March 2023

Economic scenarios for the Northern Powerhouse Independent Economic Review

Final Report

SQW

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TRANSPORT FOR THE NORTH

Contents

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Executive Summary

Introduction

1. This report sets out a series of quantified economic scenarios for the North of England. It identifies a **'New Transformational' scenario** that could increase the North's GVA by an additional £118 billion per year by 2050, increasing productivity per worker by an additional £6,000 per year, and substantially reducing the productivity gap between the North and the rest of the UK.

2. This report will inform a refresh of the **Northern Powerhouse Independent Economic Review** (NPIER), as well as Transport for the North's (TfN's) **Strategic Transport Plan**, which will be published in 2024, and wider strategy development across the North.

Context

3. The original NPIER was prepared in 2016. This set out an analysis of the North's productivity gap and, following a review of the Northern economy, identified a series of key 'capabilities' in which the North was, or had the potential to be, internationally competitive.

4. As part of the NPIER, Cambridge Econometrics and SQW identified a 'transformational' scenario looking ahead to 2050. This anticipated that productivity would be 4% higher by 2050 than it would be in a 'business as usual' scenario, supporting some 850,000 additional jobs. The transformational scenario helped to create an economic 'ambition for the North', providing an analytical basis for TfN's Strategic Transport Plan.

5. Since the 2016 NPIER, there have been significant changes in the economic and policy context. These include the political and economic consequences of Brexit; the economic shock caused by the Covid-19 pandemic and the current energy crisis; the growing policy salience of decarbonisation; the ongoing process of digitalisation driving changes in goods, services and working practices; and the continued progress of devolution to city regions and sub-regions in the North. Recent years have also seen persistently weak productivity growth (despite a buoyant labour market) and a widening productivity gap between the North and the rest of the UK.

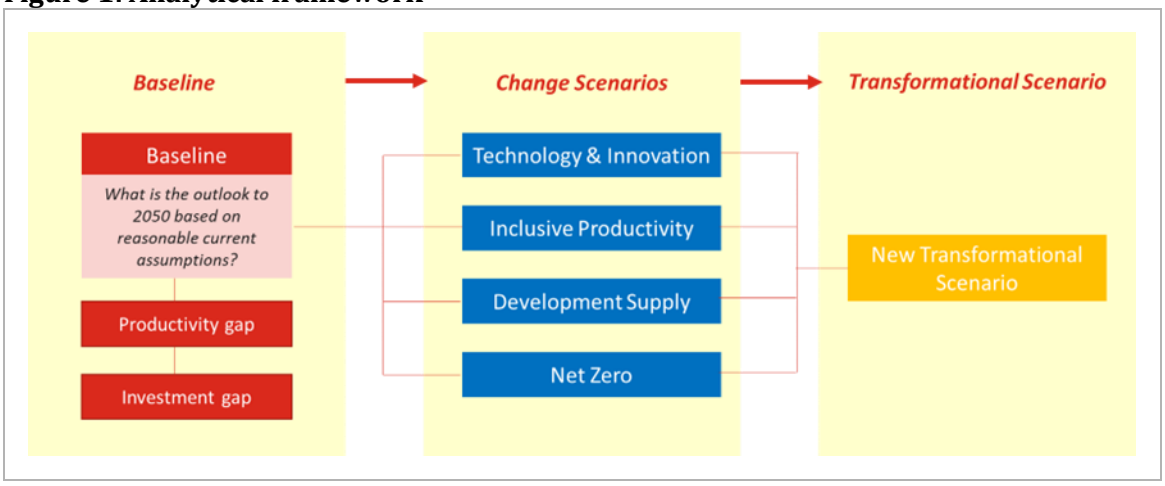
6. At the same time, the North's economic evidence base has expanded substantially. Taking recent analysis into account alongside the changed economic environment, TfN commissioned Cambridge Econometrics and SQW to prepare a fresh set of growth scenarios, with the aim of setting a revised ambition for the North's economy through to 2050.

Framework

7. Our analytical framework is illustrated below. It contains three elements:

- A **Baseline Benchmark** developed using Cambridge Econometrics' Local Economy Futures Model (LEFM). This sets out where the economy is likely to head in the absence of any additional drivers of change.
- Four **Change Scenarios**, exploring how a range of different policy mechanisms might change the baseline.
- A **'New Transformational'** scenario, which brings together the combined impacts of the four Change Scenarios and the synergies from simultaneous delivery:

Figure 1: Analytical framework



Source: SQW 2023

Baseline

8. The **Baseline Benchmark** estimates the likely trajectory of the North's economy in a 'policy-off' context to 2050. It anticipates strong jobs growth, reflecting the recent trajectory, with unemployment and economic inactivity projected to continue to decline.

9. However, **the outlook for productivity growth is low compared with the pre-financial crisis trend, and more pessimistic than the 'business as usual' scenario six years ago.** Although the 2016 NPIER set an ambition to close the productivity gap between the North and the rest of the UK, there has been limited progress towards achieving this (despite successful individual investments), and the Baseline Benchmark expects the gap to persist, in the absence of a changed approach.

Change Scenarios

10. Four 'Change Scenarios' model what the impact of a different approach might look like. Each scenario is an abstract conceptualisation, which combines a series of variables into a coherent package of interventions. These are then modelled to consider the impacts on GVA, productivity, jobs and a range of other metrics. Our four Change Scenarios are summarised in the table below:

Table 1: Change scenarios

Scenario	Modelled outputs to 2050 (over the Baseline)
Scenario 1: Technology and Innovation *The North enjoys high levels of technology adaption and investment, impacting on skills, innovation and productivity* The scenario considers the effects of increasing investment in R&D, technology diffusion and capacity for adoption	• **Additional annual GVA:** £22 bn • **Additional jobs:** 106,400 • **Additional productivity per worker:** £1,900 • **Additional population:** 252,000
Scenario 2: Inclusive Productivity *The North enjoys high levels of economic participation at good rates of pay and with good opportunities for in-work progression, re-skilling and inter-generational mobility* The scenario considers the effects of investment in health, social care, childcare, education and skills provision	• **Additional annual GVA:** £27 bn • **Additional jobs:** 296,500 • **Additional productivity per worker:** £1,000 • **Additional population:** 269,000
Scenario 3: Development Supply *The North retains and attracts more working age people, and people are better able to access a wide range of economic opportunities within a reasonable distance of home* The scenario considers the effects of investment in social housing and in improving local and regional transport networks (and therefore unlocking new development opportunities)	• **Additional annual GVA:** £21 bn • **Additional jobs:** 176,900 • **Additional productivity per worker:** £1,200 • **Additional population:** 1.5 million
Scenario 4: Net Zero *Progress towards meeting the UK's net zero target is accelerated, with public investment increased and greater certainty created for the market* The scenario considers the effects of implementation of the Net Zero strategy in relation to the decarbonisation of the built environment, transport system, energy generation, industry, waste and agriculture	• **Additional annual GVA:** £23 bn • **Additional jobs:** 168,100 • **Additional productivity per worker:** £1,500 • **Additional population:** 285,500

Source: Cambridge Econometrics/ SQW

New Transformational Scenario

11. All four scenarios would deliver significant economic gains to the Northern Powerhouse. The **New Transformational** scenario brings them together and models the effect of delivering all four simultaneously.

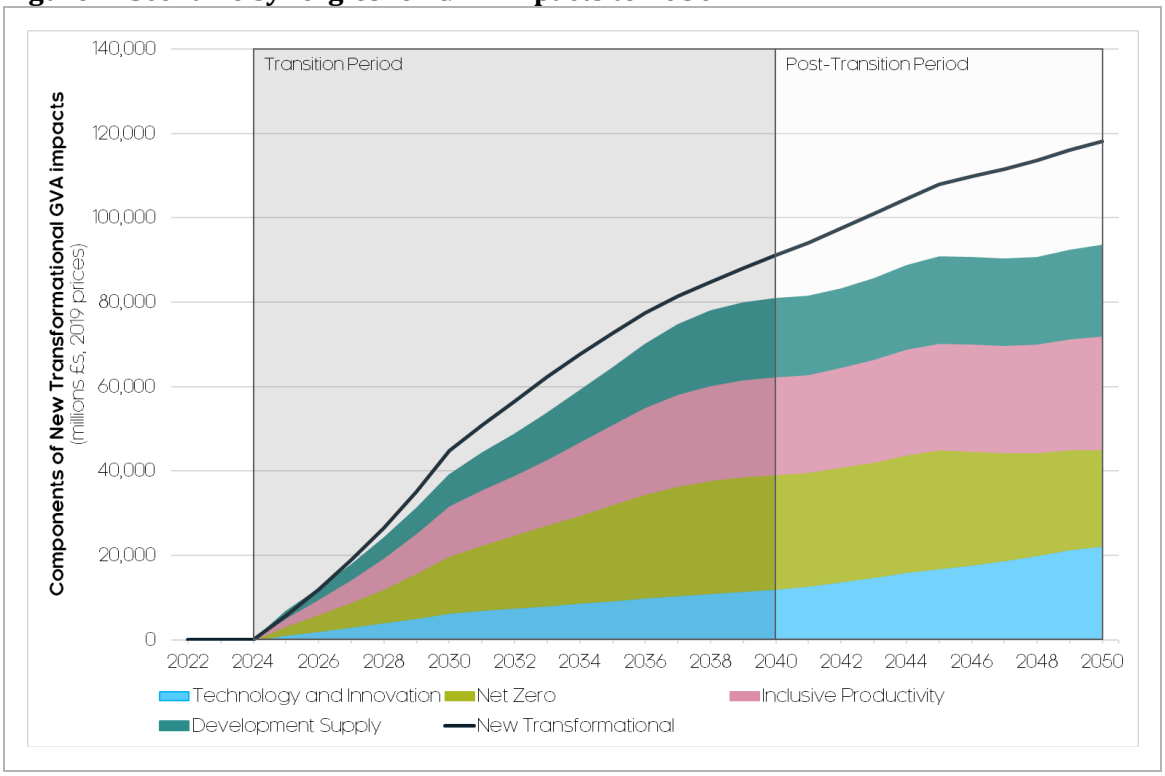
12. Figure 2 illustrates the GVA impact of the New Transformational scenario through to 2050. It shows that GVA is higher in this scenario than in the sum of the four component Change Scenarios (with a similar effect visible in relation to productivity and jobs). This is because:

- **Synergies between different scenario interventions help to release the constraints on growth**. For example, demand for more skilled workers in the Technology and

Innovation scenario match with the educational investments made in the Inclusive Productivity scenario.

- **Simultaneous delivery encourages a more capital-intensive transition** than would otherwise be the case.

Figure 2: Scenario synergies for GVA impacts to 2050



Source: Cambridge Econometrics

13. In summary, the **New Transformational scenario** delivers (to 2050, over the Baseline Benchmark, to 2050):

- **Additional GVA: £118 billion**
- **Additional jobs: 1 million**
- **Additional productivity per worker: £6,000**
- **Additional population: 1.7 million**

14. By 2050, the North's productivity catches up with and overtakes that of the "rest of England excluding London", and halves the gap with the "rest of the UK". This would represent very significant progress given the skewing effect of London on the UK as a whole.

15. The cost of delivering the New Transformational scenario is estimated (at a very high level) at £704 billion at 2019 prices between 2025 and 2050. This equates to around £28 billion per annum: a very substantial sum, although the estimated cost of supplementary support to eastern Germany is as high as £50-60 billion per annum over 30 years from 1990. Compared

with total additional GVA of £1,949 billion over the same period, this equates to a 'GVA: cost' ratio' of 2.77, as well as net positive revenue to the Exchequer over the period.

Moving forward

16. The New Transformational scenario provides a starting point for a refresh of the NPIER. This presents an opportunity to consider in greater detail how the ambition set out in the scenario may be realised, through a fresh analysis of the North's capabilities, including the synergies and linkages between strengths at sub-regional level.

17. As well as focusing on accelerating growth boosting competitiveness, stakeholder feedback highlighted the need for the new NPIER to reflect the role of the Northern Powerhouse in driving environmental transformation and reducing inequalities, linked with the Change Scenarios set out in this report – and recognising the scale of change and investment that is needed to move the North's economic trajectory away from the baseline.

1. Introduction

1.1 This report sets out a series of quantified economic scenarios for the North of England. Drawing on analysis of a wide range of opportunities for increased investment in technology and innovation, the transition to net zero, 'inclusive growth' and commercial and housing development, it identifies a 'New Transformational' scenario that could increase the North's GVA by around £118 billion per year by 2050, substantially reducing the productivity gap between the North and the rest of the UK.

1.2 The scenarios outlined in this report will inform a refresh of the **Northern Powerhouse Independent Economic Review** (NPIER), as well as Transport for the North (TfN)'s **Strategic Transport Plan**, which will be published in 2024. They will also support wider strategy development across the North, including within the Combined Authorities and the 'NP11' group of Local Enterprise Partnerships.

The Northern Powerhouse Independent Economic Review

1.3 The original Northern Powerhouse Independent Economic Review was published in 2016. The NPIER set out an analysis of the North's 'productivity gap', and, based on review of the assets and strengths of the Northern economy, identified a series of key 'capabilities' in which the North was, or had the potential to be, internationally competitive.

1.4 As part of the NPIER, SQW and Cambridge Econometrics prepared two quantified scenarios, looking forward to 2050: a 'business as usual' scenario, in which the productivity gap between the North and the rest of the UK persisted, and a 'transformational' scenario, which implied substantial restructuring of the North's economy to close the gap. The 'transformational' scenario anticipated that productivity would be some 4% higher and that some 850,000 additional jobs would be created over the 'business as usual' scenario by 2050.

1.5 The 'transformational' scenario was helpful in creating an economic 'ambition for the North' with widespread stakeholder buy-in. The NPIER was also widely used in informing strategy at regional and sub-regional level. In particular, it provided an analytical basis for TfN's Northern Transport Strategy (2016) and the Strategic Transport Plan (2019), which identified "transforming economic performance" as its first objective, linked with the NPIER 2050 ambitions[1].

Seven years on: Refreshing the scenarios

1.6 The NPIER 'business as usual' and 'transformational' scenarios were subject to technical updates in 2019 and 2020[2]. However, the intervening period has seen both a substantial

[1] Transport for the North (2019), *Strategic Transport Plan*
[2] Oxford Economics (2019, 2020)

expansion of the evidence base and extensive changes in the wider economic and policy context, which are considered further in the next chapter.

1.7 In that context, in May 2022, Cambridge Econometrics and SQW were commissioned by TfN to prepare a fresh set of quantified economic scenarios, with the aim of setting out the conditions within – and the extent to which – the North could bridge the productivity gap with the rest of the UK by 2050. The commission was not intended to 'update' the scenarios developed in 2016 in the light of new data; rather it involved a new approach to scenario development, taking account of new evidence and the policy priorities of Transport for the North, the NP11 and other key stakeholders. While the new scenarios do not in themselves constitute a revised NPIER, they will inform it when it is developed later in the year.

Our approach

1.8 Our approach to developing the scenarios involved a series of sequential steps:

- First, we carried out a **review of the use of scenarios and best practice in their development**, drawing on examples from across the UK and consultation with expert stakeholders. This was concluded in May 2022 as part of an earlier commission[3].
- Through a **scoping phase** in June and July 2022, a series of consultations sought to establish the purpose of the scenarios to meet the objectives of TfN and its partners, and to set out a series of parameters to underpin them. The conclusions of this process inform the 'key parameters' section below and the Analytical Framework described in Chapter 3.
- Further consultation linked with the evaluation and shortlisting of a range of different policy options led to the preparation of a series of **'narrative scenarios'** in early autumn, alongside a fresh baseline economic forecast.
- The narrative scenarios were then **quantified** using a range of evidence-based assumptions, with the outcomes presented in this report.

Key parameters

1.9 During the scoping phase, the scenario development exercise was framed around a series of parameters. These have guided the subsequent analysis:

- **Parameter 1:** Economic scenarios are developed for a variety of purposes (for example, they might be used to explore the effects of different policy options, or to consider the impacts of various risks and other external factors)[4]. In this case, **the purpose of the scenarios is to set out a long-term economic ambition for the North**, quantifying what

[3] Cambridge Econometrics (2022), *NPIER: Capabilities, Local Data and Narratives – Workstream 3: Economic Scenario Analysis*

[4] For an analysis of the different ways in which economic scenarios might be used, also see the Cambridge Econometrics (2022), *NPIER: Capabilities, Local Data and Narratives – Workstream 3: Economic Scenario Analysis*

the scale of the North's economic potential could be under a range of different policy assumptions. As set out above, this will help to inform the new NPIER and will provide a 'target' towards which the priorities set out in the forthcoming Strategic Transport Plan can contribute. The scenarios should also inform further sub-regional economic strategies and business cases, helping to 'make the case' for further investment. This mirrors the way in which the transformational scenario set out in the 2016 NPIER has been used by stakeholders.

- **Parameter 2:** In line with the aim of testing different policy options, **the scenarios are built from the 'bottom up'**, i.e., by identifying the potential policy levers that could help achieve a narrative ambition and estimating the impact of these. This is somewhat different from the transformational scenario in the 2016 NPIER, which was developed 'top-down' from the goal of narrowing the productivity gap, but it ought to reflect a greater level of realism.

- **Parameter 3:** All scenarios are developed with a **2050 time horizon.** This is consistent with the 2016 NPIER, although we note the length of time that some major investments may take before they lead to significant economic change.

- **Parameter 4:** All scenarios are modelled in relation to GVA, productivity and employment metrics, consistent with the 2016 NPIER. However, **there are other ambitions that partners in the North wish to consider**, for example relating to social inclusion and environmental sustainability. The range of metrics has therefore been expanded: a full list is included in Annex A, and additional metrics are referred to where relevant in the body of the report.

- **Parameter 5: All scenarios are developed at the level of the North overall.** This continues the focus within the 2016 NPIER on identifying the "peaks through the clouds" and the big strategic opportunities of genuinely pan-Northern relevance. This means that the model has been run at the level of the North overall (i.e. the North West, North East and Yorkshire and Humber ITL1 regions combined).

1.10 It should also be noted that the scenario outcomes represent estimates of an "order of magnitude", reflecting the time period over which they are modelled, the size of the North's economy and the range of assumptions included. They are evidence-based "best estimates" as opposed to very granular forecasts.

Report structure

1.11 The remainder of this report is structured across nine further chapters:

- **Chapter 2** sets out the wider context for the scenarios, including the evidence base assembled since 2016 and changes in the national and international economic and policy outlook.

- **Chapter 3** presents our **analytical framework.** It introduces four 'Change Scenarios' (focused on ambitions for technology adoption and innovation; reduced inequality; an increase in development supply; and transition to net zero) and explains our approach to the modelling work.
- **Chapter 4** introduces the **Baseline,** modelling the outlook for the North in the absence of policy change.
- **Chapters 5-8** then explain each of the four **Change Scenarios** in more detail, setting out a summary narrative for each one, explaining the core modelling assumptions used and presenting the results.
- Aggregating the outputs from all four change scenarios, **Chapter 9** presents a **'New Transformational'** scenario for the North.
- Finally, **Chapter 10** looks forward to the revised NPIER, explaining how the scenarios will be used.

1.12 In addition, sections 3.18 and 3.20 set out the metrics used for the model outputs, and the full results are presented in Annex A:.

2. Context

2.1 The fresh set of scenarios for the North have been developed in the context of significant policy and economic change since the original 'transformational scenario' was prepared for the NPIER in 2016. Starting with a summary of the conclusions of the 2016 NPIER, this chapter sets out the evolution of the policy landscape, the development of the Northern economic evidence base and other processes of scenario development that have recently taken place.

Challenges and opportunities for the North's economy: conclusions from the 2016 NPIER

2.2 Following the commitment of the then Government to a series of investments in the 'Northern Powerhouse', the 2016 NPIER sought to understand the causes of the North's relatively weak economic performance and opportunities for long-term growth[5].

The NPIER identified an economic 'performance gap' between the North and the rest of the UK which was described as 'structural and persistent', with GVA per capita consistently about 25% below the England average. Productivity accounted for the largest share of the performance gap, with weak productivity driven by a range of factors, including: insufficient high-skilled workers and too many low-skilled workers; insufficient exploitation of innovation and technology; lower levels of investment; lower levels of enterprise; lack of agglomeration; and sub-optimal transport links and under-investment in transport.

2.3 Alongside the quantified transformational scenario set out in the NPIER, the Review identified scope for growth based on the North's strengths and potential in four 'prime' capabilities which are highly productive and internationally competitive (advanced manufacturing, energy, health innovation and digital), with these supported by three 'enabling' capabilities (financial and professional services, logistics and education, especially higher education). The Review noted that the capabilities are present across the North, providing a strong basis for future growth. However, achieving the change anticipated in the 'transformational' scenario would require investment and improved performance in a number of areas, including skills, innovation and inward investment, alongside transport infrastructure and services.

Economic and policy change since the NPIER

2.4 Since the 2016 NPIER, there have been very substantial changes in the policy and economic context. These include the political and economic consequences of Brexit; the growing policy salience of decarbonisation; the economic shock caused by the Covid-19 pandemic; and the ongoing process of digitalisation driving changes in goods, services and working practices.

[5] Northern Powerhouse Independent Economic Review: Core Messages (2016)

Uncertainty in the short term has been recently exacerbated by the Russian invasion of Ukraine in 2022 and the consequent energy crisis.

2.5 Overall, **the period since 2016 has seen persistently weak productivity growth in the UK**, alongside a widening gap between the North and the rest of the country. The picture is not uniformly negative: employment growth has been historically very strong. But the productivity challenges that the original NPIER set out remain significant and at the time of writing, the economic outlook remains very uncertain, in the context of the energy price crisis and other inflationary pressures. A review of the economic data since 2016 is set out in greater detail in Chapter 4, where we introduce the Baseline.

2.6 **There has been churn in policy and funding mechanisms** since the last NPIER, reflecting a persistent feature of regional policy in England. The **Industrial Strategy** published in 2017 focused on the UK's response to a series of technological and societal 'grand challenges', highlighted the role of sectors in which the country had comparative advantage and set the framework for a series of Local Industrial Strategies[6]. This was superseded by a **Plan for Growth** in 2021 which emphasised similar themes[7]. More recently, the **Levelling Up White Paper** has taken a conceptually broader approach, covering productivity, pay and employment; health and wellbeing outcomes; and 'community pride' and sense of place, within a complex analytical framework. The White Paper sets out its first policy objectives as *"boosting productivity, pay, jobs and living standards by growing the private sector, especially in places where they are lagging"*[8]. The White Paper highlights the UK's significant and long-standing regional imbalances, potentially setting a positive context for rebalancing investment away from the Greater South East.

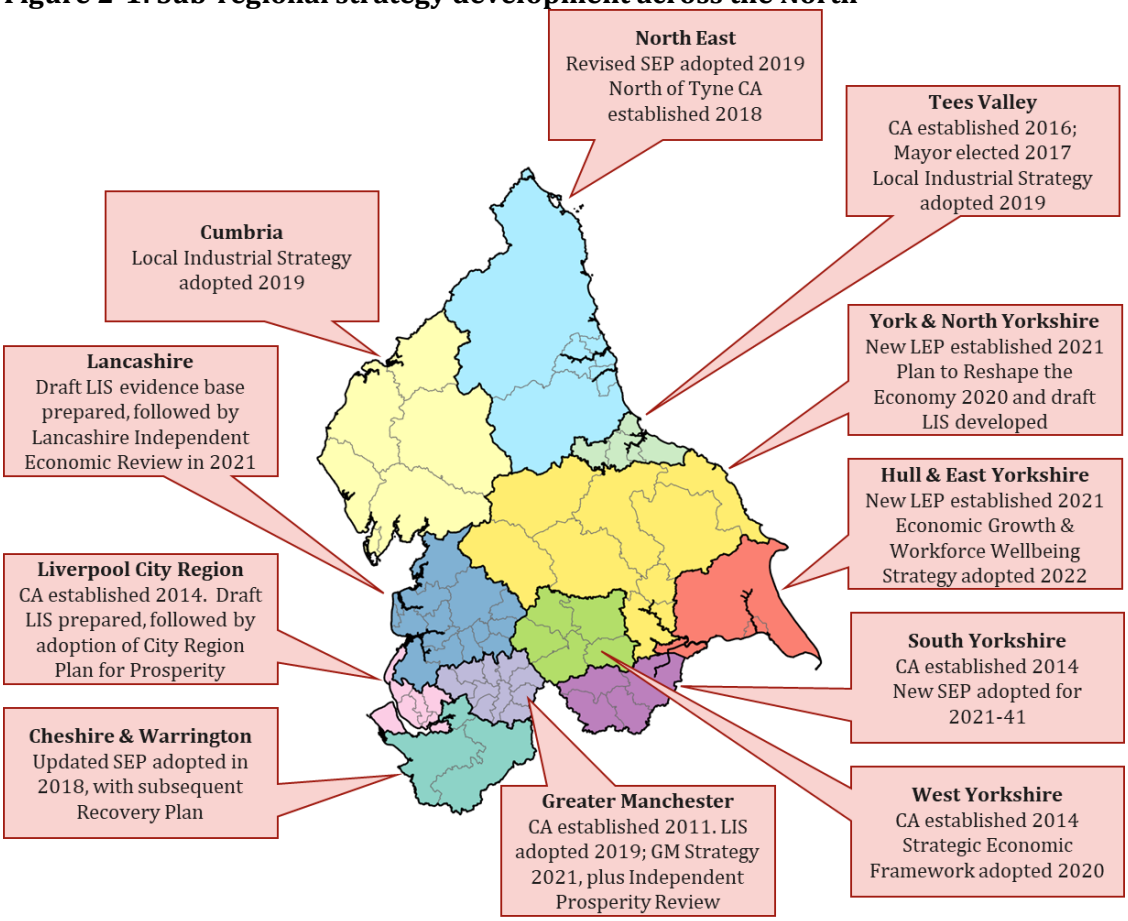
2.7 Despite this apparent churn in regional economic development policy, there are three areas in which there has been greater national policy consistency and which are relevant to the context in which the new Northern economic scenarios are developed. First, in relation to **decarbonisation**, in 2019 the UK adopted a legally-binding commitment to reduce greenhouse gas emissions to net zero by 2050 – the first large economy to do so. This has subsequently been reinforced in the adoption of a cross-Government Net Zero Strategy[9] and by recent changes to the machinery of Government[10], and has strong cross-party consensus. While decarbonisation was considered an important factor in the development of the 2016 NPIER, the salience of the net zero agenda has advanced substantially since, and this has influenced the development of the scenarios outlined in this report.

2.8 Second, **the process of devolution to city regions and sub-regions has advanced progressively and incrementally.** Mayoral Combined Authorities are now firmly

[6] UK Government (2017), *Industrial Strategy: Building a Britain Fit for the Future*
[7] UK Government (2021), *Build Back Better: Our Plan for Growth*. A further 'Growth Plan' was also published in September 2022 linked with changes to Government, although this was subsequently abandoned.
[8] UK Government (2022), *Levelling Up the United Kingdom*
[9] UK Government (2021), *Net Zero Strategy: Build Back Greener*
[10] The creation of the new Department for Energy Security and Net Zero in February 2023.

established in six Northern geographies[11]. Their role has consolidated and strengthened over time, the first mayoral devolution deal in a mainly rural area has now been agreed[12], and the local government geography has been streamlined in several areas, with the Government's ambition (as set out in the Levelling Up White Paper) to create greater consistency in sub-regional economic governance models. All 11 LEPs and Combined Authorities have adopted Local Industrial Strategies or equivalents and comprehensive evidence bases: the core strategy documents are summarised in the map below[13]:

Figure 2-1: Sub-regional strategy development across the North



Source: SQW

2.9 Since 2016, there has been an evolution in the thematic areas of focus identified by several sub-regional and city-regional plans. This reflects the greater emphasis on decarbonisation, which is now a central driver of all the plans highlighted above, with a focus on the industrial opportunities created by the transition to net zero, as well as the costs and challenges of adaption.

[11] Greater Manchester, Liverpool City Region, North of Tyne, South Yorkshire, West Yorkshire and Tees Valley.
[12] In York and North Yorkshire.
[13] A summary of the local strategy and evidence base is set out in a series of eleven Area Profiles for each Local Enterprise Partnership in the North of England, prepared separately alongside this report.

2.10 Finally, there has also been an increasing focus on **'inclusive growth'** and the need to reduce inequalities and widen access to opportunity – an orientation further emphasised in the series of recovery plans developed by LEPs and Combined Authorities in the wake of the pandemic. This agenda also recognises the interplay between growth and inequality, and the role which expanding economic opportunity more widely has in driving productivity growth. Overall, this points to an increasing strategic focus on environmental, social and economic sustainability, which we have taken into account in developing the refreshed scenarios.

Developing pan-Northern collaboration and evidence

2.11 While there has been significant progress since 2016 in developing new institutional arrangements at sub-regional and city-regional level, there remain few formal 'pan-Northern' institutions, with Transport for the North holding a unique position in this regard.

2.12 However, there has been progress in developing informal collaboration across the North, especially in developing the economic evidence base to guide future policy development. This has built on the recommendation contained within the 2016 NPIER that an ongoing programme of research should be instituted to ensure that the evidence gathered as part of the Review could be sustained. In addition to technical updates to the 2016 NPIER, this includes[14]:

- A review of **Research and Innovation in the North of England** (Cambridge Econometrics, 2019). This highlighted *(inter alia)* underperformance in the North relative to the South (although distinct strengths in areas such as materials science and process engineering); alongside the potential of larger cities in acting as hubs of collaboration alongside a recognition that the distribution of research excellence is not limited to the major urban agglomerations.
- A review of **Connectivity and Labour Markets in the Northern Powerhouse** (Cambridge Econometrics, 2018), looking at the evolving skills needs of the Northern economy, and resulting changes in commuting patterns and travel flows.
- A review of **International Trade and Connectivity in the North** (Oxford Economics/ York Aviation, 2019), which considered the future export intensity of the Northern economy in the light of the scenarios presented in the 2016 NPIER and considered the role of investment in domestic and international connectivity in facilitating this.
- Analysis of **Future Transport Demand in the North of England** (SDG, 2017, 2018), demonstrating how the volume and pattern of transport demand would respond to the changes in population and employment resulting from the scenarios set out in the 2016 NPIER.

[14] A bibliography of relevant research material is set out in Annex B:.

- Analysis of the North's **key sectoral capabilities,** including the performance and scale of the 'foundational economy', and of the strategy priorities set out at sub-regional level (SQW and Cambridge Econometrics, 2022).

2.13 This material is supplemented by a wide range of other research evidence that crosses sub-regional boundaries (such as the series of Science and Innovation Audits prepared in 2016-18 and the work of the Northern Health Science Alliance), research commissioned by sub-regional partners, but which has pan-Northern relevance (e.g. Greater Manchester's Independent Prosperity Review, research and data observatories such as the North East Data Hub and place-based research consortia such as the Yorkshire and Humber Policy Engagement and Research Network[15]), and the output of the key research institutes and think tanks. Following an independent report in 2021, a **Northern Evidence Network** has been established to consolidate research capabilities and develop a shared economic evidence base.

2.14 Consolidating the recent evidence base into 'policy propositions' for discussion and debate, the NP11 partnership developed a series of policy papers ahead of the **Convention of the North** which took place in January 2023[16]. These relate to: clean energy and net zero; advanced manufacturing and digitalisation; health; life sciences; 'people and good jobs', trade and investment, and transport, and are referred to in relation to the proposed change scenarios later in this report.

Other scenario development processes

2.15 The scenarios set out in this report also have regard to other approaches to scenario development, which have taken place over recent years[17]. For this report, two recent approaches are especially relevant: the Future Travel Scenarios developed for Transport for the North, and post-Covid scenario modelling carried out by the UK 2070 Commission.

2.16 Transport for the North's **Future Travel Scenarios** were prepared in 2020[18]. These set out a series of 'plausible futures' in the light of increased uncertainty regarding future travel patterns. The aim of the Future Travel Scenarios was to help explore some of these uncertainties, in order to increase the resilience of transport plans. The study identifies four potential futures, linked with a range of assumptions about working practices, uptake in electric vehicles, rail decarbonisation, road user pricing, freight consolidation, and so on,

[15] Yorkshire Universities, Yorkshire and Humber Policy Engagement and Research Network (Y-PERN)
[16] NP11/ Convention of the North (2023), *Convening the North: Powering Britain's Future*, and specific policy papers
[17] For an overview of approaches to scenario development (including the different ways in which economic scenarios may be developed and used) see Cambridge Econometrics (2022), *NPIER: Capabilities, Local Data and Narratives – Workstream 3: Economic Scenario Analysis*
[18] Transport for the North (2020), *Future Travel Scenarios*

quantified to 2050 in terms of population, jobs, total CO2 emissions and modal share by car, bus, rail and active travel[19].

