Transport for the North

Agglomeration and Clustering Research

Final Report

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Executive Summary

This commission

TfN has commissioned this study to strengthen their evidence base on how agglomeration and clustering take place in the context of the North's current economic structure and potential for growth in the future. The specific aim of this work is to obtain a robust analysis of different types of economic clusters in the North, underpinned by a robust theoretical framework based on cluster and agglomeration literature.

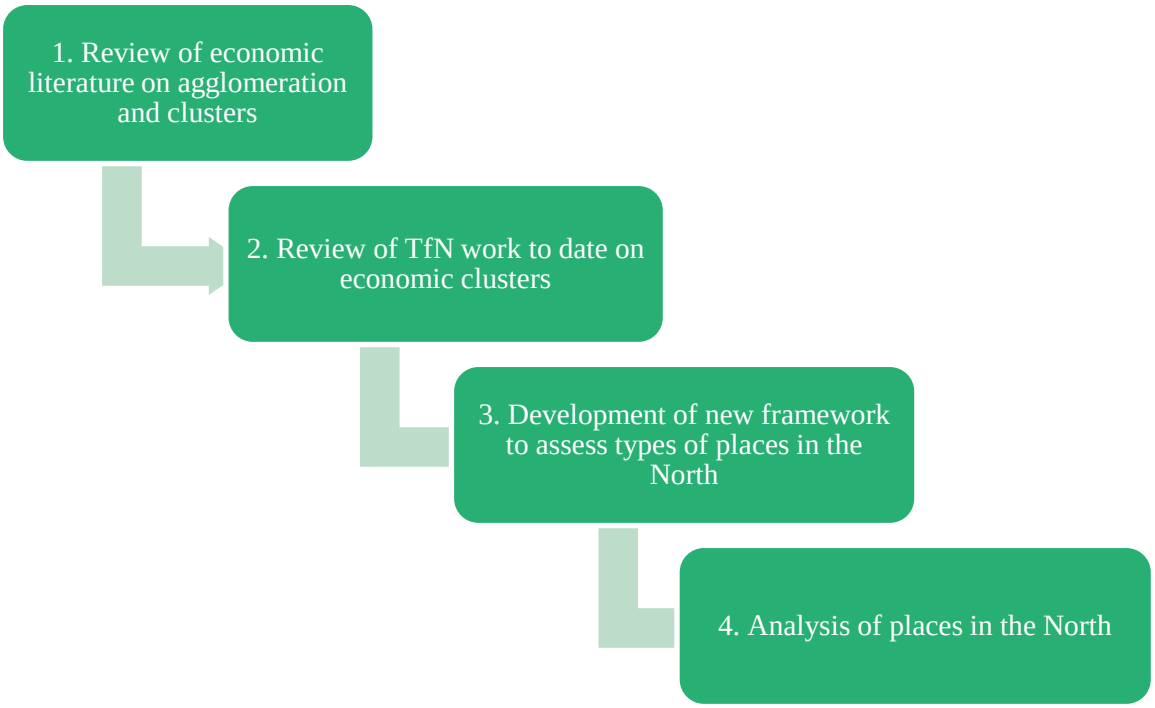
The purpose of this exercise is twofold:

- provide external validity to TfN's clusters, as presented in the STP by supplementing the existing evidence with a robust analytical approach utilising existing datasets
- build a stronger evidence base to understand the impact of improving connectivity between these economic assets or clusters will have

This report presents our approach and findings from our analysis of economic clusters in the North of England. To be consistent with the economic literature, we refer to these clusters as "types of places" throughout the report. This analysis has been developed through an iterative process in consultation with TfN.

Approach

Our approach can be broken down into four stages as follows:



Review of economic literature

The review of the agglomeration and cluster economics literature has provided the following insights:

- Agglomeration of economic activity can generate economic benefits through different mechanisms – matching, learning and sharing
- Different types of agglomeration of economic activity have been studied in the literature – the agglomeration of economic activity of one sector of the economy vs. agglomeration of diverse economic activity. There is an ongoing debate in the literature on the economic impacts of both and when they are more important.
- Connectivity improvements can have a similar impact as the physical agglomeration of economic activity – this is referred to as "static agglomeration" in the UK transport appraisal guidance (WebTAG)
- The concept of clusters is only used in the context of sectoral agglomeration and therefore does not capture other types of concentration of economic activity, which TfN are interested in analysing further

Taking into consideration these insights, we have developed a place typology framework which provides a more appropriate approach to assess economic clusters in the North.

Review of TfN Work to date

The purpose of the review of TfN's work related to economic clusters is to understand the extent and robustness of the evidence base on this subject to enable us to build on this analysis.

Our review has included:

- A review of the Strategic Transport Plan (STP), including draft and final versions
- A review of case study information provided by TfN relating to the economic clusters displayed in the STP
- A review of other related studies commissioned / undertaken by TfN

Our review has shown that TfN has undertaken a detailed sectoral analysis based on employment data, which provides a detailed analysis of where key sectors are located. In addition to this, TfN have identified 47 economic clusters and collected case study information for some of them. Regarding economic clusters, the level of analysis varies by case study and gaps in the analysis exist, as case study information for some clusters is limited or not evident. Additional information on some of these clusters is provided in other studies commissioned by TfN, for example the connectivity and labour markets study provides useful information on commuting patterns across the North.

Based on this review, we conclude that there is additional analyis required to provide a more robust understanding of the economic clusters.

Development of a new framework to assess types of places in the North

Taking an existing EU framework developed to categorise cities in Europe based on their economic and demographic characteristics as a starting point, we have identified place types and adapted these to the North of England taking relevant data and the current case studies provided by TfN into consideration, in consultation with TfN.

We have identified five place types:

Large conurbations: Large conurbations across the north, typically city-regions and combined authorities.

Commuting towns: Towns and smaller cities outside of the big cities that have a high rate of commuting within a set range of distance.

Visitor Destinations: Rural areas and small towns with important natural and historical assets, a high number of visitors and a high share of employment in tourism.

Transformational places: Places with a higher than average productivity and GVA growth compared to the average of the north.

Industrial Places: Places with a high share of employment in traditional industry, low population growth and lower productivity compared to the average of the north.

Analysis of places in the North

Analysing 11,183 Lower Super Output Areas (LSOAs) across the North and the border areas, we have analysed where the five types of places identified can be found across the North. This analysis has been based on a set of criteria defined for each place based mostly on publicly available statistics.

It is important to state that the purpose of the analysis was not to allocate all LSOAs to place types, but to identify the key assets of the north, captured in a suitable number of places. Our analysis has categorised 71% of LSOAs.

Our analysis has shown that:

- Five key types of places can be identified in the North based on their economic and demographic characteristics. These cover most of the North.
- The economic geography of the North is complex with clusters of economic activity located both inside and outside of large conurbations covering both traditional and advanced industries.
- Transformational places are strongly clustered south of Manchester and Liverpool and in the Cheshire region, as well as north of Hull.

- Traditional industrial places are located southeast of Sheffield, Carlisle and in the wider Newcastle area.
- The combined authority boundaries are a good indicator of large conurbations in Manchester and Liverpool, but less so in the other combined authorities of the North.
- Visitor destinations are a key part of the economic geography of the North, covering a large extent of the region. These form distinc t clusters are accurately identified in the map of economic clusters contained in the last version of the STP.
- Commuter towns show a large overlap with all the other place typologies, indicating that providing connectivity for commuters is key across all different areas of the North.

With the outputs from the analysis, we have adapted the original map of economic clusters produced by TfN and included in their STP. This has involved colouring and merging shapes based on where we have identified the different place typologies to be located. The original and new version are presented below on the left and right respectively.

Original and Adapted Economic clusters map (TfN and Arup analysis)

1 Introduction

1.1 Overview of the commission

TfN has commissioned this study to strengthen their evidence base on how agglomeration and clustering take place in the context of the North's current economic structure and potential for growth in the future. The specific aim of this work is to obtain a robust analysis of different types of economic clusters in the North, underpinned by a robust theoretical framework based on cluster and agglomeration literature.

The purpose of this exercise is twofold:

- provide external validity to TfN's clusters, as presented in the STP by supplementing the existing evidence with a robust analytical approach utilising existing datasets
- build a stronger evidence base to understand the impact of improving connectivity between these economic assets or clusters will have

This is important because there is a need for further understanding of the scope for sectoral specialisation and agglomeration in the North, a polycentric economy which is usually assessed as showing low levels of spatial agglomeration and therefore not fully exploiting economies of scale and scope.

The outputs of this piece of work will enable TfN to better understand the impacts of improved connectivity on productivity in the future in more detail, for example by better understanding the need for connectivity improvements and where these are required to enable improved business-to-business linkages. It is also likely to help TfN analyse the different types of productivity impacts that different clusters may show over time.

1.2 Applications of Clustering and Agglomeration theory

Agglomeration economies consist of the productivity benefits resulting from either the concentration or the connectivity of centres of economic activity, which facilitates easy access to supply chains, customers and knowledge spillovers.

Understanding and precisely mapping agglomeration and clusters across specific regions allows us to understand where the North's strengths are and how transport can enable further growth if we can better connect these clusters and assets.

The evidence developed through this commission can also support TfN's stakeholders, building their evidence base to support their development of regional and local plans. By undertaking detailed analysis of the different types of places within the North, TfN will be able to help partners convey the features of places across the North. This will provide evidence for places and sectors which may not have been highlighted through the Northern Powerhouse Independent Economic Review (NPIER).

1.3 Purpose of the report

This report presents our approach and findings from our analysis of economic clusters in the North of England. To be consistent with the economic literature, we refer to these clusters as "types of places" throughout the report. This analysis has been developed through an iterative process in consultation with TfN.

The report is structured as follows:

- Section 2 sets out our overall approach to our analysis
- Section 3 presents our review of the relevant economic literature
- Section 4 summarises the analysis undertaken by TfN prior to this study
- Section 5 presents our detailed methodology to analysing types of places in the North
- Section 6 reports our key findings
- Section 7 concludes and sets out next steps for TfN in developing this analysis further

2 Approach to this study

2.1 Introduction

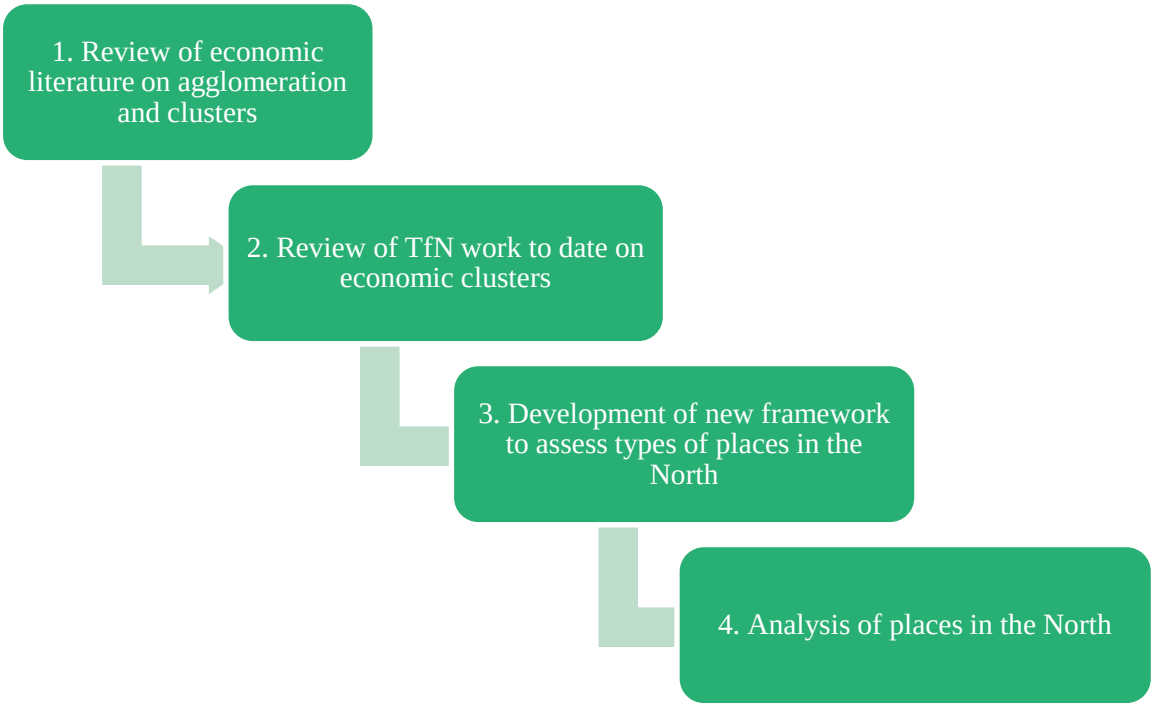
This section presents our overall approach to delivering this study. We have developed an approach which enables TfN to:

- Have a greater understanding of the literature on agglomeration, economic clusters and the criteria that define a type of place
- Have a greater understanding of the robustness of their current analysis
- Build on their work previously undertaken through robust data analysis
- Build a more detailed and robust picture of the types of places in the North and their relevance from an economic point of view

This approach has been developed taking into consideration different clustering and analysis methods and publicly available data sources in consultation with TfN.

2.2 Overall approach

Our approach can be broken down into four stages as follows:



The findings from each of the stages of the work are presented in the next sections.

3 Review of economic literature: Agglomeration and Cluster Theory

3.1 Introduction

This section presents an overview of the agglomeration and cluster theory. The purpose of this review has been to understand how clusters are defined in the Economics literature and how that can be used to identify key economic clusters in the North.

3.2 Agglomeration theory

In the broadest sense, agglomeration benefits are claimed to arise from the effects of firms and individuals being close to one another. These spatial concentrations generate 'agglomeration economies', which helps firms become more productive (Nathan and Overman, 2013).

3.2.1 Agglomeration in the Economics literature

The economic benefits of agglomeration for firms are generated through three main mechanisms, as presented in Figure 1 (Duranton and Puga, 2004):

1. Matching: creating larger labour pools enhances employment and firm performance and attracts talent and investment into a region;
2. Learning: knowledge spillovers appearing as the result of cross-pollination of ideas, research and firm exchanges;
3. Sharing: the integration and sharing of inputs, supply chains and infrastructures, such as roads, rail and street lights create dynamic and integrated environments and permitting economies of scale and scope.

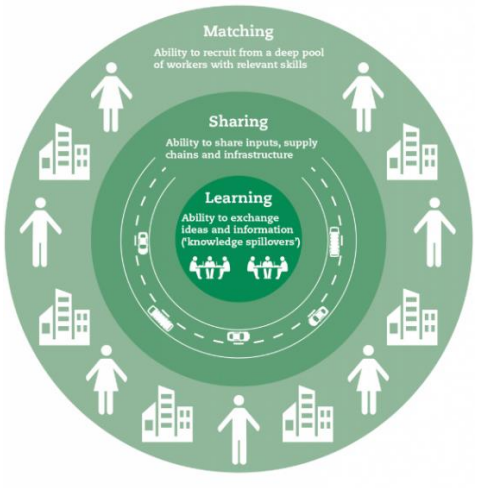


Figure 1: Types of agglomeration benefits (Illustration from Centre for Cities, 2016)

Agglomeration of economic activity is a central feature in the Economics literature and has been approached from various perspectives over time**.**

Economists in the Urban Economics tradition highlight the aggregation of these agglomeration benefits, and the offset by negative externalities such as pressure on commercial rents, housing cost, and congestion. According to this perspective, agglomeration benefits will initially outweigh the costs. However, as an agglomeration grows, the costs, for example increasing congestion, can outweigh the benefits, which in theory will cause firms and labour to locate elsewhere. The New Economic Geography tradition (Krugman 1991, Krugman and Venables 1995, Fujita et al., 1999) focuses more on the influence of trading and transport costs which causes firms to prefer to locate in larger markets.

Another central issue in the agglomeration literature focuses on knowledge spillovers – the extent to which spatial concentration causes 'learning' for individuals and innovation for firms through 'sharing' mechanisms. The central findings from this strand relate to how knowledge spillovers and innovation decrease with distance (Audretch and Feldman 1996, Jaffe et al., 1993, Crescenzi et al., 2008). This is also included in the debate regarding agglomeration types, where the debate centres around which of the following is more important for economic development:

- The 'Marshall-Arrow-Romer (MAR)' thesis argues that the agglomeration effect is stronger in places with production structures specialised in specific industries (sectoral clustering), as knowledge spillovers flow better within a specific industry. This is referred to as localisation or specialisation externalities (Marshall 1890, Arrow 1962, Romer 1986, Glaeser et al., 1992).
- The 'Jacobian' or 'diversification' thesis argues that knowledge spillovers between *different* industries cause places with diversified production structures (complementary industries) to have stronger agglomeration effects. It is often associated with more radical types of innovation and an increase in employment / stronger resilience to unemployment in the cases of economic shocks (Jacobs, 1969).

Overall, this shows that agglomeration, and resulting positive impacts on economic growth, can result from two different reasons: either firms in the same sector locating together or from a high density of diverse economic activity.

3.2.2 Agglomeration and city size

Urban economists such as Overman (2013) suggest that larger agglomerations facilitate business-to-business interactions, leading to higher attractiveness for other firms and people to locate there, turning the size effect into a self-reinforcing mechanism. However, changing the size of a city is not the sole way of generating agglomeration benefits.

In the context of the North, however, this argument has been debated by IPPR North (Cox and Longlands, 2016) who has challenged the big city narrative claiming that, except for London, the population does not always correlate with

productivity in UK metropolitan areas. McCann also argues that size and scale do not solely explain productivity gains, and that inter-urban connectivity appears to be more important in determining this outcome (at least outside the US, Japan and Korea) (McCann and Acs, 2011).

In addition to city size, city connectivity is also likely to play a big role. A recent report from Centre for Cities (2018) highlights the beneficial impacts of connectivity between towns and cities, stating that urban areas strongly influence the success of surrounding towns and vice versa. The better connected these towns and successful cities are, the better the towns' overall performance. Strong cities produce agglomeration benefits that boost investment in nearby towns, providing a significant source of jobs to town dwellers and the necessary conditions needed to scale businesses. There is a case for proximity as well, as 22% of residents in hinterland towns commute to the city. Towns that are brought closer to cities have better employment outcomes than more isolated towns, and that increased proximity to cities may then impact those economic outcomes (ibid).

3.3 Cluster theory

The word 'cluster' is defined as "a group of similar things or people positioned or occurring closer together" (Cambridge Dictionary). It is a common term to use across numerous concepts, particularly concerning Urban Economics literature.

3.3.1 The first wave – Porter's Clusters

The academic literature on clusters is vast and naturally interlinked with agglomeration theories. Most of the cluster literature defines the concept from an industrial or sectoral point of view, for example through the most acknowledged cluster academic, Michael Porter:

Clusters are "the geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated institutions" (2008: 213).

As seen by the definition, this 'wave' of thinking takes the 'MAR'[1] approach, focussing on specialised industries as the relevant clusters. At the heart of cluster thinking lies Porter's 'diamond' which maps out the underlying sources of economic competitiveness. This originally applied to nations (1990), developing into the idea of clusters due to their forces strengthening in spatially concentrations (2000, 2003). Clusters could arise from historic or geographical reasons, and their claimed importance in driving economic development has led to their widespread use in policy-making through fiscal incentives, enterprise zones, improving local infrastructure and promoting university-industry linkages (Nathan and Overman, 2013).

Porter also suggests that the geographic scope (where the sharing, matching and learning occur) of clusters can range from a region, a state, a city to span border areas in neighbouring countries. Cluster members can be SMEs, large firms,

[1] Marshall-Arrow-Romer type of agglomeration

multinationals and an array of other linked actors, such as suppliers, specialised infrastructure, channels of customers or other firms related through skills, technologies or common inputs. Many clusters also include public or third sector institutions such as think tanks, universities and trade associations that provide specialised training, education, research and technical support (Rodriguez-Pose and Comptour, 2013).

The main critique of clusters concerns the lack of a clear-cut definition (Gordon and McCann, 2000; Martin and Sunley 2003; Duranton, 2011). As stated above with scales, members and focus, the literature is vague. Another is that they lack a clear 'purpose', and thereby policies become challenging to define. Policies meant to enhance clusters often encourage easy-to-implement physical areas such as neighbourhood tech quarters or zoning, where the evidence of employment effect is weak (Nathan and Overman, 2013).

3.3.2 The second wave: Innovation systems

The second wave of cluster thinking takes a 'systems' approach to clusters. This approach suggests that clusters are best utilised for innovation and economic growth when they are not simple collocations of firms in similar or related sectors or industries, but when they develop into regional systems of innovation (Rodriguez-Pose and Comptour 2012). It developed from another critique of Porter's approach, claiming that it ignored numerous factors influencing firm capabilities, such as area-level institutions and networks. Innovation systems were originally defined by Freeman (1987: 1) as

"the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies".

'Regional Innovation Systems' apply to the regional scale often describing the key agents in a cluster and their relationships, seen as governing the evolution of the given cluster (Saxenian 1994; Cooke 2002; Asheim et al., 2011). They focus more broadly on the key agents that drive the evolution of the regional clusters, ranging from universities and public agencies, networks (such as public-private partnerships), social institutions (such as norms and customs), and national legal frameworks. The capability of regions to grow depends on both the firm performance and the presence of a well-functioning and facilitating a regional system of innovation (Iammarino, 2005).

3.3.3 The role of spatial proximity in clusters and systems

Spatial proximity is often regarded as vital for economic growth, due to the basic reasoning that barriers to innovation increase with distance. Economic actors clustered in spatial proximity tend to innovate more and to benefit more from knowledge spillovers than those working in remote locations. Innovation travels with difficulty and suffers from decay effects. Most analyses looking at the geographical diffusion of knowledge spillovers have highlighted that effects are neither felt beyond the boundaries of the functional city region, in the case of the United States (Sonn and Storper 2008). In the case of Europe, the distance that can be reasonably covered by a person by car or public transport in a day—circa

200 km (Crescenzi et al. 2007; Rodrıguez-Pose and Crescenzi 2008). Hence – innovation benefits from the proximity of the different actors involved in diffusion and absorbing knowledge, which in turn contributes to the emergence of clusters.

