Northern Health Science Alliance

A Health Partnership for Northern England

Health for Wealth

Building a Healthier Northern Powerhouse for UK Productivity

nhsa
Northern Health Science Alliance

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Acknowledgements: Simon Dixon, Jennifer Roberts

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Executive Summary

60 Second Summary

There is a well-known productivity gap between the Northern Powerhouse and the rest of England of £4 per-person-per-hour. There is also a substantial health gap between the Northern Powerhouse and the rest of England, with average life expectancy 2 years lower in the North. Given that both health and productivity are lower in the Northern Powerhouse, the NHSA commissioned this report from six of its eight university members (Newcastle, Manchester, Lancaster, Liverpool, Sheffield and York) to understand the impact of poor health on productivity and to explore the opportunities for improving UK productivity by unlocking inclusive, green, regional growth through health improvement. Our report shows the importance of health and the NHS for productivity in the Northern Powerhouse. So, as it develops its post-Brexit industrial strategy, central government should pay particular attention to the importance of improving health in the Northern Powerhouse as a route to increased wealth.

Key findings

- Productivity is lower in the North
- **A key reason is that health is also worse in the North**
- Long-term health conditions lead to economic inactivity
- **Spells of ill health increase the risk of job loss and lead to lower wages when people return to work**
- Improving health in the North would lead to substantial economic gains
- **Improving health would reduce the £4 gap in productivity per-person per-hour between the Northern Powerhouse and the rest of England by 30% or £1.20 per-person per-hour, generating an additional £13.2 billion in UK GVA**

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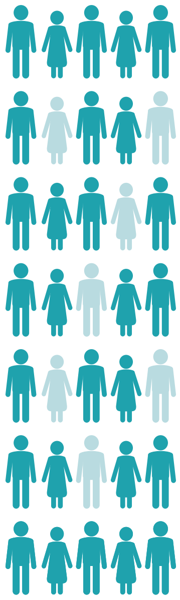

30% of the £4 per person per hour gap in productivity (or £1.20 per hour) between the Northern Powerhouse and the rest of England is due to ill-health. Reducing this health gap would generate an additional

£13.2bn in **UK GVA**

Summary of Detailed Findings

- Health is important for productivity: improving health could reduce the £4 gap in productivity between the Northern Powerhouse and the rest of England by 30% or £1.20 per-person per-hour, generating an additional £13.2 billion in UK GVA
- **Reducing the number of working age people with limiting long-term health conditions by 10% would decrease rates of economic inactivity by 3 percentage points in the Northern Powerhouse**
- Increasing the NHS budget by 10% in the Northern Powerhouse will decrease economic inactivity rates by 3 percentage points
- **If they experience a spell of ill health, working people in the Northern Powerhouse are 39% more likely to lose their job compared to their counterparts in the rest of England. If they subsequently get back into work, then their wages are 66% lower than a similar individual in the rest of England.**
- Decreasing rates of ill health by 1.2% and decreasing mortality rates by 0.7% would reduce the gap in gross value added (GVA) per-head between the Northern Powerhouse and the rest of England by 10%.
- **Increasing the proportion of people in good health in the Northern Powerhouse by 3.5% would reduce the employment gap between the Northern Powerhouse and the rest of England by 10%**
- So, given the relationship between health, health care and productivity in the Northern Powerhouse, then in order to improve UK productivity, we need to improve health in the North.

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Challenges

Although these findings demonstrate the scale of the health and economic challenges facing the Northern Powerhouse, they also provide a blueprint to overcome the problem: in order to improve UK productivity, we need to improve health in the North. However, there are challenges which need to be addressed:

- Expenditure on public health and prevention services has always lagged behind spend on the treatment of existing conditions. In 2017/18 in England, £3.4 billion was spent by local authorities on public health. This was dwarfed by Department of Health and Social Care spend of over £124 billion, the vast majority of which went on hospital-based treatment services. Public health budgets are estimated to experience real-term cuts averaging 3.9 per cent each year between 2016/17 and 2020/21.
- **Austerity presents a real challenge for Northern agencies to implement approaches to improving health. Local authorities have faced disproportionally larger cuts and reductions in social welfare since 2010 have also had more of an impact in the Northern Powerhouse.**
- Exiting the European Union is a challenge for the NHS in terms of the supply of highly skilled workers. Uncertainties over post-Brexit NHS and local authority public health budget settlements are also a challenge for planning prevention and health and social care services particularly in the Northern Powerhouse.
- **Health research funding in the UK is heavily concentrated in the so-called 'golden triangle': London, the South East and the East of England receive over 60% of funding. This is exacerbated by the fact that the Northern Powerhouse's strengths are in applied health research, for which there is high need in the region but much less funding available nationally and regionally.**
- Uncertainty around the effectiveness of public health interventions means that more applied research is needed to develop, pilot and evaluate and scale-up interventions to improve health – particularly in areas of high need such as the Northern Powerhouse.
- **Green and Inclusive Growth is required given the well-documented threats posed by climate change. It cannot be the case of 'business as usual' for an industrial strategy to increase productivity in the North, innovation is required to ensure carbon-free growth. Growth in the North also needs to be socially inclusive - reaching all places in the region and people from all social backgrounds.**

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Recommendations to Central Government

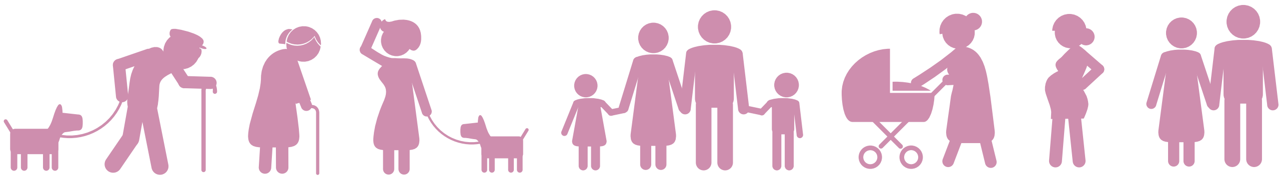
As it develops its post-Brexit industrial strategy, central government should pay particular attention to the importance of health for productivity in the Northern Powerhouse. Specifically, we make four key proposals to central government:

1) To improve health in the North by increasing investment in place-based public health in Northern Powerhouse local authorities.

2) To improve labour market participation and job retention amongst people with a health condition in the Northern Powerhouse.

3) To increase NHS funding in the Northern Powerhouse – to be spent on prevention services and health science research.

4) To reduce economic inequality between the North and the rest of England by implementing an inclusive, green industrial strategy.



Recommendations to Northern Powerhouse Local and Regional Stakeholders

We make four key proposals to Northern Powerhouse local and regional stakeholders:

1) Health and Wellbeing boards and the emerging NHS integrated care systems should commission more health promotion, condition management and prevention services.

2) Local enterprise partnerships, local authorities and devolved Northern regions should develop locally tailored 'health-first' programmes in partnership with the local NHS and third sector providers.

3) Local enterprise partnerships, local authorities and devolved Northern regions should scale-up their place-based public health programmes across the life course: 'starting well', 'living well' and 'ageing well'.

4) Local businesses should support job retention and health promotion interventions across the Northern Powerhouse workforce and Northern city regions and Northern NHS integrated care systems should lead by example.

Foreword

The vision for the Northern Powerhouse was built in the knowledge that if we harnessed the potential of the great cities of the North we would be increasing the economic strength of the United Kingdom. The North's cities and towns led the Industrial Revolution and their decline has seen a marked shift downwards into lower wages compared to the South, with lower productivity.

Henri Murison, Director of the Northern Powerhouse Partnership

Linking up Liverpool, Manchester, Sheffield, Leeds, Hull and Newcastle with high-speed, integrated transport systems and cutting-edge digital connectivity would allow those cities to collaborate and contribute more than the sum of their parts, creating a single market. Only with this joined-up approach could the sluggish productivity of the Northern Powerhouse be stimulated and allow our businesses to thrive.