2.17 More recently, the **UK 2070 Commission's post-Covid modelling work** considers four scenarios based on a range of assumptions regarding overall UK growth rates and the extent to which there is regional 'convergence' within the national economy[20]:

Table 2-1: UK 2070 Commission post-Covid scenarios

Geographic spread`	Rates of overall economic growth in the UK	
	Low growth	High growth
Business as usual	**Scenario B** Continued regional recession	**Scenario A** Persistent regional imbalance
Convergent economy	**Scenario C** Slow levelling-up	**Scenario D** Dynamic recovery

Source: Ying Jin, UK 2070 Commission (2021)

2.18 Although the UK 2070 Commission's work takes a national perspective, the post-Covid scenario modelling is especially relevant to the NPIER scenarios, given its focus on regional disparities and rebalancing. The analysis finds that **only in Scenario D, through a combination of high growth rates and active measures to achieve regional convergence, is there likely to be a plausible route to 'rebalancing' the economy**: under low rates of economic growth overall, "the progress of levelling-up would prove slow and inconsequential". It also finds that regional convergence is unlikely to be achieved through large-scale capital investment alone (although this might be a necessary component).

2.19 The purpose and approach to development of the Future Travel Scenarios and the UK2070 Commission work are different from that of the economic scenarios set out in this report. However, they are complementary, and have been used to inform our analysis in the chapters that follow.

[19] The four scenarios are: i) *Just About Managing* (limited and gradual behaviour change, moderate economic growth, limited policy intervention); ii) *Prioritised Places* (policy focus on redistribution and rebalancing and reducing spatial inequalities); iii) *Digitally Distributed* (acceleration of technology, supporting a "distributed, service-based transport system"; and iv) *Urban Zero Carbon* (significant shift in public attitudes on climate change, with a boost to economic productivity consistent with the transformational scenario in the 2016 NPIER).

[20] Ying Jin (University of Cambridge, 2021), *UK 2070 Futures: Post-Covid Scenario Modelling* ; UK 2070 Commission Working Paper Series 5

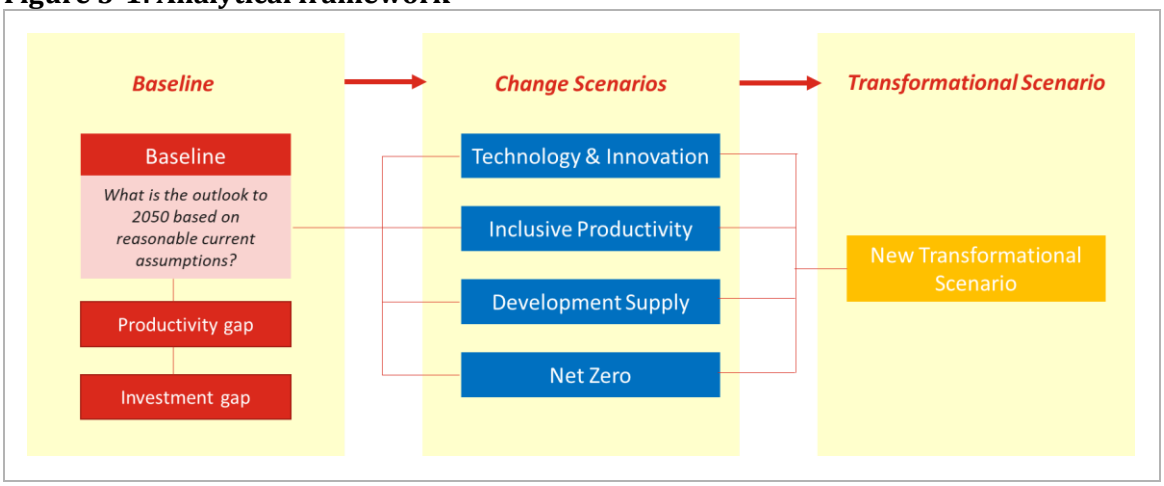
3. Analytical Framework and Approach to Modelling

3.1 This chapter sets out our overall approach to the development of the scenarios, outlining how they will be modelled and the metrics that will be used. It introduces the Baseline and four 'change scenarios', all of which are explained in greater detail in the chapters that follow

Introduction to the analytical framework

3.2 Based on the parameters set out in Chapter 1, our **analytical framework** is summarised below:

Figure 3-1: Analytical framework



Source: SQW

3.3 As illustrated, the framework contains three elements: the Baseline and a series of 'Change Scenarios', leading to a 'New Transformational' scenario, which could help to inform an 'economic vision' for the North. These are explained in turn in the following paragraphs.

The Baseline Benchmark

3.4 Our starting point is the **Baseline Benchmark,** setting out the state of the North's economy today and expectations through to 2050, based on Cambridge Econometrics' Local Economy Forecasting Model (LEFM). This is a 'top-down' model, which develops forecasts constructed at national level for 45 sectors, based on a series of assumptions on UK macroeconomic policy and global market trends. These are then disaggregated to regional and local level based on past relationships between local and national sectors. The Baseline does not take into account local intelligence and key planned investments (or disinvestments), but it provides a data-driven and independent view of **where the economy is likely to head in the absence of any additional drivers of change.** This is set out in detail in Chapter 4.

3.5 The Baseline Benchmark illustrates the scale of the expected productivity gap between the North and the rest of the UK[21]. For illustrative purposes, we show alongside the Baseline what 'closing the gap' would mean in terms of the annual rate of productivity growth that would be required. We also set out alongside the baseline an estimate of the total public sector investment gap (i.e., the gap between annual government expenditure per capita in the North and the equivalent in London and the Devolved Nations), which is subsequently used in scenario modelling.

The four Change Scenarios

3.6 We then build a series of **'Change Scenarios',** exploring how a range of different policy levers might change the Baseline. Following the process described in Chapter 1[22], we have worked through four Change Scenarios:

- **Technology and Innovation:** Within this scenario, the North enjoys high levels of technology adoption and investment relative to other nations and regions, impacting on skills, innovation and productivity. This is set out in Chapter 5.
- **Inclusive Productivity:** Within this scenario, the North enjoys high levels of economic participation at good rates of pay and with good opportunities for in-work progression, re-skilling and inter-generational mobility. This is set out in Chapter 6.
- **Development Supply:** Within this scenario, the North retains and attracts more working age people, and people are better able to access a wide range of economic opportunities within a reasonable distance of home. This is set out in Chapter 7.
- **Net Zero:** Within this scenario, progress towards meeting the UK's net zero target is accelerated, with public investment increased and greater certainty created for the market. This is set out in Chapter 8.

3.7 The first three scenarios are concerned with 'levelling up' the North, through additional investment. The fourth, Net Zero scenario, is different: rather than being principally concerned with inter-regional rebalancing, it considers the impact on the North of the full implementation of the Government's Net Zero Strategy, recognising its cross-cutting importance. For this reason, we have considered it as a separate scenario, supplementary to innovation and technology adoption.

The New Transformational Scenario

3.8 At the end of the process, Chapter 9 sets out a **New Transformational Scenario**, which brings together the cumulative effects of the four Change Scenarios and incorporates additional impacts gained from concurrent implementation of the measures associated with each one.

[21] And in relation to other metrics (e.g., employment and GVA) and comparator geographies (e.g., 'Rest of England less- London')
[22] This involved a shortlisting exercise with Northern stakeholders and Partners during consultations for the Scoping Phase in June and July 2022, and resulted in ten policy levers and ambitions.

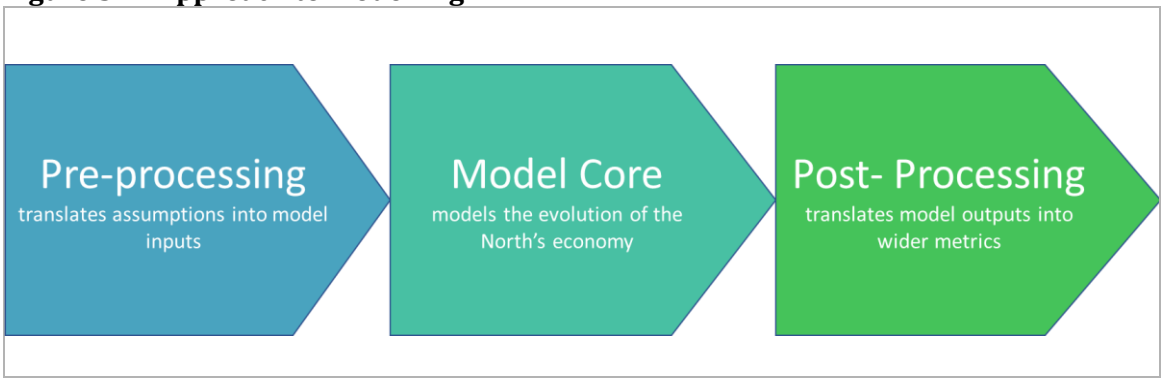
While this does not itself create a 'vision' for the North's future economy, it should help to inform one, and this can be explored further in the new NPIER.

Approach to modelling

3.9 The scenarios were modelled in three stages, with Cambridge Econometrics' Local Economy Futures Model (LEFM) used to do the complex systems modelling in the central stage. An overview of LEFM is provided below. The modelling proceeds in three stages, as shown in Figure 3-2:

- **Pre-processing:** in this stage, the assumptions used to define scenarios are converted into model inputs, with data taken from literature or econometric analysis. An example of pre-processing might be estimating the relationship between wider provision of funded childcare and resulting increase in the labour supply.
- **Model core:** once the assumptions have been input into the model, the evolution of the economy of the North is allowed to proceed freely, guided by a series of feedback loops described in the section below.
- **Post-processing:** in order to expand the number of metrics the model is able to simulate, a second series of off-model calculations are made, this time translating from model outputs to wider metrics. An example of post-processing might be estimating the relationship between the supply and demand for housing and resulting housing affordability ratios.

Figure 3-2: Approach to modelling



Source: Cambridge Econometrics

The Local Economy Futures Model

3.10 LEFM is a demand-led model that models the relationships between firms, households, government and the rest of the world in a disaggregated industrial and occupational framework (45 sectors and 25 occupations), which enables the impact on the economy (employment and value added) of both demand-side and supply-side factors to be analysed.

3.11 This latest iteration of LEFM is a successor to the previous version, known as the Local Economy Forecasting Model, that was developed by Cambridge Econometrics in collaboration

with the Institute for Employment Research at the University of Warwick. This was a software package tailored to model regional and local economies, commercially available since the early 1990s (since when it has been continually developed) and designed to empower organisations to undertake detailed economic analysis in-house. Different iterations of LEFM have been used extensively by national, regional and local agencies, and by CE for more specialised analysis, often commissioned by local authorities, for the past three decades.

3.12 Over the lifetime of LEFM, substantial research has been undertaken within academia as to the drivers of economic growth and development at the local and regional level. We include here fields such as Regional Science, New Economic Geography and Evolutionary Economics, and their insights into the role of the knowledge economy, specialisation and related variety, and, in particular, agglomeration and clustering, in shaping economic growth patterns. The latest version of LEFM differs from previous iterations in that it explicitly attempts to augment its existing functionality by utilising these now-widely accepted insights and capture these effects within the model.

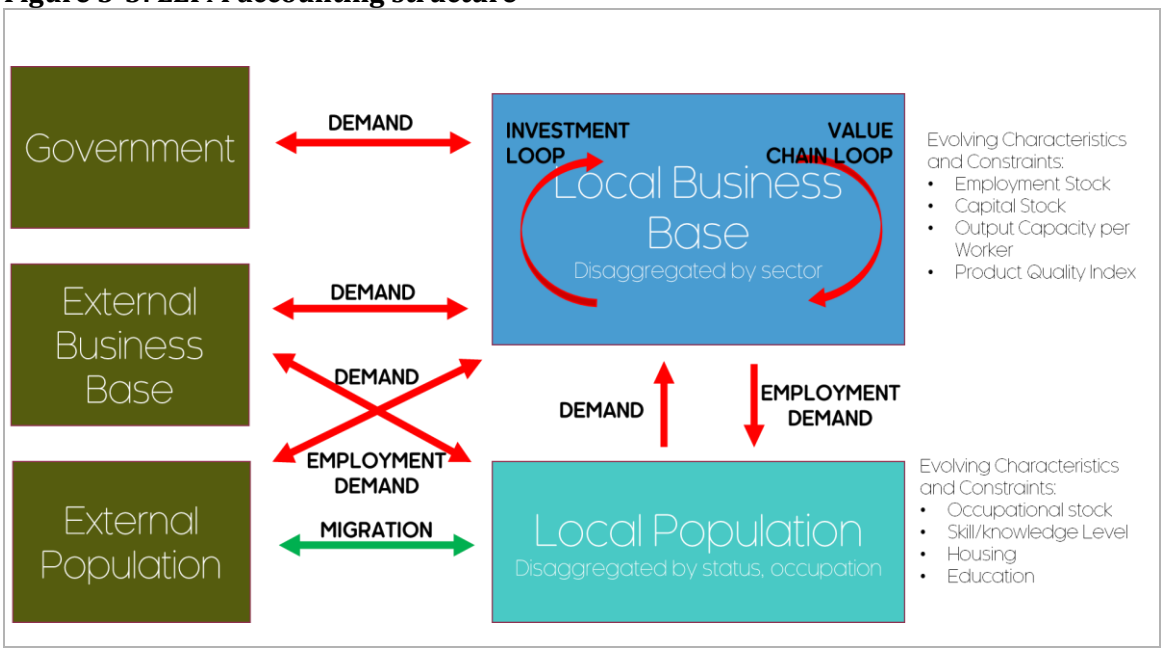
3.13 It does this by explicitly utilising a complex systems approach. This is to say, it does not assume the presence of these effects, or any other macro-level effects such as crowding out, by explicitly coding in system-level causal relationships, but instead provides sufficient detail in the nature of the relationships between economic actors, that allow the possibility that these effects may emerge spontaneously, as they would in any real-world economic system.

3.14 As the model moves through multiple timesteps, it deals with demand and supply effects in different ways. As an input/output-based model, the primary driver of short-term changes in variables within the model is demand-driven. Examples of short-run demand-driven mechanisms include: the flow of demand up a value chain between sectors, the flow of investment demand for investment goods producing sectors, the flow of labour demand from local sectors to the labour market, and the flow of demand from the local population to local service providing sectors.

3.15 However, demand is not assumed to be unconstrained. Both local sectors and local labour markets have "supply-side" constraints that dictate the extent to which changes in demand lead to changes in real outputs and activity versus price or wage responses. These constraints are fixed in the short-term, but allowed to adjust over the longer run, in response to extended changes in levels of demand. It is by allowing these supply-side variables to evolve over time according to a simple set of heuristics, that allow some of the features of agglomeration economies, for example the mutually beneficial coevolution of related sectors, or the gradually improved matching of the local sectoral base and labour market, to emerge spontaneously.

3.16 The figure below summarises the model's structure: the three broad groups of actors are: local business base (disaggregated by sector), local population (disaggregated by demographic status and occupation), and a bundle of external entities, including (UK) government, external firms, and external population.

Figure 3-3: LEFM accounting structure



Source: Cambridge Econometrics

3.17 The baseline LEFM projections are economic projections based on shift-share methods, for example historical growth in the local area relative to the regional or national level (depending on which area it has the strongest relationship with), on a sector-by-sector basis. They assume that those relationships continue into the future. Thus, if a sector in the local area outperformed (or underperformed) the sector in the region or nation as a whole in the past, then it is assumed that it will outperform (or underperform) it proportionally in the future. The absolute scenario outputs are then compared to this baseline in order to identify relative impacts.

Scenario metrics

3.18 To provide a balanced and holistic appraisal of the scenarios, we have developed and report on a wide range of scenario metrics, covering economic, social and environmental themes. Many of these are provided directly from LEFM, which provides granular coverage for more than a hundred (predominantly economic) metrics. Those of particular interest are listed in the table below, and include those reported in the previous NPIER (marked with an *).

Table 3-1: Scenario metrics from the LEFM

LEFM scenario metrics	Primary theme	Source(s)
Total population*	Economy	ONS Mid-Year Population Estimates
Working age population	Economy	ONS Mid-Year Population Estimates
Total employment: jobs*	Economy	ONS Business Register and Employment Survey (BRES), Cambridge Econometrics calculations

LEFM scenario metrics	Primary theme	Source(s)
Total gross value added (GVA)*	Economy	ONS Regional Accounts
GVA per job (labour productivity)*	Economy	ONS Regional Accounts, Cambridge Econometrics calculations
GVA per person*	Economy	ONS Regional Accounts, Cambridge Econometrics calculations
Total workplace employment	Economy	ONS Annual Population Survey (APS), Census, Cambridge Econometrics calculations
Total residence employment (and rate)	Economy	ONS Annual Population Survey (APS), ONS Labour Force Survey (LFS), Census, Cambridge Econometrics calculations
Investment (gross fixed capital formation)	Economy	ONS Regional Accounts, Cambridge Econometrics calculations
Total unemployment (and rate)	Social	ONS Annual Population Survey (APS), ONS Labour Force Survey (LFS), Census, Cambridge Econometrics calculations
Total economically active (and rate)	Social	ONS Annual Population Survey (APS), ONS Labour Force Survey (LFS), Census, Cambridge Econometrics calculations
Total economically inactive (and rate)	Social	ONS Annual Population Survey (APS), ONS Labour Force Survey (LFS), Census, Cambridge Econometrics calculations
Average wage per job	Social	ONS Annual Survey of Hours and Earnings (ASHE)
Average gross disposable household income (GDHI) per person	Social	ONS Regional Accounts
Net commuting	Environment	ONS Annual Population Survey (APS), ONS Labour Force Survey (LFS), Census, Cambridge Econometrics calculations

Source: Cambridge Econometrics

3.19 However, relative to the original NPIER, we have sought to consider a much broader series metrics, particularly within the social and environmental space, which have been developed specifically for this piece of work using secondary (i.e., "off-model") calculations. These secondary metrics are still informed by robust statistical principles and techniques, and are often closely integrated with the LEFM modelling despite sitting outside of the model.

3.20 The below table lists these secondary scenario metrics. The results of the scenarios against each of these metrics are set out in Annex A:.

Table 3-2: Secondary scenario metrics

Secondary scenario metrics	Primary theme	Source(s)
R&D spending	Economy	ONS Gross domestic expenditure on research and development (GERD)
Gini index (for mean equivalised household disposable income)	Social	ONS Living Costs and Food Survey (LCFS), ONS Household Finances Survey (HFS), Cambridge Econometrics calculations
Absolute poverty rate	Social	DWP Households Below Average Income (HBAI)
Life expectancy at birth	Social	ONS Life expectancy for local areas
Housing affordability ratio	Social	ONS Annual Survey of Hours and Earnings (ASHE), ONS House price statistics for small areas (HPSSA), Cambridge Econometrics calculations
Workforce qualification requirements	Social	Warwick Institute for Employment Research, Cambridge Econometrics calculations
Workforce skill levels	Social	Warwick Institute for Employment Research, Cambridge Econometrics calculations
Total carbon emissions	Environment	BEIS local authority and regional greenhouse gas emissions
Total 'green jobs'	Environment	ONS Annual Population Survey (APS), ONS Labour Force Survey (LFS), Cambridge Econometrics calculations

Source: Cambridge Econometrics

Some issues to consider in working through the scenarios

3.21 In thinking about the Change Scenarios, a number of issues are important to consider:

- First, **all scenarios are abstracted conceptualisations**. We have attempted across the four Change Scenarios to combine a series of variables into four coherent packages, but the range of combinations of policy measures and potential ambitions is vast – so we have been selective in the variables that we focus on and the metrics used in modelling, with a focus on setting out the long-term changes that they are seeking to effect. It should also be noted the scenarios are deliberately set out at high level: they consequently mask some complexity, and prioritise clarity and 'scale of ambition' over detail and nuance.

- Second, **each Change Scenario is self-contained**, in that it is possible to focus on one basket of policy measures without another (for example, it would be plausible to make progress on technology adoption and diffusion without increasing housing supply). However, **they are mutually reinforcing,** and the cumulative effects are set out in the New Transformational Scenario.

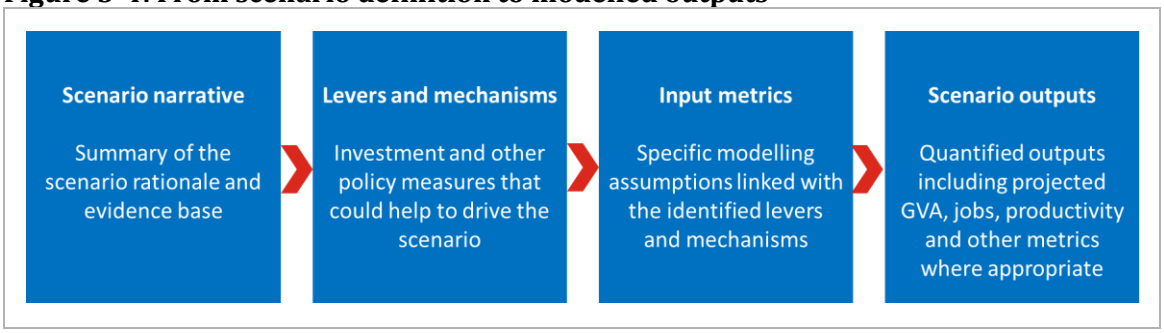
- Third, **estimated increases in investment form an important part of the quantified modelling of each scenario**. However, there could be some other routes to impact: for example, increasing the housing supply might require public investment in infrastructure

in some places, but in others, it could be enabled through planning or regulatory change. In modelling the scenarios, we have estimated both a total approximate cost and likely direct impact of each high-level policy package, however it is not the intention or role of this commission to attempt to formulate the optimum design of each policy lever.

- Given the centralised nature of policymaking and tax and spend in England, **moving towards the futures described in each scenario is likely to imply change at national level in some form**: most of the key 'levers' that we describe are not wholly within the gift of local partners.
- Finally, although each scenario is 'opportunity' based (faster technology adoption, greater levels of inclusion, greater supply-side flexibility, more rapid transition to net zero), **they will all come with downside risks**. For example, decarbonisation presents specific risks in some industries (which may be spatially concentrated), and all scenarios will be impacted by wider macroeconomic and political considerations. As set out in the parameters in Chapter 1, the focus of the scenarios is not to quantify a series of external risks, but it we have acknowledged the risks and opportunities associated with each scenario in the narrative descriptions.

3.22 For each of the change scenarios, we describe the overall rationale for the scenario. Building on this, we then identify the relevant policy mechanisms that could help to drive the scenario, and use these to inform inputs to the model:

Figure 3-4: From scenario definition to modelled outputs



Source: SQW

3.23 With these considerations in mind, the next chapter sets out the Baseline, as the starting point for analysis.

4. The Baseline Benchmark

To provide context for the change scenarios explored in the following chapters, the Baseline Benchmark estimates the likely trajectory of the North's economy in a 'policy-off' context to 2050.

Productivity is expected to grow more slowly in the Baseline projection than was anticipated in the 2016 NPIER. This means that the productivity gap between the North and the rest of the UK remains largely constant over time. But employment projections are more optimistic, reflecting strong jobs growth achieved in recent years.

Headline economic changes since the 2016 Northern Powerhouse IER

4.3 Since the publication of the original NPIER in 2016, there have been a number of headline changes which have impacted the North's economic landscape and will remain relevant for the North's longer-term context for growth.

Table 4-1: The North's economy today and headline changes since the 2016 NPIER

Headline metric	The North today (2021)	Change since IER baseline (2015-21)
Population (000's)	15,574.8	384.9
Jobs (000's)	7,707.1	283.4
GVA (£2019, millions)	369,374	15,618
GVA per job (£2019, 000's)	47.9	0.3
GVA per capita (£2019, 000's)	23.7	0.4

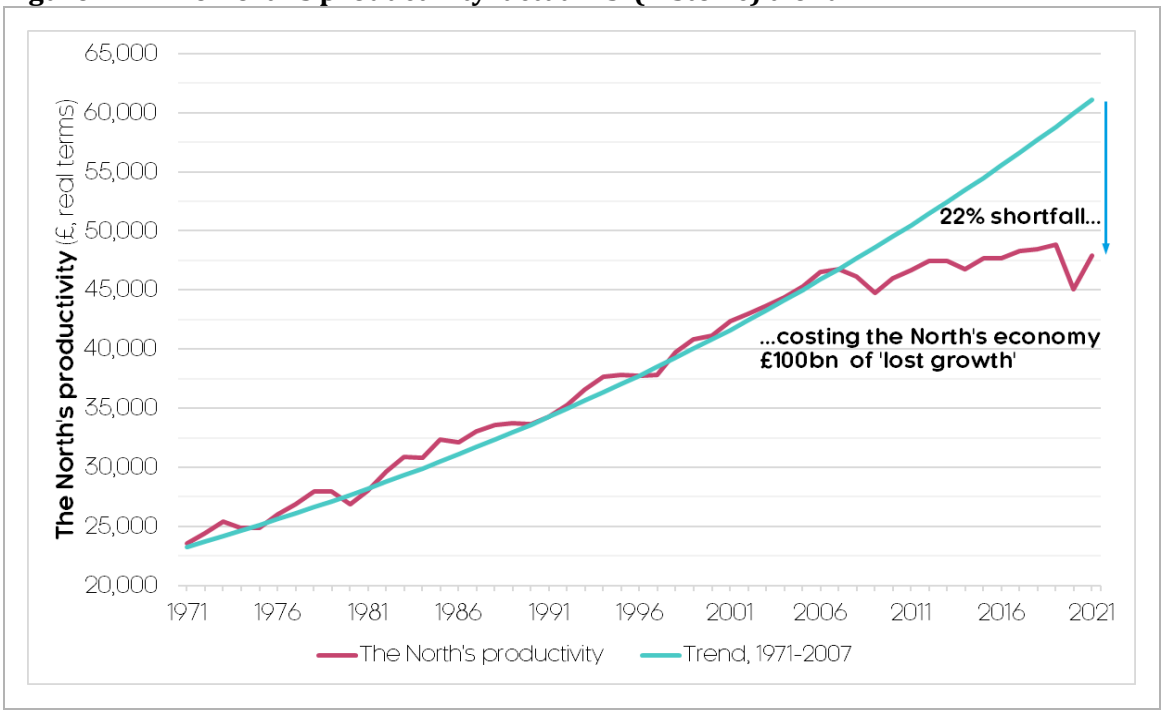
Source: ONS, Cambridge Econometrics

4.4 For instance, as the graph below shows that the North's economic narrative of the past six years continues to be dominated by its 'low and slow' productivity growth. Since 2016, productivity growth in the North has averaged only 0.1% per annum compared to its pre-Financial Crisis trend of 1.9%.

4.5 In direct terms, this is costing the North's economy an estimated £100 billion of 'lost growth' (relative to if it had followed its longer-term trend, which it trails by 22%), whilst indirectly, it has placed an unprecedented squeeze on wage growth and living standards in the North.

4.6 And against this backdrop, productivity in the North remains stubbornly below the national average. Currently the gap stands at approximately 8%, unchanged since the 2016 NPIER, with this shortfall having implications for the North's pay and competitiveness.

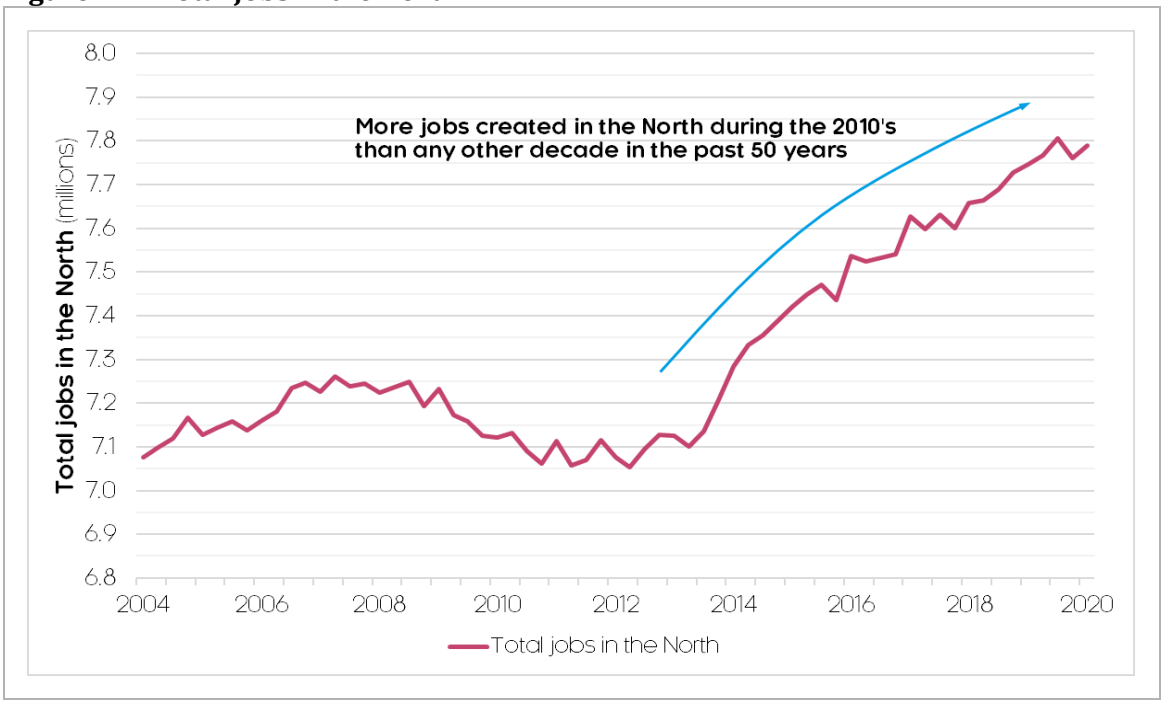
Figure 4-1: The North's productivity: actual vs. (historic) trend



Source: ONS, Cambridge Econometrics

4.7 Accompanying this stalling productivity growth has however been a relative 'jobs boom' in the North, as the graph below shows. Shortly before the Covid-19 pandemic, the total number of jobs in the North reached a record total of 7.8 million, an increase of almost 300,000 since 2016 alone.

Figure 4-2: Total jobs in the North



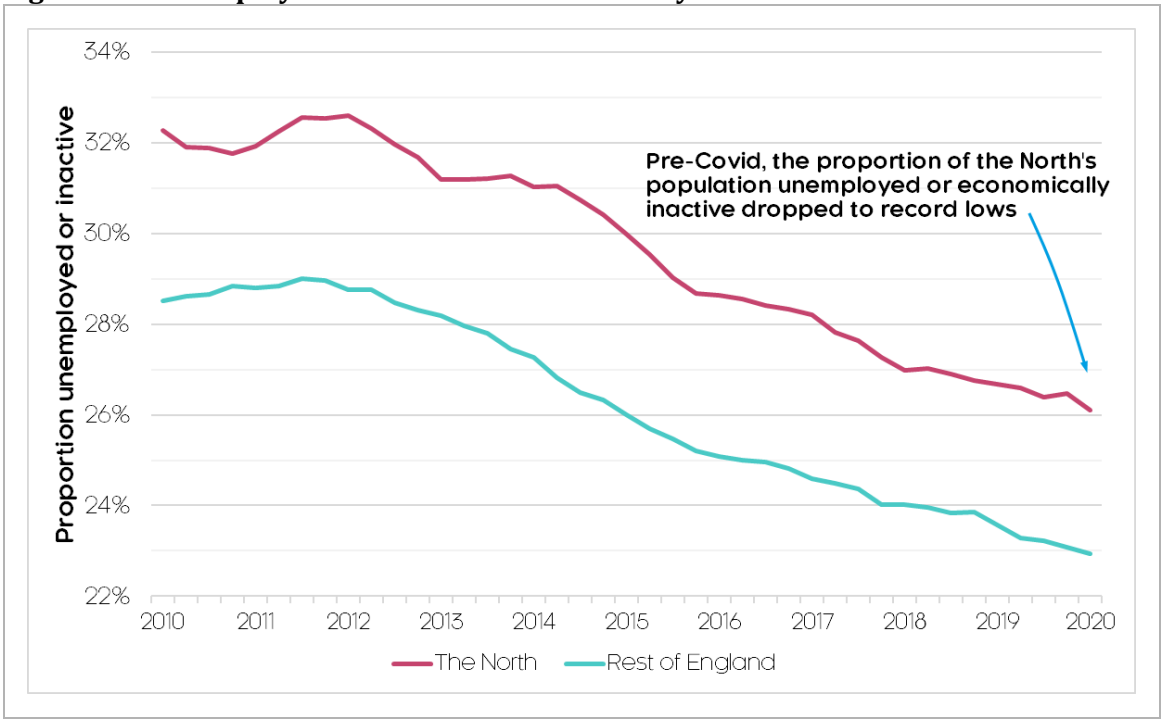
Source: ONS, Cambridge Econometrics

4.8 In fact, over the past decade more jobs were created in the North relative to any equivalent period during the past 50 years. This has been driven by both strong demand from labour intensive, high-job creation industries, and an unprecedented decline in unemployment and worklessness.

