22		D21
	16.23		E05
	16.24		E06
	16.29		F16
	31.01		F21
	31.02		F26
	31.03		F27
	31.09		F28
	32.11		G01
	32.12		G02
	32.13		G03
	32.20		G04
	32.30		G05
	32.40		G10
	32.40.9		G12
	32.50		
	32.91		
	32.99		
	95.23		
	95.24		

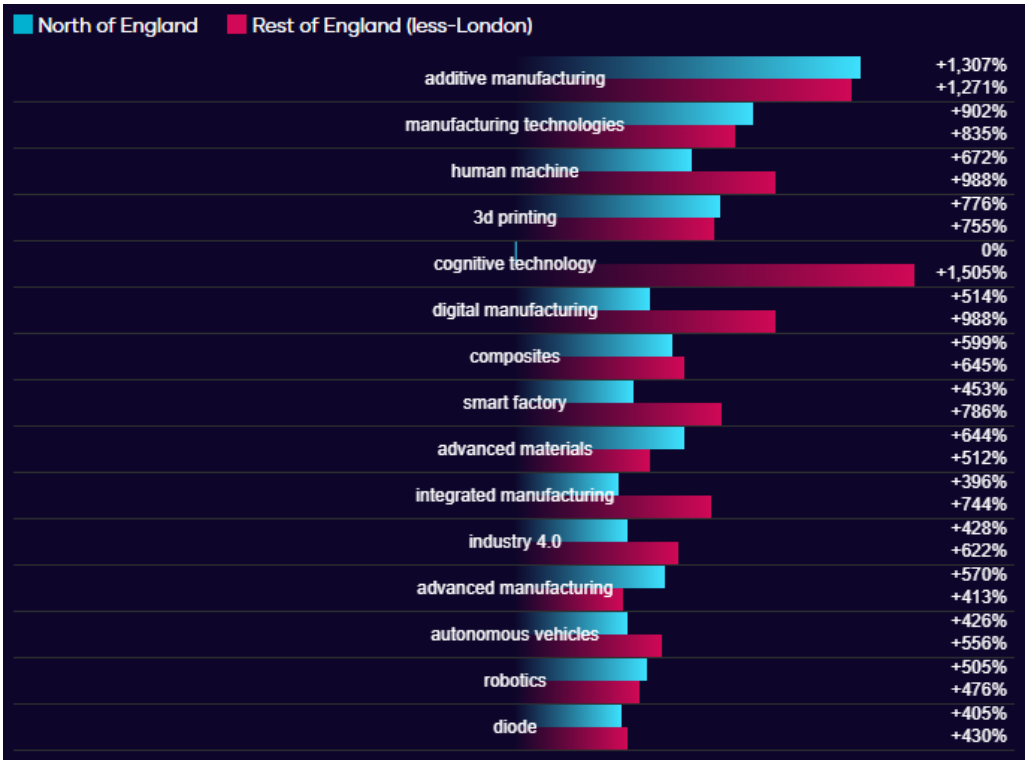
	95.25	
	95.29	
	96.01	
	98.10	
Water, Waste and Circular Economy	36.00	B09
	37.00	C02
	38.11	E03
	38.21	
	38.22	
	38.31	
	38.32	
	39.00	