Physical proximity on its own is however not enough to generate growth; other characteristics are at play to transform regions into truly functioning RIS. Regions with similar institutional framework and organisation may show different abilities to accommodate innovation (Iammarino, 2005), and aspects such as skilled labour and ability of firms to absorb technology (Fagerberg 1987, 1994) contribute to determining to what extent a region is innovation prone or innovation averse (Rodriguez-Pose 1999).

3.4 Applications of agglomeration and cluster theory

3.4.1 Agglomeration theory in transport appraisal guidance

Agglomeration benefits are now accepted as important benefits resulting from transport interventions and included in economic appraisals. These benefits are reflected in the UK's WebTAG Wider Economic impacts appraisal guidance, which identifies the wider economic benefits from transport investments that reduce transport costs including agglomeration benefits.

WebTAG recognises that, although agglomeration is usually understood in the concept of physical clustering of businesses, there is also a "static agglomeration" effect from firms being able to access markets more effectively without relocating. As recognised by Venables et al. (2014), transport plays two distinct roles in supporting agglomeration and productivity effects.

- the proximity effect: given the location of activity, transport reduces effective distance between places. This facilitates communications, trade and business links between firms, thereby increasing the sort of interactions that raise productivity.
- the cluster effect: this arises as transport enables activity (particularly employment) to locate in a spatially concentrated way.

In this context, WebTAG[2] identifies the following static and dynamic agglomeration benefits, depending on whether we assume that economic activity moves across the geography. Although not all of them are called agglomeration benefits, they all relate to the benefits typically considered within the agglomeration economies literature:

- Static Agglomeration benefits – this reflects the productivity impact of firms being able to access larger markets more easily
- Dynamic agglomeration benefits – this reflects the productivity impact of firms moving closer together leading to a higher spatial density of economic activity

[2] Department for Transport (2018), TAG Unit A2.1

- Move to more productive jobs (dynamic) – this reflects the movement of workers to more productive jobs as a result of a reduction in commuting costs
- Labour supply impacts (static) – this reflects the increase in labour supply as a result of a reduction in commuting costs
- Outputs from imperfect competition (static) – this aims to reflect the increased output from firms being able to produce at a lower cost leading to either increased output or increased profit as a result of increasing returns to scale

3.4.2 Cluster policies

The use of cluster policies is widespread globally, with the general purpose to boost regional or local economies. The cluster policy approach can take the form of facilitating and linking actors to support clustering or supporting specific clusters through dedicated projects or framework conditions key to the prioritised clusters (OECD, 2010). Policies can be promoted by a variety of different tiers of government, from supra-national (such as the EU) to national, regional and local levels. There is a distinction between a cluster initiative (organised efforts to support the development of the cluster with a person, organisation or consortium leading the actions) and a cluster organisation (ibid.). Common policy instruments are for example mapping studies of clusters and relationships, SME business development support, export networks, specialised training, R&D incentives and access to finance.

Success stories have also played a part in spreading cluster policies, especially through regions such as Silicon Valley (US), Emilia Romagna (Italy) and Baden-Wurttemberg (Germany), all clear examples of tightly interwoven economic actors operating in close proximity resulting in economic success (Lagendijk and Cornford, 2000). Another attraction was the opportunity to facilitate a better direction of inward investment efforts through collaboration between local and international firms, and the belief that local firms could learn from the international giants through supply chain interactions and knowledge spillovers (Engel and del-Palacio, 2009). The cluster concept and associated tools were also easy to comprehend, generic and flexible, and thereby popular across a variety of place contexts (Swords, 2013).

The use of cluster policies also mobilised policy-makers across the UK. New Labour made regional competitiveness a key aspect of their economic development thinking in the early 1990s, leading to the backing of Regional Development Agencies (RDAs) to help regions achieve their economic potential (Tomaney, 2002). The RDAs were established when New Labour came to power, as was the Cluster Policy Steering Group, publishing a series of cluster-related White Papers[3] and an "Innovative Clusters Fund". The Department of Trade and Industry (DTI) also carried out a mapping of existing and potential clusters across the UK, identifying 154, providing the RDAs with focal points for their

[3] Planning for Clusters (2000), "Enterprise, Skills and Innovation" (2001)

development and interests. Millions of pounds were spent on cluster development, and their influence hit their peak in the mid-2000s.

The use of cluster-policies is still widespread today. However, the backing from the national government is currently less generous. RDAs were abolished when the Conservative-Liberal Democrat Government came to power in 2010, replaced by Local Enterprise Partnerships operating with significantly lower budgets, however, with a stronger devolution policy seeing Combined Authorities taking on increased responsibilities concerning regional development.

The UK also sees the rise of Innovation Districts, which can be seen as the next development in UK cluster policies. They are defined by Katz and Wagner (2017) as:

> *"geographic areas where leading-edge anchor institutions and companies cluster and connect with start-ups, business incubators, and accelerators".*

Innovation districts are more closely aligned to the innovation systems thinking, where there is an increased focus on institutions such as universities and accelerators coupled with knowledge-intensive firms. They are often placed within the urban context, in contrast to for example Science Parks, which is often found in the outskirts of cities (Arup, 2018). There are several Innovation Districts in the UK of various level of establishment, amongst other Knowledge Quarter, Liverpool, Queen Elizabeth Olympic Park in Stratford and Leeds Innovation District (ibid.).

3.5 Key insights from the review

The review of the agglomeration and cluster economics literature has provided the following insights:

- Agglomeration of economic activity can generate economic benefits through different mechanisms – matching, learning and sharing
- Different types of agglomeration of economic activity have been studied in the literature – the agglomeration of economic activity of one sector of the economy vs. agglomeration of diverse economic activity. There is a debate in the literature on the economic impacts of both and when they are more important.
- Connectivity improvements can have a similar impact as the physical agglomeration of economic activity – this is referred to as "static agglomeration" in the UK transport appraisal guidance (WebTAG)
- The concept of clusters is only used in the context of sectoral agglomeration and therefore does not capture other types of concentration of economic activity, which TfN are interested in analysing further

Taking into consideration these insights, Section 5 presents a place typology framework which provides a more appropriate approach to assess economic clusters in the North.

4 Summary of cluster evidence in the north (summary of cluster evidence produced by TfN)

4.1 Introduction

This section presents a summary of our review of the work undertaken by TfN, and its partners, to date regarding the analysis of economic clusters in the North. The purpose of this review is to understand the extent and robustness of the evidence base on this subject to enable us to build on this analysis.

Our review has included:

- A review of the Strategic Transport Plan (STP), including draft and final versions
- A review of case study information provided by TfN relating to the economic clusters displayed in the STP
- A review of other related studies commissioned / undertaken by TfN

4.2 Review of TfN's Strategic Transport Plan

TfN's Strategic Transport Plan (STP) (final version published in February 2019) includes both:

- a cluster analysis on the Northern Powerhouse Independent Economic Review's (NPIER) (2016) analysis of prime vs. enabling capabilities(p37).
- A map of economic centres in the North, including national parks and assets of natural beauty, important for the visitor economy (p47)

Below we provide a summary of the analysis undertaken by TfN for each of them.

4.2.1 Sectoral analysis

The STP includes an analysis of the spatial distribution of the 'prime' and 'enabling capabilities' of the North.

The Northern Powerhouse Independent Economic Review (NPIER) identified these capabilities according to 'smart specialisation' principles (Jucevicius & Galbuogiene, 2013), identifying areas with a competitive advantage, high productivity, sectoral strength and distinctive capabilities that permit an area to compete at a national and international level. The method used in this approach is based on 'bottom up' qualitative information and case studies as well as an analysis of 'top-down' sectoral data, similar to the Location Quotient approach used in cluster analysis and presented in part 3.3.

It is worth noting that these are sectors that have a high propensity to cluster in urban areas and have been experiencing significant growth in the north in recent

decades. This suggests that the role of these sectors in the success in the Northern Economy, particularly in urban centres, may be prominent in driving the further development of clusters.

Table 1 Definition of prime and enabling capabilities

Prime capabilities	**Enabling capabilities**
Capabilities that are differentiated and distinctive at a pan-Northern level, performing well on productivity, and can compete at national and international scales. These are: 1. Advanced manufacturing 2. Energy 3. Health Innovation 4. Digital	Play a critical role in supporting the growth and development of the 'prime' capabilities. These are: 1. Financial and Professional Services 2. Logistics 3. Education

These capabilities are defined and calculated using the methodology presented below:

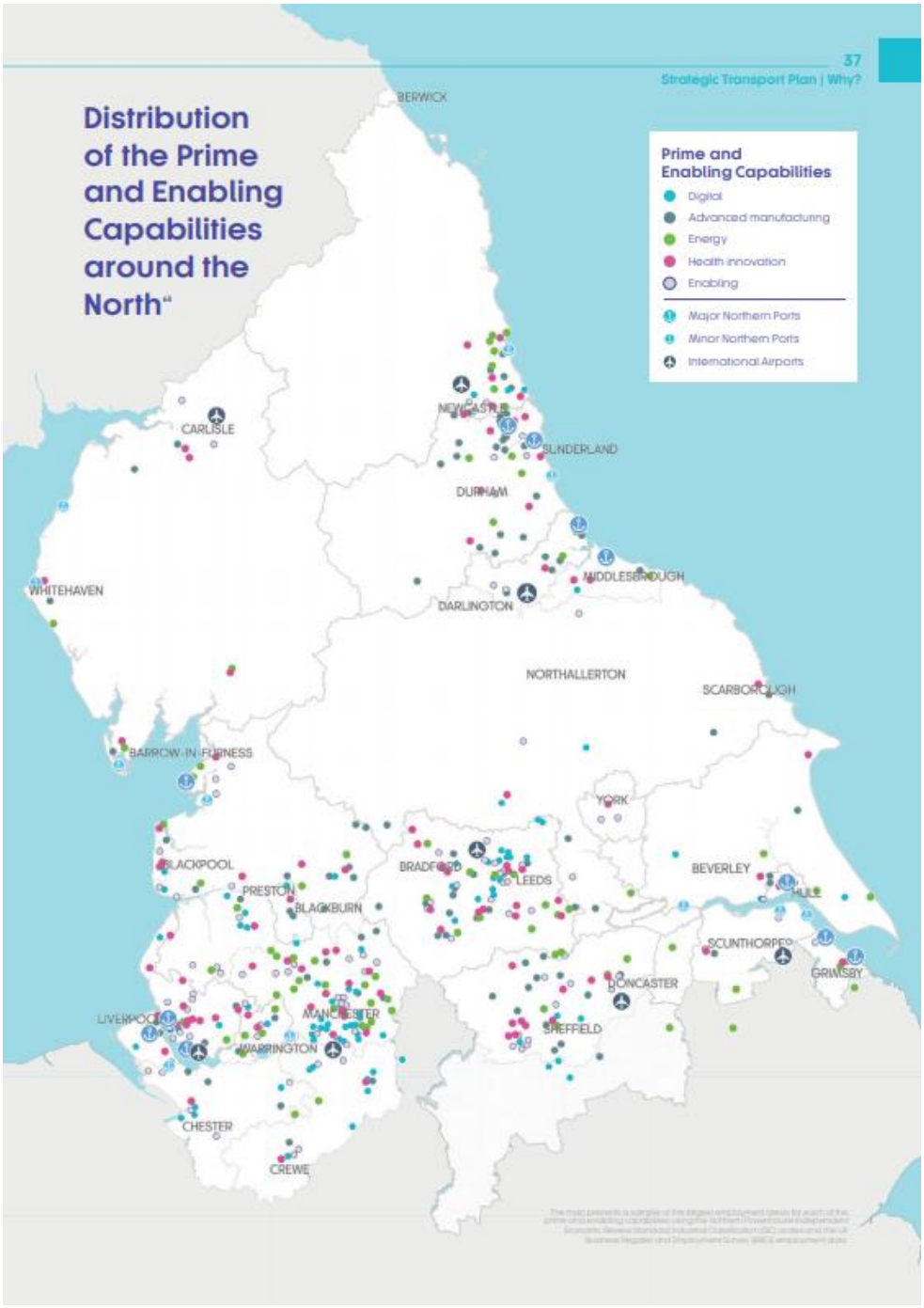
Table 2 NPIER cluster evidence methodology

Source	**Definition**	**Methodology**
Northern Powerhouse Independent Economic Review (2016)	Economic Clusters defined according to 'capabilities' according to 'smart specialisation' principles (p.11).	Top Down Sectoral Data (Cambridge Econometrics GVA, employment and productivity analysis. Baselines used: Vs. Respective Sector Average in Rest of England excl London). Similar to (yet more limited than) a location quotient method. Bottom Up LEP-level evidence of local assets and expertise (LEP plans, leading local employers and evidence basis)

Using the definitions proposed by the Northern Powerhouse Independent Economic Review, the STP presents the following map: (additional maps of prime capabilities are analysed in more depth for each regional corridor: Energy Coasts, Central Pennies, Southern Pennies, West and Wales, East Coast to Scotland, North West to Sheffield City Region and Yorkshire to Scotland).

This map has been produced by collecting employment data at Middle Super Output Area (MSOA) for the sectors belonging to the NPIER capabilities obtained from the Business Register and Employment Survey (BRES). These were identified through the use of 4-digit SIC codes by TfN. A mapping of sectoral employment at MSOA level provides a detailed picture of where the economic activity related to these industries is located and therefore provides TfN with a strong and robust understanding of their spatial distribution. This map is shown in Figure 2.

Figure 2: Distribution of Prime and Enabling Capabilities (Revised STP, 2019) [4]



4.3 Analysis of economic clusters

In consultation with partners, TfN has continued to analyse additional (mostly qualitative) evidence on economic clusters in the North, consolidating this in a set of case studies. The list of economic centres with an associated case study is presented in Appendix 1. More attention is placed on carefully defining clusters,

[4] Based on results from Northern Powerhouse Independent Economic Review's (2016) analysis of 'prime' vs 'enabling' capabilities. TfN derived data from statistical analysis of BRES data.

widening what is considered to be a cluster and moving beyond the narrow NPIER definition to consider a wider set of economic assets and finding new ways to delineate economic clusters across the North. This broadening out of the definition of clusters has sought to demonstrate that the success of the North is broader than the prime and enabling capabilities.

The final STP defines economic clusters as follows:

> "They are geographic concentrations and form the functional economic geography of an area. They tend to comprise of specialisations of firms, supply chains, support services, and specialised institutions, and typically comprise the main population centres, nationally significant assets and infrastructure, university and education institutions, and enterprise zones"

Based on this definition, consultation responses and an adaptation of the cluster theory, TfN developed four broad groups that form the make-up of a series of type of place in the North[5]:

- The large urban conurbations
- Grouping of Northern Powerhouse Independent Economic Review prime and enabling capabilities and/or other sectors.
- The National Parks and Areas of Outstanding Natural Beauty, recognising the important role of the rural and visitor economy, and residential areas.
- The commuter and market towns that have a presence of small and medium-sized business, as well as rural residents, that are located in the periphery of the large urban conurbations and have populations that may commute to other clusters.

Using the definitions and economic cluster divisions proposed above, the final STP draft presents the following map; showing 47 'clusters'. Further information is also provided for the economic purpose and function of each area.

[5] These are titles derived for this research paper and are not titles defined in any other TfN report.

Figure 3: Economic Clusters and Assets in the North (Final STP)

4.3.1 Review of economic cluster / case study information

In addition to the map above, Arup has been provided with initial cluster descriptions and justification by TfN, which have been prepared by TfN in conjunction with partners. These include 28 of the economic centres shown in Figure 4. Using the information provided, we have developed a systematic approach to the review of cluster descriptions, with the following aims:

- To assess the depth and validity of evidence provided with a view to ensuring that all potential features of each cluster are captured in a consistent manner.
- To provide an initial assessment of the consistency of the cluster descriptions and supporting evidence; and

The initial review compared the cluster descriptions under the following five key criteria:

- Is the qualitative and quantitative analysis presented based on data?
- Are multiple indicators of performance included?
- Does the evidence provided allow the clusters to be evaluated against NPIER capabilities?
- Is there a clear indication of time, such as past performance data and/or future forecast? and
- Are detailed references provided?

To evaluate the above, a consistency assessment was undertaken, which groups clusters into three levels depending upon the information provided. The three levels are described below:

Table 3 Consistency Assessment Description

Rating	Description
•••	Strong evidence which broadly matches the key criteria described above.
••	Some quantitative and qualitative analysis based on evidence and multiple indicators
•	Lack of indicators and evidence

Outcome of the review

Consistency of Cluster Descriptions

Out of the 27 cluster descriptions assessed, the number of clusters within each category are summarised below:

Table 4 Assessment Summary

Rating	No. of clusters
••• Strong evidence which broadly matches the key criteria described above.	9 clusters
•• Some quantitative and qualitative analysis based on evidence and multiple indicators	9 clusters
• Lack of indicators and evidence	9 clusters

Clearly, this demonstrates that whilst a reasonable proportion of the cluster descriptions accord with the key criteria, there is some disparity between the evidence and justification provided. Table 5 below provides an example of each assessment category to demonstrate the approach. The full assessment by local authority is presented in Appendix 2.

Table 5 Selected Assessment Examples

Cluster Example	Evidence Base	Performance Indicators	Evidence-based capabilities (1 (low) - 3 (high))	Clear indication of timescales	References	Overall assessment
East Yorkshire	Evidence and analysis not provided to TfN	Not provided to TfN	1	Unknown	N/A	●
Hull	Investments from the offshore wind sector and their associated supply chain has generated 1,000 new jobs; The Port of Hull handles some 10 million tonnes each year	The cargo volume per year, the number of jobs created, the number of passengers of the ferry services	2	Unknown	N/A	●●
The Yorkshire Coast	12,000 new homes and 6,000 new jobs in the cluster; the potential extension of Scarborough Business Park; Bridlington has the highest lobster landings in Europe (420 tonnes in 2014); investments including Yorkshire Offshore Renewables Service Centre at Whitby; visitor economy growth - East Riding over 10% since 2012; Scarborough over 4% from 2013	The number of jobs, the number of visits, turnover, planned investments	2	Growth plans to 2030, Cargo volume and tourism data in 2014	Not provided but considered potentially possible to locate	●●●

Data Capture

Alongside the consistency assessment provided above, a high-level assessment of the depth and variety of evidence provided has also been undertaken and the following observations are made:

- The proposed clusters cover a wide range of geographical locations, demographics and industrial characteristics;
- Some of these locations will have easy access to quantifiable evidence from a range of data sources and also align well with NPIER capabilities ie. areas with high levels of industry can quote job levels, forecast growth and investment with defined timescales;
- Other locations, typically areas of tourism or AONB, may not have immediately available quantifiable data and sources used between similar areas are not immediately comparable;
- Whilst the use of NPIER capabilities is a useful framework for evaluation, it is focused on competitive advantage and closing the productivity gap across the North; and perhaps does not give sufficient weighting to established industries which are important but not growing such as leisure and tourism (Table 7 at the end of this Section, indicating the spread of NPIER capability features referenced in the information provided);
- It is also noted that the information provided describes some clusters in terms of their key strengths but may not include sufficient evidence on other potential areas (as an example, North Lancashire and the South Lakes mentions major industry but includes no evidence or justification, choosing primarily to focus on tourism); and
- It is also noted that some evidence provided in the analysis so far is data driven and others described more qualitatively. Table 6 below summarises common themes and existing data sources, alongside the qualitative features currently described.
- Finally, the case studies only cover 27 of the 47 economic clusters identified in the STP.

Below is a summary of the indicators used in the case studies.

Table 6 Data Source Summary

Existing Referenced Data Indicators	**Qualitative Features Described But Currently Not Supported by Data**
GVA	Quality of life
No. of employees/jobs	Agricultural indicators
Investment (£)	Housing growth
Cargo per year (ports)	Economic benefits of HS2
Exports	
Visitor No.s/Visitor Days (STEAM)	
£ generated by tourism	

Clearly, there is a balance to be struck between ensuring the consistency of data but also allowing all features of each area to be captured with sufficient evidence to enable a fair and valid platform for developing TfN's evidence base. There is an opportunity to expand the sources of data to ensure that all potential features are captured in a consistent manner. The table below shows the references to NPIER capabilities across the case studies. A strong reference indicates that the cluster shows that there is strong evidence that the cluster has a significant amount of economic activity in a particular capability.

Table 7 – NPIER Capability Summary

Cluster	NPIER Prime capabilities			NPIER Enabling capabilities			
	Advanced manufacturing	**Health Innovation**	**Energy**	**Digital**	**Financial and Professional Services**	**Logistics**	**Education (primarily Higher Education)**
Key							
●●●	Strong evidence						
●●	Medium evidence						
●	Limited evidence						
Yorkshire Dale National Park and Nidderdale AONB							
Lake District National Park							
South East Cheshire	●				●	●●	
North East Cheshire	●●	●	●		●	●	●
Chester and Ellesmere Port	●●		●●●		●●	●	●
Mid Cheshire	●			●	●	●	
Sunderland and Durham	●●			●●		●●	●●
Banks of the Tyne	●		●	●	●●	●	●
Newcastle - Gateshead		●●		●	●●	●●	●●●
North Tyneside and South East Northumberland	●●	●●	●●		●	●	
Northumberland National Park					●	●	
North Pennines AONB and Weardale							
Scunthorpe	●●●				●●	●●●	
South Humber			●●●			●●●	●
Selby and Goole	●		●			●●	
Hull	●		●			●●	
East Yorkshire						●	●
The Yorkshire Coast					●	●●●	
York					●		●
Carlisle and Penrith	●●					●●	
West Cumbria	●		●●●			●●	●●
The Furness Peninsula	●●		●●			●●	
North Lancashire and the South Lakes	●	●	●				●
East Lancashire	●●●			●	●		
Central Lancashire	●●					●	●●
Fylde Coast	●		●●		●	●	●
West Lancashire						●	

4.4 Additional studies

Additional work has been undertaken by TfN in understanding who the users of the transport system in the North are, where they are travelling to, their employment characteristics including skills levels and how this may evolve in the future.