4.9 As the below graph shows for instance, before the Covid-19 pandemic, the proportion of the North's population out of work (either through unemployment or economic inactivity) declined to record lows. Though still above the national average, the North had made progress in closing this shortfall.

4.10 Against this backdrop, the population of the North has continued its upward trend and currently stands at just under 16 million, an increase of almost 400,000 since 2016. Recent years have however seen the emergence of both slowing and aging population growth, which bring with it additional pressures and challenges.

Figure 4-3: Unemployment and economic inactivity in the North



Source: ONS, Cambridge Econometrics

Introducing the Baseline Benchmark

4.11 To help facilitate the appraisal of the Change Scenarios, a baseline projection (the Baseline Benchmark) has been prepared which considers the likely trajectory of the North's economy in a 'policy-off' context to 2050. This benchmark is broadly analogous to the 'business as usual' scenario produced for the original NPIER.

4.12 The Baseline Benchmark has been prepared using Cambridge Econometrics' recently updated LEFM (described in the previous chapter) and has been informed by the latest data and assumptions available as of Spring 2022 (the underlying assumptions are explored further in the following sub-section).

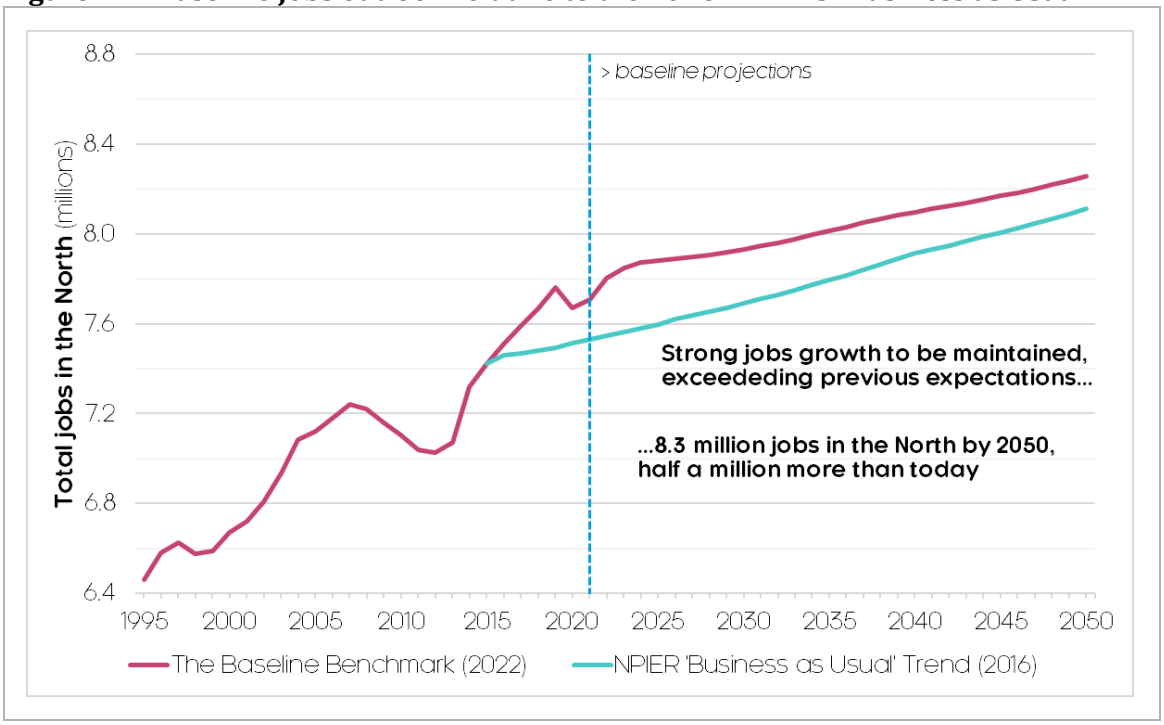
Table 4-2: Headline metrics in 2050 in the Baseline Benchmark, and relative to 2021

Headline metric	The North by 2050 (under the Baseline Benchmark)	Change relative to today (2021-50)
Population (000's)	16,995.1	1,420.2
Jobs (000's)	8,257.6	550.5
GVA (£2019, millions)	514,774.6	148,827.9
GVA per job (£2019, 000's)	62.3	14.9
GVA per capita (£2019, 000's)	30.3	6.8

Source: ONS, Cambridge Econometrics LEFM

4.13 Looking ahead to 2050, the Baseline Benchmark shows a broad continuation of the headline changes observed earlier in this chapter. For instance, as the below graph shows, the North's labour market is expected to exceed the 'Business as Usual' expectation of six years ago.

Figure 4-4: Baseline jobs outlook relative to the 2016 NPIER's "Business as Usual"



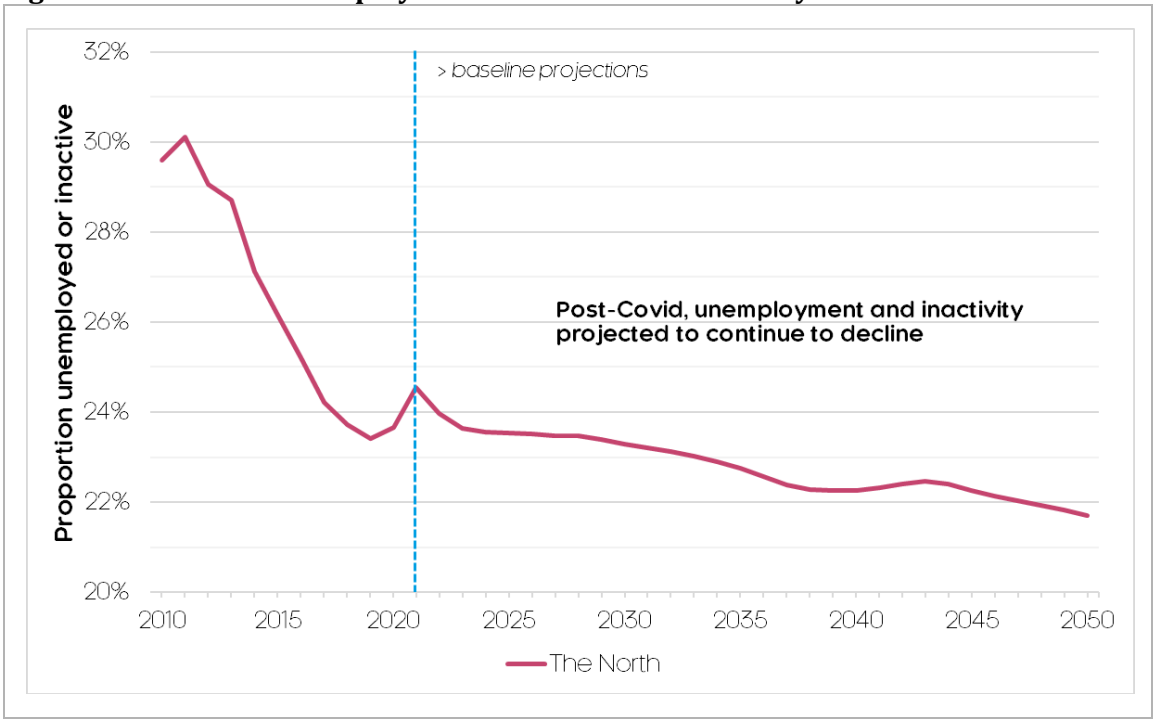
Source: Cambridge Econometrics LEFM, 2016 NPIER

4.14 Following the Covid-19 pandemic, during which the North's labour market proved more resilient than elsewhere in the country, jobs growth is expected to settle around the North's long-term average, and by 2050 there could be 8.3 million jobs in the North, half a million more than current levels.

4.15 This continued optimistic outlook for jobs growth is largely a result of expectations for ongoing labour market flexibility (i.e., the rate of people moving out of inactivity and unemployment), ongoing population growth in the North, and the more positive outlook for labour-intensive, high job creation industries over this period.

4.16 In fact, to help meet this demand from employers, as the below graph shows, worklessness in the North is expected to decline further long-term, although there is some uncertainty – given the Covid-19 pandemic and cost of living crisis – as to the pace and shape of this, at least in the short-term.

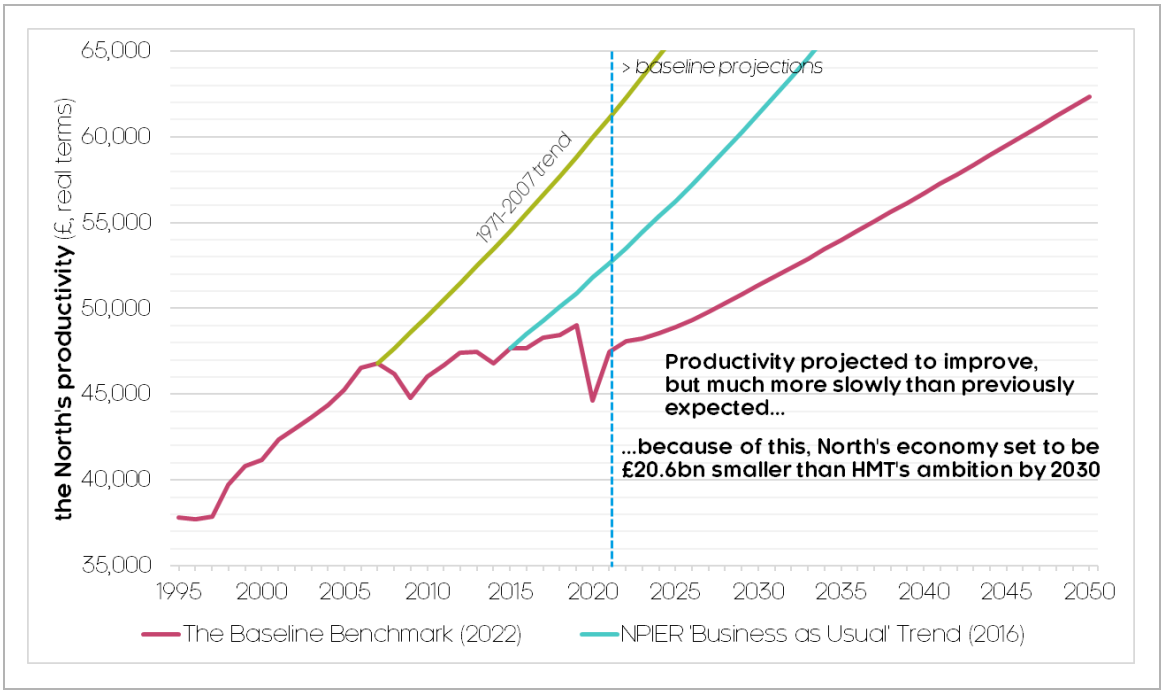
Figure 4-5: Baseline unemployment and economic inactivity outlook



Source: Cambridge Econometrics LEFM

4.17 The outlook for productivity growth in the Baseline Benchmark is still low by historic standards (i.e., relative to the North's pre-Global Financial Crisis (GFC) trend), and more pessimistic than the 'business as usual' outlook of six years ago, as the below graph shows. It should be noted that even this more pessimistic trajectory represents a significant step-up compared to the post-GFC "new normal" of stagnating productivity.

Figure 4-6: Baseline productivity outlook relative to the 2016 NPIER's "Business as Usual"

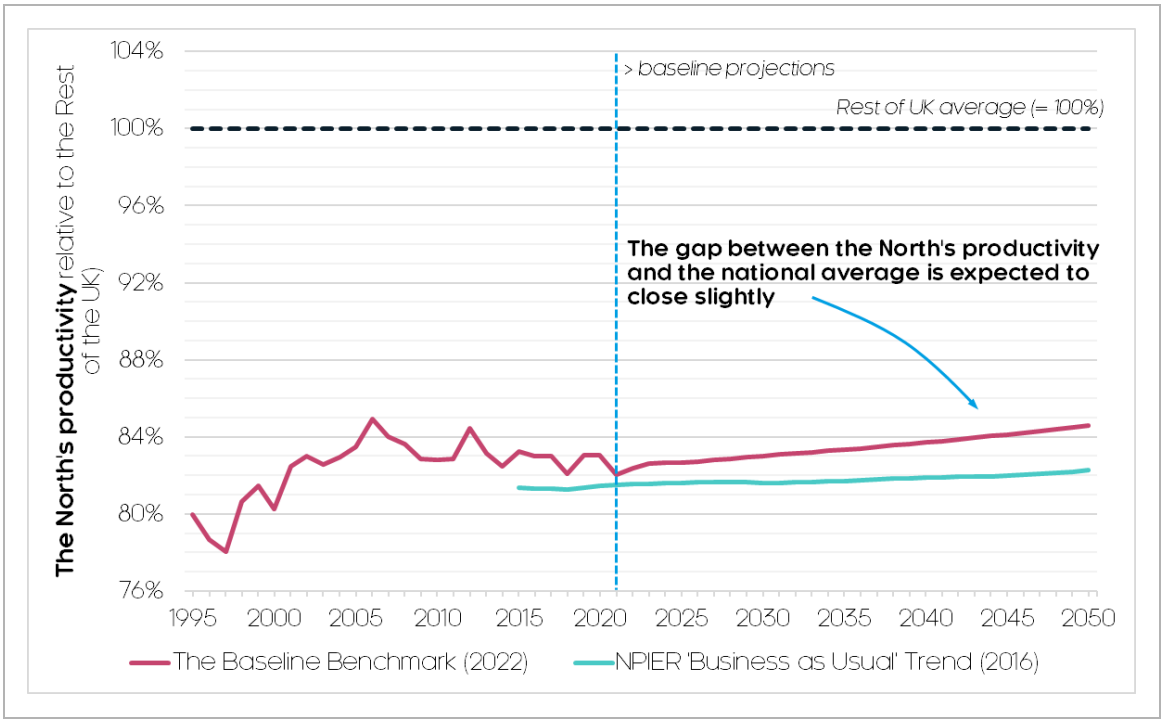


Source: Cambridge Econometrics LEFM, 2016 NPIER

4.18 Indeed, productivity forecasts such as these over the past decade have consistently proven over-optimistic, with 'lower and slower' productivity growth now an accepted assumption. This trend will continue to limit the economic potential of the North, and by 2030, the North's economy could be £20.6 billion smaller than targeted by HM Treasury back in 2015.

4.19 A central ambition of the original NPIER was to close the North's productivity gap relative to the national average (defined here as the Rest of UK average). With limited progress in closing the gap over the past decade, the Baseline Benchmark expects this gap to remain relatively stable over the long-term, as shown in the below graph.

Figure 4-7: The North's productivity relative to the national average outlook, relative to the 2016 NPIER's "Business as Usual"



Source: Cambridge Econometrics LEFM, 2016 NPIER Note: national average defined as the Rest of the United Kingdom

4.20 This context for growth is also set against the challenging backdrop of slower and aging population growth in the North. Since the 2016 NPIER, official population projections have been consistently lowered, and there is the expectation for 590,000 less people residing in the North by 2050 than the 'Business as Usual' outlook of six years ago. Of course, the longer-term impact of both Brexit and Covid-19 on demography remains uncertain, particularly in terms of the attractiveness of and migration to the North.

Baseline assumptions and outlook

4.21 The Baseline Benchmark was prepared using Cambridge Econometrics' Local Economy Futures Model, drawing on the latest data and assumptions available as of Spring 2022. The model, and the modelling assumptions, are linked to Cambridge Econometrics' global suite of models.

4.22 The Baseline Benchmark was informed by a series of UK-level macroeconomic assumptions, with tailored assumptions relating to Brexit, the Covid-19 pandemic, and the emerging cost of living an energy crisis, which are summarised below.

4.23 It should be noted that the Baseline Benchmark does not consider local intelligence, investments or policies specific to the North, beyond those already captured in the available data (e.g., population distribution during Covid-19).

4.24 The rest of this section provides an explanation of the macroeconomic assumptions that are included in the baseline, and the extent to which the outlook is different from past trends, and

how current risks have been reflected in the baseline. Although these assumptions are now a year old, they were largely prescient in the short-term, and the long-term assumptions remain valid.

Covid-19 pandemic

4.25 In the near term, it was assumed that UK policy will transition towards "living with COVID" in which restrictions are no longer placed on activities of households and businesses. There were therefore no further Covid-related restrictions assumed in the forecast period.

4.26 The post-pandemic economic trajectory (i.e., short-medium-term economic prospects) was assumed to depend on the responses of households, businesses and government:

- Households - it was assumed in this forecast that due to the distribution of savings and the dampening effects of rising inflation, the outlook for consumption was relatively muted. Pay growth was expected to be sluggish, in line with scarred productivity. Household spending was assumed to recover partially but experience permanent impacts.
- Businesses – Cash-flow issues were expected to weigh down on business investment in in the near/medium term, in light of rising input costs and weakened position as a result of economic shocks of Covid-19.

4.27 Longer-term, evidence suggests the impact of Covid-19 on migration will likely have a lasting effect on UK population. Therefore, we assume that during the pandemic around 350,000 people have permanently left the UK. We also assume that as a result of flexible working policies and lifestyle changes, 180,000 people have permanently relocated from London to other UK areas.

4.28 Furthermore, some additional population scarring effects of the Covid-19 pandemic were also reflected in this update of the forecast, as the population projections have been updated to incorporate the 2020-based ONS population projections[23], which assume levels of UK net migration being maintained at 205,000 per annum.

4.29 We have also reviewed the evidence on the long-term impact of the Covid-19 pandemic on productivity and the capacity of the economy, not only as a result of health scarring, but also as a result of the response policies. There is limited evidence on how severe and lasting the health scarring could be, and therefore, we did not introduce any related assumptions in this forecast.

4.30 School closures and remote education will likely lead to long-term impacts on human capital and productivity. In order to account for this, we are introducing an assumption that lost education of the current student cohort could lower their lifetime earnings by approximately 3%. We apply this assumption as an exogenous shock to employee earnings in the model.

[23] The 2020-based interim projections are accessible here.

Brexit and trade

4.31 We assumed that UK trade with the EU will decline by 30.6% in the long term, with the impact on services trade being roughly twice as high as for manufacturing. This reflects the relatively greater significance of non-tariff barriers at the border for goods trade (such as customs declarations), compared to services trade.

4.32 In addition, we have incorporated into the assumptions the potential effect of the future trade deals with non-EU countries, such as the US, Australia, Canada and New Zealand. We take a moderate view, with the implicit assumption that the UK will form trade arrangements similar to those it achieved through EU membership.

4.33 The resulting combined effect of these assumptions was a decline in UK exports to the world by 13.2% in the long run, which is similar in magnitude to the impact assumed in the previous version of the forecast.

4.34 It was assumed that the long run net migration to the UK will decline as a result of the new UK immigration policy. Migration assumptions have been updated and are based on the latest 2020-based ONS principal population projections, which assume a decline in net migration to 205,000 in the long run, a change primarily driven by a decline in net migration from the EU.

4.35 Post-referendum uncertainty about the future of the UK-EU relationship depressed investment. While the new agreement clarifies the current relationship, our expectation is that reductions in UK-EU trade will outweigh any gains made through other trade agreement. Combined with continued uncertainty about the speed of any future regulatory divergence, we continue to assume that UK investment post-Brexit will be lower than it might otherwise have been.

4.36 We assumed that the overall impact of the new agreement on investment in the UK will lead to a 5% decline in investment in the long run (relative to a counterfactual in which UK remains in EU). This magnitude is similar to the realised impact of the post-referendum uncertainty.

Cost of living and energy crisis

4.37 Our Spring 2022 assumptions precede some of the macroeconomic developments related to the cost of living and energy crisis, particularly the associated policy response to the significant inflationary pressures.

4.38 Despite this, our Baseline Benchmark does include some early consideration of the crisis, particularly through the ongoing supply chain crisis triggered by the Covid-19 pandemic, and the onset of the war in Ukraine.

4.39 For instance, in addition to the impacts associated with UK exit of EU, the export outlook for UK has further deteriorated owing to supply chain issues, notably the shortage of UK HGV staff, border disruptions, and fuel shortages.

4.40 We have also assumed the war in Ukraine will have a dampening effect on global growth prospects, particularly through the related sanctions and business uncertainty, which in turn will impact UK trade, investment and growth.

Investment and Productivity Benchmarks

4.41 In addition to the Baseline Benchmark, the change scenarios have also been appraised relative to an investment and Productivity Ambition Benchmark. The Productivity Ambition Benchmark takes an outcome-focused view on the returns of closing the North's productivity gap with the rest of the country, whilst the Investment Benchmark takes an input-based perspective, considering the feasible level of public investment per capita in the North that might justly be available to drive the change scenarios.

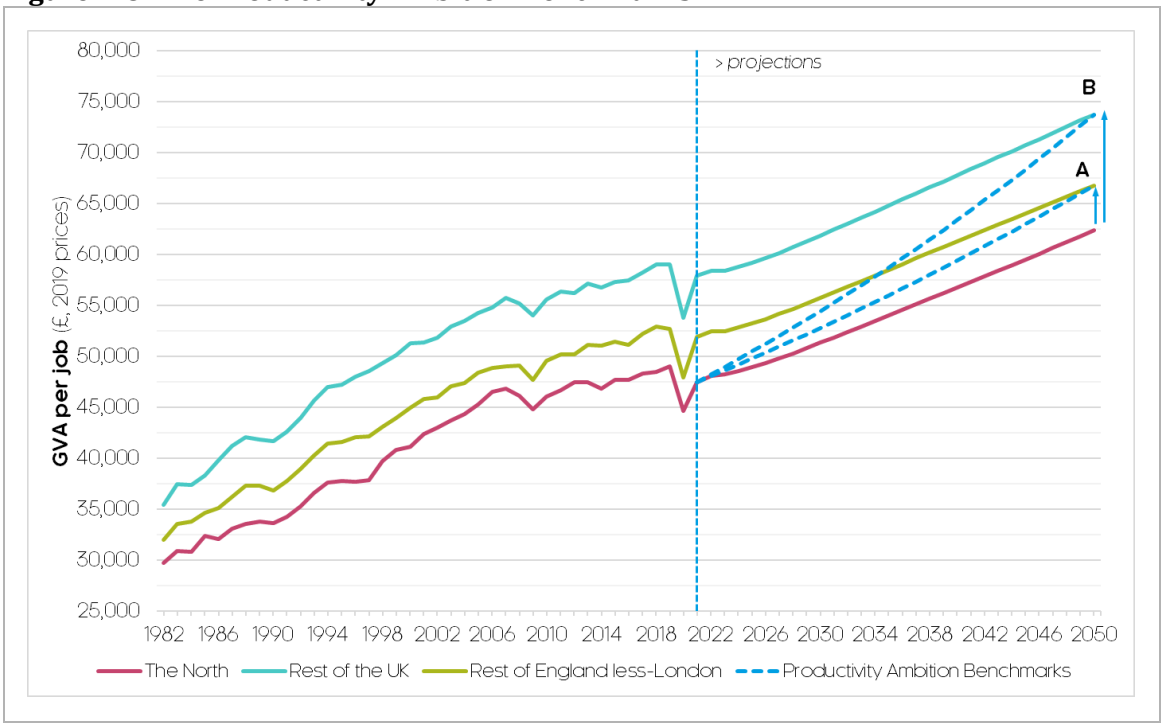
Productivity Ambition Benchmarks

4.42 Using our baseline projections for both the North of England and the wider UK, we are able to identify both the current and projected future productivity gap, and from this, calculate the additional annual productivity growth required in the North for this gap to be closed.

4.43 The figure below shows both the historical and future projected labour productivity levels of the North of England, and the chosen Productivity Ambition Benchmarks:

- **A - The Rest of England less-London:** which includes the West and East Midlands, East of England, South East and South West regions, and was the productivity benchmark included within the 2016 NPIER.
- **B - The Rest of the UK:** which includes the above regions, in addition to London and the Devolved Nations (Northern Ireland, Scotland and Wales).

Figure 4-8: The Productivity Ambition Benchmarks



Source: ONS, Cambridge Econometrics LEFM

4.44 As can be seen from the above figure, the rest of the UK has maintained a persistent productivity advantage over the North since 1981. The gap was at its widest, at 22% in 1997, and at its narrowest, in 2006, immediately prior to the great financial crisis.

4.45 Since the original NPIER in 2016, the gap has actually widened slightly from 16.8% to an estimated 17.9% in 2021, although Cambridge Econometrics' baseline forecast suggests that this could close slightly to 15.4% by 2050.

4.46 The same, albeit smaller, gap is present when compared relative to the Rest of England less-London, which currently stands at 8.5%, but could close to 6.6% by 2050.

4.47 The productivity benchmark asks the question: what additional rate of growth would it take, to close these gaps by 2050?

4.48 Between the current day and 2050, the North is projected to experience productivity growth of 0.9% per annum, compared to the Rest of the UK, which is projected to experience productivity growth of 0.8% per annum. In order to catch up to

The Rest of England excluding London currently has productivity of **£51,900 per job**... but by 2050 is projected to have a productivity of **£66,800 per job**

The Rest of the UK including London currently has productivity of **£57,900 per job**... but by 2050 is projected to have a productivity of **£73,700 per job**

The North currently has productivity of **£47,500 per job**... and by 2050 is projected to have a productivity of **£62,300 per job**

... so by 2050 the productivity of the North will be higher than the Rest of the UK is today, but still stubbornly short from where the rest of the country will be by 2050.

the level of the comparator, a labour productivity growth rate of **1.5% per annum** would be required.

4.49 This would lift the North from its current level of around £47,500 per job, to a level of **£73,700 per job**, representing a 55% improvement on current levels, and an 18% improvement on the 2050 baseline projection of around £62,300 per job.

4.50 The Rest of England less-London meanwhile is projected to experience productivity growth of 0.9% per annum. In order to catch up to the level of the comparator, a labour productivity growth rate of **1.2% per annum** would be required.

4.51 This would lift the North from its current level of around £47,500 per job, to a level of **£66,800 per job**, representing a 40% improvement on current levels, and a 7% improvement on the 2050 baseline projection.

4.52 The level of labour productivity growth required to attain these benchmarks are not unprecedented in the North: for example, between 1997 and 2007, labour productivity in the North grew at a rate of 2.1% per annum. However, it would mark a significant step change to current levels of growth: over the past decade, labour productivity in the North has only grown at 0.2% per annum.

4.53 It is not straightforward to predict what this level of labour productivity growth would imply for overall GVA and employment. In some sectors, an increase in labour productivity may result in reduced labour demand; in others, labour demand may increase. Overall, we would anticipate that the policies required to enact this level of productivity growth would simultaneously increase both the supply of and demand for labour, meaning that GVA growth would likely grow at a faster rate still.

4.54 However, if we assume that employment grows at the rate projected in the baseline, the additional GVA associated with this increase in productivity (to catch up with the Rest of the UK would) be **worth up to an additional £94bn to the Northern economy** (and hence the wider UK, ceteris paribus) over the baseline forecast.

Investment Benchmark

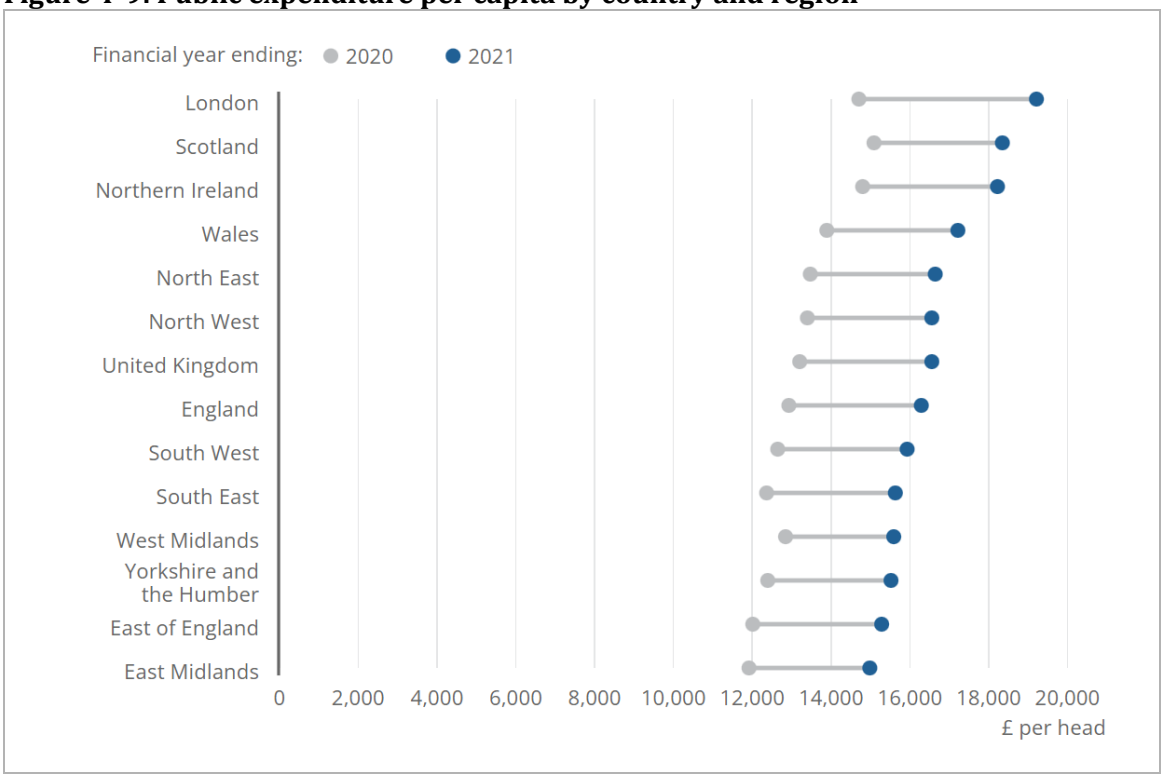
4.55 In order to identify the investment benchmark, we first compare the historic public investment per capita[24] between different regions. We find that although there is substantial variation from year to year (particularly during the pandemic period), a persistent funding gap exists between the regions of the North of England and the most generously publicly funded geographies, of around £1,500 per capita in 2019.

[24] *Total capital and current expenditure (mainly wages and salaries, goods and services, and expenditure on fixed capital, but also subsidies, social benefits, and other transfers) of central government and local government bodies as well as public corporations. See:* A brief guide to the public finances - Office for Budget Responsibility (obr.uk)

4.56 We then take this level of additional public funding as our Investment Benchmark: we think it represents a fair and realistic additional level of funding that might be provided by a government serious about levelling up the UK and solving its long-standing problem of regional economic imbalances.

4.57 For the current population of the North, a figure of £1,500 per capita corresponds to approximately £21bn per annum in additional real terms public spending. Current government spending estimate is £1,182bn for 22-23, so an additional £21bn would be 1.77% of this.

Figure 4-9: Public expenditure per capita by country and region



Source: ONS Public sector finances

4.58 As the following chapters lay out, we explore what the economic and social implications are of this £21bn figure being invested across three of our four scenarios. The fourth scenario "Net Zero" has a slightly different motivation; this is not intended to represent a policy intervention designed to "level up" the North, but is instead a representation of the impact on the North of an entirely different (but equally urgent) agenda: the UK Net Zero Strategy. We thought it would be important to model how the levelling up scenarios interact with this concurrent set of investments.