6.4 The Data City sector keywords enrichment charts

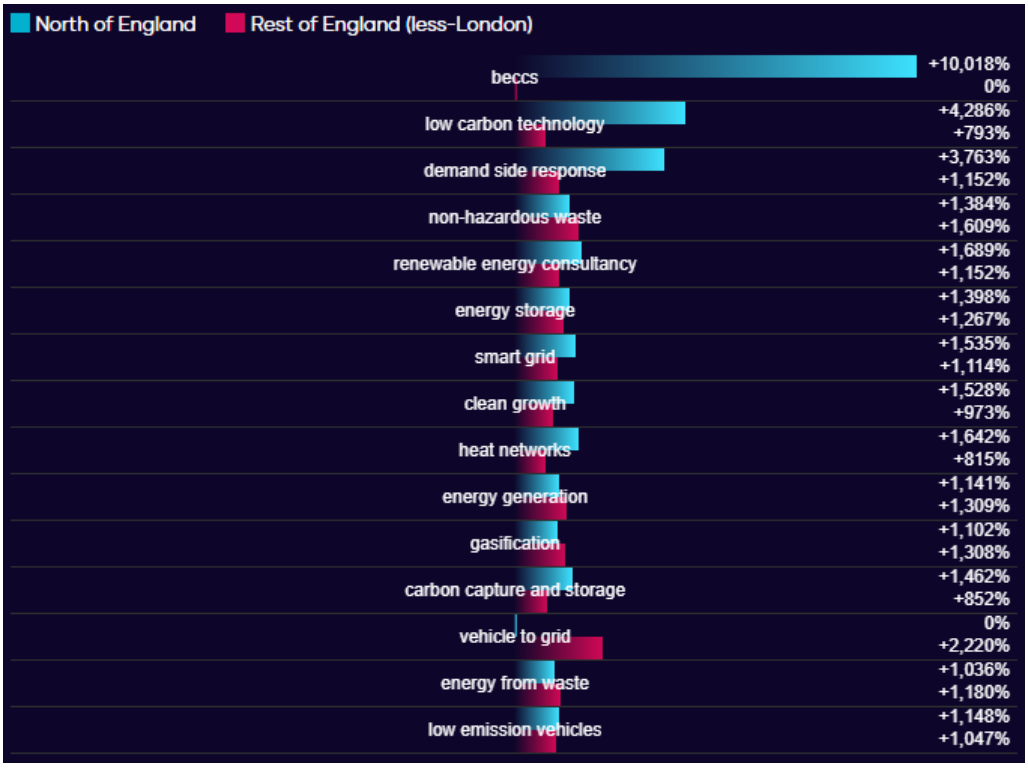
The below charts show the results from The Data City's sector keyword enrichment was which was applied to some of the "Prime" and "Enabling" Capabilities identified in our review.

According to The Data City, these are defined as "*keywords that are over-represented and under-represented among your companies compared to the average UK company. For example, a value of "Social Media +95%" means that the companies in your list and matching your filters are 95% more likely to mention the phrase "social media" on their website than the average UK company.*"