Transport is a vital component of the Northern Powerhouse, with Northern Powerhouse Rail (NPR) promising the world-class transport network our commuters, families and businesses deserve. Reducing journey times, enhancing capacity and increasing frequency are all compelling reasons to build the network, but potentially more important is the opportunity for economic growth NPR would create. Reversing decades of stagnation takes time, but opening up new labour markets and opportunities for our young people would have a transformational effect.

In addition, our businesses need access to the skilled workforce they need to embrace the digital revolution, embedding emerging technology such as robotics, AI, 3D printing and VR into everything they do.

Our education system requires major interventions, as set out in our Educating the North report, particularly tackling entrenched disadvantage leading to our children falling behind their peers in other parts of the country.

Until now health has not had the profile it should have in the Northern Powerhouse, despite its undoubted importance.

Life expectancy is on average two years lower in the North than the South, and there is a productivity gap between the Northern Powerhouse and the rest of England of £4 per-person-per-hour. In this report, led by the Northern Health Science Alliance (NHSA), the link between the two is set out across the North for the first time.

People in the North are more likely to leave work due to sickness than those in the South, and when they leave they are less likely than those in the South to go back into work. This report, put together by leading academics from six Northern universities, shows that ill health in the North accounts for over 30% of the productivity gap with the rest of England. What's more, the report's findings show that the NHS allocated budgets explain over 18% of this productivity gap.

Importantly, improving health in the North could reduce the existing gap in GVA of £4 per-person-per-hour between the Northern Powerhouse and the rest of England by up to £1.20. Improving health in the North increases the whole country's productivity.

To tackle the poor health and increase productivity in the Northern Powerhouse we need proportional interventions to the scale of the opportunity from those who can drive it forward: industry, central and local government.

The Mayor, Andy Burnham, a former Labour Health Secretary, will now be able to fully integrate health and social care utilising health devolution. Newcastle University was funded to create the National Centre for Ageing which can have an impact across the North, and in Leeds the presence of NHS Digital and a major cluster of health data businesses is of global significance.

From Liverpool to the new Mayor of the North of Tyne to be elected in May, health should be the next major transfer of power which government offers pro-actively, and without it, unlocking productivity and our economic potential will be held back.

The economic arguments for the Northern Powerhouse are ignored at the United Kingdom's risk. We need to strengthen our country's economic performance in every way we can, particularly when we leave the European Union.

The businesses of the Northern Powerhouse require a healthy, productive workforce. Addressing ill health would support a workforce which is fit and able, and – allied with improved connectivity, education and skills – could create the right conditions for a thriving Northern Powerhouse.

Government, as it looks to allocate additional NHS spending, here has the evidence needed for how that investment can also be financed sustainably through increased productivity in the Northern Powerhouse. Spending more on health here, through more efficient devolved arrangements will close the gap in fiscal terms of what the North contributes to the UK economy, generating increased revenues for the Treasury to make the NHS in the long term more financially sustainable nationally for decades to come.

Introduction 1

There is a well-known productivity gap between the Northern Powerhouse (Figure 1) and the rest of England of £4 per-person-per-hour.[1] There is also a high health gap between the Northern Powerhouse and the rest of England, with life expectancy 2 years lower in the North. Given that both health and productivity are lower in the Northern Powerhouse, the NHSA commissioned this report from six (Newcastle, Manchester, Lancaster, Liverpool, Sheffield and York) of its eight university members to understand the impact of poor health on productivity and to explore the opportunities for improving UK productivity by unlocking regional growth through health improvement.

This introductory chapter provides background on productivity and health in the Northern Powerhouse.