Two key studies have been produced that look into these issues:

- Steer (2018), User insight into pan-northern travel – this work provides insights into current travel patterns in the North and how they differ by different population segments.
- Cambridge Econometrics (2018), Connectivity and Labour Markets in the Northern Powerhouse – this work provides insights into travel to work areas in the North, current commuting patterns and how they may evolve in the future under the transformational growth scenario set out in the NPIER. As part of this work, maps were produced at local authority level of commuting flows by origin and destination, based on current commuting patterns and potential transformational commuter flows across the North.

These studies therefore provide key information on understanding the North's population, current and future commuting patterns, particularly around the large conurbations and commuter towns across the North.

4.5 Conclusion

Our review has shown that TfN has undertaken a sectoral analysis based on available data. In addition to this, TfN have identified economic clusters and collected case study information for some of them. Regarding economic clusters, the level of analysis varies by case study and gaps in the analysis exist, as case study information for some clusters is limited or not evident. Additional information on some of these clusters is provided in other studies commissioned by TfN, for example the connectivity and labour markets study provides useful information on commuting patterns across the North.

Based on this review, we conclude that there is additional analyis required to provide a more robust understanding of the economic clusters. The next sections set out our approach and findings to delivering this analysis.

5 Framework and methodology – building place typologies in the north

5.1 Introduction

This section presents a place typology framework developed to enable TfN to identify different types of economic centres in the North. This framework is recognised in the economic literature

The original brief from TfN included the following typologies:

- Large conurbations
- Commuter towns
- Natural and rural assets of outstanding beauty relevant for the visitor economy

These have been considered in the framework described below, which includes additional typologies to provide a more comprehensive view of economic centres in the North of England.

5.2 Place typology frameworks

The modern cluster literature is clearly rooted in analysing specific industrial or economic activity or systems in places, not types of places. However, that does not mean that concepts such as 'large conurbations' and 'commuter towns' are not useful; however, it is considered a 'place typology' instead of a 'cluster'.

Creating place typologies is a balancing act. Prior to Porter, sociologists such as Bruce and Witt (1971) scrutinised the use of 'city typologies' stating that "the ultimate test of any city typology is not whether it is "right" but whether it is useful". They go on to highlight the difficulty of the task (p.238):

> "*The topologist must include enough city dimensions to encompass all important city phenomena, while at the same time avoiding the particularistic fallacy (…) He must also define an operationally workable number of categories or types which group relatively homogenous cities without obscuring important differences among cities*".

In other words, it is important to strike a balance in the number and definition of criteria to come up with meaningful and useful results.

The place typology presented in Figure 2 is a useful starting point to understand the different types of places in the North. It already contains variations of the 'Large Conurbations', 'Commuter towns' and 'Visitor Destinations' categories, along with a series of other variations. The framework was developed by ECOTEC for the European Commission (EC) in 2007 to categorise cities in Europe based on elements such as economic structure, size and GDP compared to the national average. Cities performing under the national GDP average fall under different categories than those performing above. Although the framework is over

ten years old, it is still cited often in more recent literature, for example by Hall (2014) to describe the discrepancies between the North and South of England.

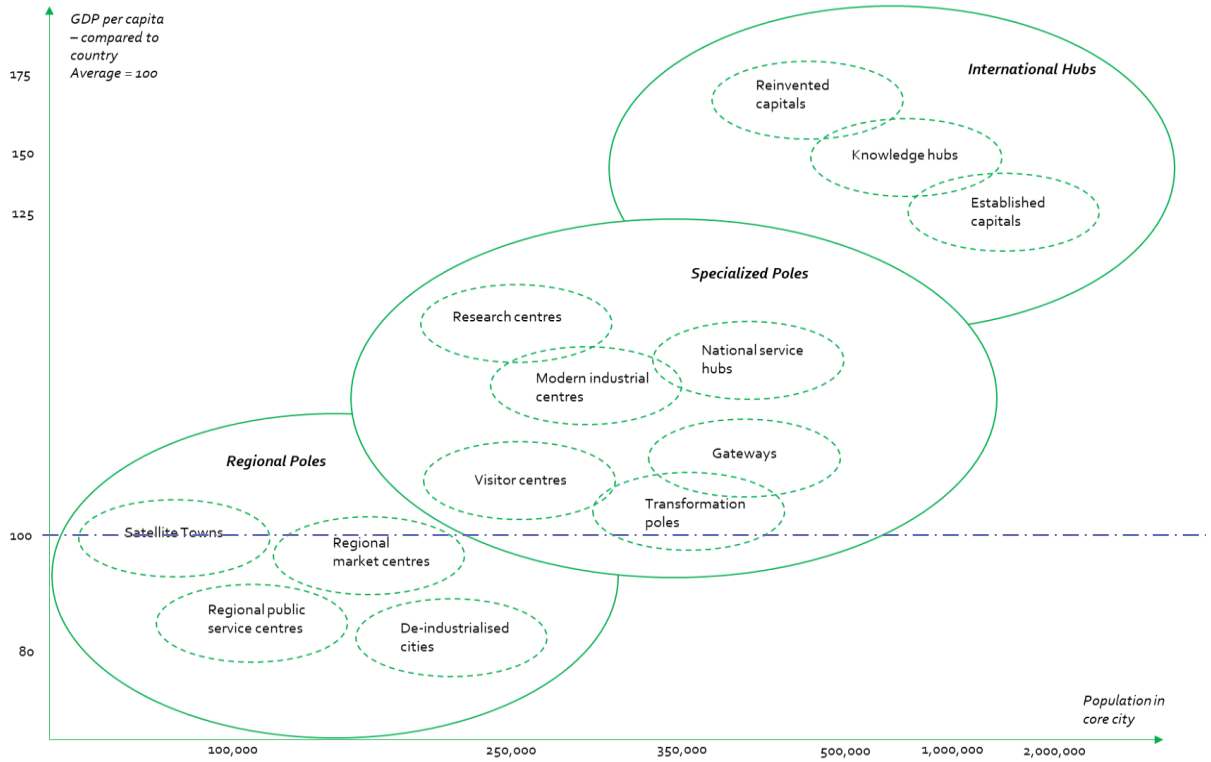


Figure 4: City typology developed for European cities (European Commission, 2007)

Fundamental differences between the city types exist in the strength of their 'ingredients'- the drivers of competitiveness. The most prominent drivers of urban competitiveness identified are:

- innovation,
- talent (in terms of qualified human resources),
- entrepreneurship, and
- connectivity.

The original report suggests that the precise composition and 'mix' of these drivers differs considerably between cities and regions, and it is the use made of the key city attributes that determines the economic success of places to a large extent.

The most productive and populated cities in Europe were placed in the **International Hubs** category. They are often recognised by strong drivers of competitiveness, whether in terms of innovation, entrepreneurship, talent or connectivity. In combination with their size, this allows these largest cities to

pursue and obtain a dominant position in a range of economic domains. They can be:

- **Knowledge hubs** – key players in the global economy, positioned above the national urban hierarchy and in the forefront of international industry, business and financial services, based on high levels of talent and excellent connections to the rest of the world.
- **Established capitals** – firmly positioned at the top of national urban hierarchies, with a diversified economic base and concentrations of wealth;
- **Re-invented capitals** – champions of transition, engines of economic activity for the New Member States.

Secondly, a wide range of **Specialised Places** are identified. They also contribute significantly to growth, jobs and prosperity. The fundamental difference with International Hubs is that the drivers are not nearly as strong and not always as evenly spread as in their larger counterparts. They also need to focus on specific economic activities if they want to dominate at an international level. These Specialised Places can choose to develop their international competitiveness sectors such as pharmaceutical, car manufacturing, creative industries, or tourism – but their size makes it very unlikely to excel in the full range of economic activities. The types of places within this category are:

- **National service hubs -** playing an essential role in the national urban hierarchy, they fulfil key national functions and often some capital functions in the (public) services sector;
- **Transformation places**[6] – with a strong industrial past, but well on their way to reinventing themselves, managing change and developing new economic activities;
- **Gateways** – larger cities with dedicated (port) infrastructure, handling large flows of international goods and passengers;
- **Modern industrial centres** – the platforms of multinational activities, as well as local companies exporting abroad; high levels of technological innovation;
- **Research centres** – centres of research and higher education, including science and technology related corporate activities; well connected to international networks;
- **Visitor Destinations** – handling large flows of people of national or international origin, with a service sector geared towards tourism.

Thirdly, **Regional Places** are identified, playing an important role within regional boundaries. Their competitive advantages are strong within a regional context, but less so beyond those borders. Their challenge lies in using their strengths,

[6] The European Commission report (2007) places Leeds, Manchester, Liverpool and Newcastle upon Tyne in this category

connecting them to future opportunities, while preserving their attractiveness. To make a national and pan-national difference, they need to have clear and convincing strategies – based on deliberate choices:

- **De-industrialised cities**[7] – having a strong (heavy) industrial base, which is in decline or recession;
- **Regional market centres** – fulfilling a central role in their region, particularly in terms of personal, business and financial services, including hotels/trade/restaurants;
- **Regional public service centres** – fulfil a central role in their region, particularly in administration, health and education;
- **Satellite towns** – smaller towns that have carved out roles in larger agglomerations.

Both Hall (2014) and the European Commission (2007) argue that cities in Northern England fall under the category of Specialised Places and Regional Places, and specifically within "Transformational Places" and "De-industrialised cities". However, this analysis is likely to be slightly out of date and more analysis is required to validate this.

5.2.1 Existing framework methodology

The State of European Cities Report used a comprehensive methodology to reach the city types and suggest further use of the framework to consider its intended aim, ***to assist cities in identifying comparator urban areas facing comparable economic development patterns***. We argue that this is in line with the aim our analysis, particularly as it will permit us to identify a wider range of 'place assets' in the north. We suggest to broadly follow the steps of the EC methodology as outlined below:

Step 1: Analyse GDP performance by size class: Applied to the North of England and not the entire EU would alter the scale of population and the levels of GDP to mirror today's landscape.

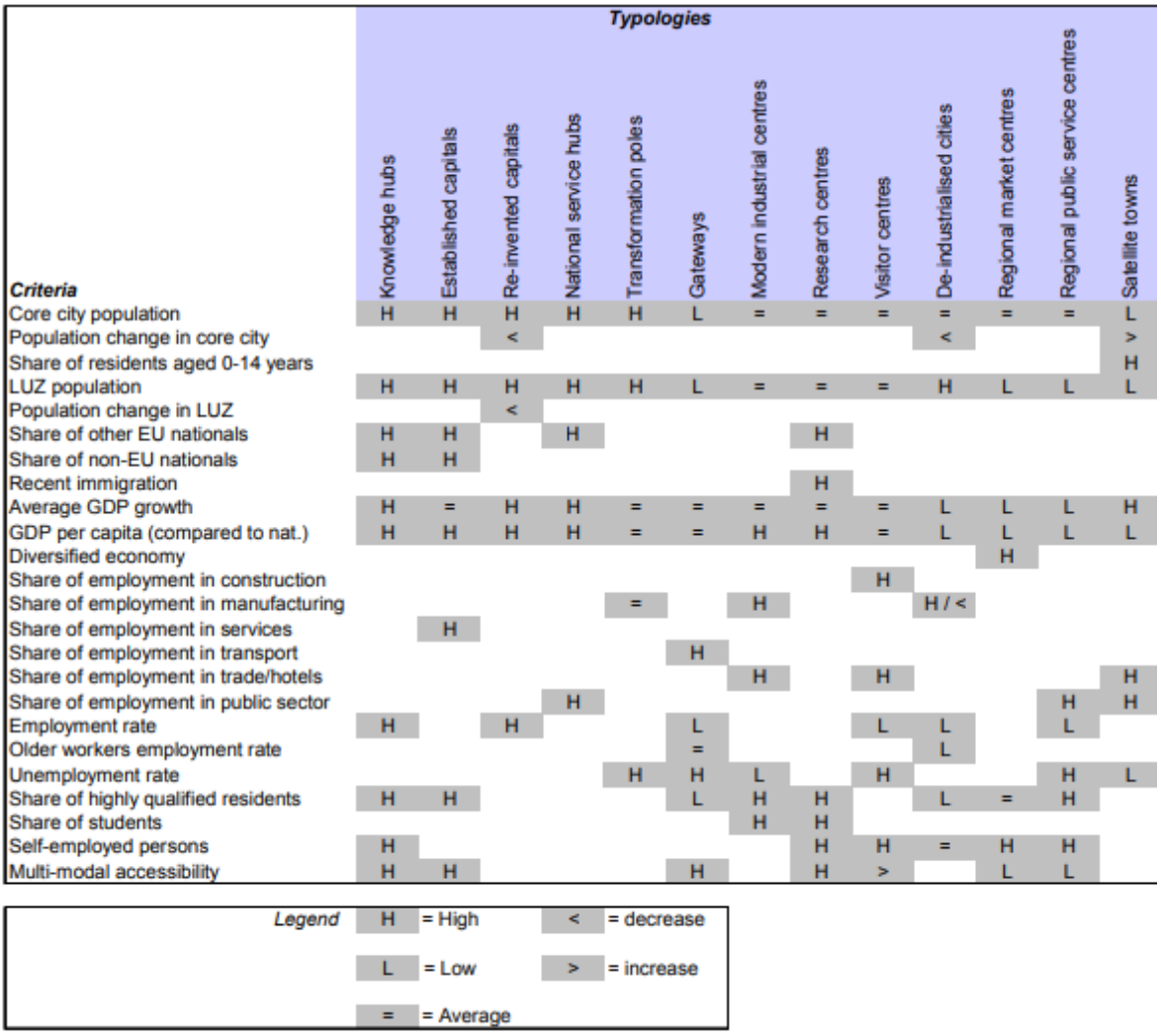
Step 2: Grouping and interpretations: The patterns of the different size classes were by the EC analysed more in-depth, depending on whether they were 'catching up', 'keeping up', 'falling behind' or 'staying behind'. Several types of places could be identified based on economic performance and city size.

We would carry out our own amendments which would result in a range of city-types relevant for the northern context.

Step 3: Adding additional criteria: Based on the initial groupings, additional criteria were added (see Figure 3). For example, a high share of employment in trade, hotels and restaurants is important to distinguish visitor's centres, while a high share of public sector employment was a pattern in Regional Public Service Centres.

[7] The European Commission report (2007) places Sheffield, Derry, and Bradford in this category

Figure 3 outlines the criteria used in the EU study. We would suggest removing the less relevant metrics, and include others, such as the share of Scale Up Businesses.



Criteria	Knowledge hubs	Established capitals	Re-invented capitals	National service hubs	Transformation poles	Gateways	Modern industrial centres	Research centres	Visitor centres	De-industrialised cities	Regional market centres	Regional public service centres	Satellite towns
	Typologies												
Core city population	H	H	H	H	H	L	=	=	=	=	=	=	L
Population change in core city			<							<			>
Share of residents aged 0-14 years													H
LUZ population	H	H	H	H	H	L	=	=	=	H	L	L	L
Population change in LUZ			<										
Share of other EU nationals	H	H		H				H					
Share of non-EU nationals	H	H											
Recent immigration								H					
Average GDP growth	H	=	H	H	=	=	=	=	=	L	L	L	H
GDP per capita (compared to nat.)	H	H	H	H	=	=	H	H	=	L	L	L	L
Diversified economy											H		
Share of employment in construction									H				
Share of employment in manufacturing					=		H			H / <			
Share of employment in services		H											
Share of employment in transport						H							
Share of employment in trade/hotels							H		H				H
Share of employment in public sector				H								H	H
Employment rate	H		H			L			L	L		L	
Older workers employment rate						=				L			
Unemployment rate					H	H	L		H			H	L
Share of highly qualified residents	H	H				L	H	H		L	=	H	
Share of students							H	H					
Self-employed persons	H							H	H	=	H	H	
Multi-modal accessibility	H	H				H		H	>		L	L	

Legend				
	H	= High	<	= decrease
	L	= Low	>	= increase
	=	= Average		

Figure 5: *Criteria for the different types of places used in the European Commission Report*

Step 4: Classifying remaining cities: This step will be used to review the types based on the analysis and identify whether there are gaps in typologies.

Step 5: Verification and adjustment: The listings by the EC were verified by internal peer reviews and expert reviews.

5.3 Adapting the city typology framework to the North of England

Inspired by the presented framework, the first task of the analysis was to adapt the typologies to the North of England, a smaller and less diverse geographic area compared to the entirety of the EU.

5.4 Methodology steps

5.4.1 Step 1: Identifying types of places

Taking the EU framework described in the previous section as a starting point, we have identified place types and adapted these alongside relevant data and the current case studies provided by TfN.

To ensure that we identify places according to data evidence, the analysis is carried out looking at 11,183 Lower Super Output Area (LSOA) levels in the north. These LSOAs include all LSOAs in the North plus some LSOAs in the Midlands and Wales, which are considered to be relevant for northern connectivity, as agreed with TfN.

It is important to state that the analysis is not meant to categorise every place in the north, but to identify the key areas according to the most common types of places, and those identified as particularly important for the purpose of this analysis. Sorting places into types is not meant to provide exact answers stating that places within the types can only be identified with these parameters, but it is a useful way of getting an overview of places that have many things in common.

To provide a more comprehensive view of the most common place typologies in the North, we have added two place typologies which reflect key areas of economic activity outside of large conurbations, the industrial and transformational places. We have therefore analysed five place types:

- **Large conurbations**: Large conurbations across the north, typically city-regions and combined authorities.
- **Commuting towns:** Towns and smaller cities outside of the big cities that have a high rate of commuting within a set range of distance.
- **Visitor Destinations**: Rural areas and small towns with important natural and historical assets, a high number of visitors and a high share of employment in tourism.
- **Transformational places:** Places with a higher than average productivity and GVA growth compared to the average of the north.
- **Industrial Places:** Places with a high share of employment in traditional industry, low population growth and lower productivity compared to the average of the north.

5.4.2 Step 2: Identifying relevant variables and setting the initial criteria

The second step of the methodology focussed on setting the right criteria suitable to the place types identified that each of the 11,183 LSOAs in the area of analysis would be classified against. Firstly, a long-list of relevant variables were identified, guided by dialogue with TfN and data availability.

The next step, through an iterative process, was to set the criteria for each of the place types. Using data for the 11,183 LSOAs included in the analysis, the average within each category was calculated. Note that the analysis includes all LSOAs in the North as well as some LSOAs in Wales and the Midlands, which are economically linked to the North and considered to be of interest. Based on the average, the criteria could consist of either of the following scores:

- Higher than average
- Average (+/- 1%)
- Lower than average
- Increasing over the last 5 years
- Decreasing over the last 5 years.

The foundation of the set criteria was based on insights from literature on the types of places, the EU framework, data and dialogue with TfN. The road to the final set of criteria was highly iterative and adapted through the on-going analysis and validation of results.

Another core element of the analysis was to set which criteria were core and which were secondary. The **core criteria** stated that the LSOA would not be classified into the place type in question if the criteria were not met. Other variables would be **secondary** to recognise the level of variations within the types of places the LSOAs. In order to be classified into one of the category, the LSOA would have to meet the core criteria, and 40% of the secondary criteria. Figure 8 illustrates the final table of which criteria are core or secondary, and the criteria score is presented on Figure 9.

For an overview of the SIC-codes included in each of the employment variables as well as the sources for each variable, see Appendix 3.

Table 8 Core and Secondary criteria by place type

		Core versus Secondary Criteria						Criteria Score				
	ASSESSMENT OF PLACES BY CRITERIA (all variables are by LSOA unless they say "in the catchment area")	**Large Conurbations**	**Visitor Destinations**	**Industrial Places**	**Transformational Places**	**Commuter Towns**		**Large Conurbations**	**Visitor Destinations**	**Industrial Places**	**Transformational Places**	**Commuter Towns**
Demographics	Population change last 5 years			S						L		
	Population density		S					H	L			
	Population in catchment area (15km from LSOA centroid)	C	C		C			H	L		L	
	Share of population aged 65+		S						H			
	Population change in 65+		S						H			
Employment / Economy	Average growth in GVA per worker in the catchment area				S						H	
	GVA per worker in the catchment area			C	C					L	H	
	Share of employment in KIBS				C						H	
	Share of employment in Tourism		C						H			
	Share of employment in Traditional Industries			C						H		
	Share of employment in Advanced Manufacturing				S						H	
	Growth in Advanced Manufacturing				S						H	
	Share of employment in the Public Sector					S						H
	Employment density		S			C			L			L
	Unemployment rate			S						H		
	Change in unemployment rate last 5 years				S						>	
	Share of self-employed		S						H			
Skills	Share of highly qualified residents			S		C				L		H
Commuting	Share of commuters in local authority commuting within local authority					C						L
	Share of commuters commuting to a combined authority + Hull	C						H				
Tourism	No of visitors in local authority		C	S					H	L		
	Number of historical assets		S						H			

H	High	A	Average	L	Low	>	Decreasing

5.4.3 Step 3: Analysis, adaptation and verification

The analysis was run through a purpose-built excel-model categorising each of the LSOAs into the set place types. The final results of the analysis were achieved through an iterative process where the criteria included, and their scoring were adapted along the way. The first round of adaptation related to the number of LSOAs allocated to a category. The analysis was purposefully started with a wide range of criteria to allow for room to reduce and adapt. A relatively low amount of LSOAs were allocated to a category in this round, leading to the next steps of adapting each category to better mirror the true place types of the north.