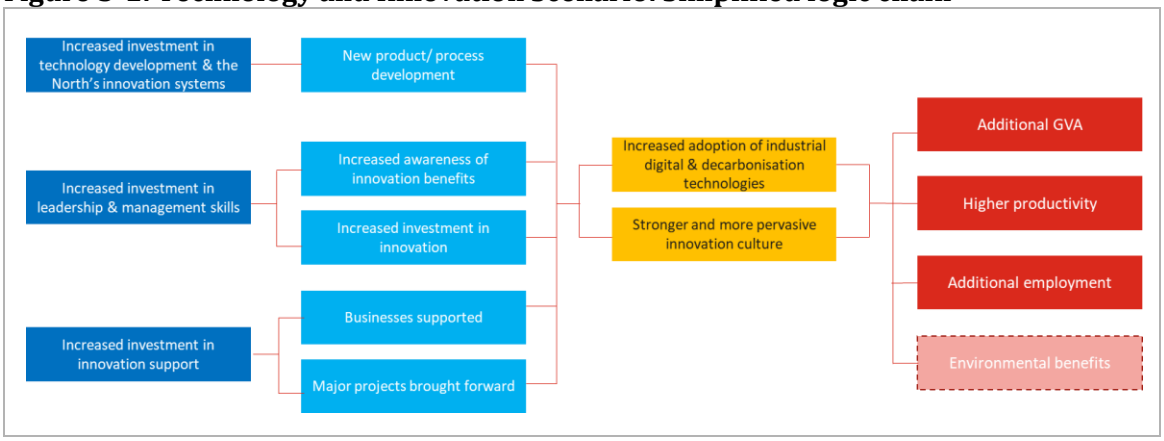
5. Change Scenario 1: Technology and Innovation

There is evidence that the North lags behind other parts of the UK (and leading regions in Europe) on some measures of technology adoption and innovation – despite several world-class industrial and university assets. Scenario 1 considers the effects of increasing investment in R&D, technology diffusion and capacity for adoption. It finds that this has the potential to provide £22bn in additional GVA growth to 2050 over the Baseline Benchmark and £1,900 of additional productivity per worker.

Introduction

Change Scenario 1 focuses on the effects of accelerating the generation, diffusion and adoption of advanced technology. The scenario assumes that higher levels of technology adoption and innovation activity will impact on GVA, productivity and employment through the stylised logic chain below:

Figure 5-1: Technology and Innovation Scenario: Simplified logic chain



Source: SQW

The scenario narrative

5.1 Before setting out the measures used to model the effects of additional investment in in innovation and technology adoption, the following paragraphs consider the general relationship between investment in innovation and technology adoption, productivity growth and employment; the current evidence on the North's position in relation to other regions; and the 'policy levers' that might be deployed to accelerate technology adoption.

5.2 An increase in public spending in R&D is thought to have multiple positive impacts on innovation in local business base, including knowledge spillovers, technology transfers,

attraction of skilled workers and rate of spin-outs. An increase in the adoption of the latest technologies is likely to boost productivity, process efficiency, and product quality in the firms involved. More funding to encourage and facilitate entrepreneurial activities such as start-ups, scale-ups and market expansion activities has the potential to boost exports, and encourage productive firms to gain market share. There are also well-documented feedback mechanisms from export market exposure to innovation and further competitiveness.

Innovation, technology adoption and the economy

Technology adoption drives productivity, but is strongly complementary with other factors

5.3 There is an extensive literature describing the links between technology adoption and economic growth. In the UK, the *Made Smarter Review* commissioned by the Government in 2017 found that the adoption of industrial digital technologies could increase "manufacturing growth" by 1.5%-3.5% per annum[25]. A study of the German economy at around the same time found that rapid adoption of automation technology could add up to 2.4 additional percentage points to national per capita GDP growth to 2030[26], with early engagement with digital technologies found to have a positive long-term effect on local economic growth[27]. There are also obvious links between the ability to develop and adopt new technology and the ability to progress decarbonisation at scale, although for the purposes of analysis, we have considered this further within Change Scenario 4.

5.4 However, recent productivity growth has been weak, despite rapid advances in technological development which we might have expected to have had a significant impact. A possible explanation for this is the extent to which productivity gains from new (digital) technologies are characterised by strong complementarities with other factors, in particular firms' capabilities and other assets, such as leadership, management and technical skills, financing capacity and the ability to drive and embed innovation[28].

5.5 One consequence of this is that firm-level technology adoption has become more polarised between rapid adopters and 'laggards'[29]. This is reflected in a 'long tail' of less-productive firms, cited as relatively more problematic in the UK than in European comparators; worsening in the aftermath of the financial crisis; perhaps reinforced during the Covid-19 pandemic[30]; and more prevalent in the North relative to the rest of the UK[31]. At the level of

[25] *Made Smarter Review* (2017), p.19
[26] Eckart Windhagen *et al* (2017), *Driving German Competitiveness in the Digital Future*, McKinsey Global Institute
[27] Emmanouil Tranos (2020), 'Digital economy in the UK: Regional productivity effects of early adoption', *Regional Studies*
[28] OECD (2019), *Economic Outlook 2019, Issue 1* (Chapter 2: 'Digitalisation and Productivity: A story of complementarities)
[29] Peter Gal *et al* (2019), 'Digitalisation and productivity: In search of the holy grail – Firm-level empirical evidence from EU countries', OECD Economics Department Working Paper 1533
[30] OECD (2021), *United Kingdom Economic Survey 2020*
[31] Centre for Cities (2018), *The Wrong Tail: Why Britain's long tail is not the cause of its productivity problems*

the economy as a whole, wider shortfalls in some of these complementary factors (such as workforce skills deficits and the operation of the innovation 'ecosystem') reduces the diffusion of new technologies – and their productivity and competitiveness benefits - within the wider economy. These issues are broadly consistent with the findings of the *Made Smarter Review*, which identified three key challenges to the adoption of industrial digital technologies, linked with leadership, poor take-up across the wider base of SMEs (associated with the firm capabilities issues highlighted above) and insufficient leverage of key innovation assets.

Technology adoption places some jobs at risk of automation, but there is likely to be a net increase in employment over time

5.6 Studies over the past decade report wide differences in the potential vulnerability of industries, occupations and regions: an analysis of 17 reports focused on the UK and abroad found a 'job loss risk' of between 2% and 57% based on occupations[32], with the increasing likelihood of automation impacting relatively higher-skilled 'white collar' jobs. Over the long term however, the evidence is that new technology generates more jobs than it destroys, albeit that the process of adjustment is often painful and has distributional impacts that need to be mitigated[33]. Recent global surveys anticipate a net gain through automation[34], while addressing the UK's deficit in digital technical skills could support a transition to an economy where human labour is augmented and complemented by technology, enhancing the quality (and therefore the productivity) of jobs, rather than replacing them[35].

Trade and enterprise

5.7 Two other factors are also relevant, relating to[36]:

- **International trade and investment:** There are close links between technology adoption and innovation and engagement in international trade and foreign direct investment, supporting productivity growth[37]. In respect of Foreign Direct Investment (FDI), the literature suggests that as international firms invest, domestic firms are exposed to new technology, increased competition drives innovation and associated skill levels rise[38]. In recent years, FDI into the North has increased (and has increased

[32] Philip Brown [Welsh Government] (2019), *Wales 4.0: Delivering Economic Transformation for a Better Future of Work*
[33] Deloitte (2015), *Technology and People: The great job creating machine*
[34] Brown (2019), citing World Economic Forum and McKinsey
[35] PwC (2022), *UK Economic Outlook 2022*, p.33.
[36] Both of these factors were considered earlier on in the process as the potential focus for scenarios in their own right. While we have not modelled trade and investment and enterprise separately, the relationships with innovation, technology adoption and productivity growth are important to note.
[37]Department for International Trade (2018), *International Trade: The economic benefits*
[38] R Harris and J Moffatt (2017), The sources of the Scotland–rest of the UK productivity gap: Implications for policy. *Regional Studies*, 51(9), 1297–1311; David Arnold (2018), *Does inward investment make regions more innovative?* LSE, Global Investments and Local Development

as share of national FDI), with an especially strong performance in the North East[39]. Export propensity remains relatively low however: a recent policy paper for the NP11 highlights that the North's share of trade exports is substantially lower than its share of national population or business stock, noting that "the North is yet to unlock its full potential"[40].

- **Enterprise and entrepreneurship:** The density of overall business stock, business starts and 'high growth' businesses is lower in the North relative to the UK as whole. Although the evidence on the links between general business start-up rates and productivity growth is limited[41], the creation of a dynamic environment in which innovative firms can start and scale up (through access to finance, workspace, skills and so on) has wider spillover effects on the rest of the economy[42].

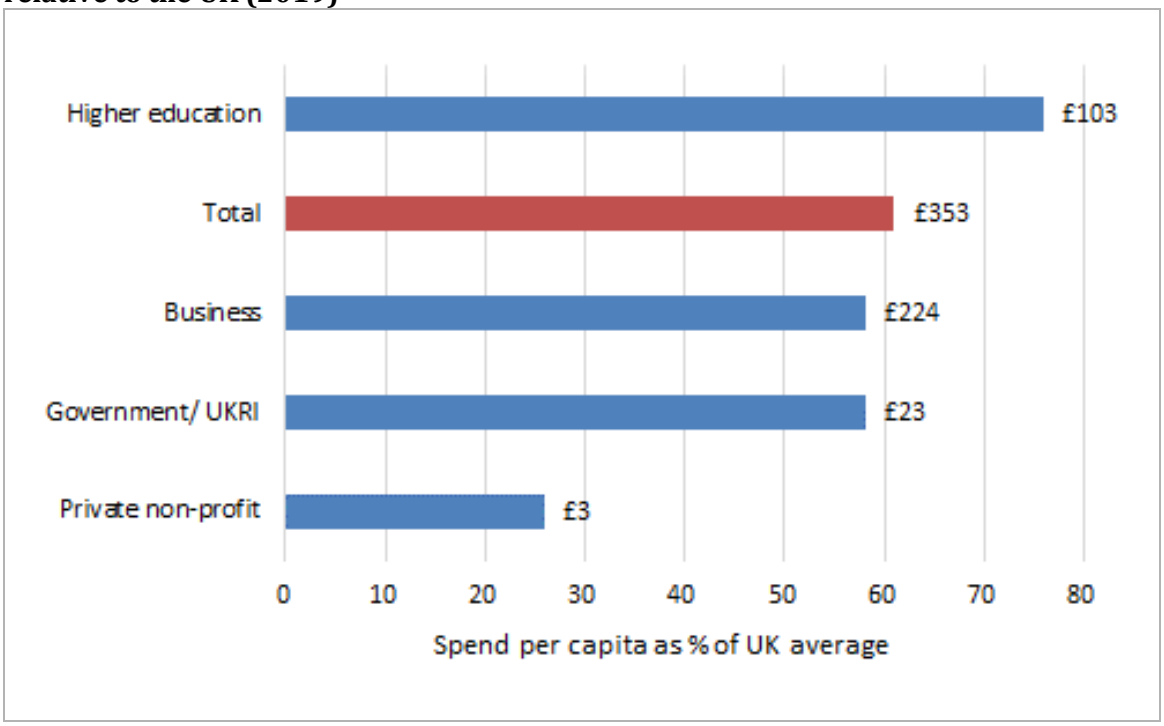
The North's relative position

5.8 Consistent with the findings of the 2016 NPIER, there is evidence that the North lags behind other parts of the UK (and leading regions in Europe) on some measures of innovation and technology adoption. For example:

- In terms of overall R&D spend (taking into account public, private and charitable R&D), the UK overall lags behind comparator economies and has done so for some time. Within the UK, business and private R&D expenditure is also substantially regionally unbalanced towards London and the South of England[43]. Potentially, this points to an important role for universities and government in bridging the gap and driving investment, but despite the global significance of the North's university base, higher education R&D per capita is also below the UK average, reflecting the relative concentration of investment within the Greater South East.

[39] Northern Powerhouse Partnership (2022), *The internationalisation of the Northern Powerhouse*; North East LEP (https://evidencehub.northeastlep.co.uk/report/foreign-direct-investment)
[40] NP11 (2023), *Convention of the North Policy Paper: Trade and investment*
[41] Sergey Anokin and Jokim Wincent (2012), 'Start-up rates and innovation: A cross-country examination', *Journal of International Business Studies* 43
[42] Beauhurst (2021), *Unlocking Growth: Creating tech ecosystems to stimulate local economies*
[43] Tom Forth and Richard Jones (2020), *The Missing £4 Billion: Making R&D work for the whole UK*

Figure 5-2: Expenditure on R&D, £ per capita in the North and % of per capita spend relative to the UK (2019)



Source: ONS, Country and regional; breakdown of expenditure on R&D in the UK by sector of performance

- Considering the 'relatedness' of strengths between key digital technologies, the UK performs strongly relative to European comparators in cybersecurity and artificial intelligence, although from a regional perspective, those strengths are principally concentrated in the Greater South East and parts of the Midlands[44].
- Mapping the geography of Industry 4.0 patents, the UK as a whole does not perform unfavourably relative to the rest of Europe. At a *regional* level however, the North underperforms relative to the rest of the UK[45].

5.9 This suggests significant scope for improvement. However, the North's asset base is substantial: see for example the scale of the university base, strengths in advanced manufacturing, life sciences and digital technology, and the development of major translational research and development facilities. This formed the core of the narrative within the 2016 NPIER and its focus on the North's 'prime' and 'enabling' capabilities, and it is also reflected in key strengths identified at sub-regional level[46].

[44] Pierre-Alexandre Balland and Ron Borschma (2021), 'Mapping the potentials of regions in Europe to contribute to new knowledge production in Industry 4.0 technologies', *Regional Studies* 55:10-11.
[45] Roberta Capello and Camilla Lenzi (2021), '4.0 technologies and the rise of new islands of innovation in European regions', *Regional Studies* 55:10-11.
[46] See the eleven Area Profiles for each Local Enterprise Partnership in the North of England, prepared separately alongside this report.

Relevant levers and mechanisms

5.10 As the narrative above demonstrates, while there is an obvious link between innovation, technology adoption and productivity growth, the 'route' is not always straightforward, and depends on wider capacities within the local economy to take advantage of new technologies (and different routes to adoption within different industries). Policy measures that could help to drive the scenario include:

- **Increasing investment in public and private R&D, including university R&D**, both of which are relatively under-represented in the North relative to the rest of the UK, despite the existence of world-class research assets.
- **Increasing SME capacity and capability**, through the provision of improved business support linked with technology adoption (for example, the Made Smarter digital adoption programme for manufacturing) and through measures to overcome finance gaps (e.g. building on the Northern Powerhouse Investment Fund). Within its policy papers for the Convention for the North, the NP11 identified a 'core proposition' linked with an expansion of investment in Made Smarter and support for digitalisation.
- **Strengthening mechanisms for technology diffusion and translational research**, for example through the expansion of the Catapult network in the North, the further development of regional facilities such as the Advanced Manufacturing Research Centre and expansion of the North's tech networks.

5.11 In addition, innovation and technology adoption are inherent to the processes of decarbonisation, both in developing new industries and transforming the North's more energy-intensive sectors. We consider this further in Chapter 8.

Input metrics and key assumptions

5.12 The challenge for modelling is to distil the wide-ranging analysis above into a set of clear and simple assumptions that we can feed into the model. Within the model, there will be both demand-side and supply-side impacts, that change the way the model evolves over our 25-year time period. In order to estimate this, we need to estimate both the costs and direct impacts of the above set of interventions. Within the model, there are mechanisms that capture the long-run process of both product and process innovation within sectors. These then have knock-on effects into labour productivity, demand for different occupational categories, and export market share. By increasing the coefficients by which these operate, we are able to simulate the impacts of increased levels of innovation and wider technology adoption. Inputting the correct additional demand is also an important driver of sectoral growth. Of the £21bn per annum identified for levelling up the UK, we allocated £6bn per annum to this scenario. Whilst there are a lot of ways this money could be spent, the box below identifies the scale and nature of interventions that level of expenditure would likely provide.

Technology and Innovation Scenario: What could this investment pay for?

£3bn per annum on direct spending on research and innovation

For example, this could fund:

- *20* new major publicly funding institutes of research and training, incubators, accelerators or innovation hubs, including substantial capital investment in shared infrastructure, for example prototyping facilities, computational space, and test beds, and ongoing funding for staffing each year (we estimate average £75m per annum each, but with large variance, total cost £1.5bn). These could be linked to existing institutes of higher education or be stand-alone institutions. We make no assumptions about where these are located or what technologies they specialise in, but instead assume these decisions are made intelligently at a regional level in collaboration with DSIT and UKRI.
- A substantial increase in R&D tax credit and RDEC allowance in order to encourage higher levels of research and innovation across firms of all size groups – specifically we assume an increase in R&D tax credit up to 50p for every pound spent and RDEC 20p for every pound spent and estimate this would cost about £1.5bn.

£3bn per annum on matched funding for start-ups and SMEs

This could co-fund a specified range of projects primarily focused on technology adoption, process improvement, product development, and market expansion, including support for exporting, reaching around 10,000 SME's per annum, with an average award of £250,000 and maximum of £500,000. Over a 25-year period, this would reach up to 40% of all SMEs in the North of England.

Modelling Inputs

5.13 In order to model this scenario in LEFM, we assume a package of interventions similar to the one above would have the following impacts:

- We assume a 1:1 increase in spending in public R&D, split 20:80 between capital investment and operational costs. The model then captures supply chain and labour market impacts organically.
- We assume an increase in the availability and generosity of R&D tax credits and Research & Development Expenditure Credit (RDEC) would lead to an increase in R&I activity in the private sector of 12% over the baseline (see evidence section above). The model then captures the impact on product quality, process efficiency and resulting market share.
- We assume that the effect of any matched grants to boost the growth rates of those firms involved by an average of 2.5pp (see evidence section above). We assume an even

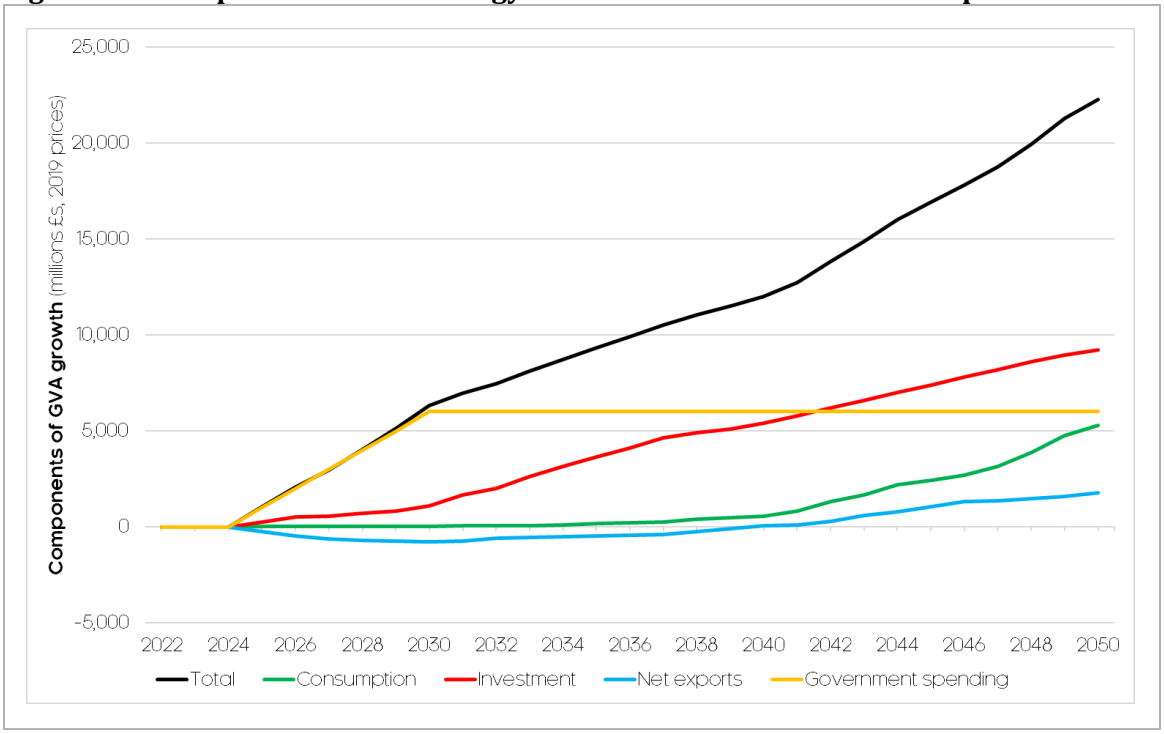
distribution across all sectors. We also assume a change in the occupational demand profile of those sectors: to do this we take the *working futures* time variant SIC/SOC matrix and accelerate it by 5 years.

Scenario outputs and description of results

Overall outturn

5.14 Figure 5-3 shows the overall narrative for how the Northern economy evolves differently over time in this scenario. The graph shows the real-terms additional GVA that results from this scenario compared to the baseline over the period 2025-2050, and its four broad components: public investment, private investment, consumption and net exports. In all scenarios, public investment is a model input, with the other three components model outputs.

Figure 5-3: Composition of Technology and Innovation scenario GVA impacts to 2050



Source: Cambridge Econometrics LEFM

5.15 The broad narrative can be understood as follows: public investment increases from zero (additional) in 2024 to £6bn per annum (additional) by 2030 and then continues at this level in real terms out to 2050. The short-term impacts of this are gradual increases in imports (both gross and net) due to the growth in demand for products and technologies that input-output analysis within the model suggests could not entirely be provided by the Northern economy, and in private investment, deliberately induced through matching provisions.

5.16 Consistent, elevated levels of public investment in R&D and other innovative sectors are widely understood to provide a level of predictable market demand that facilitates and

incentivises private investment to follow. This is captured within the model's investment and value chain loops. As a result, between 2030 and 2040 additional private investment continues to grow relative to the baseline (non-intervention) case, and by 2041 additional annual private investment exceeds the level of additional annual public investment. We might expect this to incorporate some level of import substitution, and as such, it is not surprising to see net imports return to zero.

5.17 In the longer term, from 2040 to 2050, the supply-side effects of the combined additional public and private investment in R&D, process and product innovation become the dominant evolutionary drivers within the model. Economic evidence suggests that these factors would have a number of effects at the sectoral level, including higher levels of efficiency, productivity, leading to higher wages, increased demand for skilled workers, improvements in competitiveness and export market share, and this is indeed what we see. This period hence also sees significant growth in net exports and, as a result of substantially higher median wages, and higher consumption.

Scenario metrics

Table 5-1: Headline Technology and Innovation scenario metrics in 2050, and relative to 2021 and the Baseline Benchmark

Headline metric	The North by 2050	Change relative to today (2021-50)	Change relative to the Baseline Benchmark (by 2050)
Population (000's)	17,247.1	1,672.2	252.0
Jobs (000's)	8,364.0	656.9	106.4
GVA (£2019, millions)	537,016.8	171,070.2	22,242.3
GVA per job (£2019, 000's)	64.2	16.7	1.9
GVA per capita (£2019, 000's)	31.1	7.6	0.8

Source: Cambridge Econometrics LEFM

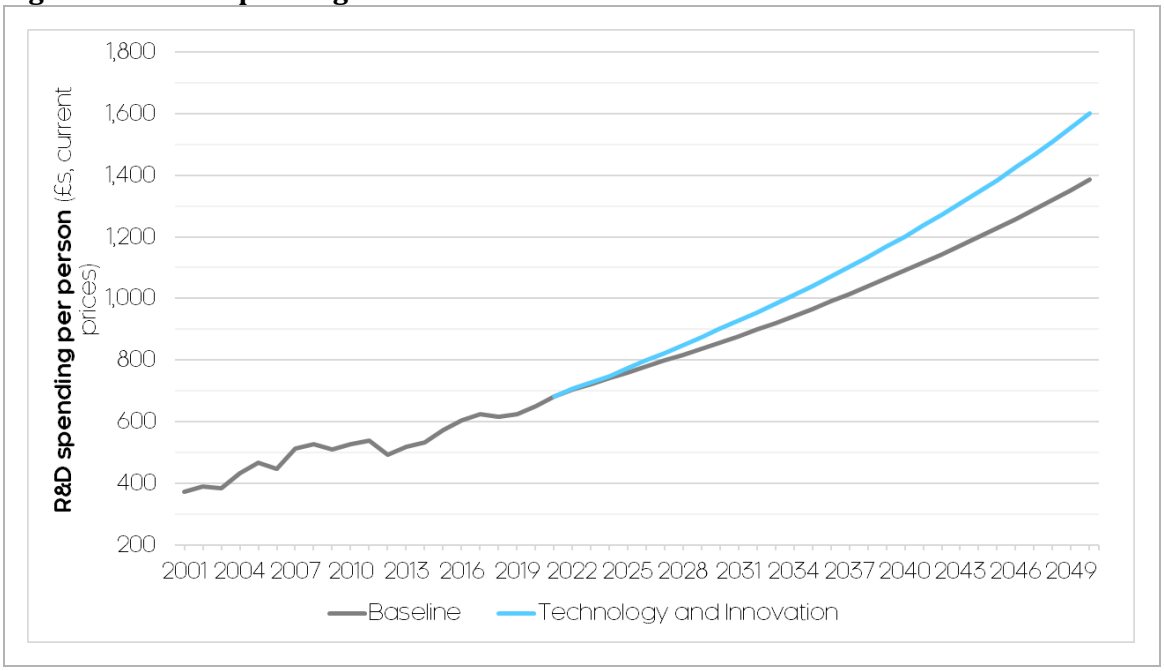
5.18 The table above shows the headline impacts under the scenario by 2050, relative to today and the expectations of the Baseline Benchmark. The Technology and Innovation scenario has the potential to provide:

- £171bn of additional GVA growth to 2050, £22bn above the Baseline Benchmark, which is the third highest of the four change scenarios.

- 656,900 more jobs, 106,400 above the Baseline Benchmark, which is the lowest of the four change scenarios.
- £16,700 additional productivity per worker, £1,900 above the Baseline Benchmark, which is the highest of the four change scenarios.
- 1.7 million increase in population, 252,000 above the Baseline Benchmark, which is the lowest of the four change scenarios.

5.19 As Figure 5.5 shows, looking at the wider scenario metrics, one of the most notable impacts under this scenario is the large increase in R&D spending, which on a per capita basis rises to £1,600 by 2050, 2.5x higher than the current average in the North, and 15% higher than the Baseline Benchmark. This would all but close the current R&D spending gap between the North and the rest of the country.

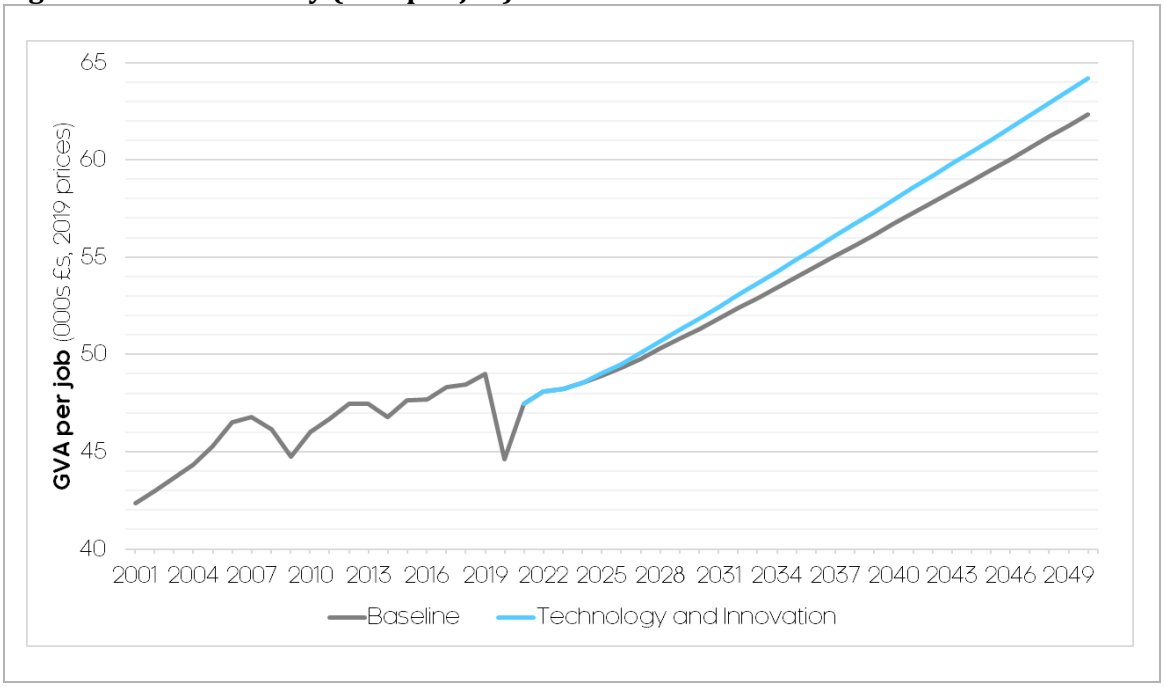
Figure 5-4: R&D spending in the North



Source: Cambridge Econometrics LEFM

5.20 This scenario also leads to the largest productivity impact of all the change scenarios, with £1,900 additional productivity per worker by 2050 relative to the Baseline Benchmark. This would still however leave the North some 13% below the Rest of the UK Productivity Ambition Benchmark, although only 4% below the Rest of England less-London benchmark.

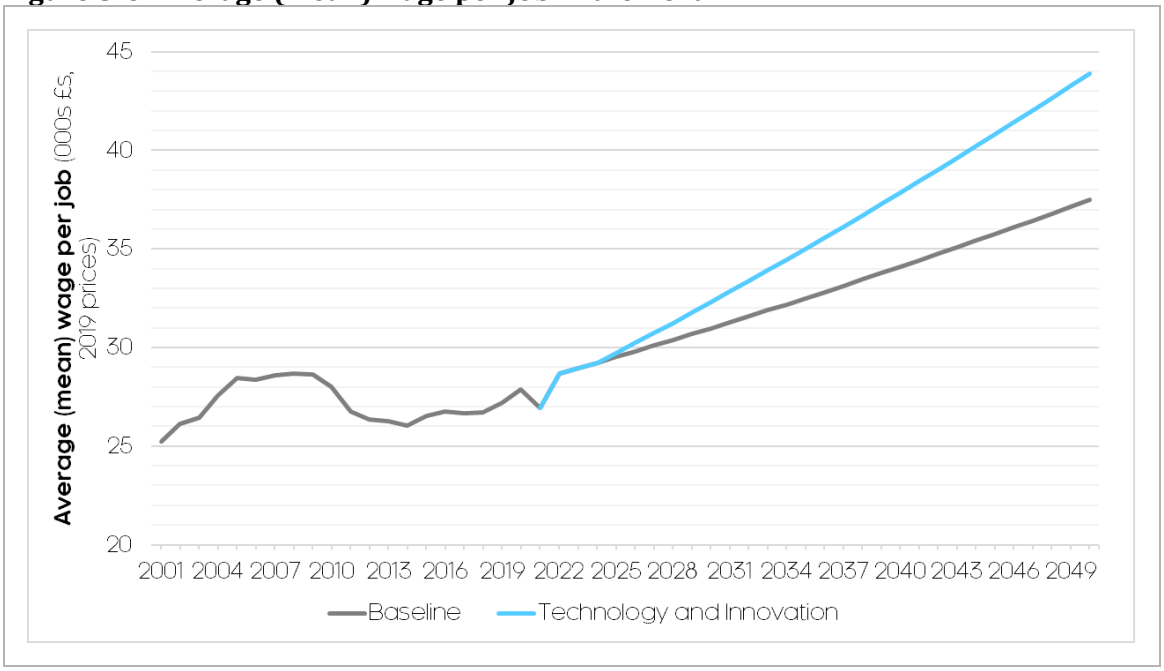
Figure 5-5: Productivity (GVA per job) in the North



Source: Cambridge Econometrics LEFM

5.21 This productivity boost, combined with a shift in demand towards higher-wage occupations with greater bargaining power, would support a significant rise in wages in the North, as Figure 5.6 shows, with the average worker taking home an additional £6,400 (in real terms) per annum relative to the Baseline Benchmark. This represents a substantial shift in the labour share in the North, and is more than twice the increase of any other change scenario.