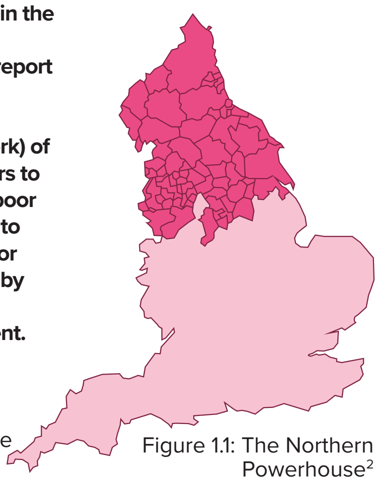


Figure 1.1: The Northern Powerhouse[2]

1.1 Productivity in the Northern Powerhouse

The UK's productivity crisis is well-documented and entrenched. While labour productivity grew at its fastest rate for a decade in the second half of last year, Britain's annual productivity rate remains well below its pre-crisis peak. Nowhere is this decline more pronounced than in the North – where job growth since 2004 has been less than 1% compared to over 12% in London, the South East and the South West.[3] The North has not been benefiting from economic growth:

- The North of England generated over £327 billion Gross Value Added (GVA)[4] to the UK economy in 2015 – around 20% of total UK GVA.[5]
- However, the Northern Powerhouse accounts for 25% of the UK population (16 million people - of which 63% are of working age)[6] so GVA per worker is well below that of the rest of the UK
- The average GVA output per worker in the Northern Powerhouse is £44,850 - 13% less than the national average.[7]
- GVA per hour worked was £28 in the Northern Powerhouse compared to £32 nationally.[8]
- There are some places in the North that do better, such as Cheshire, but generally, productivity is lower in the North.[9]
- Average annual earnings in the Northern Powerhouse are more than 10% lower than the rest of England (Figure 2).[10]
- Economic activity rates are also lower with higher rates of unemployment, economic inactivity and worklessness.
- For example, in 2018, economic inactivity rates were 25.8% in the North East compared to 18.8% in the South East.[11]
- Relatedly, poverty rates are also over 5 percentage points higher in the Northern Powerhouse than the rest of England. For example, child poverty rates are 29% in the North East, 31% in the North West and 30% in Yorkshire and Humber, compared to 21% in the South East.[12]
- The North East (21%) and North West (19%) also have some of the highest levels of fuel poverty in England, whilst the South East (11%) has the lowest.[13]
- The economy of the Northern Powerhouse has around 23% of the UK's jobs, but the job density rate[14] for the Northern Powerhouse is 0.78 compared to the national average of 0.83 and the London rate of 0.98 (as shown in Figure 1.3).[15][16]

Fig 1.2: Average regional annual pay, median, £ gross 2015 [17]

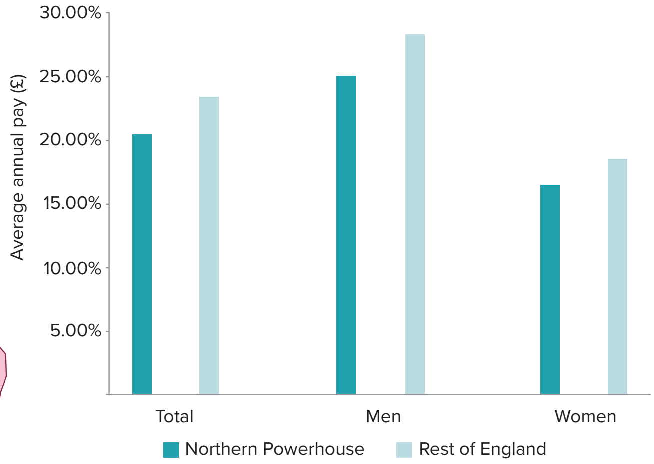
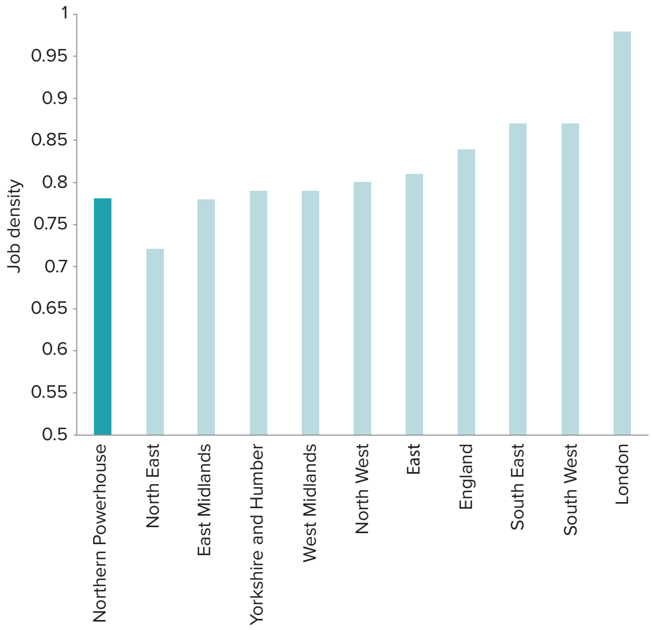