A key part to the verification process of the analysis was to map the indicative results in GIS. This allowed a more sophisticated analysis of the location of each allocated LSOA, such as whether the geographical pattern made logical sense. It displayed whether the places types were clustering, and where they were clustering. It enabled the use of local knowledge to ask questions regarding excluded places that were thought to fall into a certain type of place, and led to adaptation of several criteria, such as the range of commuting.

The variables and scores in Figure 8 and 9 show the final round of scoring. However, there have been several other variables that have been considered throughout the process, as the analysis has gone through multiple iterations to find the results that best capture the typologies of places defined. They have been taken out of the final analysis either due to:

- Causing significant overlaps between place types
- Not providing valuable insights
- Causing exclusion of a large number of relevant LSOAs

An example of an iteration to remove overlaps was the inclusion of low population density as a core criterion for transformational places in order to be able to find those productive places outside of cities. We also removed secondary criteria out of large conurbations, recognising the diversity of these places and capture a higher number of LSOAs which we considered to be in large conurbations.

A description of the analysis process is provided for each typology.

6 Results

6.1 Introduction

This section presents the key results from the clustering analysis using the methodology described in the previous section. It includes the overall results for all place typologies as well as the detailed results for each place type. These results are also analysed in the context of the work undertaken by TfN.

6.2 Overall results

The final version of the analysis categorised 7,898 (71%) of the LSOAs in the area of analysis. 54% have only one category, while 17% have more than one category. It is important to state that the purpose of the analysis was not to allocate all LSOAs, but to identify the key assets of the north, captured in a suitable number of places.

Not allocated areas are LSOAs which show average socio-economic indicators and therefore do not stand out or clearly show attributes that are characteristic of the defined five place typologies. An example of this is the local authority of North Lincolnshire, which shows average productivity as well as a mix of employment in traditional and advance industries, as well as tourism. This local authority, although important from an economic perspective, does not stand out as a particular category and appears as not allocated.

The results by LSOA are shown below. Further below we also present an adaptation of the TfN economic clusters map in two iterations, with and without changing the cluster shapes.

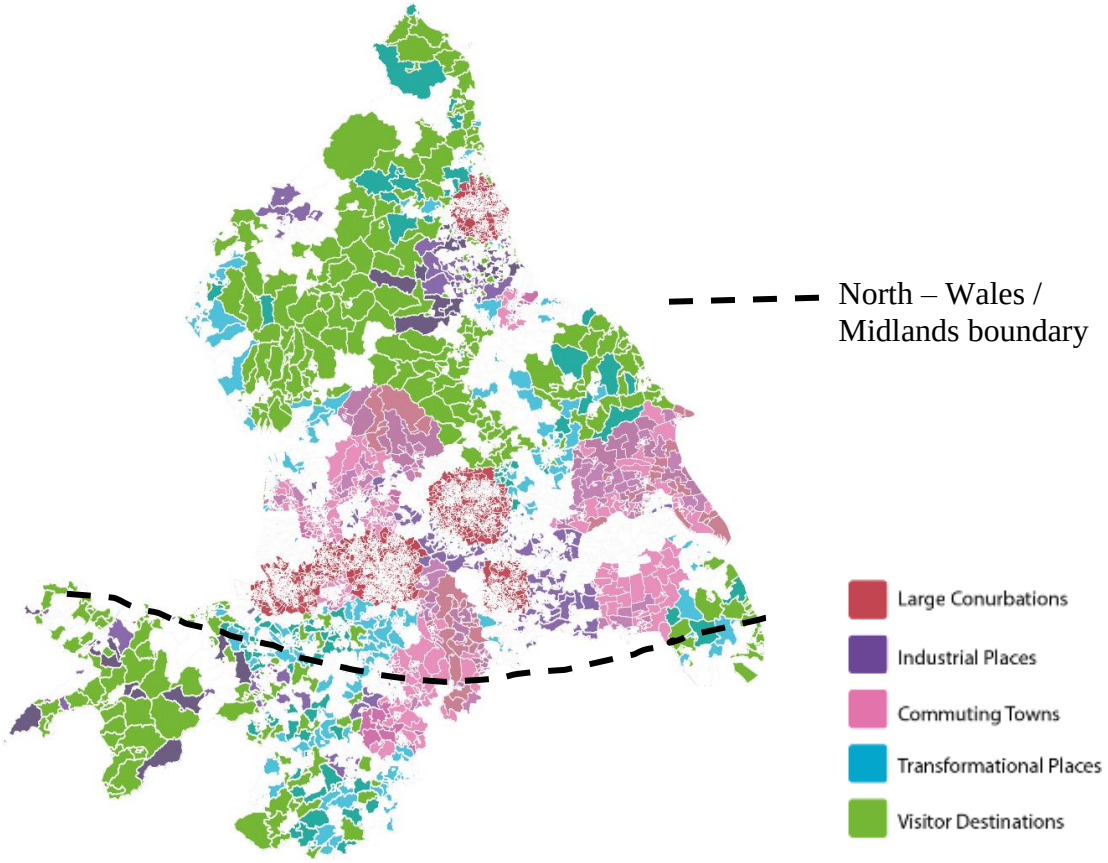


Figure 6 Place typology results by LSOA

Figure 9 Original cluster map (TfN STP 2019)

Figure 7: Cluster map coloured with analysis results (Arup)

Figure 8: Adapted TfN Cluster Map (Arup)

Figure 10, 11 and 12 show the original TfN Cluster map, an adaptation of the TfN map with the economic clusters colour-coded by the place types identified in our analysis, and the map by LSOAs, visualising the categorisation of place types by LSOA. Note that the map by LSOA contains also parts of Wales and the Midlands.

As we can see from the adaptation of the original cluster map, some areas, especially the Visitor Destinations (mapped as Natural Assets in the original map), match very well with the green areas in the original TfN map, denoting areas of natural beauty and national parks.

What is displayed as Economic Clusters on the original map is split into Transformational Places, Industrial Places and Commuter Towns in this version of analysis. Many of these places are largely allocated to one category only, while other areas such as North Yorkshire, Harrogate, Wetherby and Knaresborough, East and Central Lancashire, Hull and East Yorkshire contain LSOAs with characteristics from three types of places. As the cluster captures quite large areas, this is to be expected.

As the map by LSOAs shows, the reality is slightly more ‘chaotic’, which is true of the nature of places, with some place typologies overlapping in some locations. However, it also shows that the types of places do cluster in geographical patterns.

The following sections go in-depth into each of the place types, presenting each of their criteria and scores along with individual maps compared to the original TfN cluster map for ease of reference.

The list of economic clusters identified by TfN and their corresponding place typology is listed in Appendix 2.

6.2.1 Large Conurbations

Large Conurbations are systems of large cities and adjacent areas, typical of a city-region.

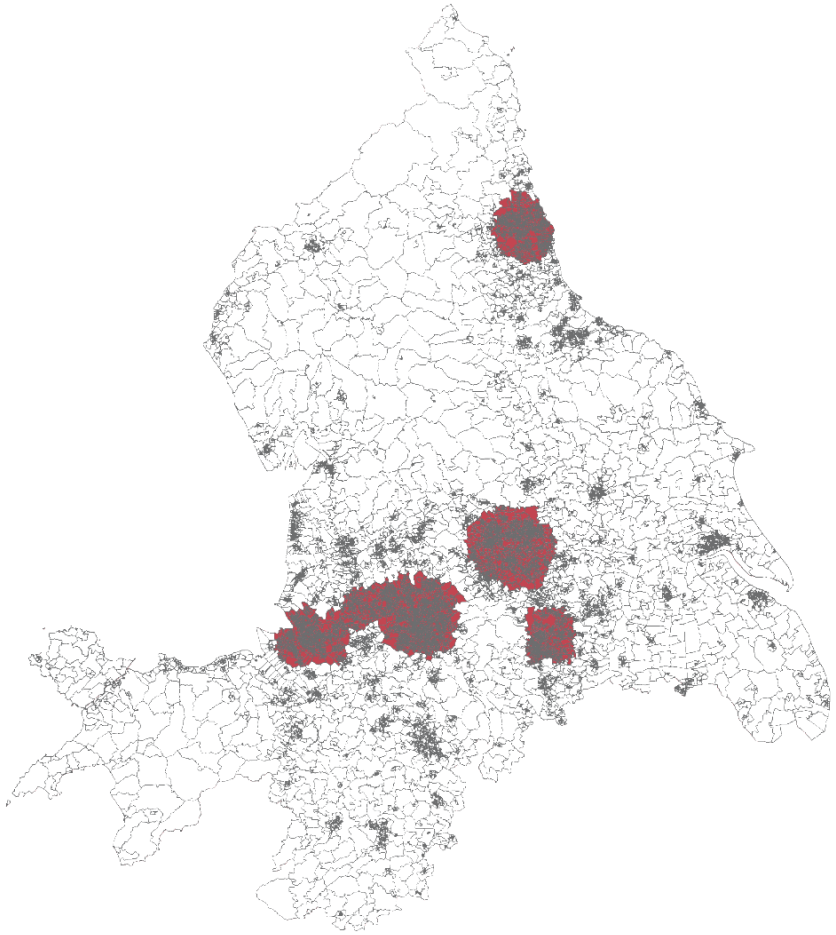
Number of LSOAs in category: **4830**
Percentage of LSOAs in category (out of 11,183 LSOAs in scope)**: 43%**
Overlap with Visitor Destinations: **0**
Overlap with Industrial Places: **691**
Overlap with Commuter Towns: **665**
Overlap with Transformational Places: **0**

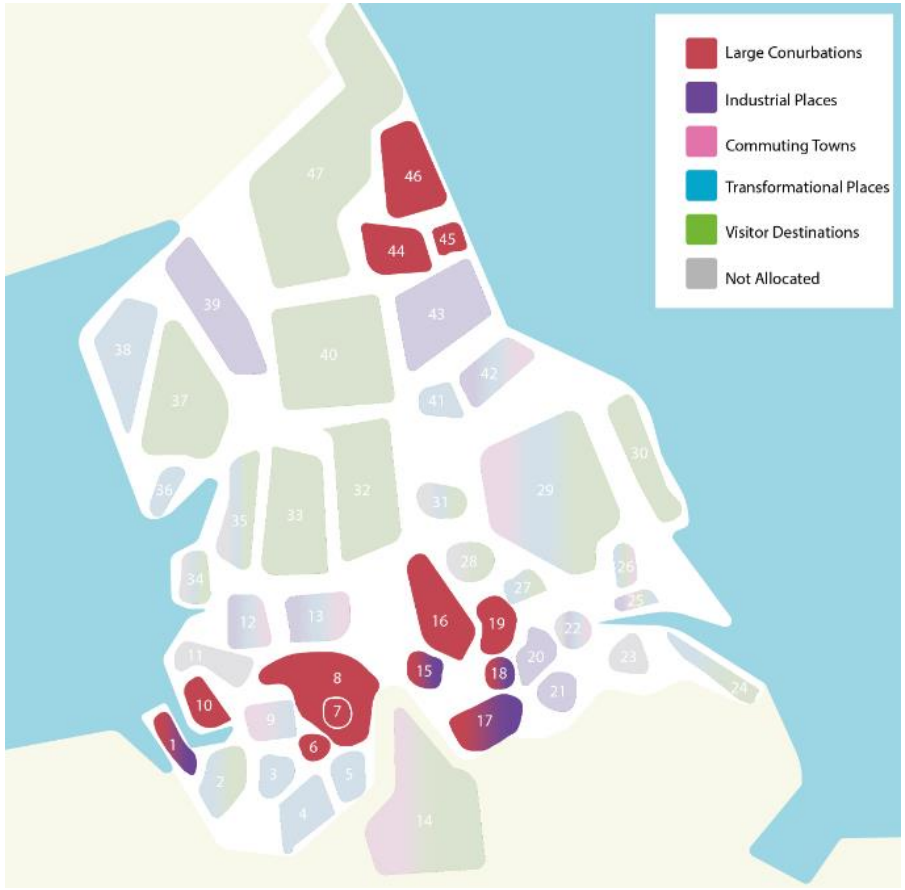
Criteria and Score

Topic	Variable	Criteria Score	Score	Core/ Secondary
Demographics	Population in catchment area		H	C
Commuting	Share of commuters commuting to a combined authority + Hull		H	C

LSOAs within Local authorities categorised

Local Authority	Number	Local Authority	Number	Local Authority	Number
Leeds	457	Salford	150	Sefton	110
Sheffield	329	Sunderland	150	Gateshead	109
Liverpool	298	Tameside	141	South Tyneside	102
Manchester	282	Oldham	140	Knowsley	98
Bradford	246	Trafford	138	Calderdale	95
Wigan	193	Rotherham	136	Halton	55
Stockport	190	North Tyneside	131	County Durham	37
Wirral	183	Rochdale	125	Barnsley	29
Bolton	177	Bury	120	Northumberland	23
Kirklees	177	St.Helens	119	Doncaster	8
Newcastle upon Tyne	170	Wakefield	112		

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Large Conurbations is the Place Type containing the fewest criteria. It only includes ‘population in catchment areas’ and ‘share of commuters commuting to a combined authority and Hull”. This is because large conurbations show different demographic and economic characteristics within them, for example, city centres tend to show higher productivity levels and a younger population compared to the outer skirts. A broad definition is therefore necessary to capture the wide-ranging characteristics of large agglomerations of people and economic activity in large conurbations.

Analysis

- The analysis captures the large conurbations of Liverpool, Manchester, Sheffield, Leeds and Newcastle.
- While in the case of Liverpool and Manchester the shape of the large conurbations matches considerably well the combined authority boundaries, this is less the case for Sheffield and Newcastle, where the combined authorities containing these cities extend significantly beyond the actual large conurbation
- Hull is not captured as a large conurbation, as the population in the catchment area is below the average for all LSOAs in the North. Hull is considered to be a mix of place typologies as opposed to a large conurbation.
- The large conurbations of Manchester and Liverpool are significantly close to each other, almost merging.

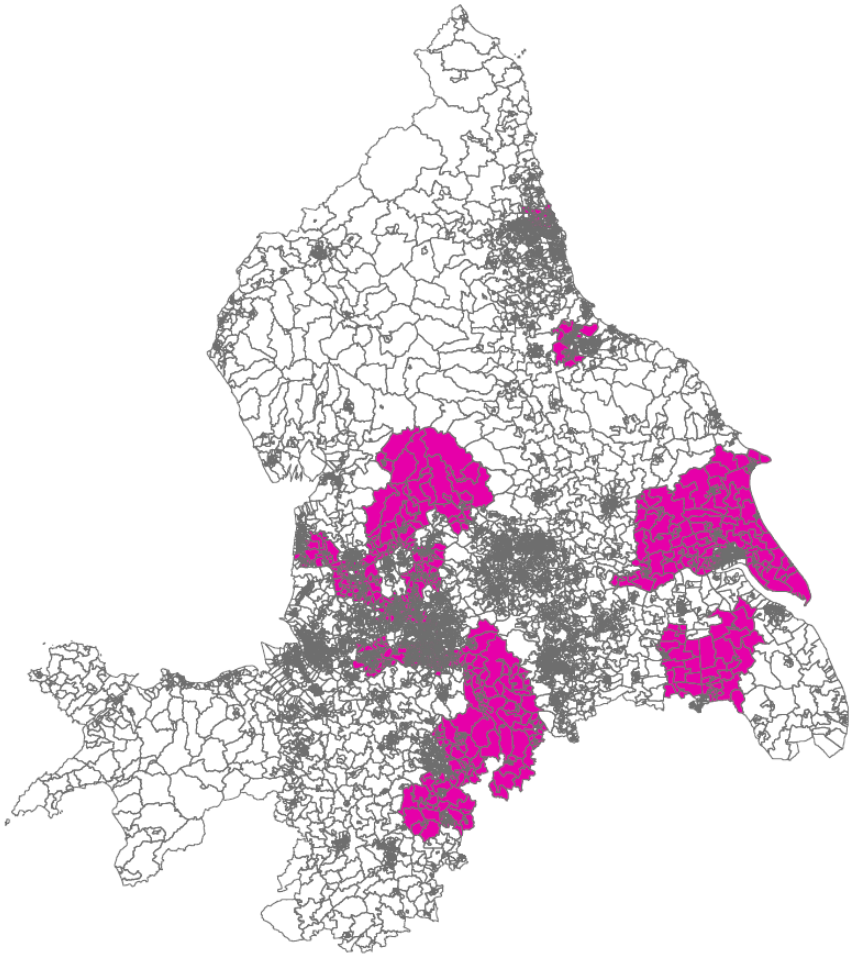
6.2.2 Commuting Towns

Commuter towns represent areas with a high number of skilled people not working in their area of residency.

Number of LSOAs in category: **1584**
Percentage of LSOAs in category**: 14%**
Overlap with Large Conurbations: **665**
Overlap with Industrial Places: **82**
Overlap with Commuter Towns: **124**
Overlap with Transformational Places: **194**

Topic	Variable	Criteria Score	Score	Core/ Secondary
Employment	Employment density		L	C
	Share of employment in the Public Sector		H	S
Skills	Share of highly qualified residents		H	C
Commuting	Share of commuters in local authority commuting within local authority		H	C

Local authority	Number of LSOAs	Local authority	Number of LSOAs
Bolton	128	Burnley	41
Bury	82	Chorley	54
Manchester	140	Fylde	39
Stockport	128	Ribble Valley	37
Trafford	91	Rossendale	41
North Tyneside	96	South Ribble	51
Stockton-on-Tees	97	West Lindsey	49
Warrington	93	Craven	26
East Riding of Yorkshire	177	Stafford	68
Derbyshire Dales	39	Staffordshire Moorlands	55
High Peak	52		

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Commuter Towns are clearly defined by their share of people commuting outside of their local authority, a low employment density, and a tendency to have a higher share of highly skilled people, these are people who prefer to live in the suburbs and commute to city centres. We also expect these places to have a higher share of employment in the public sector providing essential services such as schools and health services.

Analysis

- The analysis captures areas surrounding large conurbations as well as Hull to some extent Durham.
- Commuter Towns is the category that shows the highest overlap with other typologies, particularly large conurbations, showing that commuter towns can play different roles at the same time.
- The overlap with transformation places shows that commuter towns can also be productive places.
- The peak district, in addition to being a visitor destination, is also captured as a commuting area.

6.2.3 Visitor Destinations

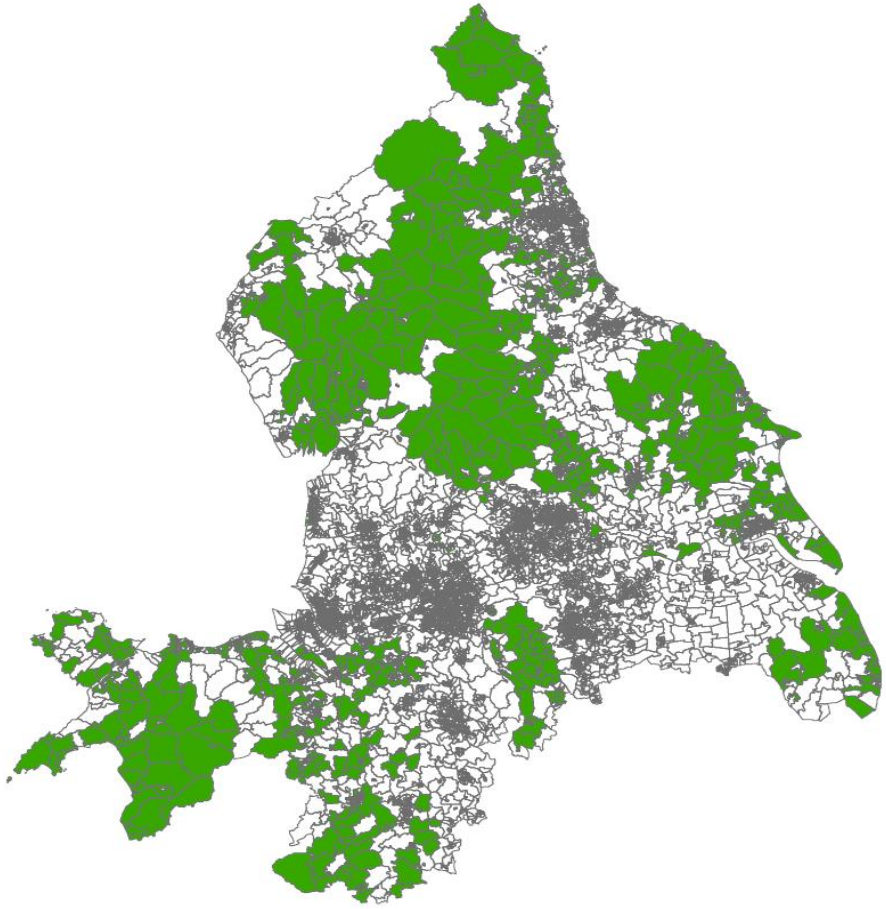
Visitor Destinations are rural areas or small towns with valuable natural assets, high share of employment in the tourism sector, and a high share of holiday trips.

Number of LSOAs in category: **935**
Percentage of LSOAs in category**: 8.3%**
Overlap with Large Conurbations: **0**
Overlap with Industrial Places: **61**
Overlap with Commuter Towns: **124**
Overlap with Transformational Places: **210**

Topic	Variable	Criteria Score	Score	Core/ Secondary
Demographics	Population density		L	S
	Population in catchment area		L	C
	Share of population 65+		H	S
	Population Change n 65+ category		H	S
Employment	Share of employment in tourism		H	C
	Employment Density		L	L
	Share of self-employed		H	S
Tourism	No of visitors in local authority[8]		H	C
	Number of historical assets		H	S

Local Authority	LSOAs	Local Authority	LSOAs	Local Authority	LSOAs
County Durham	111	South Lakeland	37	Ryedale	20
Shropshire	85	Harrogate	34	Isle of Anglesey	20
East Riding of Yorkshire	80	Derbyshire Dales	26	Allerdale	19
Northumberland	78	York	26	Craven	19
Cheshire West and Chester	56	Blackpool	23	Wrexham	18
East Lindsey	43	Flintshire	22	High Peaks	16
Gwynedd	43	Denbighshire	21	Leeds	10
Scarborough	41	Eden	21	Rossendale	3
Conwy	38	Richmond shire	21	Newcastle upon Tyne	2

[8] Note that visitor data was not available for Wales or Northumberland, but both are considered to be key visitor destinations and therefore this core criterion was removed for these specific areas.