Figure 5-6: Average (mean) wage per job in the North

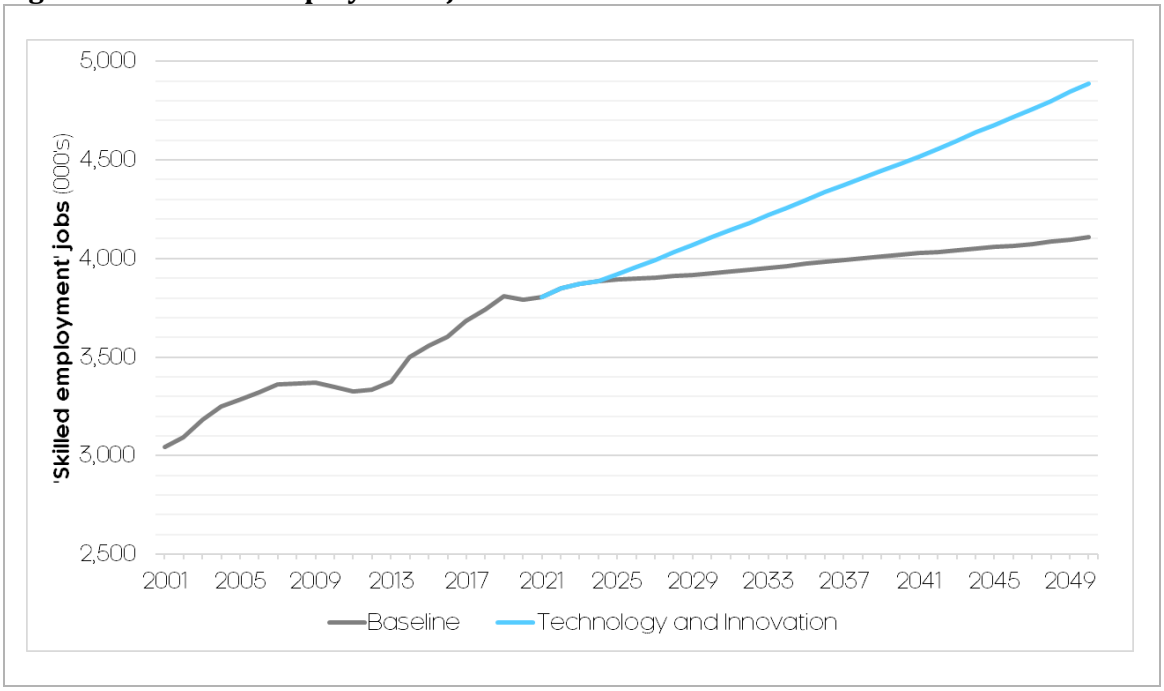


Source: Cambridge Econometrics LEFM

However, key to enabling this scenario will be the supply of skilled workers in the North. As Figure 5.7 below shows, the demand for 'skilled employment' jobs[47] is highest under this scenario, with almost two-thirds (58%) of workers in the North expected to be in 'skilled employment' by 2050, well ahead of the Baseline Benchmark of 50%.

5.22 In the absence of significant complementary skills and education programmes, or an increase in the attractiveness of the region to highly skilled workers, it is unlikely that this condition would be met, and indeed this scenario also sees the highest levels of net in-commuting into the North to help satisfy this demand from employers.

Figure 5-7: 'Skilled employment' jobs in the North



Source: Cambridge Econometrics LEFM

[47] Defined here as in the Levelling Up White Paper as SOC2010 major groups 1-3 and 5.

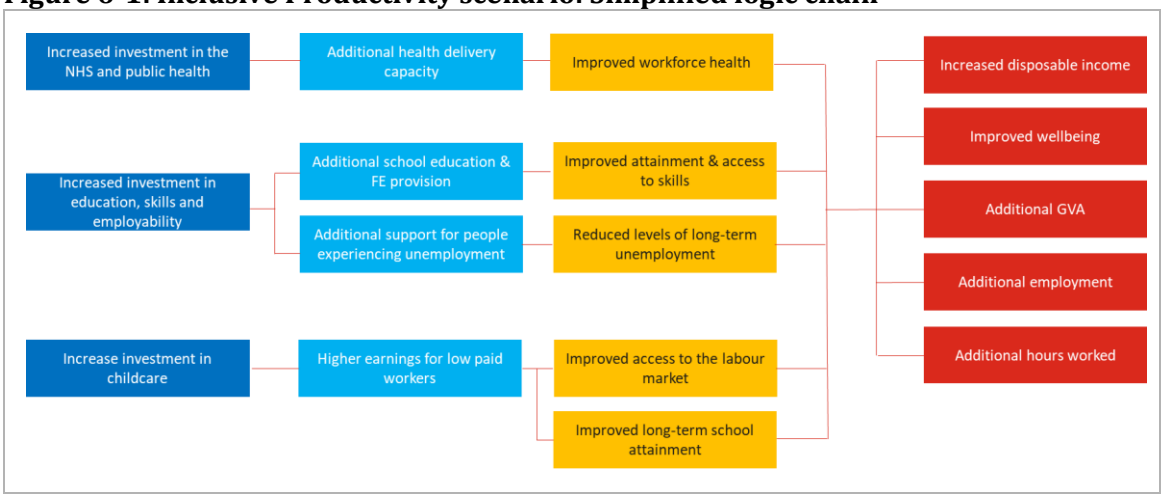
6. Change Scenario 2: Inclusive Productivity

While the 2016 NPIER was strongly focused on GVA, productivity and jobs, the ambition for the North should reflect the relationship between growth and measures that directly improve wellbeing outcomes and economic inclusion. Through investment in health, social care, childcare, and education skills provision, Change Scenario 2 is estimated to deliver additional GVA of £27 billion above the Baseline Benchmark to 2050, and an additional £1,000 in productivity per worker.

Introduction

6.1 Change Scenario 2 focuses on the effects of improvements in health and social care, education and skills and childcare as mechanisms to engage more people – and enable them to progress – in the labour market, drive demand in the 'foundational' sectors of the economy and reduce inequalities. The scenario assumes that investment leads to higher workforce skills, improved health and increased disposable income through the following stylised logic chain:

Figure 6-1: Inclusive Productivity scenario: Simplified logic chain



Source: SQW

Scenario narrative

Defining inclusive growth

6.2 The 2016 NPIER was strongly focused on GVA, productivity and employment growth. During consultation on the development of a fresh set of scenarios, stakeholders recognised the continuing importance of these core indicators, but also considered that new scenarios should better reflect the ambition for the North's economy to be more 'inclusive', with a greater

emphasis on how overall economic growth might translate into living standards and opportunities across the region[48].

6.3 The concept of 'inclusive growth' is well-established. The OECD defines it as *"economic growth that is distributed fairly across society and creates opportunities for all"*[49]. In the UK, the Scottish Government adopted 'inclusive growth' within its Economic Strategy in 2015, defining it, along the lines of the OECD, as *"growth that combines increased prosperity with greater equity; that creates opportunities for all; and distributes the dividends of increased prosperity fairly"*[50].

6.4 Examining it in more detail, the IPPR defines 'inclusive growth' as based on the principle that a fairer economy is a stronger economy, noting that high levels of inequality or lack of access to opportunity damage economic growth overall: *"to realise inclusive growth, you need not just growth, or greater inclusion, but growth that is designed to generate greater economic and social inclusion – not one or the other, and not sequentially"*, and with measures to reduce inequality 'built in' to the process of economic growth, rather than addressed separately through redistribution mechanisms[51]. This is important: the concept does not presuppose a trade-off between economic growth and inclusion; rather, it assumes that the two are mutually reinforcing[52].

Dimensions of Inclusive Productivity

6.5 Potentially, we could include a wide range of dimensions of inclusion within this scenario. The Index of Multiple Deprivation (for example) recognises the complex interconnections between different forms of disadvantage, including housing (affordability and quality), access to amenities, connectivity, the prevalence of local crime, and so on. However, for the purposes of modelling, and to maintain the clear link with productivity, we focus here on the effects of removing or mitigating three specific barriers to economic opportunity currently experienced by residents within the North, relating to issues of poor health, low skills, and inadequate access to childcare.

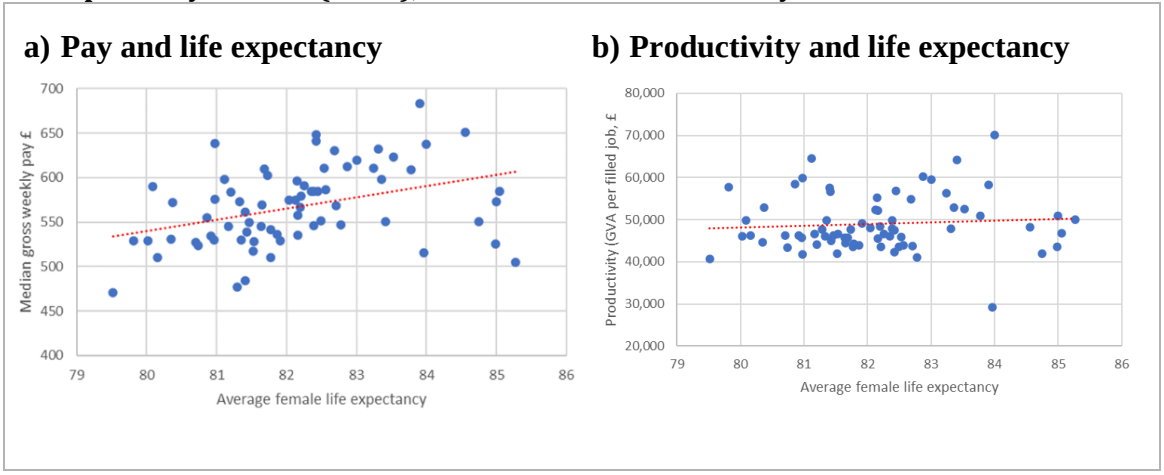
Health

6.6 The relationship between health outcomes and economic outcomes is widely recognised, with the NP11 recently noting that: "there is a symbiotic relationship between the economy and health: a strong, sustainable, inclusive economy is critical to supporting people to be healthy,

[48] MetroDynamics (2021), *Northern Powerhouse Independent Economic Review: Building a Northern Evidence Programme*
[49] OECD (https://www.oecd.org/inclusive-growth/)
[50] Rachel Statham and Russell Gunson (2022), *Inclusive Growth: What does it look like?* (IPPR Scotland for Scottish Government)
[51] Ibid.
[52] There is a much wider debate about the concept of 'inclusive growth': whether it really means more than 'growth' per se, and how much agency sub-regional partners have to influence it (see David Waite and Graeme Roy (2022), 'The promises and pitfalls of operationalising inclusive growth', *Regional Studies).* But for current purposes, the key point is the ambition to reduce inequalities and ensure a widespread distribution of benefit at the same time as increasing aggregate prosperity.

while a healthy population is a critical part of a productive economy"[53]. Across the UK, good health deteriorates faster for people living in the most deprived areas, and women in the least deprived areas in England live a further 19.7 years in good health than those in the most deprived areas[54]. This is also clearly visible in the relationship between earnings and life expectancy at district level across the North, although the correlation with productivity is much weaker:

Figure 6-2: Resident gross median weekly pay (2021), productivity (2020) and female life expectancy at birth (2018), all Northern local authority districts



Source: ONS, Annual Survey of Hours and Earnings; Life Expectancy at Birth; GVA (B) per filled job.. Note that the data exclude Copeland district, which is an outlier (very high resident median pay on the 2021 data)

6.7 Related to this is the relationship between health and productivity performance. In the North of England, recent research found that up to 30% of the gap in productivity levels between the region and the rest of the UK could be reduced by raising participation in the workforce through addressing ill health[55]. The Northern Health Sciences Alliance estimates that this might equate to an additional £13.2 billion in GVA per annum[56]. Separately, analysis demonstrates a correlation at local authority level across the UK between lower output (measured as gross value added per capita) and the incidence of mental ill-health, long-term limiting health conditions and musculo-skeletal health problems[57]. The Levelling Up White Paper further highlights local correlations between 'lifestyle'-related health issues (such as smoking rates and overweight and obesity prevalence) with wider measures of disadvantage[58].

6.8 Apart from spatial inequalities, poor health has a significant impact on workplace output across the board. Research indicates that across the UK, over 70 million working days are lost

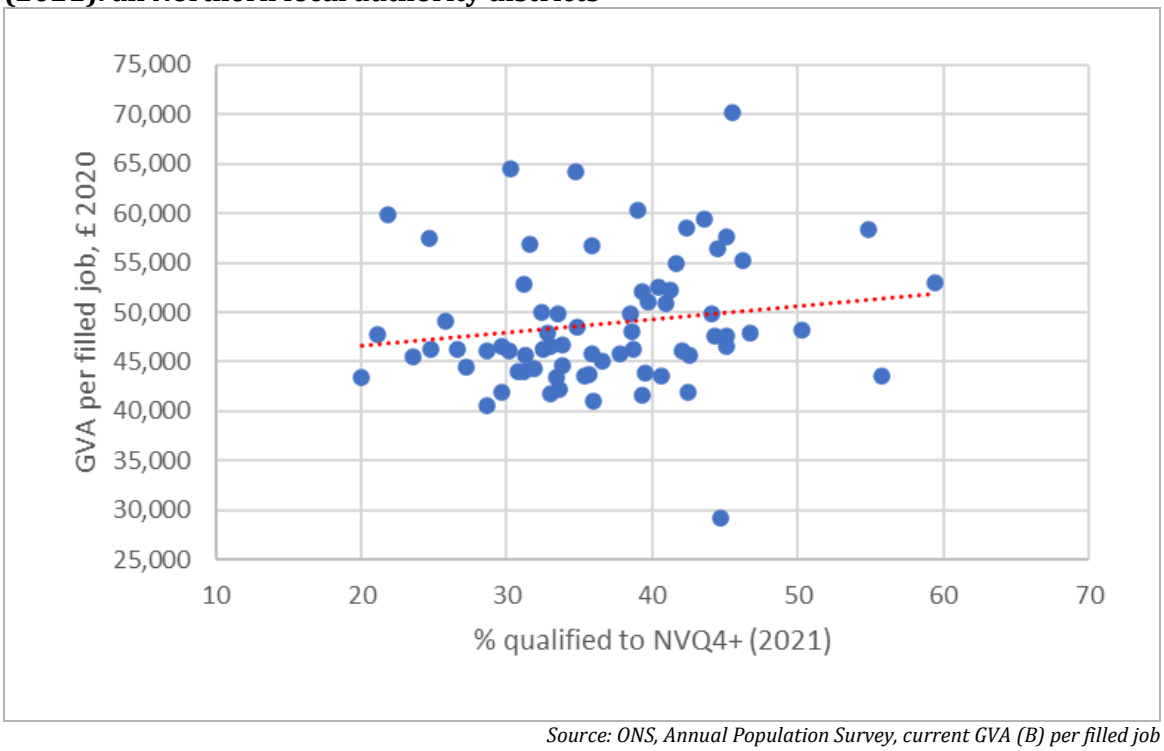
[53] NP11 (2023), *Convention of the North Policy Paper: Health*
[54] Health Foundation (January 2022). The equivalent male gap is 18.3 years.
[55] Bambra, Munford, Brown *et al* (2018), *Health for Wealth: Building a Healthier Northern Powerhouse for UK Productivity*, Northern Health Science Alliance
[56] Ibid.
[57] Greater Manchester Independent Prosperity Review (2019), *Productivity and Pay Research Summary*
[58] HM Government (2022), *Levelling Up White Paper*, p,63-66

each year to mental ill health alone[59]. Ill-health is also a major driver of exit from the labour market, an issue which has come to greater prominence in the past couple of years. Health reasons accounted for about one third of the approximate 1.1 million workers lost to the UK labour market during the Covid-19 pandemic[60], and Covid-19 related health outcomes were worse in the North than in the rest of England, partly due to higher levels of deprivation and pre-existing poor health[61].

Skills

6.9 The relationship between workforce skills and productivity is widely recognised: the Leitch Review back in 2006 observed that skills deficits accounted for some 20% of the UK's productivity deficit with Germany and France, and we highlighted in relation to Change Scenario 1 the contribution that technical and management skills make in realising the opportunities associated with technology adoption. Across the North, higher productivity correlates with higher workforce qualifications:

Figure 6-3: Productivity (2020) and % of residents aged 16-64 qualified to NVQ4+ (2021): all Northern local authority districts



Source: ONS, Annual Population Survey, current GVA (B) per filled job

[59] Institute of Employment Studies (2018), *Unlocking Employee Productivity: The role of health and wellbeing in manufacturing*

[60] Chris Thomas *et al* (2022), *Health and Prosperity: Introducing the IPPR Commission on Health and Prosperity*, IPPR. Separately, the Institute for Fiscal Studies (2017) estimated that about 15% of exits from the labour market for people aged 50-70 were for health reasons, with the proportion greater among those with lower qualification levels.

[61] Luke Munford, Sam Khavandi *et al* (2021), *A year of COVID-19 in the North: Regional inequalities in health and economic outcomes*, Northern Health Science Alliance

6.10 From a policy perspective, the 2021 Skills White Paper places an emphasis on improving access to vocational learning, especially in the further education sector, responding to a long-recognised deficit in the UK skills system and reflecting the skills priorities that are generally set out in sub-regional strategy across the North[62]. There is however a recognition that skills do not necessarily equate to formal qualifications, given the value of 'employability skills' (problem-solving, communications, etc.) at all levels of the labour market[63], and the nature of much re-skilling and continuous development.

6.11 A series of reports highlights digital 'skills gaps' in the UK and a lack of workforce skills is cited as a key barrier to effective adoption. A recent Government report on quantifying the data skills gap found that there are between 178,000 – 234,000 data-related roles in UK companies to be filled, but graduate supply is likely to be limited to around 10,000 per year, and about half of all relevant workers report no data skills training in the past year[64]. Relevant measures are likely to relate both to new entrants to the market and the existing workforce.

Childcare and early years education

6.12 Over time, female labour market participation rates have risen strongly, including for women with dependent children[65]. However, there is still a significant gender pay gap: while female educational attainment is higher than male attainment levels overall, the gap between the median gross earnings of men and women was 15.5% for all employees, with this gap persisting at all levels of education. Part of the explanation for this is the higher level of part-time working among women with children, with an immediate decline in pay followed by a lower earnings trajectory thereafter[66].

6.13 Research for the Centre for Progressive Policy finds that the availability of childcare makes an important contribution to the participation and pay gap, with looking after the family or home representing the largest single cause of female economic inactivity (26% of all economically inactive women in 2019, compared with 6% of men)[67]. However, relatively higher childcare costs in the UK mean that some economic inactivity through family responsibilities is 'involuntary' (i.e., more people would be active in the labour market if childcare were more easily accessible). Research for the Open University found that through increased workforce participation and higher earnings, the costs to the taxpayer of a 'comprehensive childcare offer' would be recovered after between 7 and 13 years of work[68],

[62] Department for Education (2021), *Skills for Jobs: Lifelong Learning for Opportunity and Growth*
[63] Graham Hasting-Evans and Paul Bivand (2018), *Skills to Drive a Productive Society*, Learning and Work Institute
[64] DCMS (2021), *Quantifying the UK Data Skills Gap – Full Report*
[65] Norma Cohen (June 2021), *Women in the Labour Market; Why childcare can drive economic recovery* (Centre for Progressive Policy). Just before the start of the pandemic, around three-quarters of women with dependent children were in work, compared with around two-thirds in 2000.
[66] Sara Connolly, Mary Gregory (2009), The *part-time pay penalty: Earnings trajectories of British women,* Oxford Economic Papers 61
[67] ONS (2021), quoted in Cohen (2021)
[68] J. De Henau (2019) *Employment and fiscal effects of investing in universal childcare: a macro-micro simulation analysis for the UK*, IKD working paper no. 83, The Open University

6.14 Beyond labour market benefits, there is also evidence that greater investment in early years services will have long-term educational and health outcomes. Research for the Northern Health Services Alliance found *"ample evidence that child cognitive ability is an important predictor of labour market outcomes, including earnings, occupation, work experience and youth unemployment"*, with access to childcare an important factor in supporting this[69]. Given the relative prevalence of child poverty in the North and the correlation between measures of child health and welfare and wider economic outcomes, the NHSA found that the benefits of additional investment in early years education could be disproportionately significant, with the enrolment of all low-income children in high quality early education programmes potentially reducing the gap in long-term educational outcomes by 20-50%[70].

Wider metrics, not modelled at this stage

6.15 Beyond the dimensions of inclusive growth set out below, there is a wide range of other factors that contribute to quality of life. These include the quality of and access to housing and connectivity to services and opportunities, both of which are included in Change Scenario 3. They also include access to leisure, cultural, environmental and heritage assets, in which the North has important strengths. While we have not considered these in detail within the scenario, there should be an opportunity to explore their contribution further in the refreshed NPIER when it is produced later in 2023.

[69] Northern Health Services Alliance (2021), *Child of the North: Building a fairer future after Covid-19*
[70] Ibid., also quoted in NP11 (2023), *Convention of the North Policy Paper - Health*

Input metrics and key assumptions

6.16 The challenge for modelling is to distil the wide-ranging analysis above into a set of clear and simple assumptions that we can feed into the model. Within the model, there will be both demand-side and supply-side impacts, that change the way the model evolves over our 25-year time period. In order to estimate this, we need to estimate both the costs and direct impacts of the above set of interventions.

Inclusive Productivity Scenario: What could this investment pay for?

£6bn per annum on health and social care.[1]

- The LSE–Lancet NHS Commission estimated that £102 billion in real terms, or 3·1% of gross domestic product (GDP) in 2030–31, is needed for the NHS, social care, and public health
- The Health Foundation estimate that the NHS budget needs to grow at 4% annually, instead of the 2% annual growth seen in the last decade and currently planned for.
- We assume £4bn per annum of the £6bn per annum is spent on the NHS directly to help plug this gap: this is roughly equivalent to an additional 2pp of budgetary growth for the next decade, however beyond that, more money may be required.
- For social care, we follow the Health Foundation *Social Care Scenario 4*: "Meet future demand, improve access to care, and pay more for care". We assume that an £2bn within the North of England goes some way to delivering this scenario.

£4bn per annum on childcare, education and skills[1]

An IFS study into plans (initially proposed by the Labour Party) to boost education spending identified the following costed interventions:

- Reversing cuts to schools: £5bn, of which we assume £1.3bn in the North. This would substantially increase the core school budget, the pupil premium, and provide free school meals to all pupils**.**
- A further £5bn would reintroduce the education maintenance allowance and the higher education maintenance grant, and abolish upfront fees for FE courses, and expand provision of adult skills courses. We assume 1.3bn would be spent in the North.
- A further £5.4bn would be required to offer 30 hours' free childcare during term-time for all 1- to 4-year-olds. We assume this costs £1.4bn in the North.

Modelling Assumptions

6.17 The direct impacts here manifest within the labour market module within the model. The primary mechanisms we attempted to capture were four-fold:

- estimating the impacts of improved health on labour inactivity rates. We assume that the proportion of the population out of work due to long-term health problems is reduced by 25%: that is from current levels of ~4% of the total population, to a figure of 3% of the total population. This brings an additional ~120,000 people into the workforce by 2050.
- estimating the impacts of improve childcare on labour inactivity rates. We assume the net result would be a 50% decrease in the total proportion of the population currently out of work due to caring for family from approx. 3% today, to 1.5% by 2050. This could bring a further additional 140,000 people into the workforce by 2050.
- estimating the impacts of improved education and skills on the occupational composition of the labour market (increasing the share of higher skilled workers and decreasing the share of lower skilled workers). We assume the impact of the above set of educational packages is an increase in the proportion of the workforce with level 4 and level 3 skill levels. We assume that the impact is a 10% increase in participation in both HE and adult FE, leading to an addition ~200,000 skilled workers entering the Northern workforce per annum. We convert these into 25 occupational categories in our labour market model. The wider availability of skilled workers has knock-on effects within the model for more knowledge-based sectors.
- the demand impacts in the health & social care and education sectors of the additional spending, and subsequent impacts on labour demand.

Scenario outputs and description of results

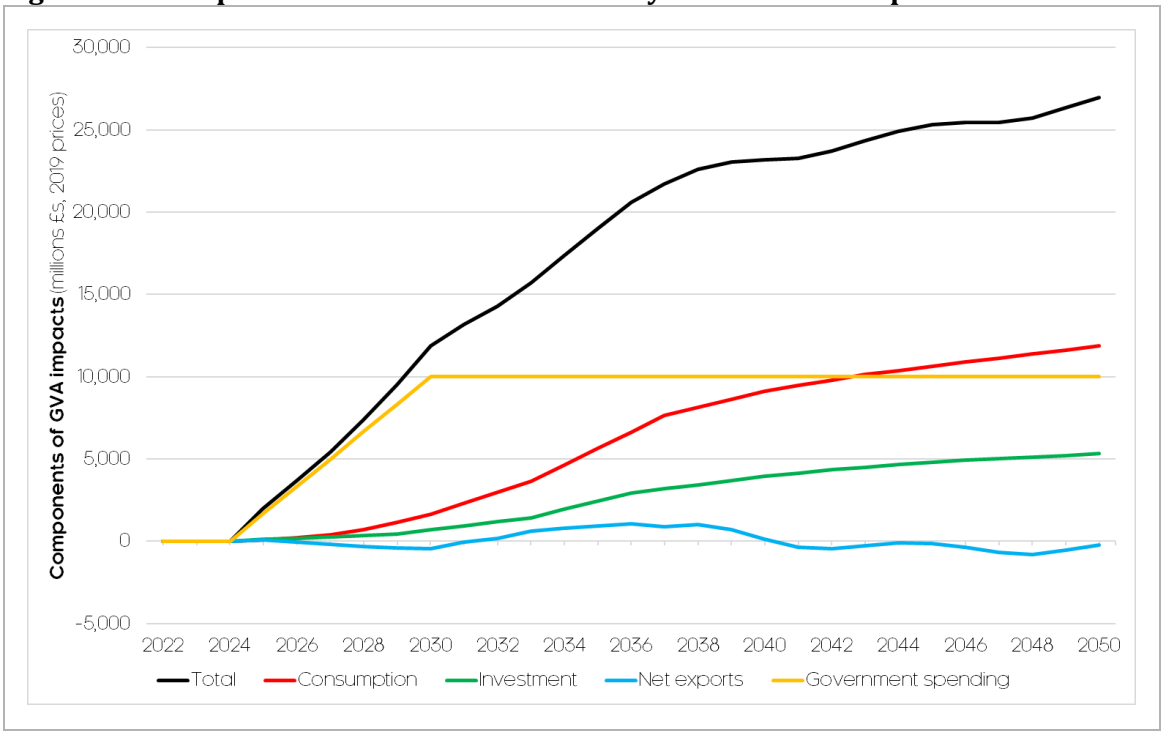
Overall outturn

6.18 Figure 6.4 shows the overall narrative for how the Northern economy evolves differently over time in this scenario. The graph shows the additional GVA that results from this scenario compared to the baseline over the period 2025-2050, and its four broad components: public investment, private investment, consumption and net exports. In all scenarios, public investment is a model input, with the other three components model outputs.

6.19 In this scenario, public investment increases from 2024 to 2030, and then maintains a level of £10bn additional spending over the baseline from 2030-2050, primarily in the health, social care, and education sectors. Economically, the evidence suggests that the direct results of this would likely be an increase in labour activity and labour skills, and this is what is captured within the model. The simultaneous growth in both labour supply generally and skilled labour supply more specifically has a positive effect on both aggregate employment and productivity. Sectors that were constrained within the model by a lack of available

workers in particular occupations are now able to grow more rapidly. The primary effect of this is a growth in additional consumption due to the substantial increase in household income as a result of both higher wages and higher employment rates, with a smaller positive effect on private investment, induced by the availability of more, and more skilled, workers.

Figure 6-4: Composition of Inclusive Productivity scenario GVA impacts to 2050



Source: Cambridge Econometrics LEFM

6.20 The effect on net exports is small and ambiguous, with different factors within the model pulling in different directions, for example whilst increased consumption tends to drive growth in imports, increased economic activity and productivity tends to increase exports.

Scenario metrics

Table 6-1: Headline Inclusive Productivity scenario metrics in 2050, and relative to 2021

Headline metric	The North by 2050	Change relative to today (2021-50)	Change relative to the Baseline Benchmark (by 2050)
Population (000's)	17,264.1	1,689.2	269.0
Jobs (000's)	8,554.1	847.0	296.5
GVA (£2019, millions)	541,752.7	175,806.0	26,978.1

Headline metric	The North by 2050	Change relative to today (2021-50)	Change relative to the Baseline Benchmark (by 2050)
GVA per job (£2019, 000's)	63.3	15.9	1.0
GVA per capita (£2019, 000's)	31.4	7.9	1.1

Source: Cambridge Econometrics LEFM

6.21 The table above shows the headline impacts under the scenario by 2050, relative to today and the expectations of the Baseline Benchmark. The Inclusive Productivity scenario has the potential to provide:

- £176bn of additional GVA growth to 2050, £27bn above the Baseline Benchmark, which is the highest of the four change scenarios.
- 847,000 more jobs, 296,500 above the Baseline Benchmark, which is also the highest of the four change scenarios.
- £15,900 additional productivity per worker, £1,000 above the Baseline Benchmark, which is the lowest of the four change scenarios.
- 1.7 million increase in population, 269,000 above the Baseline Benchmark, which is the third highest of the four change scenarios.

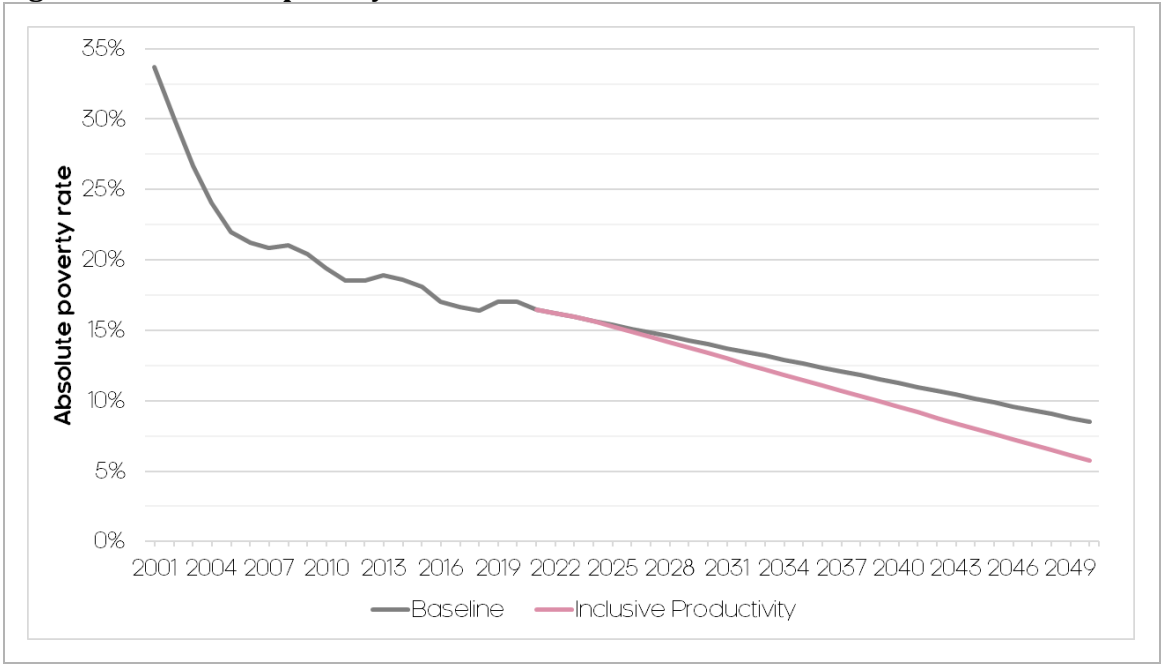
6.22 Looking at the wider scenario metrics, the impacts of this scenario are most keenly felt in the North's labour market. Economic activity rates, as shown below are expected to continue rising, reaching a potential high of 84.5% by 2050, 2.2 p.p. above the Baseline Benchmark, as barriers to work (especially health and care related) are reduced in the North.

Figure 6-5: Economic activity rates in the North

Source: Cambridge Econometrics LEFM

6.23 This increase in economic activity, complemented by a rise in incomes due to more, better quality, higher-paying job opportunities, also has the potential to have a significant impact on poverty levels in the North, as shown in Figure 6-6. In absolute terms, poverty rates could decline to 5.7% by 2050, below the Baseline Benchmark of 8.5%, moving thousands of Northern households out of potential poverty.

Figure 6-6: Absolute poverty rate in the North



Source: Cambridge Econometrics LEFM

6.24 This reduction in poverty, coupled with wider health and social care improvements, could see a sustained increased in the North's life expectancy. As Figure 6.8 shows, life expectancy could rise to 84.3 years by 2050, 1.1 years higher than under the Baseline Benchmark, reversing the recent stagnation in life expectancy in the North, and significantly improving the quality of life for residents in the North. We would expect a similar improvement in healthy life expectancy, especially relevant to the North's productivity potential.