Fig 1.3: Job density by region, 2015 [20,21]



So, productivity in the North is consistently below the UK average. This indicates clear potential for improvement - if productivity in the Northern Powerhouse increased to match the UK average, it would equate to a potential £44 billion real terms gain to UK GDP.[18] The 2016 Northern Powerhouse Independent Economic Review concluded that a step change in economic performance in the North is required for UK growth. Increasing

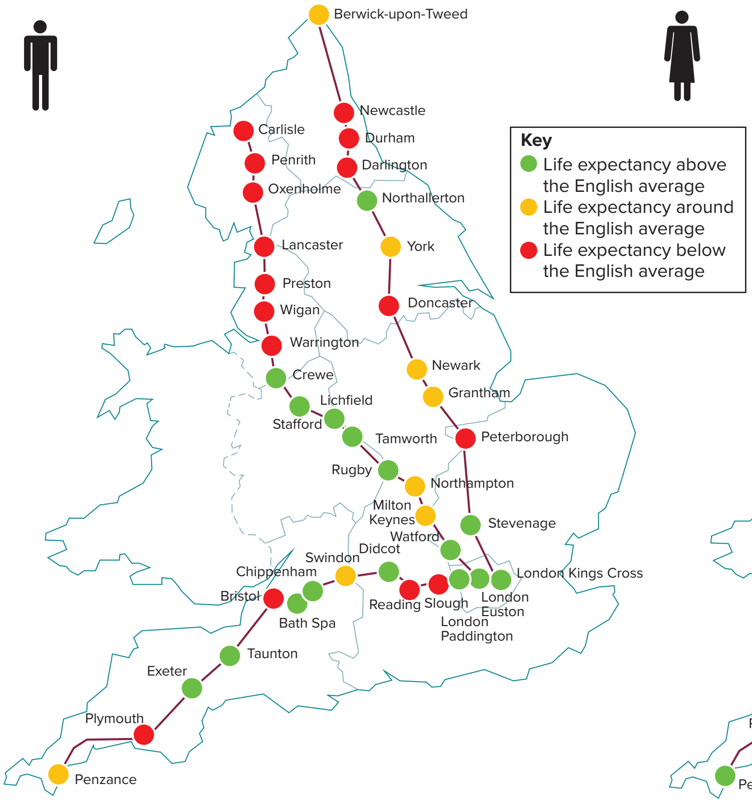


Figure 1.4: An English Journey – life expectancy for men along the East Coast, Great Western and West Coast Mainlines[27]

Figure 1.5: An English Journey – life expectancy for women along the East Coast, Great Western and West Coast Mainlines[28]

productivity in the North by 4% by 2050 would increase GVA by 15% and create around 850,000 additional jobs in the North.[19] Northern productivity must be a priority if the UK wants to return to the rates of productivity last seen before 2008 and to grow all parts of the country.

1.2 Health in the Northern Powerhouse

There are deep-rooted and persistent regional inequalities in health across England, with people in the North consistently found to be less healthy than those in the South - across all social groups and amongst both men and women (Table 1.1). [22]

There is a two year life expectancy gap between the Northern Powerhouse and the rest of England (Table 1.1), and premature death rates are 20% higher for those living in the North across all age groups.[23] Over the last 50 years, this is equivalent to over 1.5 million Northerners dying earlier than if they had experienced the same lifetime health chances as those in the rest of England.[24]

Figures 1.4 and 1.5 present average life expectancy at birth for both men and women for the stops along some of the major train lines in England: the West Coast Mainline (WCM, a route of 300 miles from London Euston to Carlisle in the North West), the East Coast Mainline (ECM, a route of 335 miles from London Kings Cross to Berwick in the North East) and the Great Western Mainline (GWM, a route of 300 miles from London Paddington to Penzance in the South West).[25] The data is geo-referenced to each of the main stations along the routes using the relevant Local Authority (e.g. the data for Newark is for Nottinghamshire). The circles represent values above (green), around (amber) or below (red) the English average of 79.4 years for men and 83.1 years for women.