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Visitor destinations are rural areas with natural or historic assets that attract a large number of visitors every year. These areas have usually a higher number of jobs in the tourism sectors such as food and accommodation.

Analysis:

- The results from the Visitor Centre type match well with the initial clusters identified by TfN. The main Visitor Destinations are Northumberland and Hadrian's Wall, North pennies and Wearside, The Yorkshire Dales, Forest of Bowland, The Lake District, The Yorkshire Coast, and The Peak District.
- Several other clusters have a significant number of areas classified as Visitor Destinations. This is for example North and East Yorkshire, South Humber, Chester and Ellesmere Port, The Fylde Coast, and North Lancashire and the South Lakes.
- The analysis also picks up a rather large area in Northern Wales, including Snowdonia National Park and coastal areas of North Wales.
- This category shows strong clustering of Visitor Destinations, there are fewer areas scattered on their own, signalling the link with natural assets such as National Parks.

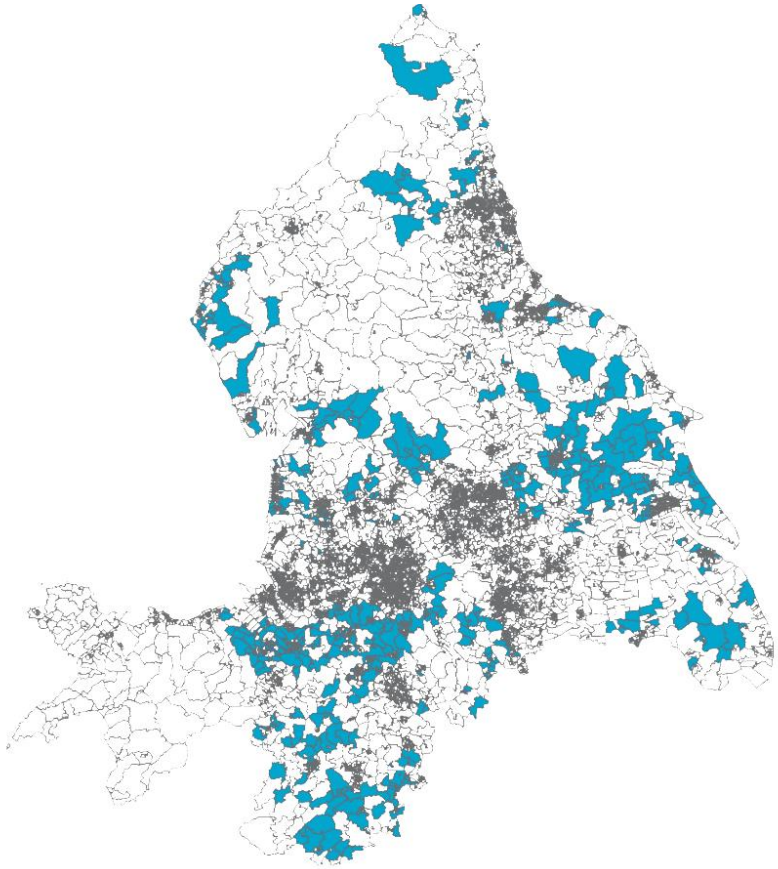
6.2.4 Transformational Places

Transformational Places categorise areas with lower population and high productivity, high productivity growth and low unemployment. There is often a higher than average share of employment in KIBS and advanced manufacturing.

Number of LSOAs in category: **959**
Percentage of LSOAs in category**: 8.5%**
Overlap with Large Conurbations: **0**
Overlap with Industrial Places: **0**
Overlap with Commuter Towns: **194**
Overlap with Visitor Destinations: **210**

Topic	Variable	Criteria Score	Score	Core/ Secondary
Demographics	Population in catchment area		L	C
Employment	Average growth in GVA per worker in catchment area		H	S
	GVA per worker in catchment area		H	C
	Share of employment in KIBS		H	C
	Share of employment in advanced manufacturing		H	S
	Growth in advanced manufacturing		H	S
	Change in unemployment last 5 years		>	S

Local Authority	LSOAs	Local Authority	LSOAs	Local Authority	LSOAs
Cheshire East	111	Lancaster	22	North East Derbyshire	10
Cheshire West and Chester	93	Leeds	20	Scarborough	9
East Riding of Yorkshire	92	Copeland	19	Halton	8
Shropshire	76	Derbyshire Dales	18	West Lindsey	7
York	57	High Peak	18	Hambleton	5
Flintshire	52	Darlington	18	Selby	5
Northumberland	49	Barrow-in-Furness	18	Rossendale	4
South Staffordshire	32	Craven	16	Sunderland	4
Redcar and Cleveland	30	East Lindsey	13	Staffordhire Moorlands	4
South Ribble	26	Allerdale	13	West Lancashire	2
North East Lincolnshire	25	Ryedale	12	Richmondshire	1
Fylde	25	Warrington	11		
Wyre	23	Ribble Valley	11		

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Transformational places are those higher than average productive places across the North, which do not form part of a large conurbation. They tend to have a high share of employment in advanced manufacturing. With low population density, economic activity is more dispersed, but key to the economic prosperity of the North.

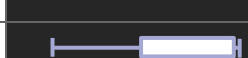
Analysis

- The main areas categorised within this type of place is West Cumbria, East, West and Mid Cheshire, West Lancashire, and the Furness Peninsula.
- Several of the TfN identified clusters have a significant share of LSOAs categorised as Transformational Places. This is the case for North Yorkshire, Northallerton and Thirsk, Central and East Lancashire, The Fylde Coast, The Tees Estuary, and South Humber.
- The Transformational Places identify places with lower than average population in the catchment area and high productivity. The map clearly shows that there are a wide range of areas in the north that are productive outside of the major cities.

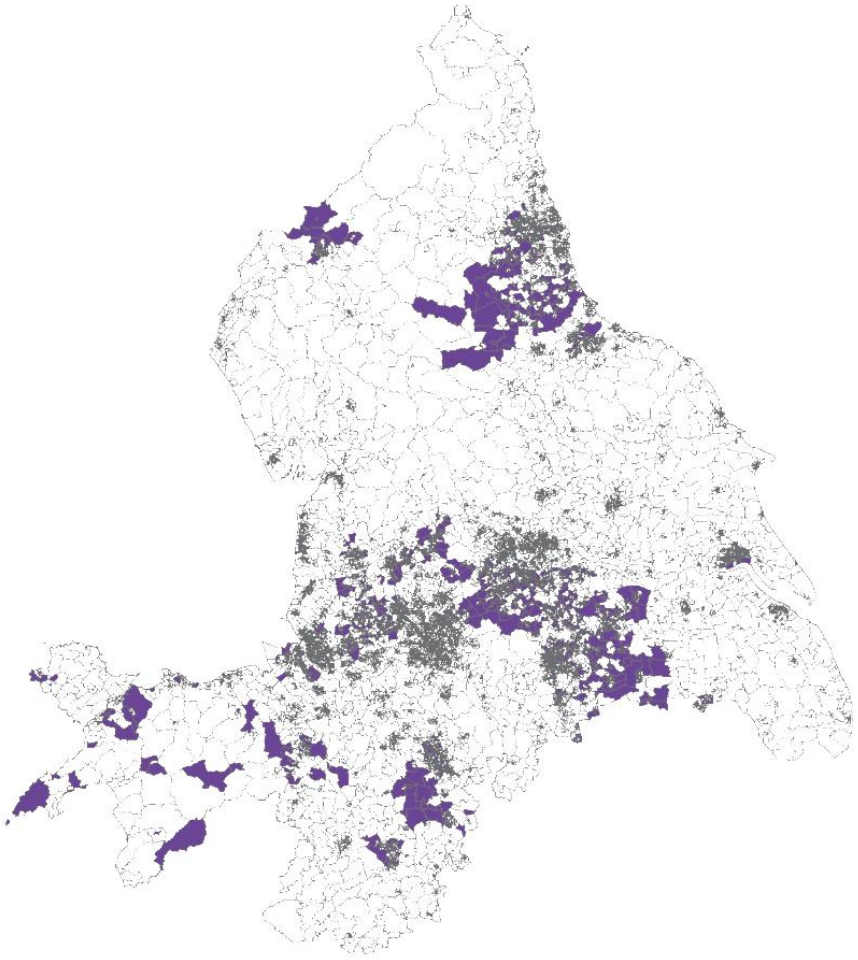
6.2.5 Industrial Places

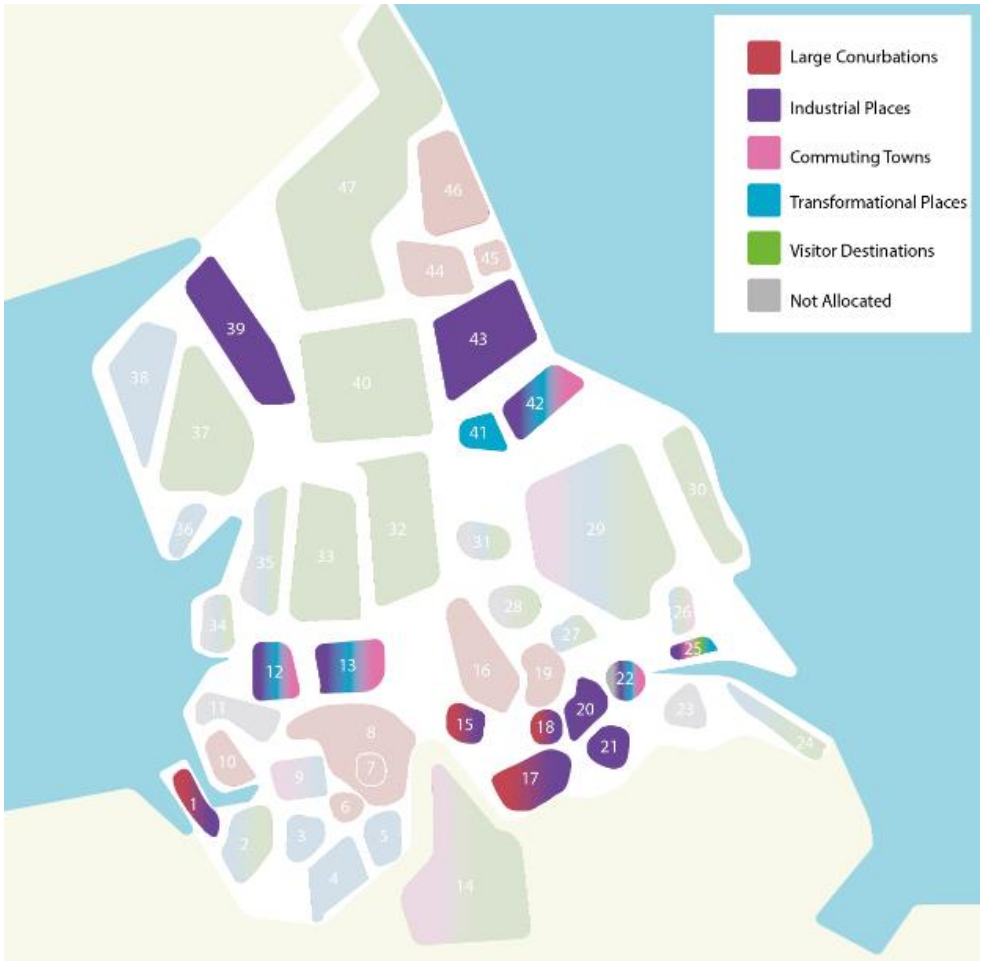
Industrial places identify areas with a high share of employment in traditional industries and lower than average productivity and commuting. There is also often higher than average unemployment and low population growth change.

Number of LSOAs in category: **1537**
Percentage of LSOAs in category**: 13.7%**
Overlap with Large Conurbations: **691**
Overlap with Transformational Places: **0**
Overlap with Commuter Towns: **82**
Overlap with Visitor Centres: **61**

Topic	Variable	Criteria Score	Score	Core/ Secondary
Demographics	Population change last 5 years		L	S
Employment	GVA per worker in catchment area		L	C
	Share of employment in traditional industries		H	C
	Unemployment rate		H	S
Skills	Share of highly qualified residents		L	S
Commuting	Share of commuters in LA commuting within LA		L	C

Local Authority	LSOAs	Local Authority	LSOAs	Local Authority	LSOAs
Kirklees	126	St. Helens	37	Wrexham	20
County Durham	93	Blackburn with Darwen	37	South Tyneside	20
Wakefield	81	Liverpool	36	Newcastle-under-Lyme	20
Sheffield	78	Newcastle upon Tyne	35	Gwynedd	19
Wigan	75	Wirral	32	Preston	19
Doncaster	63	Bassetlaw	30	Stockton-on-Tees	18
Barnsley	57	Blackpool	27	Chesterfield	18
Oldham	55	Gateshead	27	Bolsover	17
Calderdale	55	Pendle	27	Chorley	16
Bolton	52	Telford and Wrekin	26	Lincoln	13
Stoke-on-Trent	51	Stafford	23	Conwy	6
Rotherham	50	Carlisle	22	Denbighshire	6
Kingston upon Hull	42	Hyndburn	22	Middlesbrough	6
Sefton	39	Burnley	21	Isle of Anglesey	4

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Industrial places reflect those areas working on traditional manufacturing industries, with a lower productivity than the average for the North.

Analysis

- The analysis categorises places such as Sunderland and Durham, Carlisle and Penrith, Wakefield and the Five Towns and Doncaster.
- Several other of the identified TfN Clusters have parts of them characterised in this category, such as The Wirral, Sheffield and Rotherham, The Tees Estuary, Barnsley, Halifax and Huddersfield and Darlington.
- The areas of Halifax and Huddersfield, Sheffield and Rotherham, Barnsley, Wakefield and Doncaster form a cluster of Industrial Places. The same relates to the area around Sunderland and Durham.
- There are several areas captured in North Wales.
- Some LSOAs are captured in the outskirts of Greater Manchester, Liverpool and Leeds City Region.

7 Conclusions

7.1 Summary

This study has presented the work undertaken to analyse the key economic clusters in the north, building on the work produced by TfN for the current STP.

The work has included:

- A review of economic literature
- A review of previous TfN work
- Producing a new framework to analyse the types of places in the North and the spatial distribution of economic activity
- Analysing the types of places in the North and comparing that to the evidence presented in the STP

This work helps TfN by:

- Providing a better understanding of the robustness of the evidence collected by TfN to date
- Providing a new framework to analyse the North's economy
- Providing a robust data analysis that shows the characteristics of different types of places in the North, which can be used for future investment business cases

7.2 Next steps

This work has relied heavily on publicly available data. This work could be further expanded to consider additional variables in the future.

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Appendix 1 – List of case studies provided by TfN

The table below shows the list of case studies provided by TfN providing information on 27 economic clusters.

Clusters
Yorkshire Dale National Park and Nidderdale AONB
Lake District National Park
South East Cheshire
North East Cheshire
Chester and Ellesmere Port
Mid Cheshire
Sunderland and Durham
Banks of the Tyne
Newcastle - Gateshead
North Tyneside and South East Northumberland
Northumberland National Park
North Pennines AONB and Weardale
Scunthorpe
South Humber
Selby and Goole
Hull
East Yorkshire
The Yorkshire Coast
York
Carlisle and Penrith
West Cumbria
The Furness Peninsula
North Lancashire and the South Lakes
East Lancashire
Central Lancashire
Fylde Coast
West Lancashire

Appendix 2 – Analysis of case studies provided by TfN

The table below shows our classification of the 47 Economic clusters identified by TfN. This provides the basis of the colouring of TfN's original map of economic clusters included in the STP. Those coloured in light orange are the Economic clusters that were not provided a case study (missing from the list in Appendix 1).

Clusters	Type of place based on LSOA analysis
The Wirral	Large conurbation / industrial place
Chester and Ellesmere Port	Transformational place / visitor destination
Mid Cheshire	Transformational place
South East Cheshire	Transformational place
North East Cheshire	Transformational place
Manchester Airport	large conurbation
Greater Manchester Regional Centre	large conurbation
Greater Manchester	Large conurbation
Warrington, Halton and the Atlantic Growth Corridor	Commuter town/Transformational Place
Liverpool and the port	Large conurbation
West Lancashire	not classified
North West Manchester	Large conurbation
Central Lancashire	mix of industrial, transformational and commuting destinations
East Lancashire	mix of industrial, transformational and commuting destinations
The Peak District	visitor destination / commuter town
Halifax and Huddersfield	Large conurbation / industrial place
Bradford	large conurbation
Sheffield and Rotherham	large conurbations / industrial places
Barnsley	industrial place / large conurbation
Leeds	large conurbation
Wakefield and the Five Towns	industrial place
Doncaster	industrial place
Selby and Goole	not allocated / mix of industrial / transformational and commuting
Scunthorpe	not allocated
South Humber	visitor destination / transformational place
Hull	industrial place, surrounded by commuter, visitor and transformational places / places
East Yorkshire	mix of transformational, visitor and commuting destinations
York	mix of visitor and transformational places
Harrogate, Wetherby, and Knaresborough	not allocated, surrounded by visitor destinations
North Yorkshire	mix of not allocated / transformational places / visitor destinations
The Yorkshire Coast	visitor destination
Northallerton and Thirsk	mix of not allocated / transformational places / visitor destinations
The Yorkshire Dales	visitor destination

Forest of Bowland	visitor destination
Fylde Coast	mix of not allocated / transformational places / visitor destinations
North Lancashire and the South Lakes	mix of not allocated / transformational places / visitor destinations
The Furness Peninsula	transformational place
Lake District National Park	visitor destination
West Cumbria	transformational place
Carlisle and Penrith	industrial place
North Pennines AONB and Wearside	visitor destination
Darlington	Mix of industrial place and visitor destination
The Tees Estuary	Mix of industrial, commuting and transformational places
Sunderland and Durham	industrial place
Newcastle - Gateshead	Large conurbation
Banks of the Tyne	Large conurbation
North Tyneside and South East Northumberland	Large conurbation
Northumberland and Hadrian's Wall	Natural assets/visitor destination

The table below shows the share of place types in each local authority, matched to the economic cluster numbers produced by TfN.

No.	Main cluster (The cluster where the majority of the LA is covered)	Local Authority	Large Conurbations	Visitor Destinations	Industrial Places	Transformational Places	Commuter Towns
1	The Wirral	Wirral	89%	0%	16%	0%	0%
2	Chester and Ellesmere Port	Cheshire West and Chester	0%	26%	0%	44%	0%
4	South East Cheshire	Cheshire East	0%	0%	0%	47%	0%
7	Greater Manchester Regional Centre	Manchester	100%	0%	0%	0%	50%
8	Greater Manchester	Bolton	100%	0%	29%	0%	72%
8	Greater Manchester	Bury	100%	0%	0%	0%	68%
8	Greater Manchester	Oldham	99%	0%	39%	0%	0%
8	Greater Manchester	Rochdale	93%	0%	0%	0%	0%
8	Greater Manchester	Salford	100%	0%	0%	0%	0%
8	Greater Manchester	Stockport	100%	0%	0%	0%	67%
8	Greater Manchester	Tameside	100%	0%	0%	0%	0%
8	Greater Manchester	Trafford	100%	0%	0%	0%	66%
9	Warrington, Halton and the Atlantic Growth Corridor	Halton	70%	0%	0%	10%	0%
9	Warrington, Halton and the Atlantic Growth Corridor	Warrington	0%	0%	0%	9%	73%
10	Liverpool and the port	Knowsley	100%	0%	0%	0%	0%
10	Liverpool and the port	Liverpool	100%	0%	12%	0%	0%
10	Liverpool and the port	Sefton	58%	0%	21%	0%	0%
10	Liverpool and the port	St. Helens	100%	0%	31%	0%	0%
11	West Lancashire	West Lancashire	0%	0%	0%	3%	0%

12	Central Lancashire	Chorley	0%	0%	24%	0%	82%
12	Central Lancashire	Preston	0%	0%	22%	0%	0%
12	Central Lancashire	South Ribble	0%	0%	0%	37%	73%
13	East Lancashire	Burnley	0%	0%	35%	0%	68%
13	East Lancashire	Hyndburn	0%	0%	42%	0%	0%
13	East Lancashire	Rossendale	0%	7%	0%	9%	95%
14	The Peak District	Chesterfield	0%	0%	26%	0%	0%
14	The Peak District	Derbyshire Dales	0%	60%	0%	42%	91%
14	The Peak District	High Peak	0%	27%	0%	31%	88%
14	The Peak District	North East Derbyshire	0%	0%	0%	16%	0%
15	Halifax and Huddersfield	Calderdale	74%	0%	43%	0%	0%
15	Halifax and Huddersfield	Kirklees	68%	0%	49%	0%	0%
16	Bradford	Bradford	79%	0%	0%	0%	0%
17	Sheffield and Rotherham	Bolsover	0%	0%	35%	0%	0%
17	Sheffield and Rotherham	Rotherham	81%	0%	30%	0%	0%
17	Sheffield and Rotherham	Sheffield	95%	0%	23%	0%	0%
18	Barnsley	Barnsley	20%	0%	39%	0%	0%
19	Leeds	Leeds	95%	2%	0%	4%	0%
20	Wakefield and the Five Towns	Wakefield	54%	0%	39%	0%	0%
21	Doncaster	Doncaster	4%	0%	32%	0%	0%
22	Selby and Goole	Selby	0%	0%	0%	10%	0%
23	Scunthorpe	North Lincolnshire	0%	0%	0%	0%	0%
24	South Humber	East Lindsey	0%	53%	0%	16%	0%
24	South Humber	North East Lincolnshire	0%	0%	0%	24%	0%
25	Hull	Kingston upon Hull, City of	0%	0%	25%	0%	0%
27	York	York	0%	22%	0%	48%	0%
29	North Yorkshire	East Riding of Yorkshire	0%	38%	0%	44%	84%
29	North Yorkshire	Hambleton	0%	0%	0%	10%	0%
29	North Yorkshire	Ryedale	0%	67%	0%	40%	0%
30	The Yorkshire Coast	Scarborough	0%	58%	0%	13%	0%
31	Northallerton and Thirsk	Harrogate	0%	33%	0%	0%	0%
32	The Yorkshire Dales	Craven	0%	59%	0%	50%	81%
32	The Yorkshire Dales	Richmondshire	0%	62%	0%	3%	0%
33	Forest of Bowland	Ribble Valley	0%	0%	0%	28%	93%
34	The Fylde Coast	Blackpool	0%	24%	29%	0%	0%
34	The Fylde Coast	Fylde	0%	0%	0%	49%	76%
34	The Fylde Coast	Wyre	0%	0%	0%	33%	0%
35	North Lancashire and the South Lakes	Lancaster	0%	0%	0%	25%	0%
36	The Furness Peninsula	Barrow-in-Furness	0%	0%	0%	37%	0%
37	The Lake District	South Lakeland	0%	63%	0%	0%	0%
37	The Lake District	Staffordshire Moorlands	0%	0%	0%	7%	93%