Figure 6-7: Life expectancy at birth in the North

Source: Cambridge Econometrics LEFM

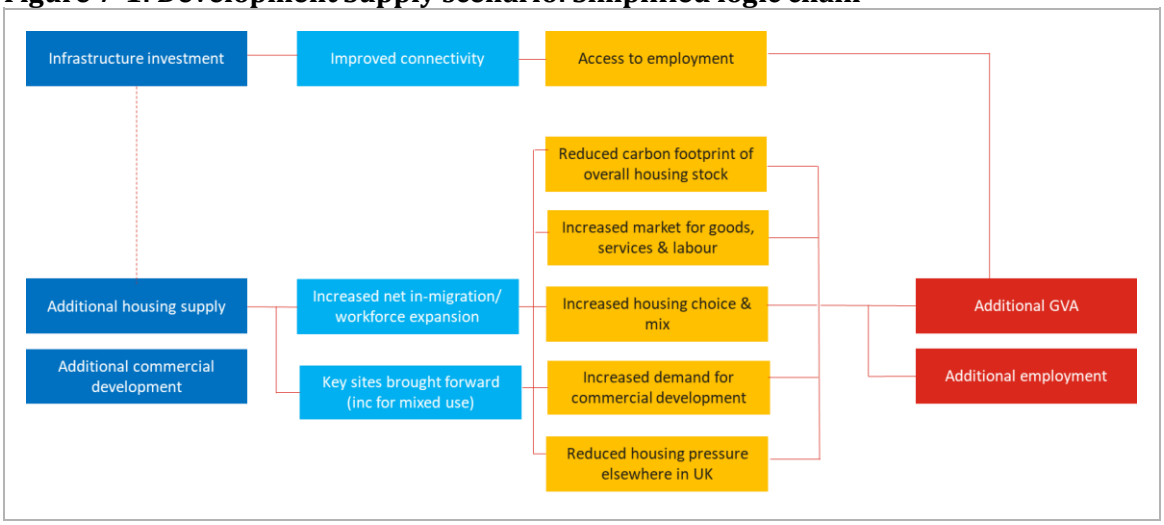
7. Change Scenario 3: Development Supply

Increasing the effective density of the North through improved connectivity and an increased, and more stable supply of housing should help to drive agglomeration economies. Through investment in social housing and in improving local and regional transport networks (and therefore unlocking new development opportunities), Change Scenario 3 delivers £21 billion in additional GVA over the Baseline Benchmark to 2050, and £1,200 in additional productivity per worker.

Introduction

7.1 Change Scenario 3 focuses on the delivery of additional housing and commercial development in the North. It assumes increased housing delivery over time, accompanied by investment in transport and other infrastructure to unlock new developments, leading to additional economic activity and improved access to employment through the following simplified logic chain:

Figure 7-1: Development Supply scenario: Simplified logic chain



Source: SQW

Scenario narrative

Agglomeration and housing growth

7.2 Central to the "building back better" agenda in the North is the delivery of high-quality, affordable, and well-connected homes in the right places. Increasing the effective density of

Northern cities would be a key driver of agglomeration economies[71]. A stable supply of social housing acts as an anchor on local rents and prevents key workers being priced out of urban markets. Whereas private sector housing completions tend to drop dramatically in recessions, a programme of counter-cyclical social housebuilding could provide the long-term market stability to incentivise more capital-intensive, and ultimately more efficient, methods of house building.

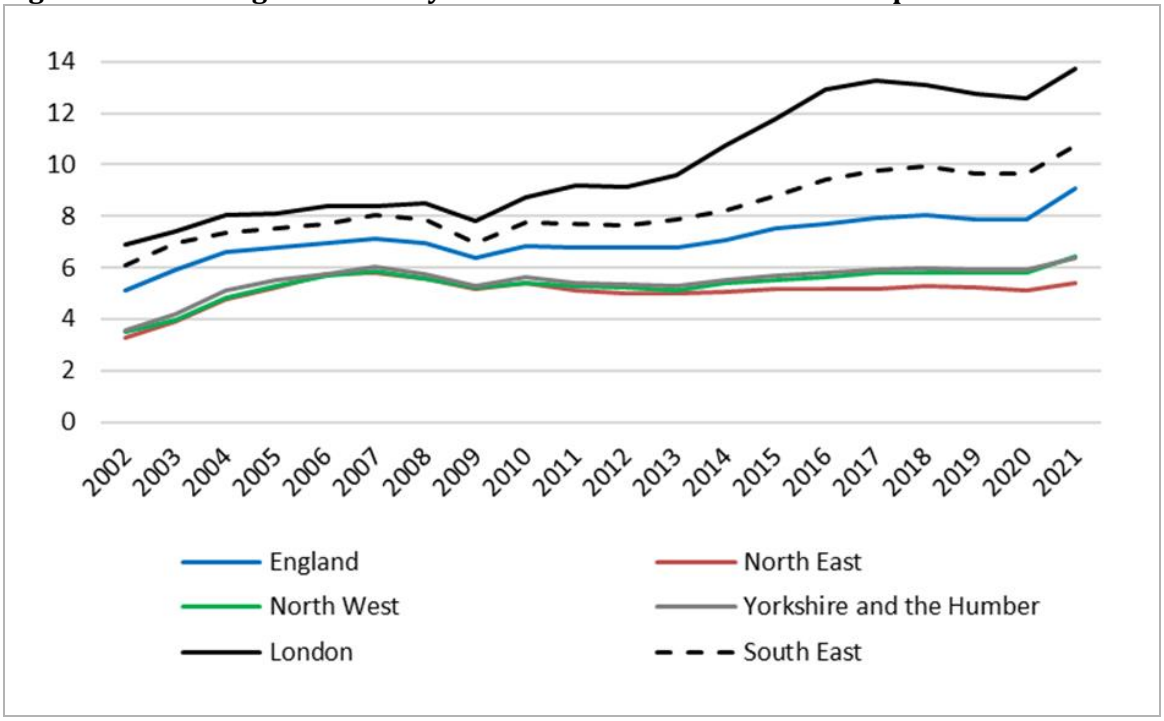
Additional housing supply

7.3 The 2016 NPIER Transformational Scenario assumed that the North's working-age population would be 792,000 higher in 2050 relative to the 'Business as Usual' scenario, while the total population would be 1,464,000 higher. Overall, this would support some 855,000 additional jobs. As we have seen in Chapter 3, the North's population has continued to increase (with around 400,000 additional people since the 2016 NPIER), and the Baseline forecast anticipates population growth of over 1 million by 2050. Nevertheless, reduced assumptions in relation to international migration combined with the ageing population leads to lower expectations of workforce size[72].

7.4 However, there is potentially greater physical capacity for growth in the North relative to the constraints on the Greater South East. In aggregate, while housing affordability has worsened somewhat in the North over time, in relative terms, the region has become *increasingly* affordable as demand continues to rise in London and the South East and the scope for development is limited by environmental pressures and opposition, despite high investment (at least relative to other parts of the country) in infrastructure. Following the Levelling Up White Paper, the Government has also sought to refocus the role of Homes England away from a concentration on major sites in existing 'high demand' areas (principally in the South) to a greater orientation towards regeneration and regional rebalancing.

[71] Note that a relative lack of agglomeration was cited as a key factor in the North's productivity performance within the 2016 NPIER
[72] Cambridge Econometrics (2018), *Connectivity and Labour Markets in the Northern Powerhouse*

Figure 7-2: Housing affordability ratio in the North relative to comparators



Source: Department of Housing, Levelling Up and Communities. Note: defined as median house price relative to median workplace wages

7.5 Perhaps reflecting these differential regional pressures, the North has seen modest net internal migration since 2016, reversing a previous trend of net outflows, although the effect of this remains low relative to international migration[73]. The proposition is therefore that an increase in housing supply could help to meet the Government's England housing target of 300,000 additional dwellings per annum, increase choice and flexibility and support overall population growth.

7.6 Aside from the benefits arising from the expansion of the housing stock, there is substantial evidence on the impact of housebuilding itself: research in 2018 found that every 100,000 homes built in the UK generated some £13.6 billion in GVA and around 430,000 full-time equivalent jobs[74]. Turning to the part of the housing sector in which public investment has particular direct traction, social housing generates similar economic impacts as market housing[75], with a large body of evidence further demonstrating the wider social and preventative impacts of social housing, with research showing large social and economic benefits to individuals and society, often exceeding the public funding costs[76].

[73] In 2019/20 (the latest year for which data are available), net internal migration into the North was 13,491 (0.1% of the resident population); international net migration was around 54,000 (0.3% of the resident population)
[74] Lichfields (2018), *The economic footprint of housebuilding in England and Wales*
[75] Mike Foden *et al* (2015), *The economic impact of social housing organisations in Northern Ireland*, Sheffield Hallam University
[76] Kenneth Gibb *et al* (2020), *The impact of social housing: Economic, social, health and wellbeing*, UK Collaborative Centre for Housing Evidence

Commercial development

7.7 Beyond housing development, the sub-regional strategies in all NP11 areas highlight a demand for additional commercial stock, underscored by a widely recognised lack of supply, especially for good-quality industrial premises[77]. Linked with Change Scenario 1, bringing forward additional commercial space, especially linked with the North's 'prime' and 'enabling' capabilities, ought to form an important element of the regional approach to technology and innovation exploitation.

Enabling infrastructure

7.8 Delivering an increase in the overall stock of housing and commercial development will be reliant on substantial investment in infrastructure, especially transport. In that context, while the 2016 NPIER cited a lack of agglomeration as a key factor in the North's productivity performance[78], the North contains several conurbations that are, by European standards, relatively large and in close proximity to each other. A key challenge, recognised in TfN's Strategic Transport Plan (2019) and in the case advanced to Government by TfN for full investment in Northern Powerhouse Rail, is the relatively weak connectivity within and between the North's major urban centres and their hinterlands: by improving sustainable access to employment centres and driving investment potential, TfN estimates that Northern Powerhouse Rail could yield a net gain of 74,000 jobs across the North by 2050[79], although delivering a sustained increase in housing and commercial supply will also demand further investment in active travel and public realm to support sustainable, '15 minute' neighbourhoods, some road schemes and a wide range of environmental and community infrastructure.

7.9 In considering this scenario, we assume an aggregate expansion of housing (and commercial development, although this has not been specifically modelled), with associated transport investment at the level of the North overall. However, we have not sought to replicate any transport modelling work carried out by TfN and Partners. We also note that capacity for development is locally dependent (and linked with site availability and viability, environmental designations, and so on). There is no assumption of a 'housing target' for the North, nor any assumption about where housing (or commercial development) should be located, other than that optimal locations and development quantums will be determined through the planning process.

Input metrics and key assumptions

7.10 The challenge for modelling is to distil the wide-ranging analysis above into a set of clear and simple assumptions that we can feed into the model. Within the model, there will be both

[77] Lambert Smith Hampton (2021), *Industrial and Logistics Market 2021*
[78] Cited in Northern Powerhouse Independent Economic Review.
[79] Transport for the North (2021), *Northern Powerhouse Rail: Connecting the People, Communities and Businesses of the North*

demand-side and supply-side impacts, that change the way the model evolves over our 25-year time period. In order to estimate this, we need to estimate both the costs and direct impacts of the above set of interventions.

Development Supply Scenario: What could this investment pay for?

£2bn per annum on new and improved social housing

We assume that long-term competitive contracts are put in place with a range of modern housing manufacturers to provide a number of housing completions within a minimum and maximum range per annum, with a bias towards counter-cyclical delivery. This long-term stabilisation of demand in an otherwise volatile sector could be expected to lead to higher levels of capital intensity and consistently reduced marginal costs of both manufacture and installation.

We estimate this would lead to an average unit cost of around £50,000 in real terms, implying a mean of approximately 40,000 new social homes delivered each year – we assume that some 10% of these may be used to replace existing public housing stock. Over a 25-year period, this could result in 800,000 to 1m additional homes.

£3bn per annum on local infrastructure

£3bn in capital investment is enough to substantially transform the infrastructure of a single city or rural region. Over a 25-year period, a number of areas within the North could see radically improved transport infrastructure. For example, in a single year, this could fund:

30-50 miles of a new tram or light-rail network – a substantial network

OR

The reopening of up to 100 rural rail stations (where existing track is in place)

OR

Retrofit an entire city region with comprehensive active travel infrastructure

We assume local infrastructure investments are distributed wisely and evenly across the North on a per capita basis, but make no specific assumptions about the location of nature of the exact investments: we assume this will be decided at regional and local level. It is worth noting that this is addition to the wider-regional Transport Decarbonisation intervention described in the Net Zero scenario.

Modelling Assumptions

7.11 We way we have tried to capture this scenario within the model is to explore the implications of upgrading the North's transport and housing infrastructure in improving attraction and retention of workers, and in doing so building labour market supply and "thickness", in order to understand how this would impact the wider economy through both demand for services and additional supply of workers at the level of the North as a whole. Land use and transport interventions would also very likely result in a variety of local and regional agglomeration benefits; however, such benefits are spatially and sectorally distinct, and cannot realistically be accurately estimated with the non-spatial modelling approach we have undertaken here. Instead, we anticipate that further land use/transport interaction (LUTI) modelling will be undertaken to test the implications of different specific land use planning and transport intervention options in best facilitating the level of economic growth identified, and delivering additional local agglomeration benefits within the parameters of the overall level of investment outlined. Instead, we have focused on three major mechanisms to impact the level of the North as a whole:

- A substantial increase above baseline in the population of the North, due to growth in housing stock and improved relative housing affordability (we test this assumption within the model). We assume 90% occupancy and a bias towards smaller homes and households, leading to a figure of 1.5 head of population per new home to estimate population impacts. We make no explicit assumptions about the exact locations within the North of the new social homes and resulting additional population. The model then calculates the impact of this higher level of population growth on both demand for different sectoral outputs and sectoral response to increased labour supply.
- We assume that the additional investment in local and regional transport is sufficient to accommodate this additional level of population growth without causing additional crowding or congestion or other unaccounted costs and in doing so damage the attractiveness of the North or inducing agglomeration disbenefits. As explained above, we explicitly do *not* assume the existence of any further local agglomeration benefits.
- Finally, the demand impact on the construction sector and other sectors involved in delivering this level of capital investment and development.

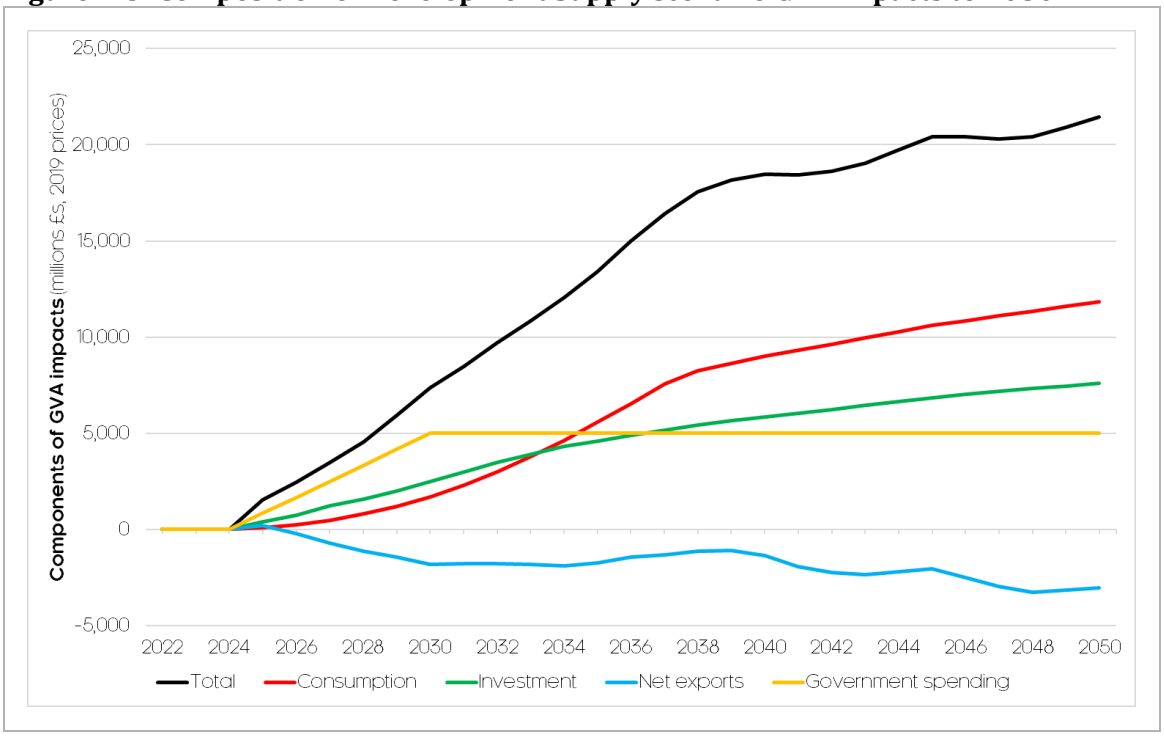
Scenario outputs and description of results

Overall outturn

7.12 Figure 7.3 shows the overall narrative for how the Northern economy evolves differently over time in this scenario. The graph shows the additional GVA that results from this scenario compared to the baseline over the period 2025-2050, and its four broad components: public investment, private investment, consumption and net exports. In all scenarios, public investment is a model input, with the other three components model outputs.

7.13 This scenario sees public investment in social housing, local and regional housing and public space, and local transport infrastructure grow from 2024 to a level of £5bn additional spending (over the baseline) by 2030. It continues at that level in real terms until 2050.

Figure 7-3: Composition of Development Supply scenario GVA impacts to 2050.



Source: Cambridge Econometrics LEFM

Related private investment is also induced in the short-term and maintains at a steady level above the baseline. In the long-term, the main driver of regional economic evolution is the additional growth of population attracted by the provision of new homes and better functioning local infrastructure. This translates to higher levels of consumption, a proportion of which is met through imports, leading to a growing long-run decrease in net exports.

Scenario metrics

Table 7-1:Headline Development Supply scenario metrics in 2050, and relative to 2021

Headline metric	The North by 2050	Change relative to today (2021-50)	Change relative to the Baseline Benchmark (by 2050)
Population (000's)	18,493.2	2,918.3	1,498.1
Jobs (000's)	8,434.5	727.4	176.9
GVA (£2019, millions)	536,207.9	170,261.2	21,433.3

Headline metric	The North by 2050	Change relative to today (2021-50)	Change relative to the Baseline Benchmark (by 2050)
GVA per job (£2019, 000's)	63.6	16.1	1.2
GVA per capita (£2019, 000's)	29.0	5.5	-1.3

Source: Cambridge Econometrics LEFM

7.14 The table above shows the headline impacts under the scenario by 2050, relative to today and the expectations of the Baseline Benchmark. The Development Supply scenario has the potential to provide:

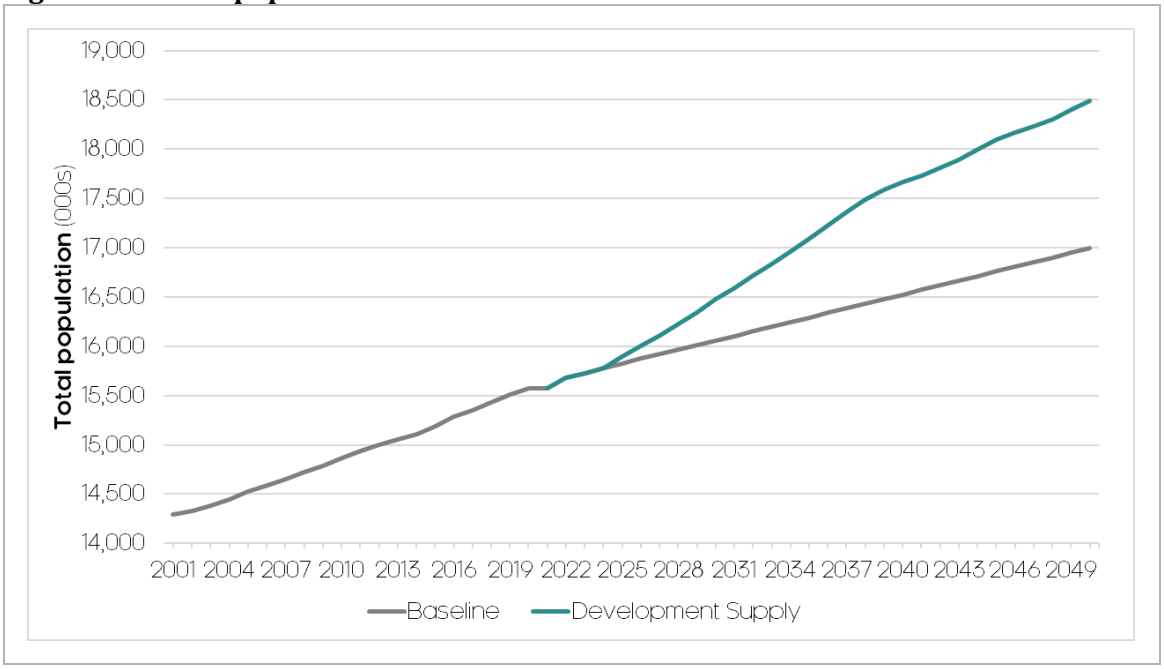
- £170bn of additional GVA growth to 2050, £21bn above the Baseline Benchmark, which is the lowest of the four change scenarios.
- 727,000 more jobs, 176,900 above the Baseline Benchmark, which is the second highest of the four change scenarios.
- £16,100 additional productivity per worker, £1,200 above the Baseline Benchmark, which is the third highest of the four change scenarios.
- 3.8 million increase in population, 1.5 million above the Baseline Benchmark, which is the highest of the four change scenarios.

7.15 Looking at the wider scenario metrics, this scenario has the potential to significantly change the number and type of people residing in the North. As Figure 7.5 shows, under this scenario the North's population could increase to 18.5 million by 2050, 1.5 million above the Baseline Benchmark, and of whom 10.8 million (two-thirds) would be of working age[80], an increase on the 9.7 million working age residents today.

7.16 The rate of population growth to 2050 (0.8%) would be double that seen in the Baseline Benchmark (0.4%), and an increase on the North's recent (pre-Covid) pace of population growth (0.4%). Given the scale of this growth, it is not expected all additional residents will be economically active though, particularly through the assumed increase in the number of students, retirees and (family) dependents in the North, as the region becomes an increasingly more affordable and attractive place to study, retire, or start a family.

[80] Aged between 16-64 years

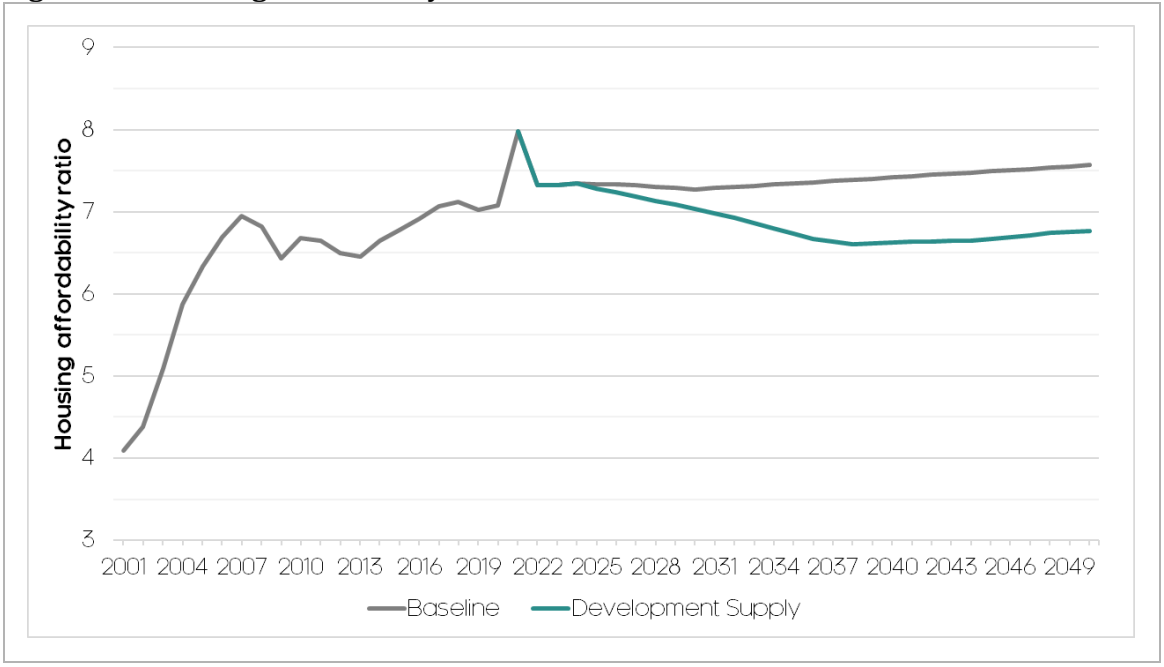
Figure 7-4: Total population of the North



Source: Cambridge Econometrics LEFM

7.17 Despite the accompanying increase in demand for housing, the scale and nature of housing supply and infrastructure in this scenario would see a sustained improvement in housing affordability in the North. As shown in Figure 7.6, housing could be 11% more affordable relative to Baseline Benchmark, which would increase rates of home ownership in the North, and thus the potential for greater wealth generation and re-distribution, thereby reducing poverty and inequality.

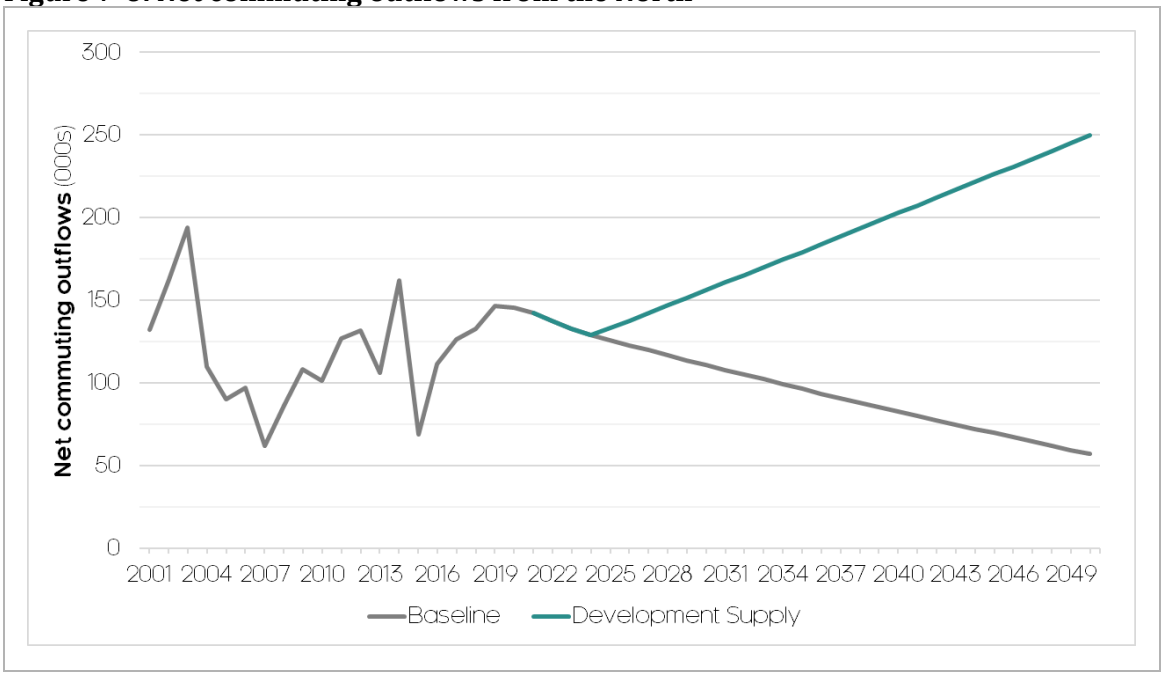
Figure 7-5: Housing affordability ratio in the North



Source: Cambridge Econometrics LEFM. Note: defined as mean house price relative to mean workplace wages

7.18 Given the significant increase in population, coupled with improving infrastructure and connectivity (including digital, for remote working), the North could see much higher levels of net out-commuting, as the attractiveness and affordability of the North sees an increase in people moving to the North but working elsewhere (be it workplace-based work in bordering regions e.g. the Midlands, or using the North as a base for hybrid working in London, Birmingham, Edinburgh, etc, or simply working entirely remotely).

Figure 7-6: Net commuting outflows from the North



Source: Cambridge Econometrics LEFM

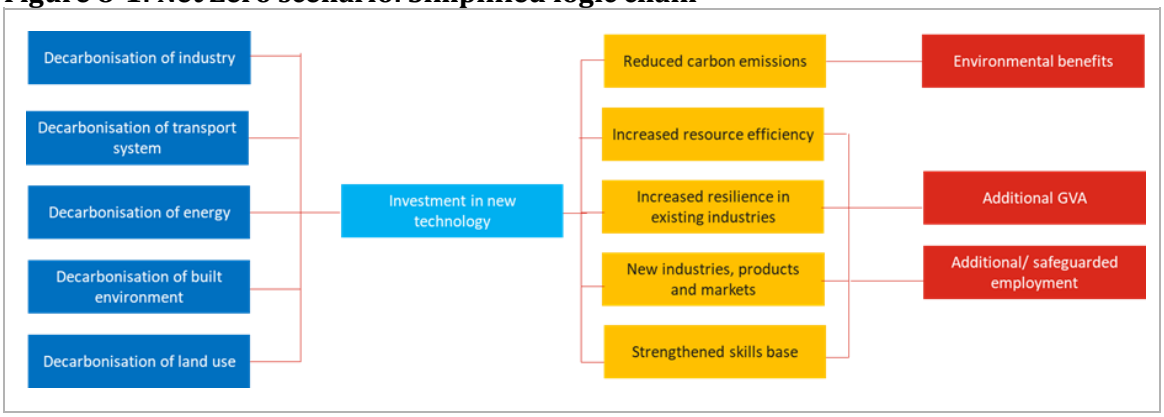
8. Change Scenario 4: Net Zero

While Scenarios 1-3 consider the impact of investment on 'levelling up' the North, Change Scenario 4 has a different focus, highlighting the impact of the full implementation of the Government's Net Zero agenda. It finds that the decarbonisation of the built environment, transport system, energy generation, industry, waste and agriculture has the potential to deliver £23 bn of additional GVA growth above the Baseline Benchmark to 2050, or £1,500 of additional productivity per worker.

Introduction

8.1 Change Scenario 4 focuses on the impacts of decarbonising the North's economy to achieve the UK's commitment to net zero greenhouse gas emissions by 2050. This will demand far-reaching change across a number of fronts: we assume decarbonisation of the built environment, transport system, industry, energy supply and distribution and land use will yield benefits via the following simplified logic chain:

Figure 8-1: Net Zero scenario: Simplified logic chain



Source: SQW

Scenario narrative

8.2 Since the 2016 NPIER was prepared, the decarbonisation agenda has accelerated strongly. The UK was the world's first major economy to make a legally binding commitment to achieve net zero greenhouse gas emissions by 2050, subsequently launching a cross-Government Net Zero Strategy in 2021. The Net Zero Strategy sets out the measures that will need to be taken for the UK to meet its carbon reduction targets up to the end of the sixth carbon budget period in 2037, focused on:

Table 8-1: National policies and proposals in the UK Net Zero strategy

Area of focus	Policies and proposals
Power	Full decarbonisation of the energy generation system by 2035, including additional capacity for offshore wind, other renewables and nuclear (including new nuclear power plant and small nuclear reactors)
Fuel supply and hydrogen	Development of hydrogen and biofuel alternatives to oil and gas, including establishment of Industrial Decarbonisation and Hydrogen Revenue Support Scheme
Industry	Decarbonisation of the industrial base, including support for fuel switching and energy efficiency, as well as the development of spatially concentrated industrial clusters (see below).
Heat and buildings	Improved energy efficiency of residential and commercial properties through installation of low carbon technologies (e.g., heat pumps) and potentially hydrogen heating depending on viability.
Transport	Zero emissions vehicle mandates, investment in electric vehicle development and infrastructure and further investment in public transport and active travel.
Natural resources	Support for afforestation, low-carbon farming and other measures to support carbon sequestration and emissions reductions
Greenhouse gas removals	Measures to balance residual emissions from the hardest sectors to decarbonise.

Source: UK Government (2021), Build Back Greener: Net Zero Strategy

8.3 Overall, the Net Zero Strategy anticipates that these cross-economy measures will "support up to 440,000 jobs" by 2030. Given the legal commitment to net zero and the risks that decarbonisation presents to some industries (for example, those in carbon-intensive sectors), some of the gains will come through increasing resilience and safeguarding employment, as well as by strengthening the UK's competitive position through early-mover advantage.