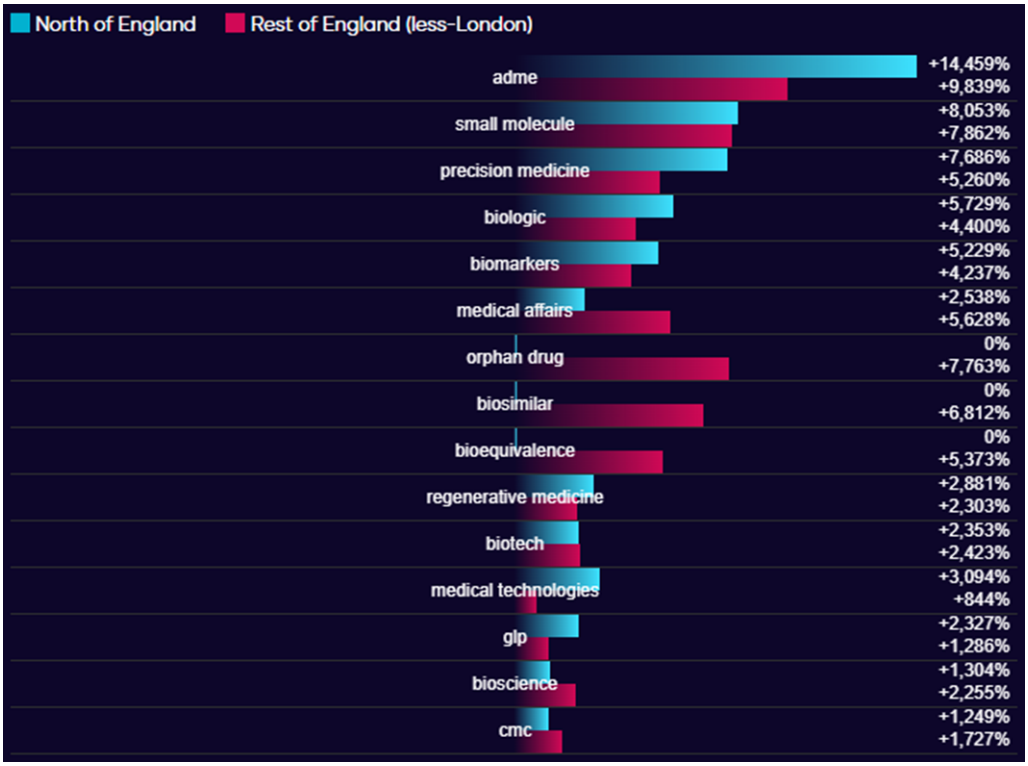
Advanced Manufacturing



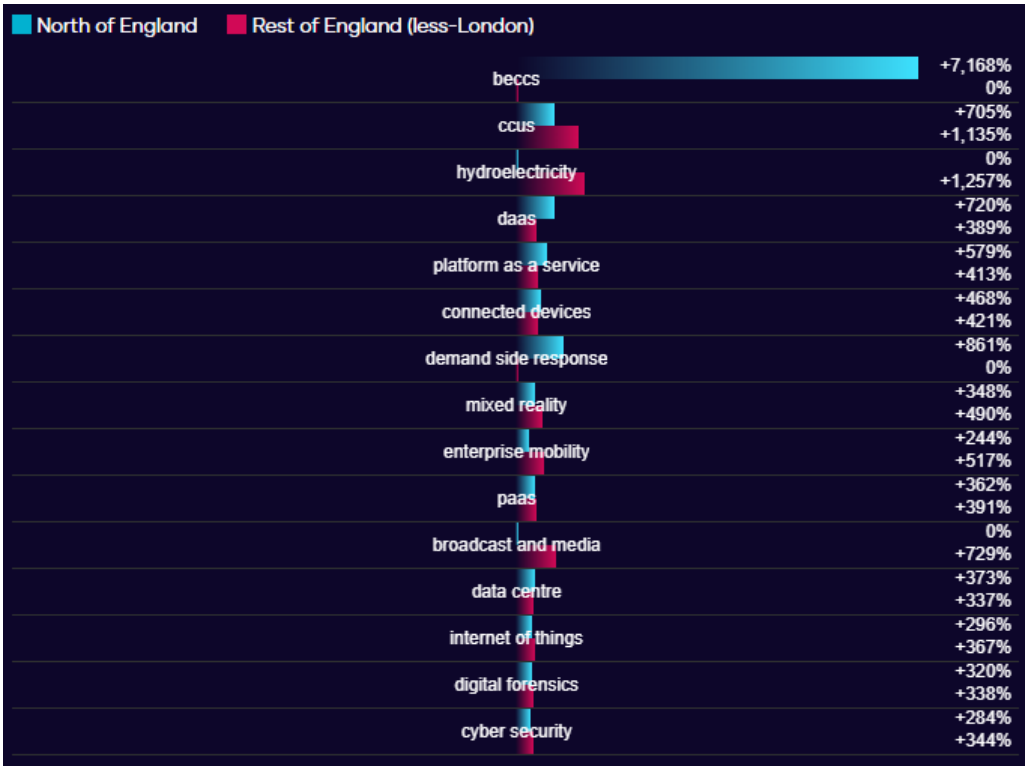
Energy



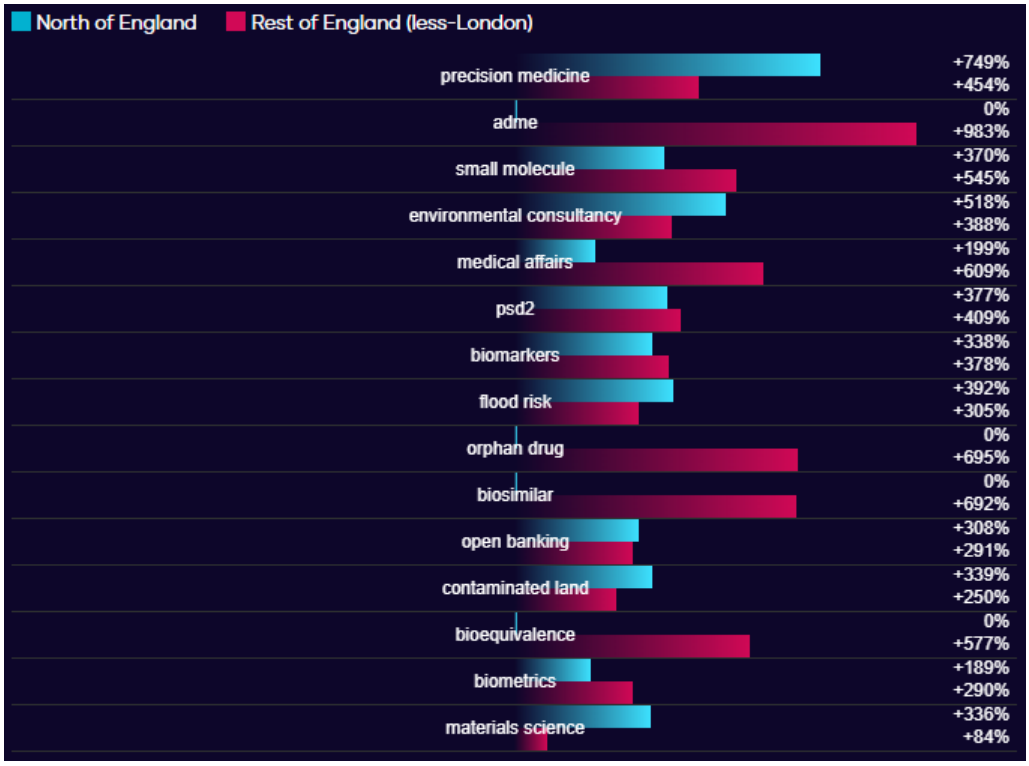