The visualisations show very clearly the health divides within England, particularly between the North East and South East regions, which have the lowest and highest life expectancies respectively for both men and women. There are gaps of 4 years

Table 1.1: Key health outcomes by English region [26]

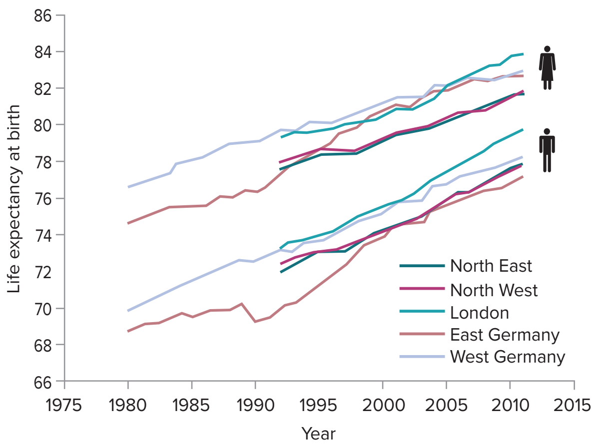
	Population (Millions)	Life expectancy at birth (years)		CVD deaths (<75 years	Cancer deaths (<75 years /100,000)	Diabetes % (> 17 years) /100,000)	% Obese or overweight (> 16 years)
		Men	Women				
NORTHERN POWERHOUSE	**15**	**78**	**81.9**	**89.6**	**161.4**	**6.5**	**66.5**
North East	2.6	78	81.7	88.8	169.5	6.5	68.0
North West	7.1	78	81.8	92.8	159.8	6.5	66.0
Yorkshire & Humber	5.3	78.5	82.2	87.3	155.0	6.4	65.4
REST OF ENGLAND	**38**	**79.8**	**83.6**	**74.3**	**138.7**	**6.2**	**63.3**
East Midlands	4.5	79.3	83.0	80.0	143.8	6.6	65.6
West Midlands	5.6	78.8	82.8	82.1	147.8	7.1	65.7
East of England	5.8	80.3	83.8	70.0	136.0	6.0	65.1
South West	5.3	80.1	83.8	80.1	136.5	6.0	57.3
London	8.2	80	84.1	66.4	134.0	5.6	63.1
South East	8.6	80.4	83.9	67.1	134.3	5.9	62.7
ENGLAND	**53**	**79.4**	**83.1**	**78.2**	**144.4**	**6.2**	**63.8**

for men and 5 years for women between the best Southern and worst Northern areas. They also demonstrate a socio-spatial gradient, with average life expectancy at birth decreasing the further north the journey takes. There are exceptions to this, with some areas that, whilst "Northern" (e.g. Cheshire), have above average health outcomes.

This health divide has been widening in recent years. Between 1965 and 1995, there was no health gap between younger Northerners aged 20-34 years and their counterparts in the rest of England. However, mortality is now 20% higher amongst young people living in the North. Similarly since 1995, for those aged 35–44 years, excess mortality in the North increased even more sharply to 49%.[29] England's regional health inequalities are now some of the largest in Europe – greater than that between the former East and West of Germany (Figure 1.6).[30]

The Northern health disadvantage is particularly apparent when examining the great Northern cities. Table 1.2 shows which English local authorities perform the best and the worst in terms of deaths from cancer and cardiovascular disease – the two leading causes of death in the UK. In each case, the Top 5 local authorities with the lowest death rates are in the South East, and the bottom 5 with the highest death rates are predominantly in the North.