Elements of decarbonisation

8.4 Based on the national Net Zero Strategy, the broad areas in which decarbonisation may yield economic benefits fall into five main categories:

Industrial decarbonisation

8.5 The Government's recent Industrial Decarbonisation Strategy notes that *"a net zero target requires major change in how industry makes goods and consumes energy. This transformation is unprecedented in terms of scale, pace and cost":* within this context, its technology strategy to 2050 focuses on three primary areas: efficiency (including the development and adoption of industrial digital technologies, as well as better energy management and the reuse of materials); carbon capture, use and storage; and fuel switching[81]. Potentially, the contribution

[81] HM Government (2021), *Industrial Decarbonisation Strategy*

of industrial digital technologies to support efficiency improvements could be significant: the 2017 *Made Smarter Review* anticipated a sustained manufacturing carbon reduction as a result, at the same time as achieving continued output growth.

8.6 While opportunities for industrial decarbonisation are present across the economy[82], the scale of the opportunity is potentially greater for the North (as are the downside risks of failing to adapt), given the North's presence in some relatively high-carbon sectors. Over 50% of the UK's industrial carbon emissions are within six spatially-concentrated clusters of activity, of which three are in the North, at Teesside, the Humber Estuary and Cheshire/ Merseyside/ Deeside. All of these have adopted ambitious decarbonisation plans linking energy generation with local concentrations of industry[83]. The Net Zero Strategy identifies these three locations areas of focus for investment in hydrogen, carbon capture and storage and other technologies over the long term.

Energy

8.7 For the UK to fully decarbonise by 2050, renewable sources will need to constitute a much larger share of the energy mix than now. The North will require significant investment across a range of sectors in order to roll this out, although around 50% of the anticipated £500 million investment required in new offshore wind and nuclear capacity is expected to be located in the North.

Transport

8.8 In the context of the Government's Net Zero Strategy and the *Ten Point Plan for a Green Industrial Revolution*, Transport for the North published its *Decarbonisation Strategy* in December 2021. The Decarbonisation Strategy focuses on surface transport (acknowledging that significant measures will also need to be taken in relation to aviation and sea transport) and sets out a 'decarbonisation trajectory', which seeks to achieve a 56% reduction in emissions between 2018 and 2030 and a 96% reduction between 2018 and 2040[84]. The Strategy identifies eight key themes to support this target, relating to: the uptake of low emission vehicles; uptake of hydrogen vehicles; demand management and digital substitution; the decarbonisation of freight transport and the logistics industry; rail decarbonisation; and modal shift to active travel, public transport and 'micro mobility'[85].

[82] As is demand for new technology (and the skills and labour to implement it) for domestic decarbonisation and the decarbonisation of transport, logistics, etc.
[83] Net Zero North West (July 2021), *Net Zero North West: Investment Prospectus*
[84] Transport for the North (December 2021), *Transport Decarbonisation Strategy*
[85] 'Micro-mobility' means travel undertaken on small, lightweight vehicles, such as e-bikes

Built environment

8.9 The UK has an ageing building stock relative to the rest of Europe. While the proportion of homes built before 1900 is not dissimilar in the North to the rest of the country[86], the age of the stock still presents a substantial challenge for energy efficiency. There are also important distributional issues associated with the energy efficiency of residential properties, given unpredictable and (currently) high energy costs and concentrations of older dwellings in some areas of greater economic disadvantage.

8.10 Building on improvements to energy efficiency in recent years, the Net Zero Strategy proposes a series of measures to decarbonise the building stock and heating systems. This includes phasing out gas boiler sales by 2035; incentivising heat pump installations; reducing direct emissions from public sector buildings by 75% by 2037. In total, the Government anticipates an investment package of around £510m, of which 25% would indicatively be spent in the North.

Land use

8.11 Finally, for the UK to fully decarbonise by 2050, land use will need to change to favour low-carbon agriculture and other uses that do not emit. This will require investment in agriculture and forestry sectors in particular. Following the recommendations of the Climate Change Committee[87], the Net Zero Strategy commits to substantial decarbonisation of agriculture, with a tripling of tree planting rates to 30,000 ha per year by 2035 and the restoration of at least 25,000 ha of peatlands by 2025.

Cross-cutting issues

8.12 Given that decarbonisation is a universal imperative, the consequences will impact on all aspects of the economy and therefore the other scenarios described in this report. In particular, there is a substantial evidence base on the evolving demand for new skills for the decarbonised economy, which points to demand for specialist skills at all levels (including re-skilling to adapt existing knowledge to alternative fuel and other systems), and evidence of net job creation[88]. However, transition presents important distributional issues, and realising the full economic benefits will require investment in re-skilling and adaption.

Identifying priorities and interventions: Net Zero North

8.13 In 2019, the NP11 published an Energy and Clean Growth Prospectus, which highlighted the North's key role in offshore technologies, the circular economy, new nuclear energy, carbon

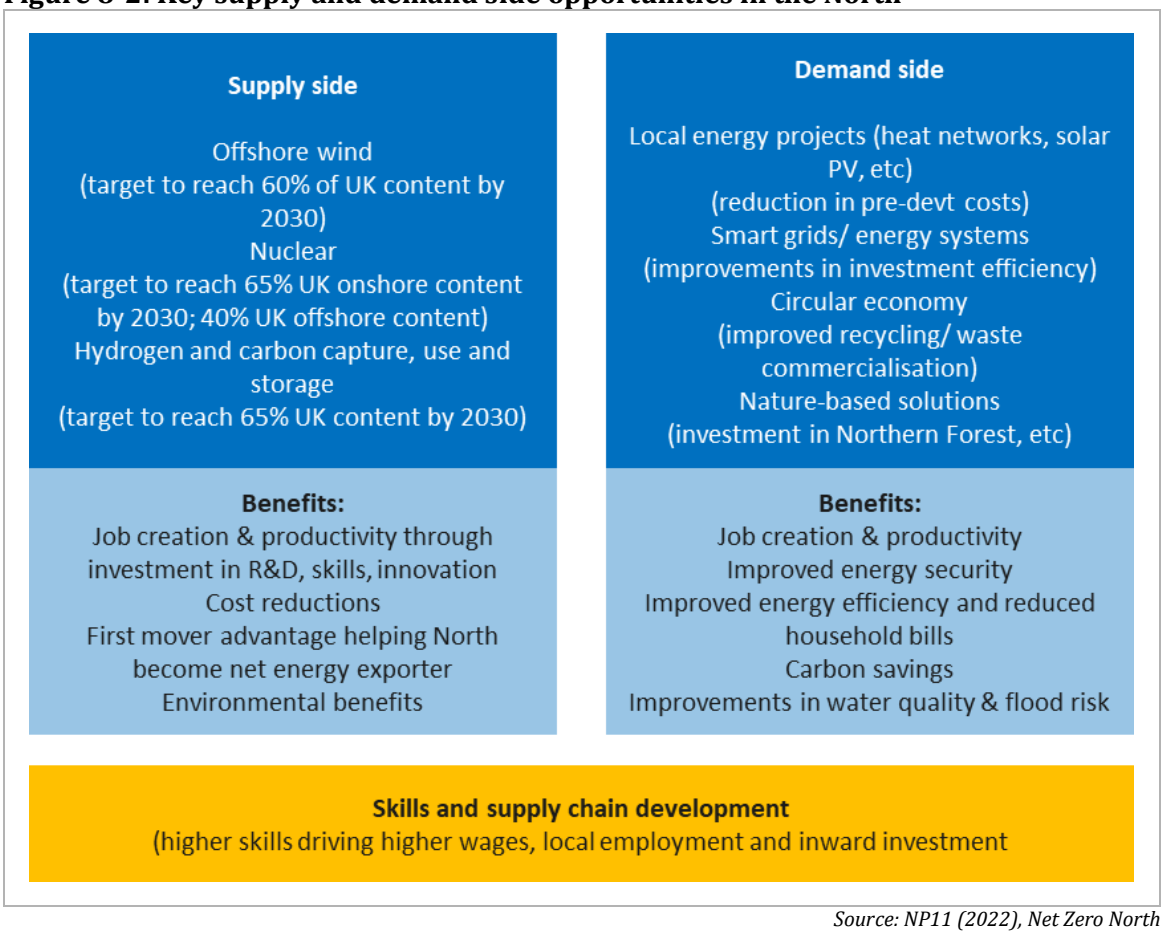
[86] ONS (January 2022), Age of the property is the biggest single factor in the energy efficiency of homes

[87] Climate Change Committee, *Sixth Carbon Budget: Agriculture and land use, land use change and forestry*

[88] Richard Hanna *et al* (April 2022), *Green job creation, quality and skills: A review of the evidence on low carbon energy*, UK Energy Research Centre.

capture utilisation and storage, and hydrogen[89]. Building on this, and in the context of the Government's Net Zero Strategy, a further report published in November 2022, outlined how these opportunities could be unlocked through investment in regional leadership and coordination capacity[90]. The analysis associated with this identified seven key economic opportunities on the 'supply' and 'demand' sides, broadly paralleling the 'elements of decarbonisation' highlighted above, and underpinned by investment in skills and supply chain development. These are linked with a series of specific targets and identified benefits[91]:

Figure 8-2: Key supply and demand side opportunities in the North



Source: NP11 (2022), Net Zero North

Input metrics and key assumptions

8.14 The challenge for modelling is to distil the wide-ranging analysis above into a set of clear and simple assumptions that we can feed into the model. Within the model, there will be both demand-side and supply-side impacts, that change the way the model evolves over our 25

[89] NP11 (2019), *Northern Powerhouse: Energy and Clean Growth*
[90] NP11 (2022), *Net Zero North: Collaboration Powering Global Britain*
[91] NP11 (2022), *Net Zero North: Collaboration Powering Global Britain – Economic Analysis and Delivery Plan*. The analysis quotes quantified economic benefits of £6 billion to 2030, although this is related to the benefits of additional collaboration rather than overall investment.

year time period. In order to estimate this, we need to estimate both the costs and direct impacts of the above set of interventions.

Net Zero Scenario: What could this investment pay for?

In many cases, we assume that because of its existing capabilities, particularly in Energy, Manufacturing, and Industry, the North plays a leading role in driving forward the Net Zero agenda.

An estimated £200bn UK national investment is required to decarbonise the built environment: retrofitting heat pumps, solar panels, and insulation in both existing and new. We assume **£3bn per annum** in the North, of which 50% (£1.5bn) is public investment.

£220bn UK investment spent decarbonising transport system, split across EV infrastructure roll out, electrification of rail, and installing new fuel systems for shipping and aircraft. We assume **£4bn per annum** in the North, of which 62.5% (£2.5bn) public investment.

£60bn UK investment in waste and agriculture, eliminating methane emissions, reducing pesticide use, and restoring natural environments like forests and peatlands. We assume **£1bn per annum** in the North, of which 50% (£0.5bn) is public investment.

£120bn UK investment in decarbonising industry and developing alternate fuels: split between CCUS infrastructure, and clean industrial processes, for example cement manufacture, and development of sustainable fuels, such as hydrogen: We assume **£4bn per annum** in the North, of which 37.5% (£1.5bn) is public investment.

£400bn total UK investment in clean energy production, split between Nuclear, Wind, Solar, and Biomass, plus Electricity Storage, Transmission and Distribution. We assume **£10bn per annum** in the North, of which 40% (£4bn) is public investment.

Modelling Assumptions

8.15 Other than the obvious and critically important impacts on reduced emission by sector and household, most of the economic inputs in this scenario are simply demand-side effects: a large and continued combined public and private expenditure in the sectors involved in the decarbonisation agenda. The model is designed to capture both how this demand flows through the economy in the short-medium term, and also how both sectors respond to that sustained increase in demand over the long-run, through increased capacity in order to take advantage of new opportunities. There are knock-on effects for labour demand, wages and unemployment rates. Building on the above evidence base, we have estimated that peak implementation across the North would require a budget of approximately **£22bn per annum**, of which we assume **£10bn per annum** would be required from the public sector.

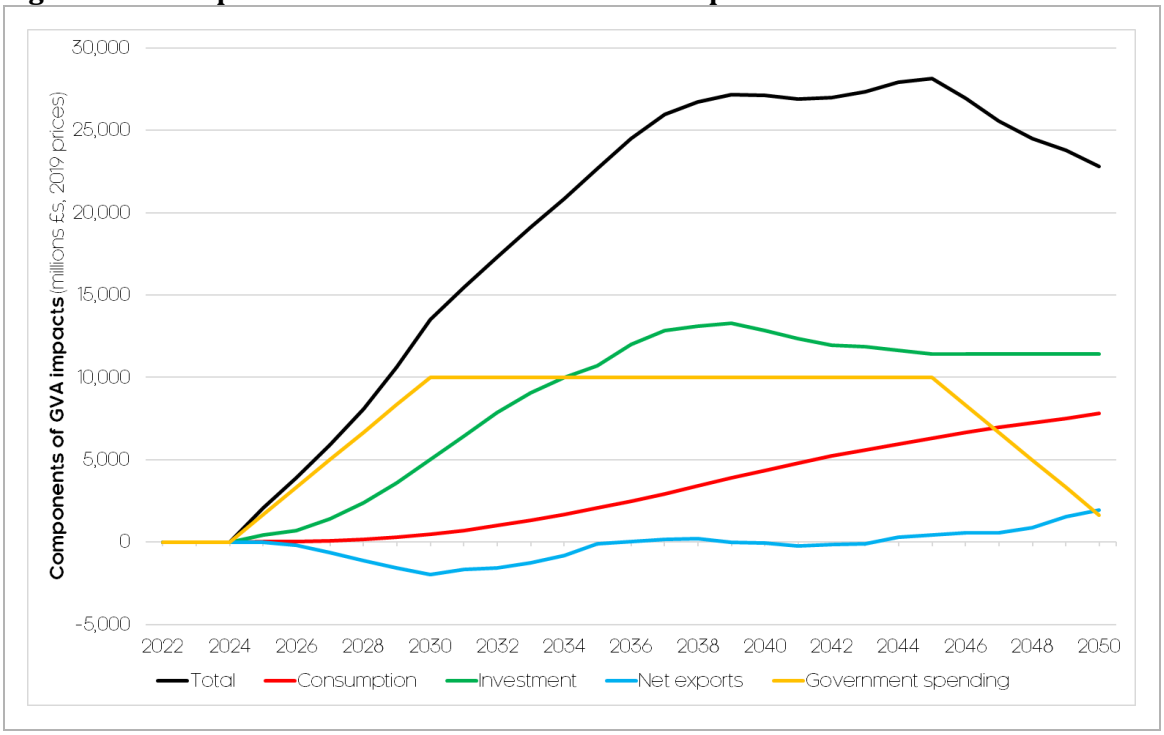
Scenario outputs and description of results

Overall outturn

8.16 Figure 8.1 shows the overall narrative for how the Northern economy evolves differently over time in this scenario. The graph shows the additional GVA that results from this scenario compared to the baseline over the period 2025-2050, and its four broad components: public investment, private investment, consumption and net exports. In all scenarios, public investment is a model input, with the other three components model outputs.

8.17 This scenario has a different evolutionary profile to the others, with both public and private investment in driving the net zero transition peaking during the late 2030s. Public sector investment is assumed to maintain a level of £10bn between 2030 and 2045 and then declines towards zero by 2050. The model predicts that this will stimulate a similar level of private investment, which surpasses public investment by 2034, peaks at ~£13bn in 2038, and then declines slightly, settling at a level of ~£11bn additional investment through 2050. As public investment declines after 2045, a proportion of that demand is replaced by an increase in exports.

Figure 8-3: Composition of Net Zero scenario GVA impacts to 2050



Source: Cambridge Econometrics LEFM

8.18 Consumption increases steadily from 2030 onwards, driven by increases in labour demand leading to higher employment and wages. Net exports initially decrease relative to the baseline, as substantial levels of imports are required to facilitate the net zero transition, but from 2040 onwards, they turn positive again, reflecting projected relative future demand

levels for carbon-neutral vs carbon-intensive products, and the ability of now established high-capacity, highly competitive to win global market share.

Scenario metrics

Table 8-2: Headline Net Zero scenario metrics in 2050, and relative to 2021

Headline metric	The North by 2050	Change relative to today	Change relative to the Baseline Benchmark (by 2050)
Population (000's)	17,280.5	1,705.7	285.5
Jobs (000's)	8,425.8	718.7	168.1
GVA (£2019, millions)	537,582.1	171,635.5	22,807.6
GVA per job (£2019, 000's)	63.8	16.3	1.5
GVA per capita (£2019, 000's)	31.1	7.6	0.8

Source: Cambridge Econometrics LEFM

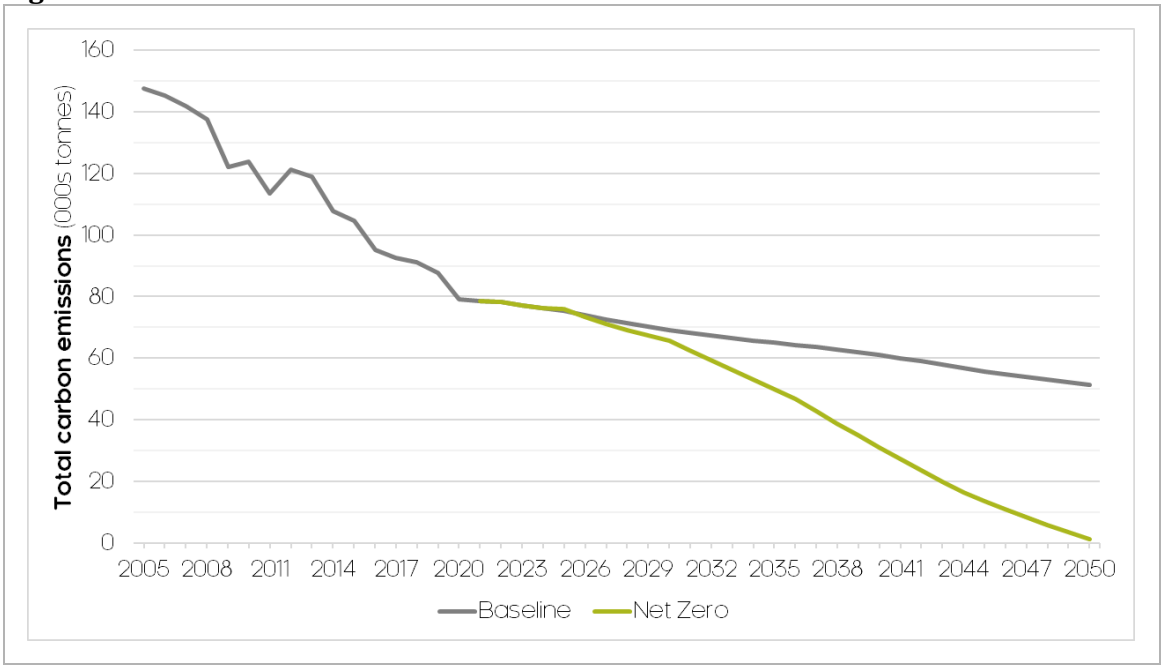
8.19 The table above shows the headline impacts under the scenario by 2050, relative to today and the expectations of the Baseline Benchmark. The Net Zero scenario has the potential to provide:

- £172bn of additional GVA growth to 2050, £23bn above the Baseline Benchmark, which is the second highest of the four change scenarios.
- 718,700 more jobs, 168,100 above the Baseline Benchmark, which is the third highest of the four change scenarios.
- £16,300 additional productivity per worker, £1,500 above the Baseline Benchmark, which is the second highest of the four change scenarios.
- 1.7 million increase in population, 285,500 above the Baseline Benchmark, which is the second highest of the four change scenarios.

8.20 Looking at the wider scenario metrics, the most important result of assumed investments in this scenario is the impact on total carbon emissions, as shown in Figure 8.3 below. This has been modelled by multiplying the output of different sectors with a carbon-intensity coefficient.

8.21 It is this coefficient that the accompanying net zero investments eventually decrease over time, allowing the North's economy to continue to grow, whilst reducing carbon emissions at the rate required to reach the 2050 target. This would result in 50,300 tonnes less carbon emission produced in the North relative to the Baseline Benchmark by 2050.

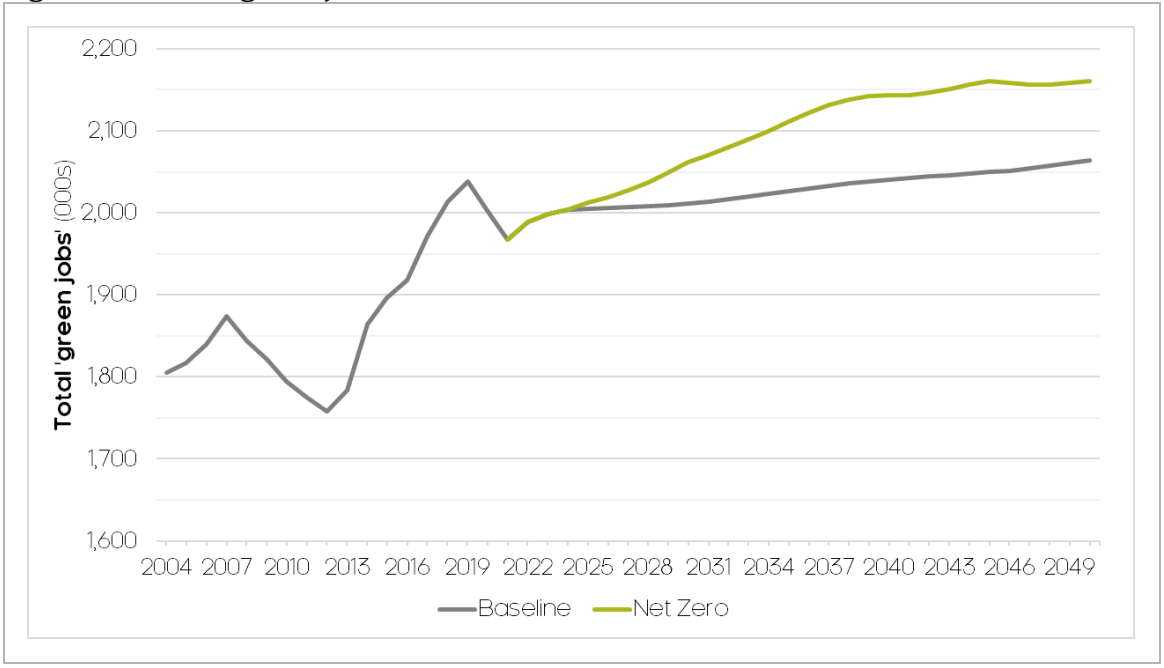
Figure 8-4: Total carbon emissions in the North



Source: Cambridge Econometrics LEFM

8.22 The other impact of this scenario is a rapid increase in labour demand for green jobs, particularly over the period 2025-2040, as shown in Figure 8.4. In fact, under this scenario, the North's labour market could undergo a significant 'greening', with the potential for 1 in every 3 new jobs in the North to be a 'green job'[92] over the period to 2050.

Figure 8-5: Total 'green jobs' in the North



Source: Cambridge Econometrics LEFM

[92] 'Green jobs' defined using 4-digit SOC codes, as outlined in this GLA Economics report

9. New Transformational Scenario

The New Transformational scenario demonstrates the impact of delivering all four Change Scenarios together. This delivers £118 billion of additional GVA over the Baseline Benchmark to 2050, or £6,000 in additional productivity per worker. This is greater than the sum of the four Change Scenarios, because by delivering them all, multiple constraints on growth are released – and simultaneous delivery helps to drive a more capital-intensive implementation path.

9.1 The New Transformational scenario is the result of simultaneously implementing all of the policy interventions outlined in the four Change Scenarios. These interventions are designed to be complementary with each other. These are shown in the table below.

Table 9-1: Interventions underpinning the New Transformational scenario

Intervention	Cost (£2019 pa)
Public & Private R&D	3bn
Start-up & SME Funding	3bn
Health and Social Care	6bn
Education, Skills and Childcare	4bn
Social Housing	2bn
Local Infrastructure	3bn
Levelling Up Sub-Total	**21bn**
Net Zero North	10bn
Grand Total	**31bn**

Source: Cambridge Econometrics, SQW

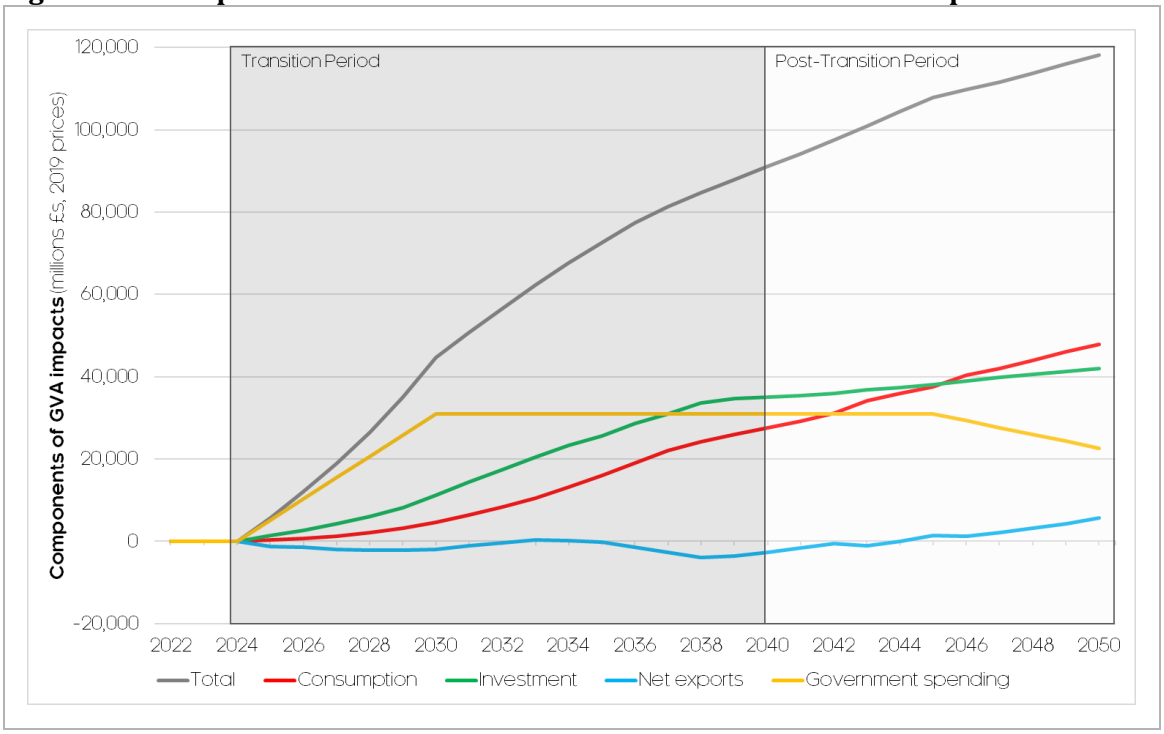
9.2 The £21bn per annum figure required to "level up" the North represents the level of spending per capita identified in the **Investment Benchmark** in chapter 4. This is separate from the additional approximate £10bn that is likely to be spent in the North as part of the national Net Zero programme.

9.3 The New Transformational scenario was modelled by taking the individual model inputs and assumptions for each of the four change scenarios, and inputting them simultaneously into LEFM, and allowing the model to run from 2025 to 2050. The model outputs are shown below.

9.4 Figure 9.2 shows the overall narrative for how the Northern economy evolves differently over time in this scenario. The graph shows the additional GVA that results from this scenario compared to the baseline over the period 2025-2050, and its four broad components: public investment, private investment, consumption and net exports.

9.5 The narrative of combining all four sets of investments follows a similar broad trend to each individual scenarios: during the transition period, which we define as 2025-2040, investment by the public sectors leads, followed swiftly by the private sector, taking advantage of the many new market opportunities created. During the post-transition period, which we define as the period 2040-2050, the additional level of (human and physical) capital accumulation resulting from the heightened growth rates starts to feed through into productivity performance. This period sees higher household incomes, job opportunities and total aggregate consumption, as well as positive and growing net export performance.

Figure 9-1: Composition of the New Transformational scenario GVA impacts to 2050



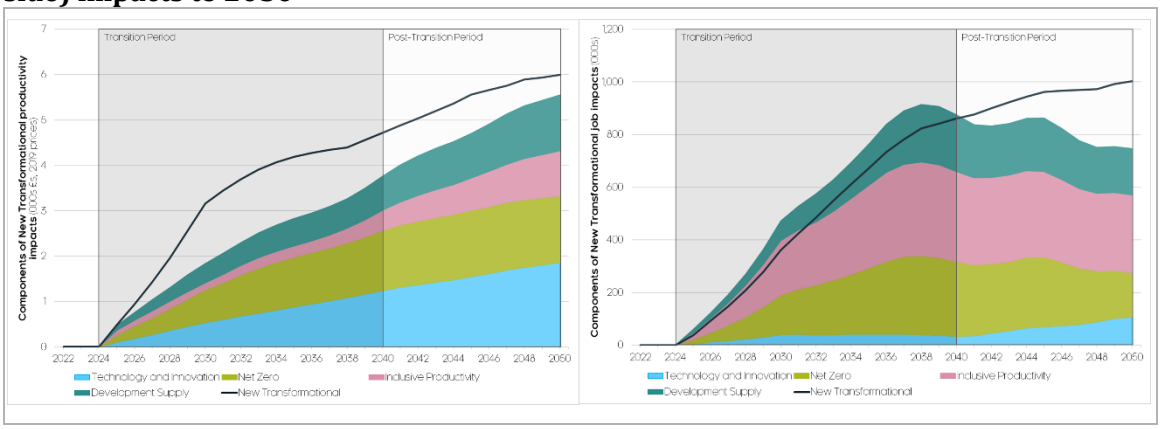
Source: Cambridge Econometrics LEFM

9.6 It is worth inspecting the two graphs in figure 9.3 below side by side. These show the productivity and employment trajectory of the New Transformational case, compared to the sum of the four individual scenarios. We see that the New Transformational scenario, with is higher aggregate levels of investment, produces an economic evolution pathway through the transition period, that is substantially more capital intensive, more highly productive, and less labour intensive than the sum of its component scenarios.

9.7 This can be understood as the interaction of two effects: positive productivity spillover benefits during this period result from the synergies of different scenario interventions, alleviating constraints that remain in individual scenarios: for example synergies between the shift towards labour demand for more skilled workers in the Technology & Innovation scenario being matched with the educational investments in the Inclusive Productivity scenario enabling this; and the "hot" labour market during this phase being most strongly felt in the New Transformational scenario, thus incentivising a more capital-intensive transition than would otherwise be the case. One can imagine firms here still look to hire staff to fulfil

the heightened level of demand in the New Transformational scenario, but as there is more competition for labour in this scenario than in any of the individual scenarios, they are also incentivised to expend more effort getting more output from existing staff. In extremis, some lower wage sectors may struggle to hold onto their (potentially overqualified) workers, as more and better job opportunities become available, forcing them to rapidly switch to less labour-intensive production methods. We see particularly rapid productivity growth in the initial five years of the transformation (2025-2030), as multiple investment agendas are expanded simultaneously. In the longer run, the steady delivery of housing and resulting increase in the labour supply starts to mitigate this immediate effect; that is to say, the labour market cools down again in the post-transition period, but at a higher level of capital intensity and at a higher overall level of productivity and wages.

Figure 9-2: Scenario synergies for productivity (left hand side) and job (right hand side) impacts to 2050



Source: Cambridge Econometrics LEFM

9.8 The story of the post-transition period is therefore of higher levels of employment being maintained even after the bulk of the Net Zero transition activity is complete. Within the model, this is a result of higher levels of both internal demand due to wealthier households, and external demand, due to higher levels of international competitiveness.