Health Innovation



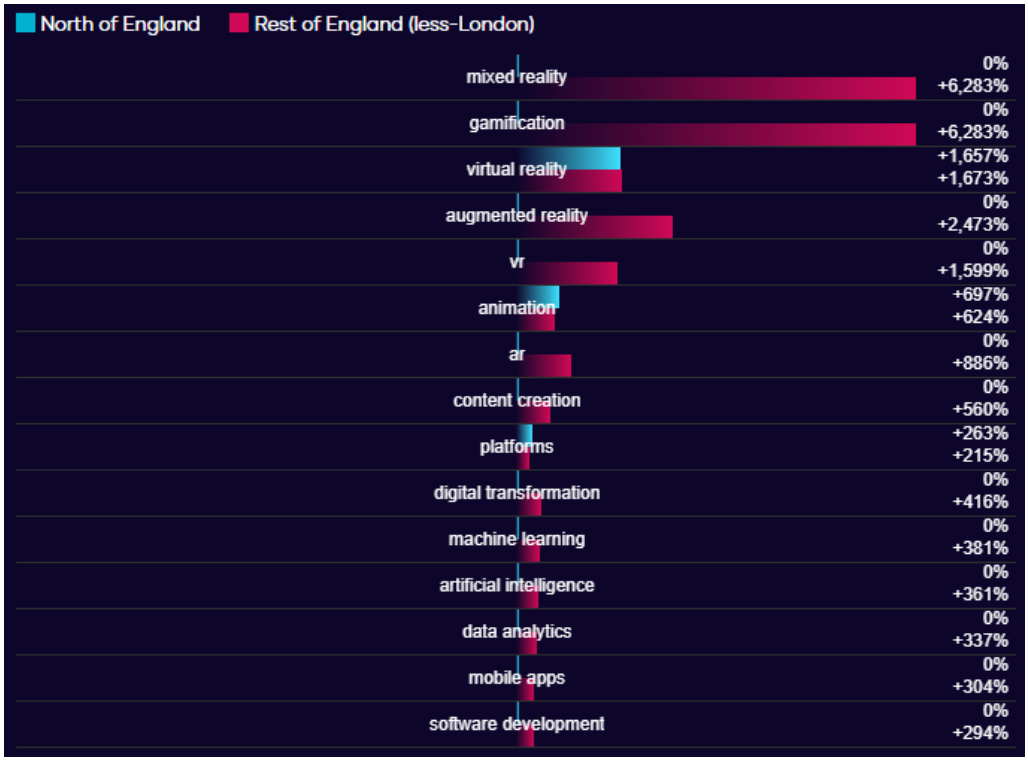
Digital



Financial and Professional Services



Education



Logistics