38	Harrogate, Whetherby and Knarlesborough	Allerdale	0%	32%	0%	22%	0%
38	Harrogate, Whetherby and Knarlesborough	Copeland	0%	0%	0%	39%	0%
39	Carlisle and Penrith	Carlisle	0%	0%	32%	0%	0%
39	Carlisle and Penrith	Eden	0%	58%	0%	0%	0%
41	Darlington	Darlington	0%	0%	0%	28%	0%
42	The Tees Estuary	Hartlepool	0%	0%	0%	0%	0%
42	The Tees Estuary	Middlesbrough	0%	0%	7%	0%	0%
42	The Tees Estuary	Redcar and Cleveland	0%	0%	0%	34%	0%
42	The Tees Estuary	Stockton-on-Tees	0%	0%	15%	0%	81%
43	Sunderland and Durham	County Durham	11%	34%	34%	0%	0%
43	Sunderland and Durham	Sunderland	81%	0%	0%	2%	0%
44	Newcastle-Gateshead	Gateshead	87%	0%	21%	0%	0%
45	Banks of the Tyne	South Tyneside	100%	0%	20%	0%	0%
46	North Tyneside and South East Northumberland	Newcastle upon Tyne	97%	1%	20%	0%	0%
46	North Tyneside and South East Northumberland	North Tyneside	100%	0%	0%	0%	73%
47	Nothumberland and Hadrian's Wall	Northumberland	12%	40%	0%	25%	0%

Appendix 3 – List of data sources used in the analysis

Category	Variable	Unit	Source	Year
Demographics	Population change last 5 years	LSOA	ONS	2017
	Population density	LSOA	ONS	2017
	Population in catchment area (15km radius)	LSOA	ONS/GIS analysis	2017
	Share of population aged 65+	LSOA	ONS	2017
	Population change in 65+ over last 5 years	LSOA	ONS	2012-2017
Economic variables	Average growth in GVA per worker in the catchment area	LA	ONS	2010-2015
	GVA per worker in the catchment area	LA	ONS	2015
	Share of employment in KIBS (KIBS refers to Knowledge-Intensive Business Services. SIC codes: 58, 59, 60, 61, 62, 63, 64, 65, 66, 69, 70, 71, 72, 73, 74)	LA	BRES	2017
	Share of employment in Tourism **3-digit** SIC Codes: 551, 552, 553, 561, 563, 771, 910, 931, 932	LA	BRES	2017
	Share of employment in Traditional Industries. SIC-codes: 05, 06, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 22, 23 24, 25, 31, 32, 49, 50, 52, 53	LSOA	BRES	2017
	Share of employment in Advanced Manufacturing. SIC-Codes: 20, 21, 26, 27, 28, 29, 30, 33,	LSOA	BRES	2017
	Growth in Advanced Manufacturing in the last 5years	LSOA	BRES	2012-2017
	Share of employment in Public Sector	LSOA	BRES	2017
	Employment density	LSOA	ONS	2017
	Unemployment Rate	LA	ONS	2018
	Change in unemployment rate last 5 years	LA	ONS	2013-2019

	Share of self-employed		ONS	2017
Skills	Share of population with NVQ4 qualifications (residence)	LA	ONS Census	2011
Commuting	Share of commuters in local authority commuting within the local authority	LA	ONS Census	2011
	Share of commuters commuting to a combined authority + Hull	LA	ONS Census	2011
Tourism	Number of holiday trips in local authority	LA	Visit Britain	2015-2017
	Number of historical assets	LA	Historic England	2018

Appendix 4 How to use the model – worked example

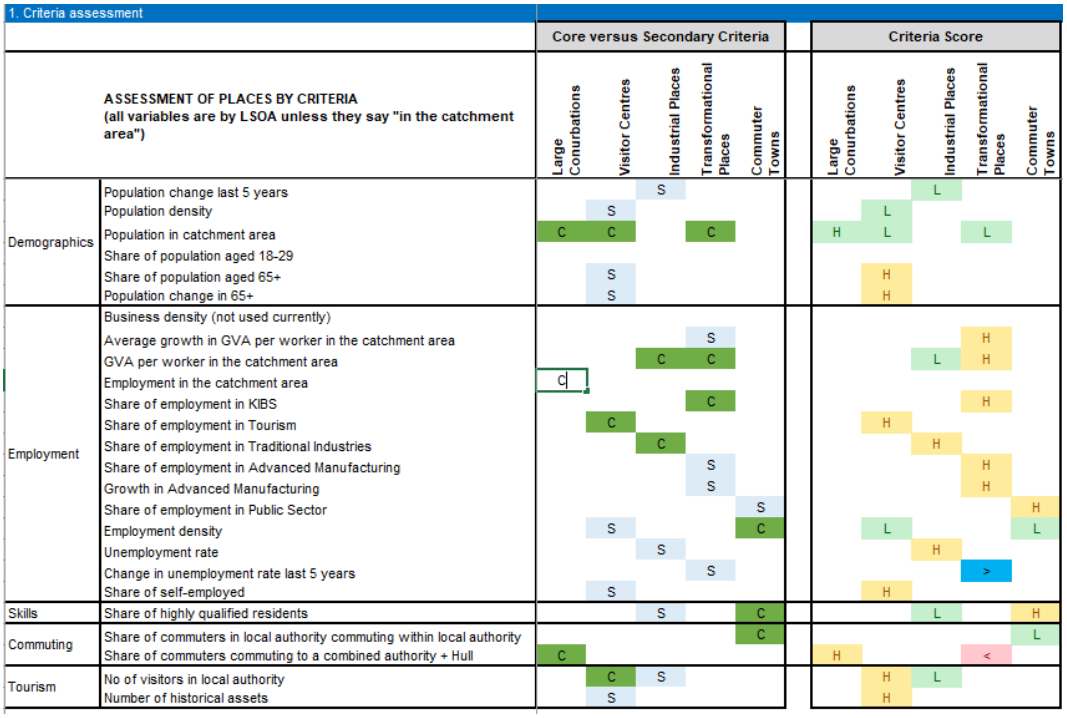
TfN may wish to modify the clusters and produce further iterations of the analysis, playing with the criteria for each cluster. This can be performed easily in the model provided with this report. In this appendix, we present a worked example of how the criteria for a specific typology may be modified, including how to check the results.

Worked example:

The model user wishes to amend the criteria for large conurbations to include an additional core criterion. This criterion is Employment in the catchment area.

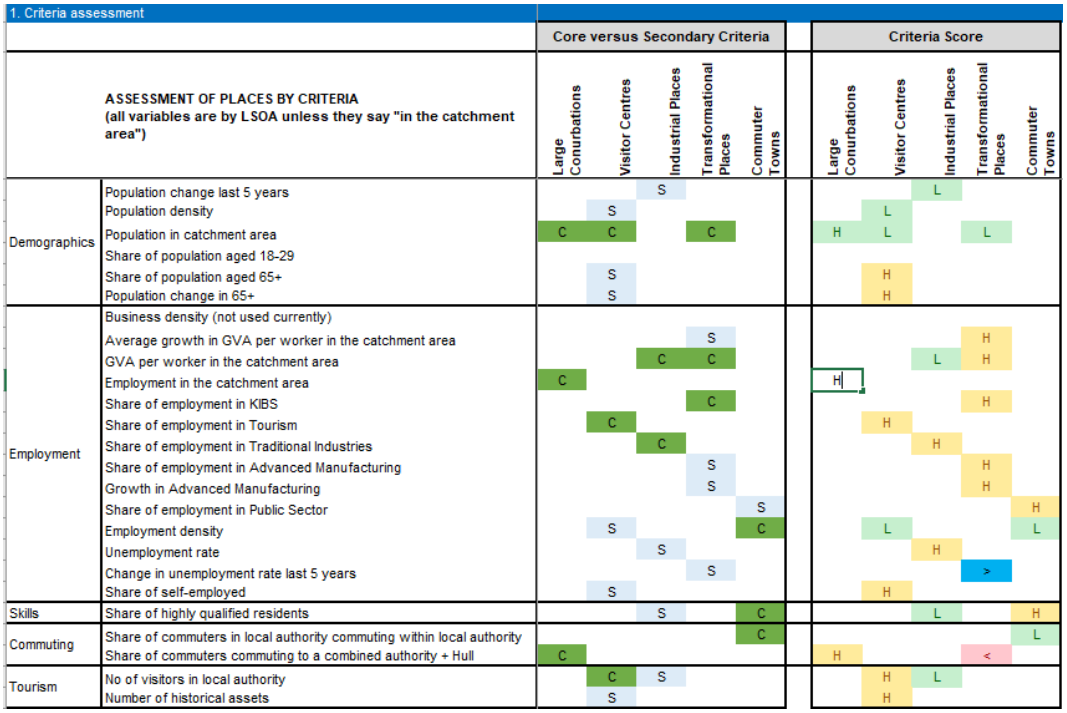
To do this, the user should:

- Go to the "Criteria" tab
- Include a C in cell C16 as follows. The cell will automatically be coloured green.



1. Criteria assessment		Core versus Secondary Criteria					Criteria Score				
	ASSESSMENT OF PLACES BY CRITERIA (all variables are by LSOA unless they say "in the catchment area")	Large Conurbations	Visitor Centres	Industrial Places	Transformational Places	Commuter Towns	Large Conurbations	Visitor Centres	Industrial Places	Transformational Places	Commuter Towns
Demographics	Population change last 5 years			S					L		
	Population density		S					L			
	Population in catchment area	C	C		C		H	L		L	
	Share of population aged 18-29										
	Share of population aged 65+		S					H			
	Population change in 65+		S					H			
Employment	Business density (not used currently)										
	Average growth in GVA per worker in the catchment area				S					H	
	GVA per worker in the catchment area			C	C				L	H	
	Employment in the catchment area	C									
	Share of employment in KIBS				C					H	
	Share of employment in Tourism		C					H			
	Share of employment in Traditional Industries			C					H		
	Share of employment in Advanced Manufacturing				S					H	
	Growth in Advanced Manufacturing				S					H	
	Share of employment in Public Sector					S					H
	Employment density		S			C		L			L
	Unemployment rate			S					H		
	Change in unemployment rate last 5 years				S					>	
	Share of self-employed		S					H			
Skills	Share of highly qualified residents			S		C			L		H
Commuting	Share of commuters in local authority commuting within local authority					C					L
	Share of commuters commuting to a combined authority + Hull	C					H			<	
Tourism	No of visitors in local authority		C	S				H	L		
	Number of historical assets		S					H			

- Define whether this criterion should be High, Low, Average, Increasing or Decreasing. Note that Increasing or Decreasing should only be applied to variables which show changes. In this case, we choose High, inputting an H in cell I16 as follows:



1. Criteria assessment		Core versus Secondary Criteria					Criteria Score				
	ASSESSMENT OF PLACES BY CRITERIA (all variables are by LSOA unless they say "in the catchment area")	Large Conurbations	Visitor Centres	Industrial Places	Transformational Places	Commuter Towns	Large Conurbations	Visitor Centres	Industrial Places	Transformational Places	Commuter Towns
Demographics	Population change last 5 years			S					L		
	Population density		S					L			
	Population in catchment area	C	C		C		H	L		L	
	Share of population aged 18-29										
	Share of population aged 65+		S					H			
	Population change in 65+		S					H			
Employment	Business density (not used currently)										
	Average growth in GVA per worker in the catchment area				S					H	
	GVA per worker in the catchment area			C	C				L	H	
	Employment in the catchment area	C					H				
	Share of employment in KIBS				C					H	
	Share of employment in Tourism		C					H			
	Share of employment in Traditional Industries			C					H		
	Share of employment in Advanced Manufacturing				S					H	
	Growth in Advanced Manufacturing				S					H	
	Share of employment in Public Sector					S					H
	Employment density		S			C		L			L
	Unemployment rate			S					H		
	Change in unemployment rate last 5 years				S					>	
	Share of self-employed		S					H			
Skills	Share of highly qualified residents			S		C			L		H
Commuting	Share of commuters in local authority commuting within local authority					C					L
	Share of commuters commuting to a combined authority + Hull	C					H			<	
Tourism	No of visitors in local authority		C	S				H	L		
	Number of historical assets		S					H			

- The user can now check the results in the "Results" tab. In this case, this change has resulted in the share of allocated LSOAs to decrease from 71% (results reported in the main body of this report) to 55%. The number of LSOAs allocated to large conurbations has also decreased from 4,830 to 2,246.

Results analysis

Total number of LSOAs	11,183
Number of LSOAs allocated	6,121
Share of LSOAs allocated	55%
Share of LSOAs with just one category	44.99%
Share of LSOAs with more than one category	9.75%

Analysis by typology	Large Conurbations	Visitor Centres	Industrial Places	Transformational Places	Commuter Towns	Total LSOAs allocated	Total LSOAs not allocated
Number of LSOAs allocated	2246	935	1537	959	1584	6,121	5,062
Share of LSOAs	20%	8%	14%	9%	14%	55%	45%

	Large Conurbations	Visitor Centres	Industrial Places	Transformational Places	Commuter Towns
Large Conurbations	1727	0	288	0	231
Visitor Centres	0	590	61	210	124
Industrial Places	288	61	1106	0	82
Transformational Places	0	210	0	605	194
Commuter Towns	231	124	82	194	1003
Allocated to 3 types	0	50	0	50	50

Appendix 5 Productivity Analysis

This work was produced using statistical data from ONS. The use of the ONS statistical data in this work does not imply the endorsement of the ONS in relation to the interpretation or analysis of the statistical data. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

Purpose of the analysis

The purpose of this analysis is to assess the role of agglomeration economies and connectivity in explaining productivity differences across the North. This analysis can inform TfN's future investment decisions regarding new transport infrastructure.

Methodology

We employ a methodology used in the Manchester Independent Economic Review 2009. Using regression analysis, we examine how productivity differs across various locations in the North, considering the role of agglomeration, skills and transport accessibility in explaining those differences.

The advantage of this approach is using data on a company level. Data on a company level comes directly from companies' responses to surveys conducted by the ONS. Analysing a big data set on companies' productivity levels together with their specific characteristics like sector and size, and their access to agglomeration economies, skills and transport, allows us to analyse relationships between productivity and those factors and assess scale of those relationships with a given level of confidence. We are not able to conduct such an analysis when using publicly available Gross Value Added (GVA) estimates at local authority level published by Office for National Statistics (ONS).

In our analysis we do not estimate absolute levels of productivity for various locations. We estimate relative differences in average business productivity between various places and one reference location, in this case the Manchester local authority. We choose Manchester as it is consistent with the Manchester Independent Economic Review and it is a local authority that people can quickly recognise. It is also worth noting that the present analysis focuses on productivity at a business level as opposed to productivity per job, a more standard measure of productivity.

Data

Study area

Our study area covers the North (North West, North East and Yorkshire and The Humber) and Transport for the North Functional Economic Area[9], including the following local authorities:

[9] Based on information provided by the client.

- in Wales: Conwy, Denbighshire, Flintshire, Gwynedd, Isle of Anglesey, Wrexham
- in East Midlands: Bassetlaw, Bolsover, Chesterfield, Derbyshire Dales, East Lindsey, High Peak, Lincoln, North East Derbyshire, West Lindsey;
- in West Midlands: Newcastle-under-Lyme, Shropshire, South Staffordshire, Stafford, Staffordshire Moorlands, Stoke-on-Trent, Telford and Wrekin;

In total our study area includes 94 local authorities. Each business in our dataset is assigned to one of them. Each of our model includes 93 binary variables indicating whether specific observation is located in a given local authority. There is no dummy variable for Manchester local authority as our reference category. That allows us to analyse the relative variation in average productivity between all local authorities and Manchester. We can then state with a specific level of confidence that productivity level in a given location is significantly lower or higher by a relative amount than in Manchester.

Step by step we analyse whether productivity advantages or disadvantages for each local authority narrow down by including additional factors described in the following section on Location Data. We can then find that accounting for specific factors, i.e. excluding their impact on productivity, businesses in a given location are on average as productive as in Manchester, or that there are still significant differences between them not explained by measures included in our model.

Business data

Business data come from Annual Business Survey 2017 (ABS), one of the main surveys conducted by ONS. The ABS collects financial information from businesses representing about two-thirds of the UK economy in terms of GVA.

Each business sampled in the ABS is classified against the UK Standard Industry Classification 2007 (SIC07). For England and Wales, information is provided at the 4-digit SIC level. However, there are several industries that are not fully covered by ABS, including:

- Financial service activities, insurance and pension funding (Division 64 –66),
- Public administration and defence; compulsory social security (Division 84),
- Education (Division 86.1),
- Hospital, medical dental and other human health activities (Division 86.1, 86.2, 86.9)

Nonetheless, the ABS is still the largest and most comprehensive business survey conducted by ONS, with 62,000 questionnaires distributed each year in Great Britain, with around 600 different questions asked in total.

The financial variables covered include turnover, purchases, employment costs, capital expenditure and stocks. Based on that collected information ONS calculates an approximate gross value added (aGVA), i.e. “a measure of the income generated by the surveyed businesses (and the industry or sector they

represent) less their intermediate consumption of goods and services used up in order to produce their output. This is an input into the measurement of the UK's gross domestic product (GDP)"[10].

Location data

1) Agglomeration economies

We use measures of *agglomeration economies* and *access to skills* as suggested in the Manchester Independent Economic Review.

The *agglomeration economies index* used in MIER is the same as the effective density index proposed by Graham (2006)[11]. In MIER it is calculated at postcode district level, while for the purpose of this analysis we calculate it at LSOA level. For each LSOA within our study area[12], the index is produced as a weighted sum of employment in all LSOAs within 100km from a given origin LSOA. The employment in each destination LSOA is weighted by inverse distance between origin and destination LSOA. The distances are straight-lines distances between LSOA centroids. The index includes employment in the origin LSOA as well, as per MIER approach. We use publicly available 2017 employment data from Business Register and Employment Survey.

2) Access to skills

For each LSOA within the study area, a measure of access to skills is defined as the average proportion of working age population with NVQ Level 4+ qualifications from all local authorities within 20 km radius from the origin LSOA (based on distances between centroids).

3) Transport accessibility

A comprehensive transport accessibility estimation is beyond the scope of this study. In this analysis we use publicly available Journey Time Statistics published by Department for Transport[13] at LSOA level.

Our model includes the following measures:

- Travel time in minutes to nearest town centre by public transport (2016),
- Number of town centres by public transport within 60 minutes (2016),
- Number of town centres by car within 60 minutes (2016),
- Travel time in minutes to nearest employment centre with 100 to 499 jobs by public transport (2016),
- Travel time in minutes to nearest employment centre with 500 to 4999 jobs by public transport (2016),

[10] ONS, Annual Business Survey Metadata, April 2015
[11] Graham, D. (2006) Wider economic benefits of transport improvements: link between agglomeration and productivity. Stage 2 report to Department of Transport, London
[12] The North and its Functional Economic Area, based on information provided by the client
[13] https://www.gov.uk/government/statistical-data-sets/journey-time-statistics-data-tables-jts

- Travel time in minutes to nearest employment centre with at least 5000 jobs by public transport (2016),
- Average travel time to the closest rail station (2015 morning peak).

Analysis

Simple model – Model 1

We start with a simple model, controlling for company size and location (local authority), without controlling yet for other factors. Location is accounted for in the regression model by including 94 binary variables, indicating whether or not a given observation (in our case a company) is located within a given area (local authority) or not. Coefficients estimated at those variables, their value and statistical significance, allow us to assess how business productivity in those places is different than for businesses in Manchester district.

Based on this model, average business productivity in over half of the local authorities does not seem significantly different from average productivity in Manchester. Those include most of the areas in North West, North East and most of the included ones from the Midlands.

Based on the first model, average productivity does seem significantly lower than in Manchester in almost 40 districts. These include almost all Wales areas (from the ones included in TfN Functional Economic Area) and 60% of authorities in the Yorkshire and The Humber.

Controlling for sectoral breakdown – Model 2

In the second model we introduce 29 variables representing various sectoral groups and therefore we would expect the sector mix to have an impact on productivity. This is because some sectors are typically more productive than others. Each company observation in our sample is assigned to one of those groups. We then move to comparing values and significance of coefficients estimated for each location (i.e. local authority). If the absolute value of a coefficient for the same location is lower in the second model, it suggests that sectoral composition in a given area is part of the explanation for productivity difference between that location and Manchester. Depending on the scale of change in the coefficient, sectoral breakdown can play bigger or smaller role in explaining those differences. If a coefficient has quite a high and significant value in the first model, while its estimate becomes statistically insignificant in the second model, it suggests that sectoral structure explain practically all of the productivity gap and changing that structure would lead to increasing productivity in that area.