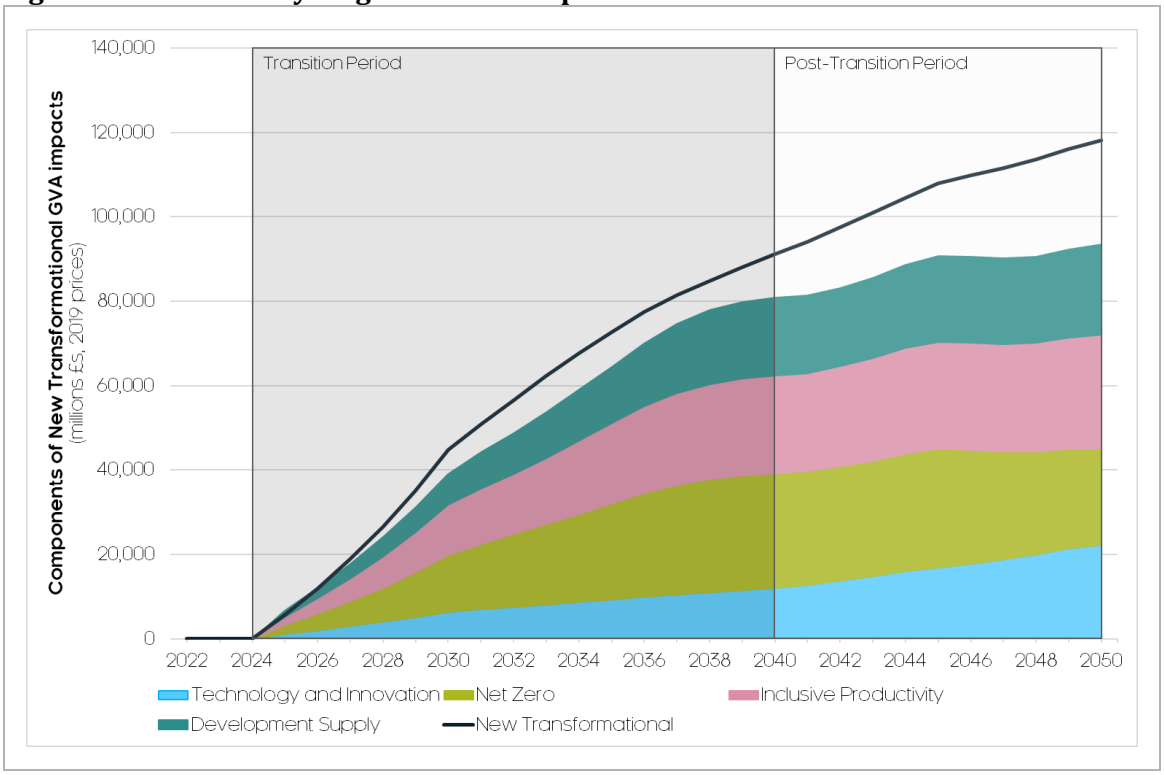
9.9 One way of understanding this synergy is to consider the remaining constraints to growth existing in each scenario:

- **Technology and Innovation:** high levels of innovation and capital, but growth constrained by a lack of suitably skilled workers, and the North held back by suboptimal public infrastructure
- **Inclusive Productivity:** this scenario sees high levels of availability of skilled workers, but productivity is still limited by a lack of innovation and accumulated capital, and (once again) suboptimal public infrastructure
- **Development supply:** this scenario depicts a large, well-housed and well-connected population, but economic performance is constrained by a lack of innovation, capital, and skills

- **Net Zero:** the decarbonisation agenda requires to high levels of investment and labour demand during the transition period, but this subsequently fades
- **New Transformational:** combining all of these investments together leads to high levels of innovation and capital, a healthy and educated workforce, a large, well-housed and well-connected population, and high levels of well-matched labour demand and supply that continues to grow through the post-transition period and beyond.

9.10 The net result on GVA can be seen below: the synergies for GVA are positive and growing over time. As we have seen above these correspond initially to productivity synergies during the capital-intensive transition period, and to labour demand synergies in the now highly-productive, highly-competitive, highly-prosperous post-transition period.

Figure 9-3: Scenario synergies for GVA impacts to 2050



Source: Cambridge Econometrics LEFM

9.11 Table 9-2 below shows the headline impacts under the scenario by 2050, relative to today and the expectations of the Baseline Benchmark. The New Transformational scenario has the potential to provide:

- £267bn of additional GVA growth to 2050, £118bn above the Baseline Benchmark.
- 1.6 million more jobs, 1 million above the Baseline Benchmark.
- £20,900 additional productivity per worker, £6,000 above the Baseline Benchmark.
- 3.1 million increase in population, 1.7 million above the Baseline Benchmark.

Table 9-2: Headline New Transformational scenario metrics in 2050, and relative to 2021

Headline metric	The North by 2050	Change relative to today (2021-50)	Change relative to the Baseline Benchmark (by 2050)
Population (000's)	18,652.5	3,077.7	1,657.4
Jobs (000's)	9,261.0	1,553.9	1,003.3
GVA (£2019, millions)	632,877.3	266,930.6	118,102.7
GVA per job (£2019, 000's)	68.3	20.9	6.0
GVA per capita (£2019, 000's)	33.9	10.4	3.6

Source: Cambridge Econometrics LEFM

9.12 The impacts on wider metrics are shown in Annex A, however the results can be summarised that the New Transformational scenario sees the "best" of all its component Change Scenarios: the rapid decarbonisation of the Net Zero Transition, the growth in R&D spending of the Technology and Innovation Scenario, the improvements to housing affordability seen in the Development Supply scenario, and the effects of labour activity, life expectancy and reduced poverty seen in the Inclusive Productivity Scenario.

9.13 A comparison between the 2016 Transformational and 2022 New Transformational scenarios are shown in Table 9-3. The magnitude of the impacts are broadly similar, with the New Transformational scenario actually resulting in slightly higher levels of performance, particularly with regards to improved labour productivity.

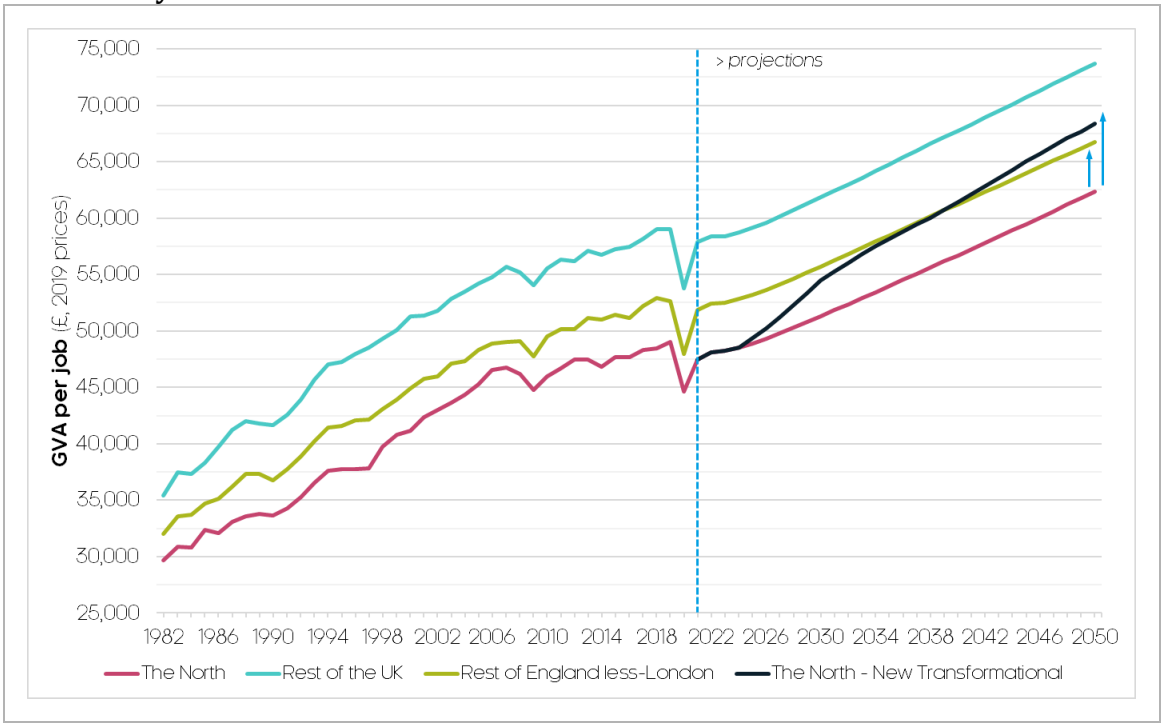
Table 9-3: Comparison of the 2022 New Transformational with the 2016 IER Transformational

	2016 IER Transformational		New Transformational	
	Difference from baseline by 2050	*% difference from baseline by 2050*	**Difference from baseline by 2050**	*% difference from baseline by 2050*
Jobs (000's)	855	*10%*	**1,003**	12%
GVA (£2019, millions)	97	*16%*	**118**	23%
GVA per job (£2019)	3.2	*4%*	**6.0**	10%

Source: 2016 NPIER, Cambridge Econometrics LEFM

9.14 A comparison with projections for various benchmark regions within the wider UK reveals the positive productivity impact of the proposal policy combinations. The productivity of the North catches up and overtakes the *Rest of England excluding London* benchmark (effectively the Midlands, the East, and the South), and halves the gap with the *Rest of the UK* benchmark, which is of course, heavily skewed upwards due to the inclusion of the capital city. For a 25-year period, this is exceptionally rapid progress.

Figure 9-4: Productivity in the New Transformational scenario relative to the Productivity Ambition Benchmarks



Source: Cambridge Econometrics LEFM

9.15 It is also possible to calculate approximate cost/benefit ratios based on the modelling outputs. In this case, we compare the total cost of real-terms additional proposed government spending over the 25-year time period, compared to a narrow definition of the benefits – the total additional GVA produced over the same period. As depicted in Annex A, there are, of course, a far greater value of social and environmental benefits not captured by this statistic.

9.16 However, even so, we see high ratios of between 2.06 and 3.09[93] for each scenario, with the New Transformational scenario providing an additional GVA/additional cost ratio of 2.77.

9.17 Using a government revenue to GVA ratio of 37%, we can also estimate, very approximately, the total additional revenue that might result from this additional GVA, and thus are able to identify the net cost to the exchequer. Most pertinently, we find that the New

[93] We suspect this particular ratio is a small overestimate at the UK level, as a component of the narrative here is greater population retention and attraction within the North, some of which may result in relatively lower population growth in the rest of the UK.

Transformational scenario actually produces **net positive revenue** to the exchequer over the 25-year time period. On top of all the social, environmental and economic benefits to the North, this series of policy intervention measures actually pays for itself.

Table 9-4: Cost-GVA ratios and revenues for the New Transformational scenario

	Total cost 2025-50 (£2019bn)	Total additional GVA 2025-50 (£2019bn)	Cost-GVA ratio	Total potential Government revenues (£2019bn)
Technology and Innovation	141	291	**2.06**	108
Net Zero	210	532	**2.53**	197
Inclusive Productivity	235	482	**2.05**	178
Development Supply	118	365	**3.09**	135
New Transformational	**704**	**1,949**	**2.77**	**721**

Source: Cambridge Econometrics

Comparing the cost

9.18 The New Transformational scenario demonstrates the scale of the North's economic potential, and the level of investment that is needed to change the historic trajectory.

9.19 However, the total estimated cost of around £28 billion per annum between 2025 and 2050 is not unprecedented. Eastern Germany is frequently cited as a relevant comparator: with a population of around 15 million, it is approximately the same size as the North of England, and the reunified Germany inherited structural economic divide in 1990 (at the time, significantly more severe than that experienced in the UK today)

9.20 Over time, economic growth has meant a steady improvement in the relative position of the six eastern states, to the extent that by 2019, they were comparable with, and in some cases out-performing, the North of England in terms of GVA per capita[94].

9.21 Estimates of the cost of supplementary support for the eastern German economy post-reunification vary, with an upper estimate of between £50-60 billion per annum over thirty years[95]. Taking a narrower estimate, which considers the total funding invested in the

[94] OECD Regional Accounts
[95] Marcus Johns and Hannah Hutt (2022), *Looking Out to Level Up: How the North and the UK measure up*, IPPR. The figure is quoted at €70 billion per annum.

Solidarity Pact (a joint fund between the federal and state governments, which was focused on infrastructure, economic development and some fiscal support), funds equated to around £10 billion per annum, in addition to European Structural Funds and some other investments – although this only relates to the later years of the transition process. Further cross-country comparison would be helpful and could be taken forward in the next stage of work.

10. Moving Forward to a Revised NPIER

Key conclusions: the scale of the opportunity

10.1 The North's productivity deficit relative to the UK as a whole is widely recognised. Despite a strong performance in generating new jobs and bringing people into employment, the period since the 2016 NPIER has been characterised by 'low and slow' productivity growth. As a result, the productivity gap between the North and the rest of the UK has remained largely stable. In the Baseline Benchmark, we anticipate much slower productivity growth than previously expected – with the consequence that a significant gap will continue into the long term. This impacts on pay and living standards – and it also impacts on the performance of the UK economy as a whole.

10.2 It is also important to note that the Baseline Benchmark of slow growth and a persistent regional imbalance is not a 'do nothing' scenario. On the contrary, 'business as usual' takes into account some of the substantial individual investments that the North has seen in recent years. Moving away from the baseline trajectory is therefore going to require a significant change of pace and focus at the level of the North overall. In that context, it is worth noting that most of the levers of change (at least in terms of overall investment) are with central Government.

10.3 Combining the interventions set out in each of the four change scenarios, the New Transformational scenario anticipates £267 billion of additional GVA growth to 2050 (or £118 billion by 2050 over and above the Baseline Benchmark). Synergies from the transport, skills and other interventions are expected to overcome constraints on growth to deliver a more productive capital trajectory in the New Transformational scenario than through the sum of its parts. Aside from GVA and employment impacts (and the social and environmental benefits captured in the modelling), there are also expected to be significant positive exchequer benefits through higher growth over time.

Building on the scenarios: Developing a refreshed NPIER

10.4 The scenarios presented in this report provide a starting point for a refreshed NPIER, which TfN intends to commission later in 2023. While the scenarios set out in broad terms the potential scale of the ambition, the NPIER presents an opportunity to consider in greater detail how the ambition may be realised, through a fresh analysis of the North's strengths and capabilities, including the synergies and linkages between strengths at a sub-regional level. This should also take account of the substantial evidence base developed over the past few years, both across the North and at a city-regional/ sub-regional level.

10.5 Early consultation with stakeholders on the direction and focus of a future NPIER found considerable support and enthusiasm for a refresh, especially in making the 'case for change' linked with the ambition that the New Transformational scenario sets out. Stakeholders also

found the framework identified in the 2016 NPIER of four 'prime capabilities' (advanced manufacturing, energy, health innovation and digital) and three 'enabling capabilities' (finance and professional services, logistics and education) to have had considerable policy traction, albeit that the agenda has evolved since 2016, especially in relation to the cross-economy opportunities of digitalisation, energy and the transition to net zero.

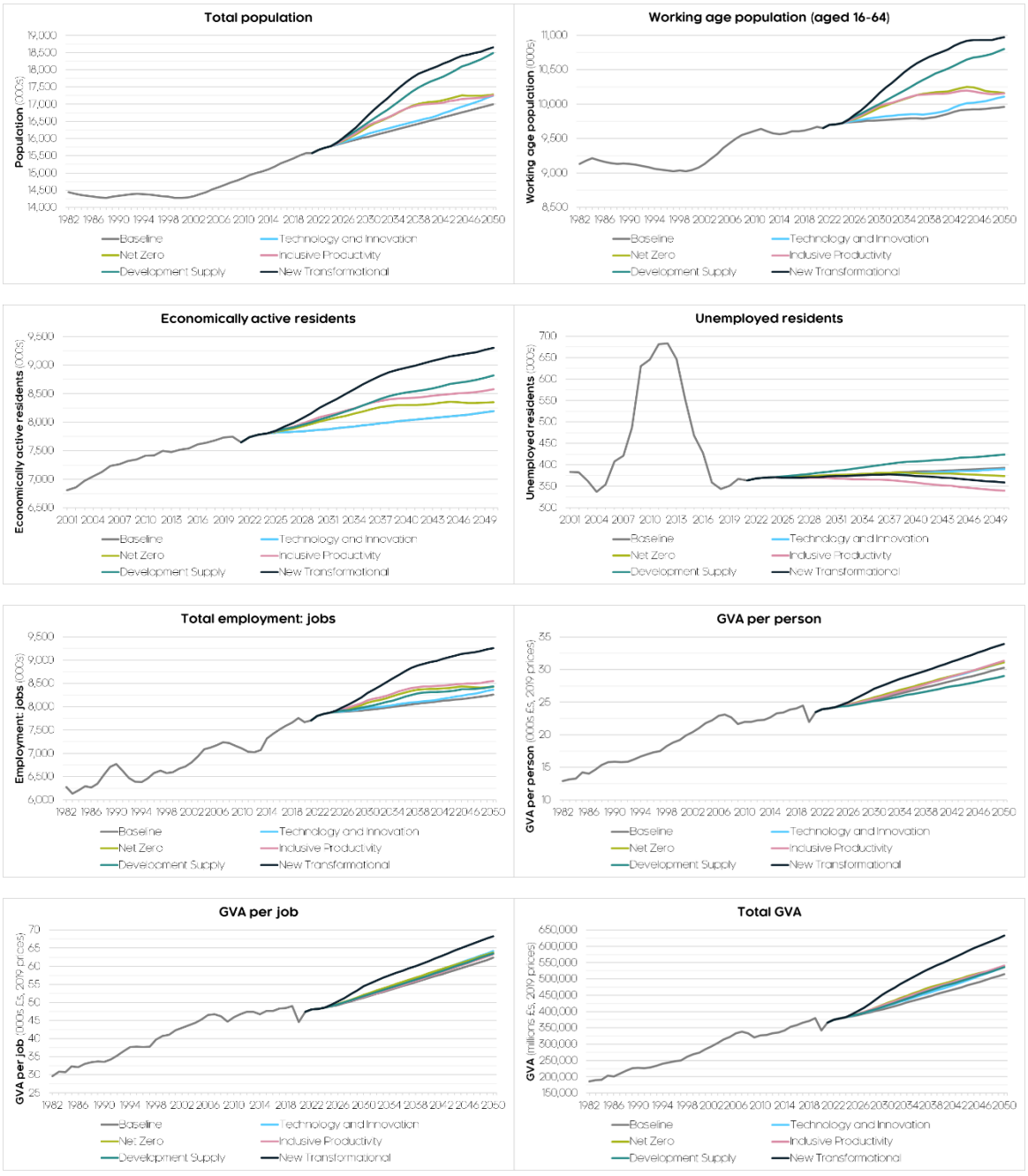
10.6 The next stage of work involves framing the parameters for the new NPIER in the light of the scenarios and the evidence associated with them. Taking into account the focus on the wider aspects of economic growth (beyond 'traditional' measures of GVA, productivity and employment), potential areas of focus include:

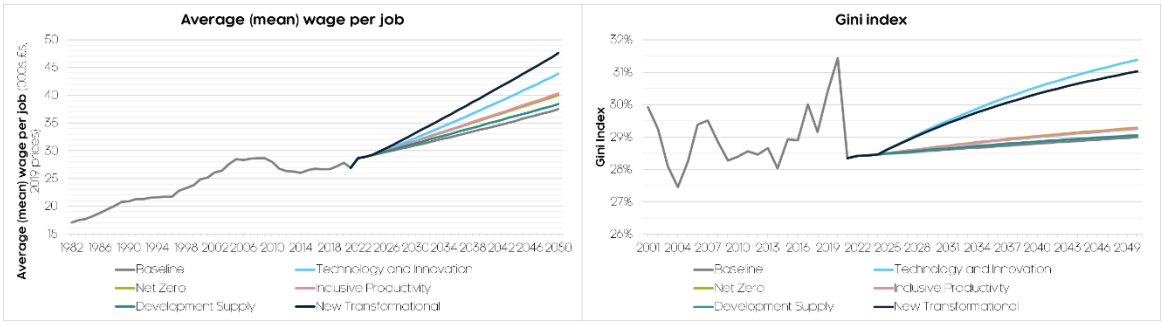
- **Accelerating growth and boosting competitiveness:** Starting from the perspective of the UK's weak productivity growth record in recent years and the very challenging growth outlook, the first theme might set out the North's role in driving overall growth across the UK as a whole. This is likely to highlight those capabilities (sectors and institutions) that are nationally and internationally significant and are of pan Northern relevance, linked with the 4+3 capabilities framework or a version of it and innovation-led growth, considering where the North makes (or could make with additional investment) a net contribution to the UK economy.
- **Narrowing the gaps:** Building on this, within the UK, focusing on reducing the North's relative performance gap. This was front and centre in the 2016 NPIER, although the overall UK outlook was more positive at the time.
- **Securing social resilience and reducing vulnerabilities:** Within the North, reducing concentrations of deprivation and inequalities and increasing access to better paid, productive employment.
- **Driving environmental transformation**, as a cross-cutting theme across all activity.

10.7 A key imperative for the NPIER will be to reconcile the challenge of concentrating on those areas of national and international competitiveness while recognising the wider economy and the scale of the North's productivity gap, which will not be 'solved' purely at the leading edge - not least since sectors and capabilities are often highly interconnected, as the scenarios presented in this report have demonstrated. But the overall purpose is to galvanise action at scale, recognising the scale of change that is needed to narrow the productivity gap and improve social, economic and wellbeing outcomes.

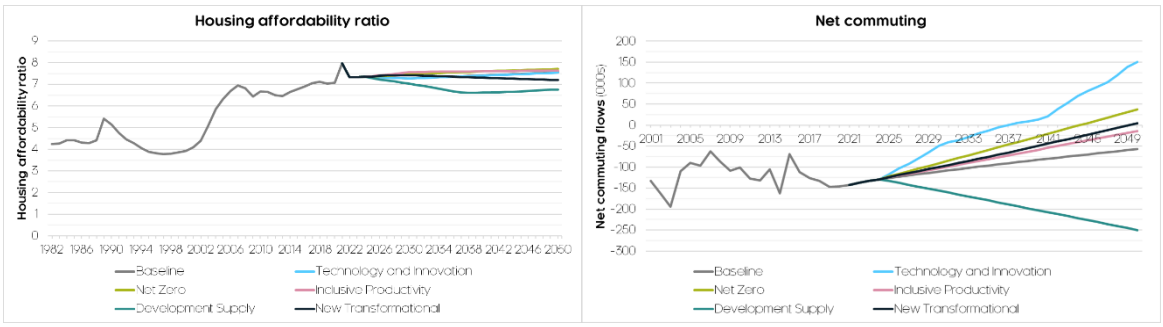
Annex A: Scenario Metrics

A.1 This annex presents selected scenario metrics in graph and tabular form, for the baseline and accompanying five change scenarios. An overview of metric sources can be found in the Analytical Framework and Approach to Modelling chapter.

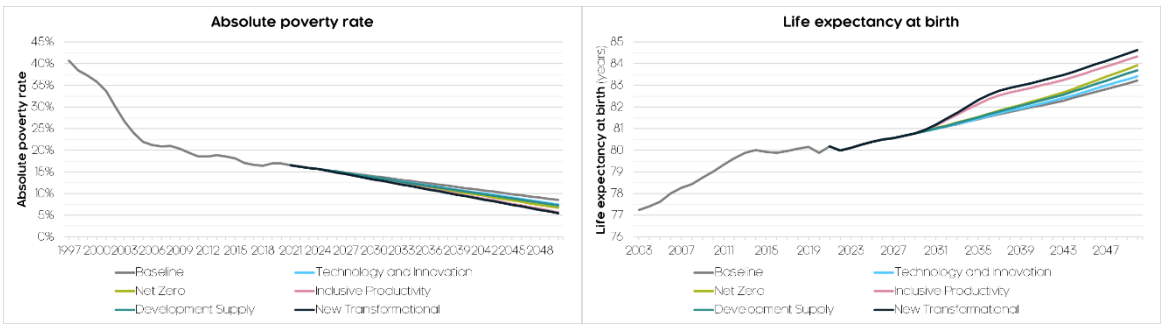



Average (mean) wage per job
Average (mean) wage per job (000s £s, 2019 prices)
Baseline
Technology and Innovation
Net Zero
Inclusive Productivity
Development Supply
New Transformational

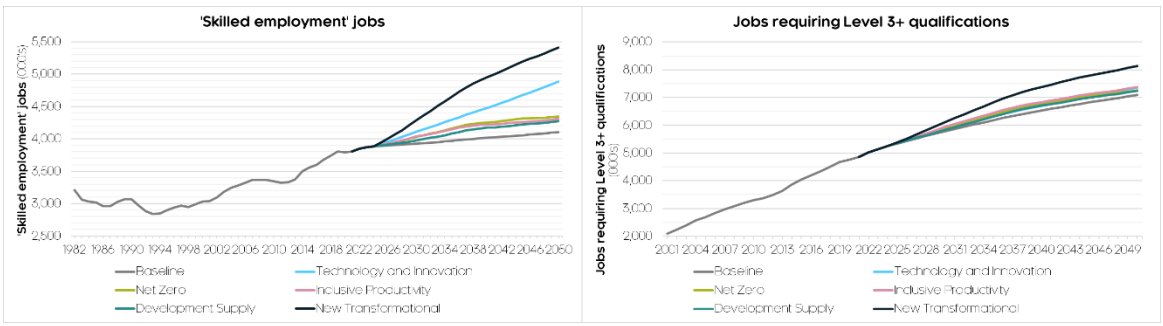
Gini index
Gini index
Baseline
Technology and Innovation
Net Zero
Inclusive Productivity
Development Supply
New Transformational


Housing affordability ratio
Housing affordability ratio
Baseline
Technology and Innovation
Net Zero
Inclusive Productivity
Development Supply
New Transformational

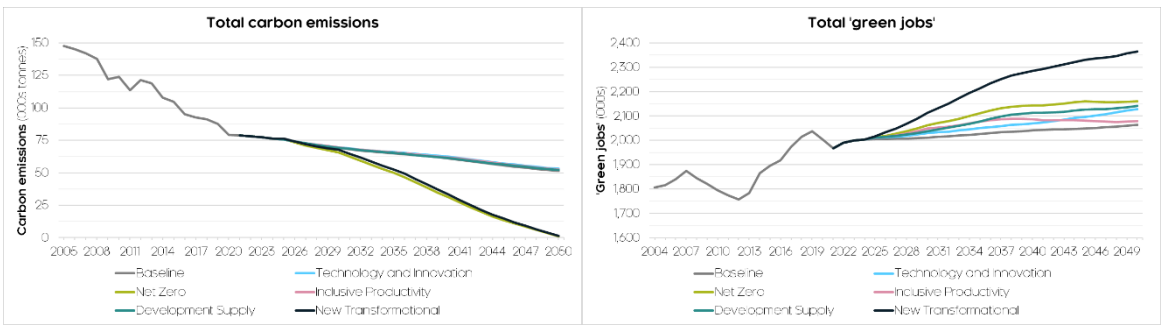
Net commuting
Net commuting flows (000s)
Baseline
Technology and Innovation
Net Zero
Inclusive Productivity
Development Supply
New Transformational


Absolute poverty rate
Absolute poverty rate
Baseline
Technology and Innovation
Net Zero
Inclusive Productivity
Development Supply
New Transformational

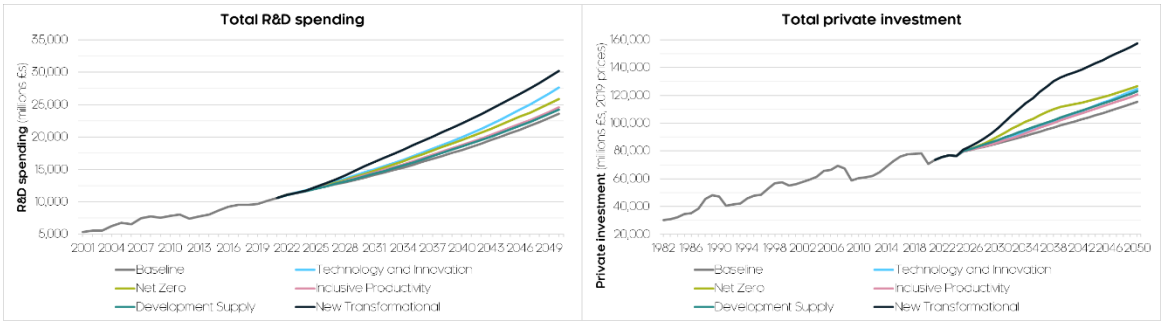
Life expectancy at birth
Life expectancy at birth (years)
Baseline
Technology and Innovation
Net Zero
Inclusive Productivity
Development Supply
New Transformational


'Skilled employment' jobs
'Skilled employment' jobs (000s)
Baseline
Technology and Innovation
Net Zero
Inclusive Productivity
Development Supply
New Transformational

Jobs requiring Level 3+ qualifications
Jobs requiring Level 3+ qualifications (000s)
Baseline
Technology and Innovation
Net Zero
Inclusive Productivity
Development Supply
New Transformational


Total carbon emissions
Carbon emissions (000s tonnes)
Baseline
Technology and Innovation
Net Zero
Inclusive Productivity
Development Supply
New Transformational

Total 'green jobs'
'Green jobs' (000s)
Baseline
Technology and Innovation
Net Zero
Inclusive Productivity
Development Supply
New Transformational


Total R&D spending
R&D spending (millions £s)
35,000
30,000
25,000
20,000
15,000
10,000
5,000
2001 2004 2007 2010 2013 2016 2019 2022 2025 2028 2031 2034 2037 2040 2043 2046 2049
Baseline
Technology and Innovation
Net Zero
Inclusive Productivity
Development Supply
New Transformational
Total private investment
Private investment (millions £s, 2019 prices)
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
1982 1986 1990 1994 1998 2002 2006 2010 2014 2018 2022 2026 2030 2034 2038 2042 2046 2050
Baseline
Technology and Innovation
Net Zero
Inclusive Productivity
Development Supply
New Transformational

Scenario metric	Scenarios baseline, 2021	Baseline Benchmark, 2050	Technology and Innovation, 2050	Inclusive Productivity, 2050	Development Supply, 2050	Net Zero, 2050	New Transformational, 2050
Total population (000s)	15,574.8	16,995.1	17,247.1	17,264.1	18,493.2	17,280.5	18,652.5
Working age population (aged 16-64, 000s)	9,654.9	9,959.1	10,106.8	10,153.1	10,798.2	10,162.8	10,969.5
Economically active residents (000s)	7,649.1	8,191.6	8,191.6	8,575.9	8,816.6	8,347.4	9,303.7
Unemployed residents (000s)	363.5	393.2	390.2	339.5	424.1	374.3	358.9
Total employment: jobs (000s)	7,707.1	8,257.6	8,364.0	8,554.1	8,434.5	8,425.8	9,261.0
GVA per person (000s £s, 2019 prices)	23.5	30.3	31.1	31.4	29.0	31.1	33.9
Total GVA (millions £s, 2019 prices)	365,946.7	514,774.6	537,016.8	541,752.7	536,207.9	537,582.1	632,877.3
GVA per job (000s £s, 2019 prices)	47.5	62.3	64.2	63.3	63.6	63.8	68.3
Average wage per job (000s £s, 2019 prices)	26.9	37.5	43.9	40.3	38.4	40.0	47.6
Gini index (%)	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Housing affordability ratio	8.0	7.6	7.5	7.6	6.8	7.7	7.2
Net commuting (000s)	-142.5	-56.9	150.0	-14.4	-249.8	36.9	4.3
Absolute poverty rate (%)	0.2	0.1	0.1	0.1	0.1	0.1	0.1

Scenario metric	Scenarios baseline, 2021	Baseline Benchmark, 2050	Technology and Innovation, 2050	Inclusive Productivity, 2050	Development Supply, 2050	Net Zero, 2050	New Transformational, 2050
Life expectancy at birth (years)	80.2	83.2	83.4	84.3	83.7	83.9	84.6
Skilled employment' jobs (000s)	3,806.3	4,108.0	4,887.2	4,311.6	4,276.6	4,347.2	5,414.0
Jobs requiring Level 3+ qualifications (000's)	4,863.8	7,087.7	7,356.3	7,376.3	7,243.1	7,251.9	8,131.4
Total carbon emissions (000s tonnes)	78.7	51.5	53.1	52.6	52.3	1.1	1.2
Total 'green jobs' (000s)	1,967.0	2,063.6	2,129.1	2,078.9	2,142.0	2,161.0	2,365.0
Total private investment (millions £s, 2019 prices)	73,694.0	115,358.6	124,558.6	120,676.6	122,969.8	126,787.6	157,306.4
Total R&D spending (millions £s)	10,599.3	23,569.7	27,615.5	24,571.6	24,263.1	25,864.9	30,186.1

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About us

SQW Group

SQW and Oxford Innovation are part of SQW Group.
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SQW

SQW is a leading provider of research, analysis and advice on sustainable economic and social development for public, private and voluntary sector organisations across the UK and internationally. Core services include appraisal, economic impact assessment, and evaluation; demand assessment, feasibility and business planning; economic, social and environmental research and analysis; organisation and partnership development; policy development, strategy, and action planning. In 2019, BBP Regeneration became part of SQW, bringing to the business a RICS-accredited land and property team.
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Oxford Innovation

Oxford Innovation is a leading operator of business and innovation centres that provide office and laboratory space to companies throughout the UK. The company also provides innovation services to entrepreneurs, including business planning advice, coaching and mentoring. Oxford Innovation also manages investment networks that link investors with entrepreneurs seeking funding from £20,000 to £2m.
www.oxin.co.uk