There are three districts for which their coefficient becomes insignificant in the second model: Halton, Liverpool and Preston. For two others, their coefficient in the second model decreases by around 30%: Sefton and Wirral. For the rest we don’t see any major changes.

The above suggest that **business productivity differences between Manchester and Halton, Liverpool, Preston and Lincoln exist purely due to differences in**

sectors present in those areas. In case of **Sefton and Wirral the sectoral composition explains one third of the productivity gap**.

We would like to stress that the model estimates are not directly translatable into real GVA figures estimated by the ONS due to the use of different methodologies. For instance, GVA per company in Liverpool in 2015 was 7% lower than in Manchester according to the ONS. The exact interpretation of the Liverpool estimate in Model 1 is: "business productivity is on average 18% lower in Liverpool than in Manchester". Those two statements are different and answer different questions. We should not therefore focus on the exact values of the coefficients, especially based only on one study, but on their general relative scale and significance and most importantly, on how they change across the models after adding more variables of interest.

Table 9 Locations where productivity gap can be explained by sectoral composition

Id	Local authority	GVA per company in 2015	Difference to Manchester	Difference %	Coefficient in Model 1	Coefficient in Model 2
1	Halton	£818,402	£50,247	7%	26%	insignificant
2	**Manchester**	£768,155	-	-	-	-
3	Liverpool	£710,554	-£57,601	-7%	-18%	insignificant
4	Lincoln	£674,543	-£93,612	-12%	-24%	insignificant
5	Preston	£556,876	-£211,280	-28%	-25%	insignificant
6	Wirral	£463,090	-£305,065	-40%	-27%	-20%
7	Sefton	£449,861	-£318,294	-41%	-28%	-18%

Controlling for agglomeration effects – Model 3

In the third model we introduce a variable *access to jobs*, representing agglomeration effects. The variable is mapped on Figure 12. The map shows normalised values of the index, with 1 representing an average level of access to jobs across the study area. Therefore all LSOAs shown in red and orange have level of access to jobs below the average in the whole study area.

First of all we see that on average, every 1% increase in the agglomeration effects is associated with an increase in business productivity of 0.01%. We then look again at how estimates for various locations change between the first and the second model. In the case of six locations, their coefficients become statistically insignificant. It suggests that in the case of those places (listed in Table 10) their average business productivity gap with Manchester can be explained primarily by a lower level of agglomeration economies.

Table 10 includes Sefton, where one third of the gap in productivity can be explained by differences in sectoral composition.

Table 10 Locations where the productivity gap can be explained by a lower level of agglomeration economies

Id	Local authority	GVA per company in 2015	Difference to Manchester	Difference %	Coefficient in Model 2	Coefficient in Model 3
1	Manchester	£768,155	-	-	-	-
2	Kingston upon Hull	£629,711	-£138,444	-18%	-17%	insignificant
3	York	£588,618	-£179,537	-23%	-17%	insignificant
4	Redcar and Cleveland	£531,008	-£237,147	-31%	-24%	insignificant
5	County Durham	£490,366	-£277,789	-36%	-20%	insignificant
6	Sefton	£449,861	-£318,294	-41%	-18%	insignificant

There are numerous local authorities for which agglomeration economies seem to explain a few percentage points of the productivity gap. We do not list them here not to complicate the picture coming out of our analysis, as relative changes in the coefficients are usually small.

Controlling for access to skills – Model 4

In the fourth model we turn to testing access to skills as a potential determinant of productivity variation in the North, by including this variable in our model. This variable is defined as the average proportion of working age population with NVQ Level 4+ qualifications from all local authorities within 20 km radius from the origin LSOA (based on distances between centroids).

As before, we then compare the location coefficients between the last two models. However, we do not see any major changes that could suggests a significant role of the skills levels (defined as described in the section describing "Location data") in explaining the differences in average business productivity across the North[14]. The only local authority in which case it seems to have significant importance is Bury. After including access to skills in the model, the -18% coefficient from the previous model becomes insignificant.

Controlling for transport accessibility – Model 5

Including transport accessibility variables in our regression model seems to explain the whole of productivity differences in 16 locations. In addition, it helps explain almost half of the difference in South Lakeland and around one fourth in Ryedale.

[14] We are not able to assess the importance of access to skills for Wales locations, as data used to construct that indicator were not available for that region.

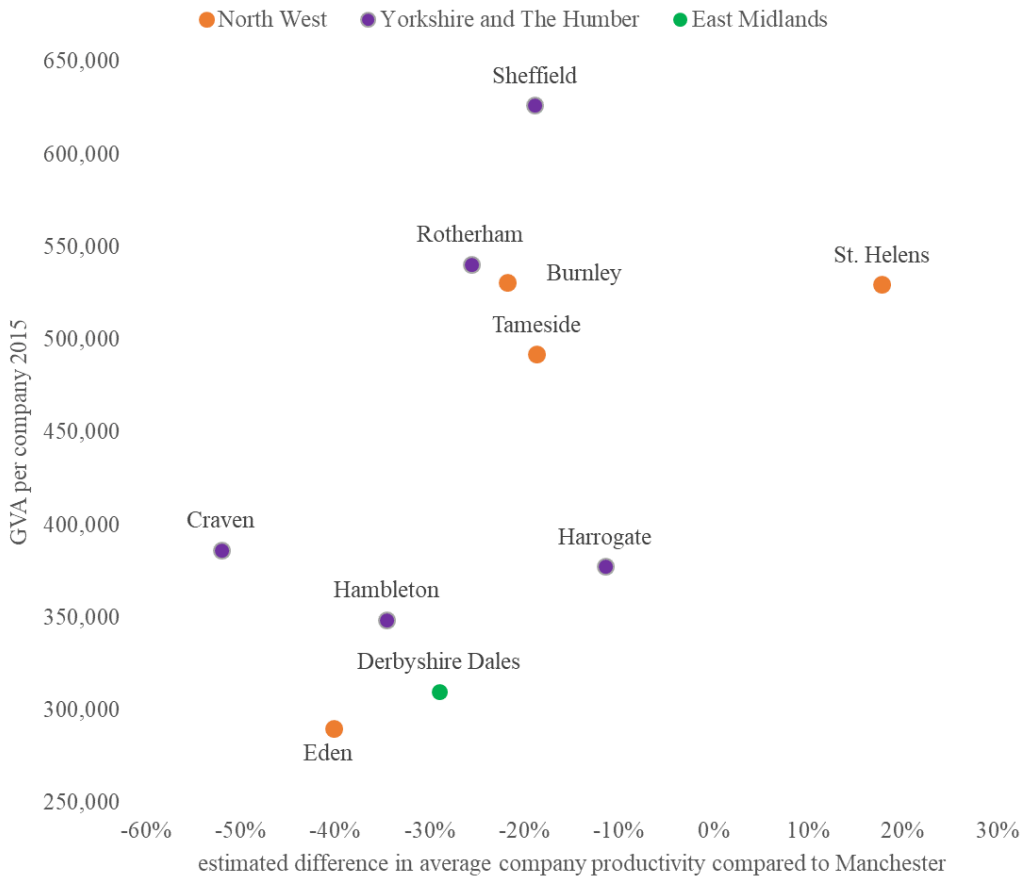
Table 11 Locations where productivity gap can be explained by a lower level of transport accessibility

Id	Local authority	GVA per company in 2015	Difference to Manchester	Difference %	Coef. in Model 4	Coef. in Model 5
1	Manchester	£768,155	-	-	-	-
2	Barrow-In-Furness	£627,843	-£140,312	-18%	-59%	insignificant
3	Copeland	£546,795	-£221,360	-29%	-75%	insignificant
4	Doncaster	£508,696	-£259,460	-34%	-19%	insignificant
5	Barnsley	£503,091	-£265,064	-35%	-19%	insignificant
6	Wirral	£463,090	-£305,065	-40%	-20%	insignificant
7	Carlisle	£438,904	-£329,251	-43%	-40%	insignificant
8	Scarborough	£417,097	-£351,058	-46%	-41%	insignificant
9	East Riding Of Yorkshire	£391,248	-£376,908	-49%	-31%	insignificant
10	Northumberland	£382,725	-£385,431	-50%	-27%	insignificant
11	High Peak	£371,991	-£396,164	-52%	-22%	insignificant
12	East Lindsey	£346,739	-£421,416	-55%	-35%	insignificant
13	Shropshire	£345,842	-£422,313	-55%	-26%	insignificant
14	Wyre	£345,022	-£423,134	-55%	-33%	insignificant
15	Allerdale	£343,231	-£424,925	-55%	-53%	insignificant
16	South Lakeland	£342,658	-£425,497	-55%	-52%	-30%
17	Staffordshire Moorlands	£321,499	-£446,656	-58%	-37%	insignificant
18	Ryedale	£310,354	-£457,802	-60%	-56%	-41%
19	Richmondshire	£308,039	-£460,117	-60%	-39%	insignificant

Unexplained productivity differences

Including all the control variables described earlier does not explain all the business productivity differences between Manchester and other local authorities in the North. There are 10 locations where their productivity gap to average business productivity in Manchester seems to be caused by other factors which are not controlled for or not controlled for enough in our model. Those locations are shown on Figure 11 and on Figure 19 below.

Figure 11 Locations with productivity differences not explained by the model



Summary

Our analysis indicates that:

- There are several local authorities in the study area where their productivity gap with Manchester seem to be explained by a different sectoral breakdown: Halton, Liverpool, Lincoln and Preston, and to some extent in Wirral and Sefton.
- In the case of 6 local authorities, their productivity disadvantage to Manchester seems to be explained by lower lever of agglomeration economies. These are listed in Table 10.
- There are 16 districts where their productivity disadvantage to Manchester seems to be explained by lower level of transport accessibility. These are listed in Table 11.
- There are around 50 local authorities where business productivity does not seem to be significantly different from companies in Manchester. Most of those are local authorities in North West and North East, shown on Figure 15.
- Access to skills, controlled for in the way described in the section on Location Data, does not seem to help explaining business productivity variations in our model.
- For 10 local authorities, we found significant differences in productivity compared to Manchester, which are not explained by sectoral breakdown, agglomeration economies, access to skills or transport accessibility. These are listed on Figure 19.
- Please note that the modelling could not be finalised for local authorities in Wales and Scotland, due to differences in data availability.

Figure 12 Access to jobs representing agglomeration economies, LSOA level, normalised index

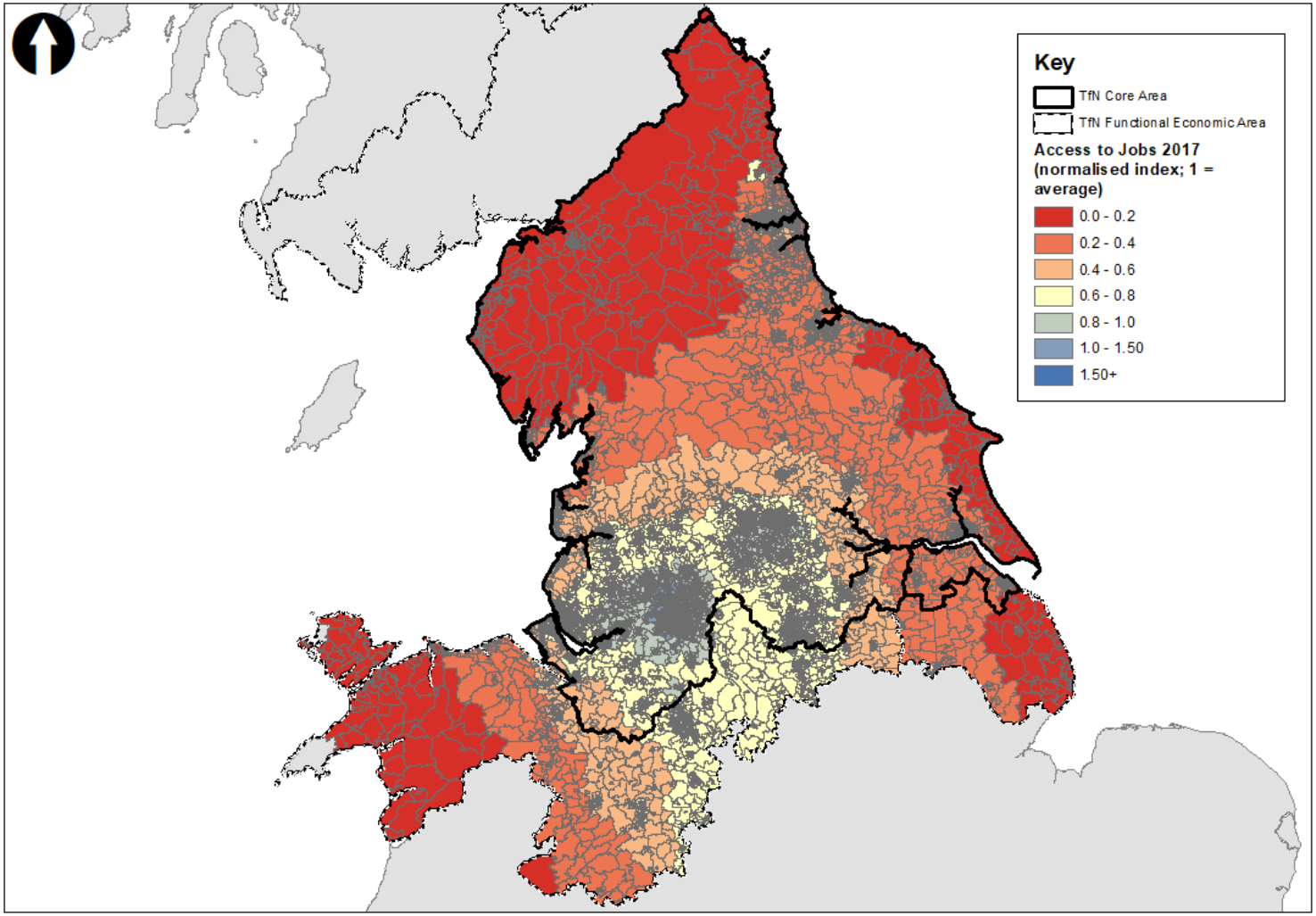


Figure 13 Access to jobs representing agglomeration economies, LSOA level, normalised index, North West central

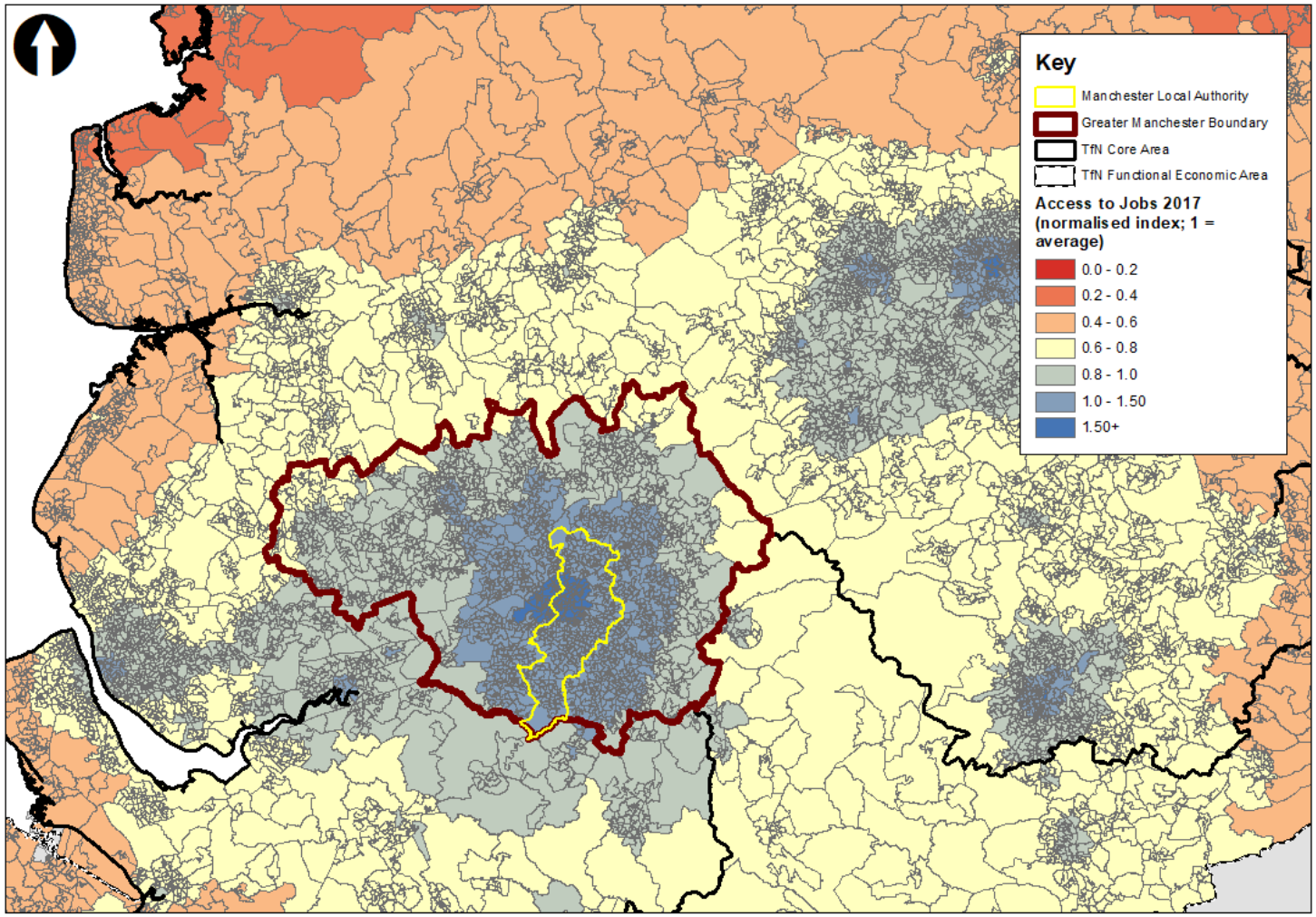


Figure 14 Access to jobs representing agglomeration economies, LSOA level, normalised index, North East

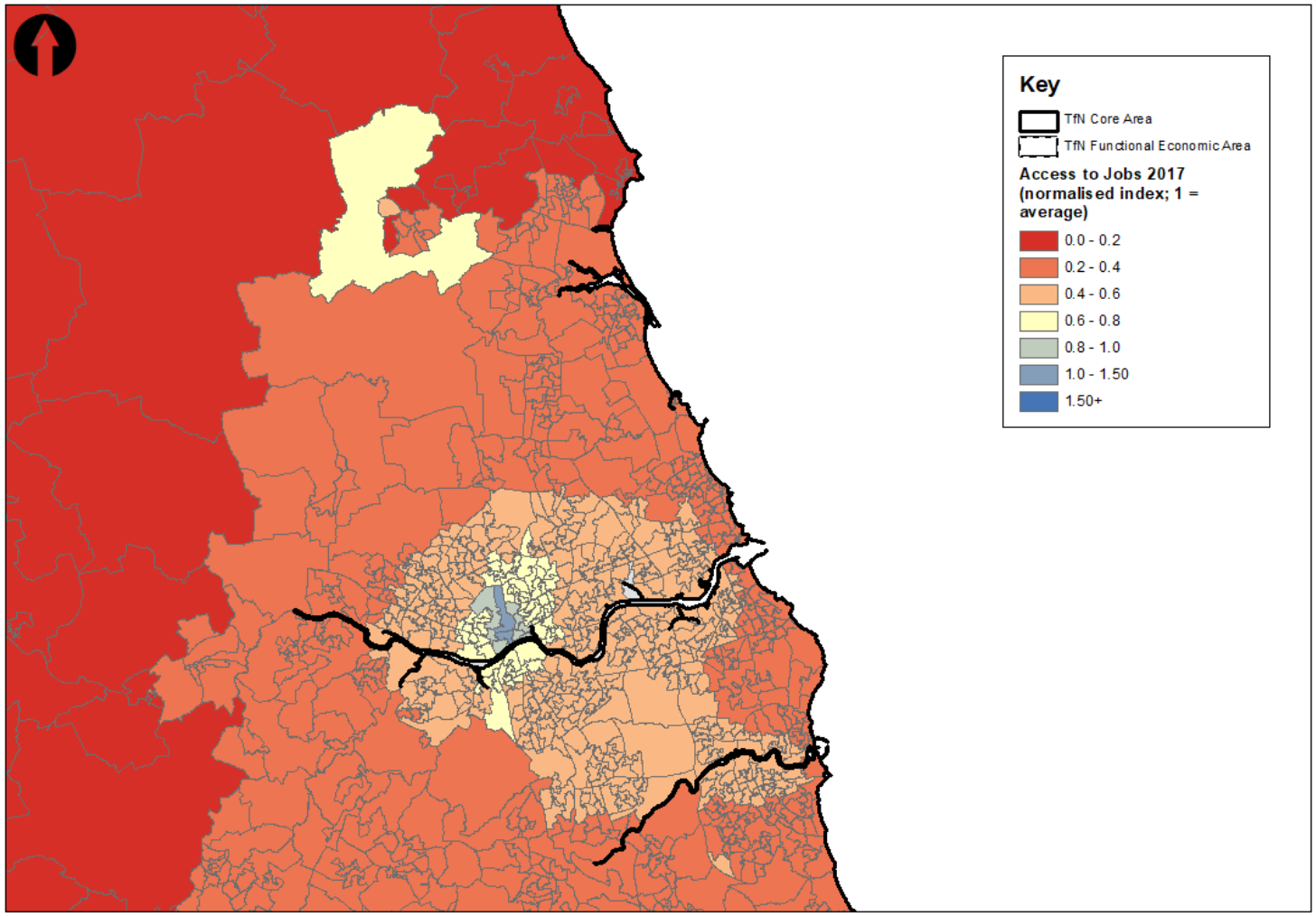


Figure 15 Local authorities with no significant business productivity difference in relation to Manchester local authority

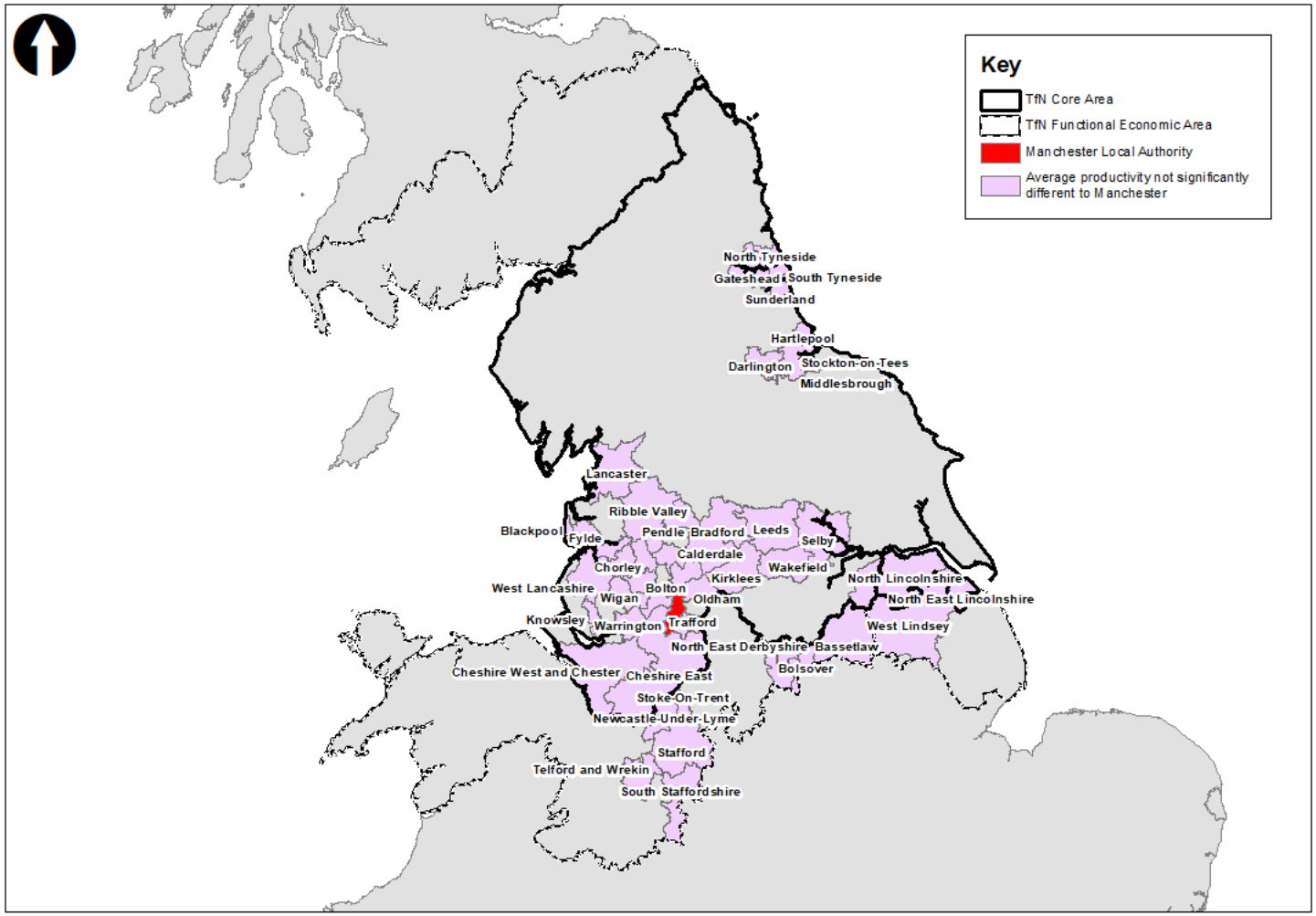


Figure 16 Local authorities for which sectoral composition seem to be an important reason for their productivity difference in relation to Manchester local authority

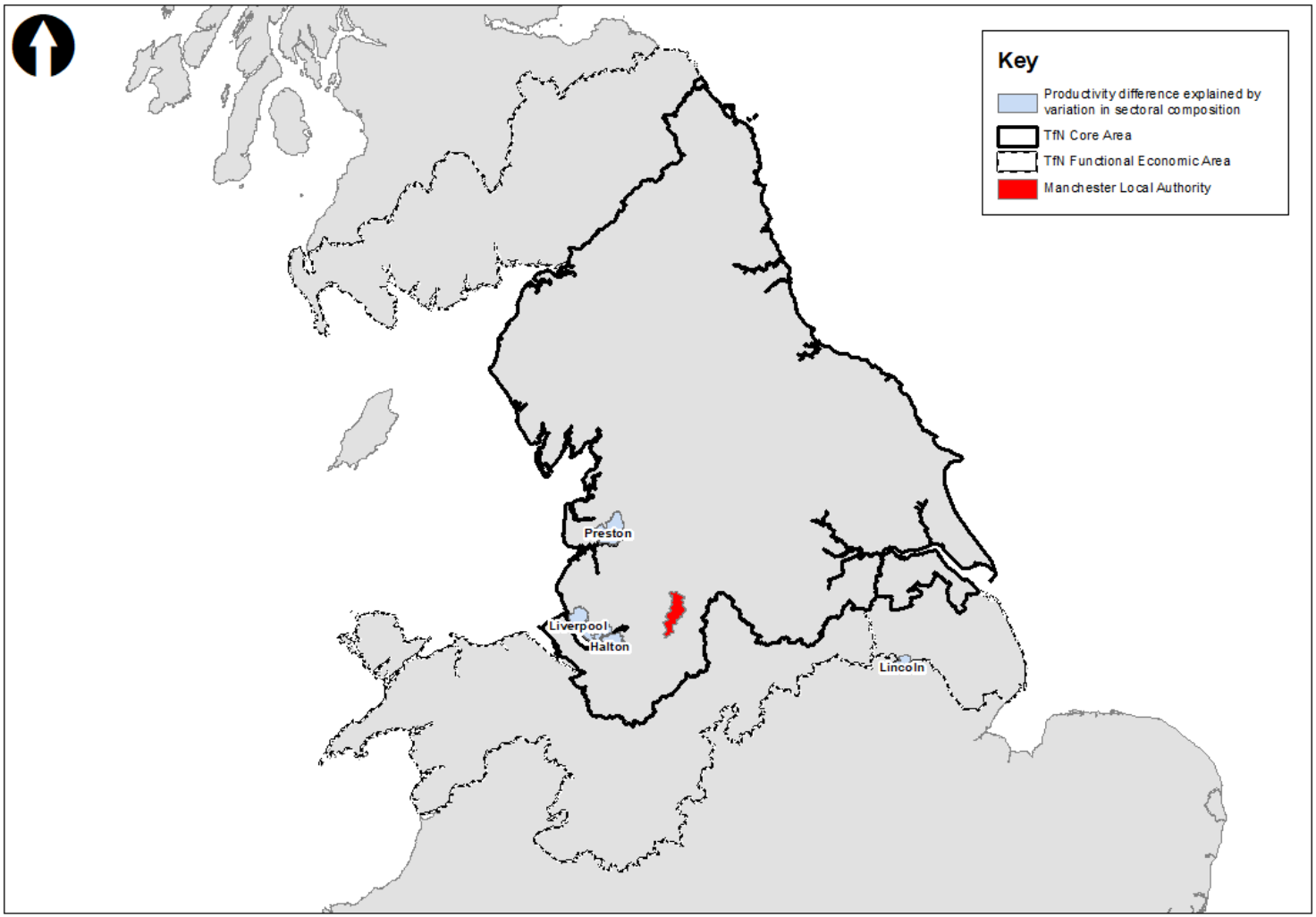


Figure 17 Local authorities for which agglomeration economies seem to be an important reason for their productivity disadvantage in relation to Manchester local authority

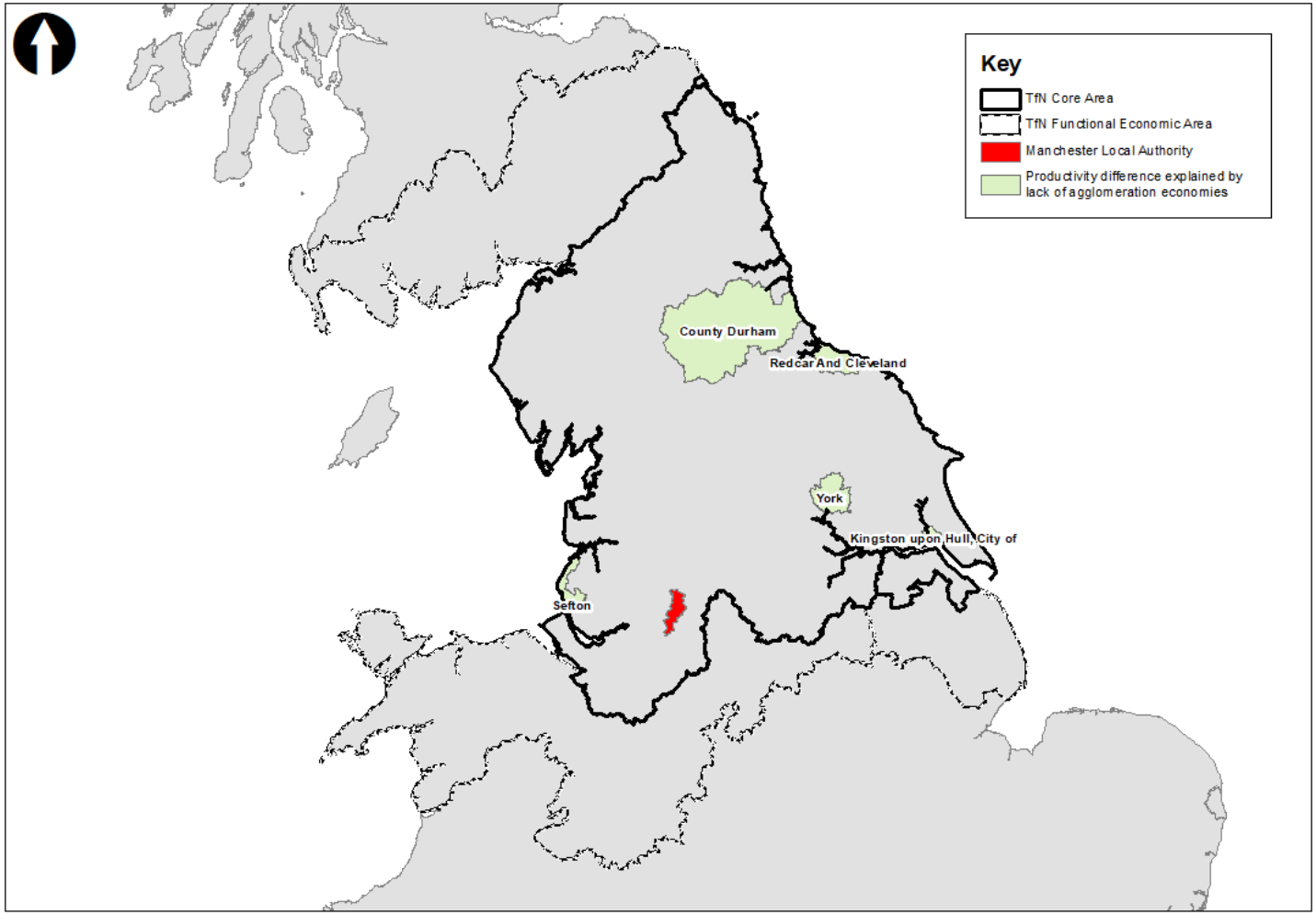


Figure 18 Local authorities for which transport accessibility seems to be an important reason for their productivity disadvantage in relation to Manchester local authority

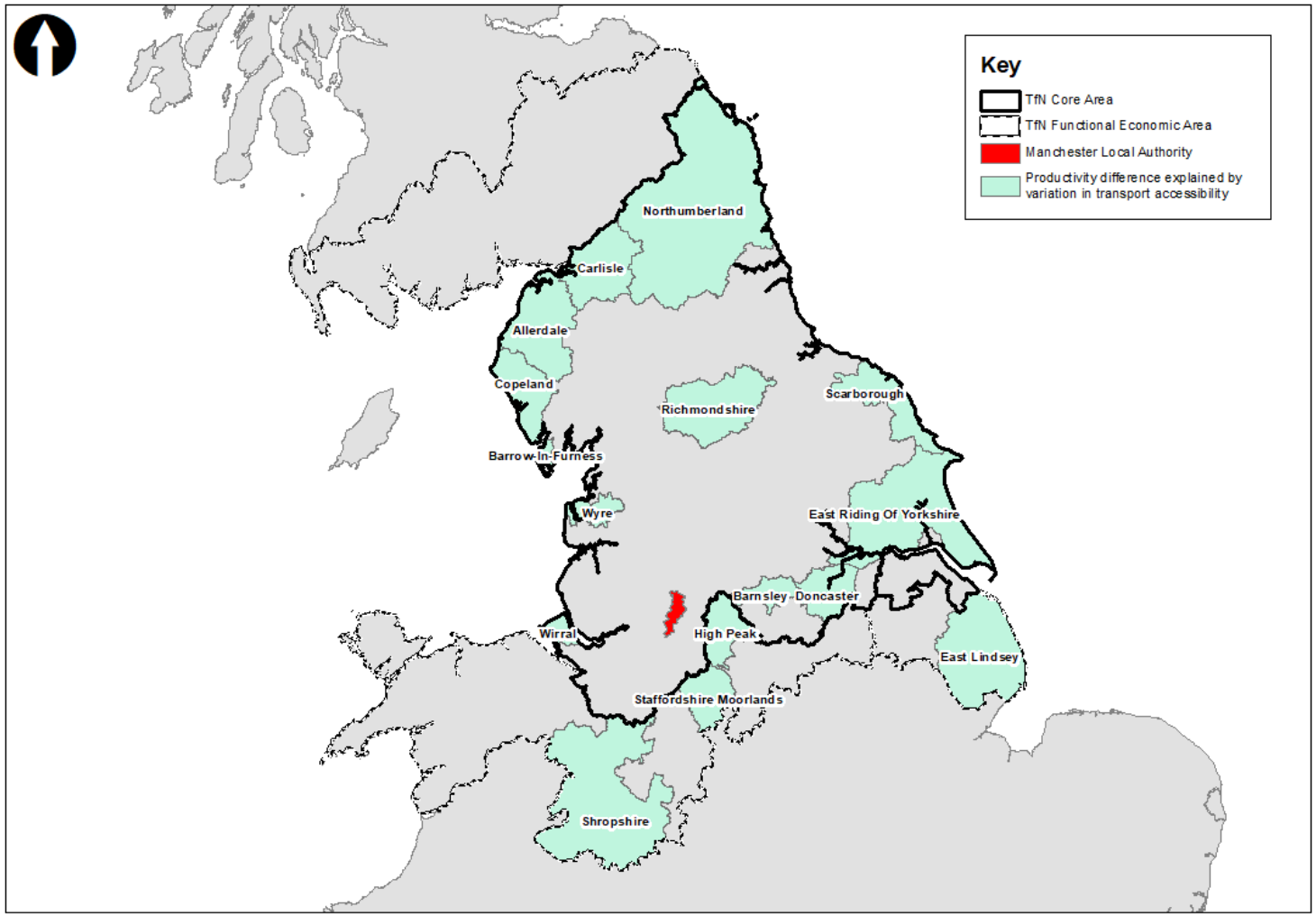
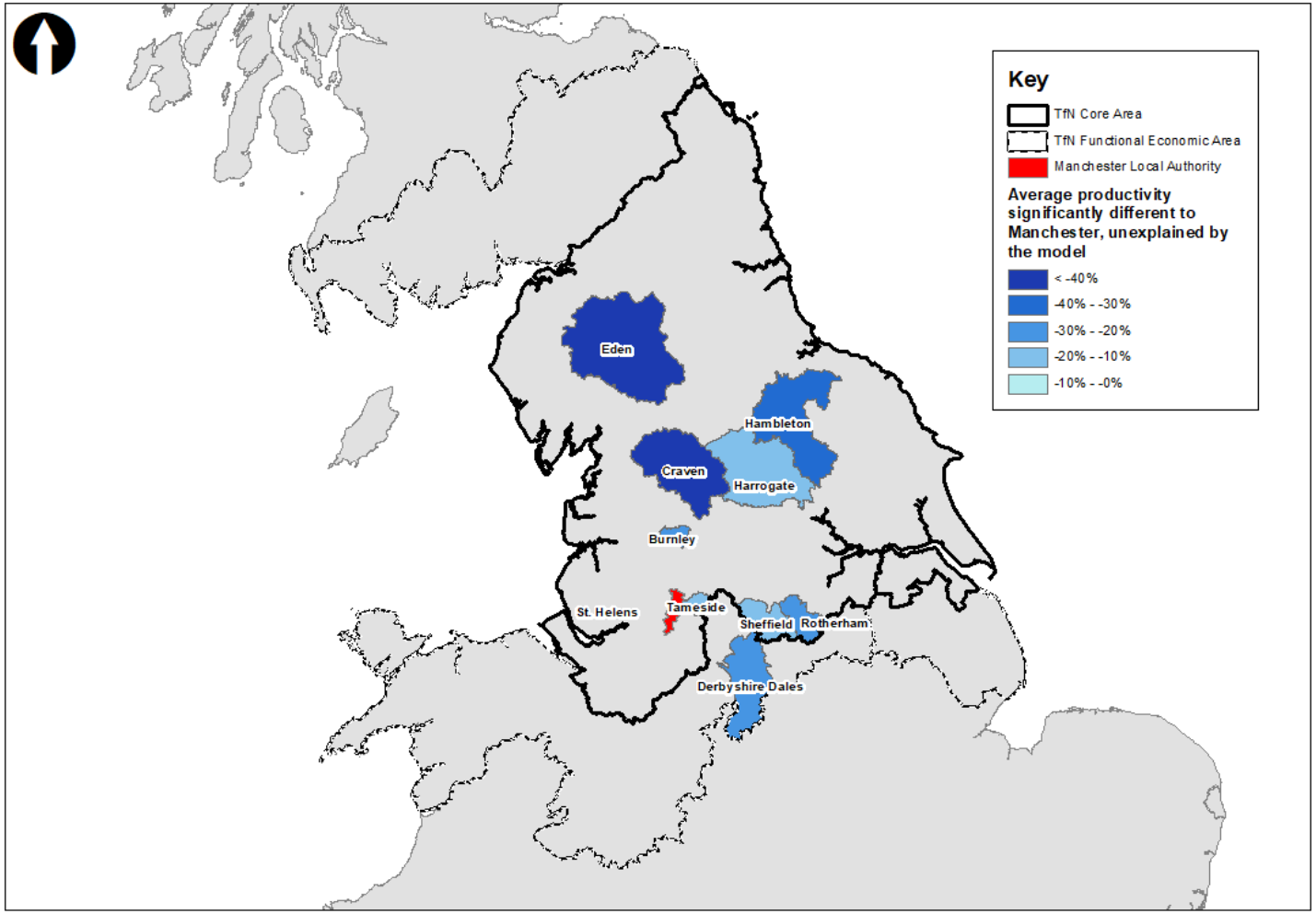


Figure 19 Local authorities with productivity differences in relation to Manchester local authority, not explained by the model



Suggestions for further research

The analysis describe above has been scoped as an addition to a broader cluster and agglomeration study. Although it provides important initial insights into productivity determinants across the North, it could and should be elaborated for more robust and detailed findings.

1. Time dimension

First of all, our analysis is only cross-sectional, i.e. it is based on Annual Business Survey data from one year only. To account for long-term trends, we would suggest conducting a panel data analysis. Cross-sectional datasets is a dataset describing observations at one point in time. Panel datasets allow for the same observations to be tracked across time. The biggest advantage of using a panel dataset is a possibility of accounting for factors which are not observable, i.e. for which we do not have data available[15].

2. Definition of key productivity determinants

The section on Location Data describes the way we defined variables representing agglomeration economies, access to skills and transport accessibility. These could be further elaborated or defined differently if desired. In particular, the crude transport accessibility variables that we used most likely do not fully represent the specifics of transport accessibility levels in the North. TfN might consider using other measures available through Transport for London strategic transport modelling. We would encourage TfN to follow that approach before making final conclusions about the role of transport accessibility plays in explaining productivity variation across the North.

3. Controlling for other factors

Our analysis concentrates on three key determinants and identifying general insights about their role in explaining business productivity differences across the region. In addition, we control for a company size and an industry in which it operates. While satisfactory for the purpose of our study, further research shall consider including other factors in the analysis, particularly at a company level. For example, the quality of management has recently been identified as a potential contributor to low productivity levels. A wide range of factors that could affect productivity should be explored to provide a more comprehensive explanation of differences in productivity levels.

[15] To be precise we can account for unobservable factors which are fixed for each observation across time (known as state fixed effects), or which happened only in some periods but affects all the observation in the same way (known as time fixed effects).

4. Sectoral analysis

While we control for the fact that companies operate in various sectors, the way our model is set up does not allow to analyse relative strengths and weaknesses of all sectors in all locations. It would require a different specification of the model and including many more variables (by interacting location dummy variables with industry dummy variables). Before proceeding with that approach, we would suggest revisiting the number of location we analyse, as the more locations, the slightly more challenging interpretation of results becomes.

5. Choice of locations and the reference location

Our model estimate productivity differences between Manchester and almost 90 local authorities the study area. That is in fact a very large number. You could consider defining various locations in the North in a different way, depending on your interest. They do not need to be the same type of places, for instance they do not have to all be local authorities. The only technical condition is that each observation can be assigned to only one location, i.e. the locations cannot overlap. For instance, the same model cannot include a dummy variable for both Manchester district and Greater Manchester. Choice of the reference location is also important, and you might change it, depending on how you want to interpret your results.