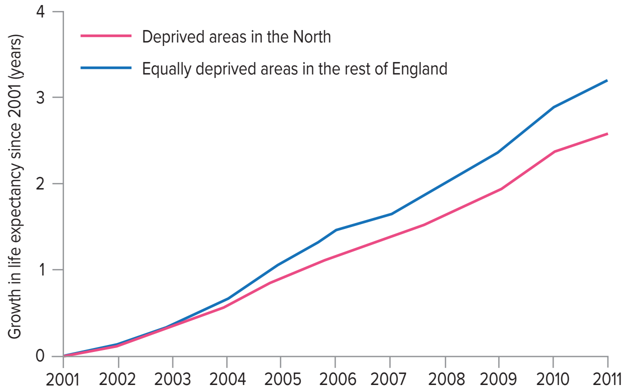
Fig 1.6: Life expectancy trends for men and women in London, the North East and North West of England compared to East and West Germany, 1980-2012 [31]



In 2014, Public Health England commissioned the Due North Inquiry into health equity for the North. This reported that a baby boy born in Manchester can expect to live for 17 fewer years in good health and a baby girl 15 fewer years than babies born in Richmond upon Thames.[33]

Likewise, people in Liverpool, Hull, Manchester or Middlesbrough are almost twice as likely to die early (before age 75) as people living in Wokingham, Rutland, Harrow or Kensington and Chelsea.[34] For example in Manchester premature mortality rates are 539 deaths per 100,000 compared to 241 per 100,000 in Kensington and Chelsea.[35]

Fig 1.7: Comparison of growth in life expectancy in deprived local authorities in the North and rest of England since 2001[36]



The health disadvantage for the North is not just about socio-economic deprivation. The most deprived local authorities in the North now have worse health than the most deprived local authorities in the rest of England.[37] Figure 1.7 shows how, since 2001, life expectancy in deprived Northern local authorities has improved more slowly than in similar local authorities in the rest of England: on average, people living in the most deprived local authorities in the North have a life expectancy of around 6 months shorter than those in the rest of England: the North is falling behind. This profound and widening health divide requires effective public policies, including a rebalancing of the economy between the North and the rest of England that is proportionate to the scale of the problem.

1.3 Health for Wealth in the Northern Powerhouse

However, all is not 'grim up north' - since 2014 there has been increased recognition of the untapped potential of the northern economy and the 'Northern Powerhouse' has emerged as both a concept and a tangible vehicle in the form of the Northern Powerhouse Partnership through which a shared cross-party, business and public sector vision of economic growth for the North is being developed.[38]

The result of the EU referendum has further highlighted the need for regional economic rebalancing, and exiting the EU provides both an opportunity and a challenge for making sure that all regions of the UK feel the benefits of future national prosperity through the shared development of a 'place-based' industrial strategy.

Table 1.2: Top and Bottom Five English Local Authorities for early Cardiovascular Disease (CVD) and Cancer deaths[32]

Bottom Five English Local Authorities				Top Five English Local Authorities			
CVD deaths (<75 years /100,000)		Cancer deaths (<75 years /100,000)		CVD deaths (<75 years /100,000)		Cancer deaths (<75 years /100,000)	
Manchester	137.0	Manchester	198.9	Dorset	52.1	Harrow	104.0
Blackpool	125.2	Liverpool	195.2	Surrey	54.4	Kensington & Chelsea	116.3
Tameside	121.2	Middlesbrough	194.4	Wokingham	54.9	Barnet	118.0
Hackney	116.3	Kingston upon Hull	192.2	Kensington & Chelsea	54.9	Rutland	119.3
Salford	115.9	South Tyneside	192.0	Richmond upon Thames	55.9	Buckinghamshire	120.0
England	78.2	England	144.4	England	78.2	England	144.4

This report seeks to contribute to this process by examining the relationship between health and wealth in the Northern Powerhouse. To-date, there has been limited research into the impact of poor health on the regional productivity gap and the opportunity for the UK that comes from addressing regional health inequalities.[39]

The poor productivity performance of the North has previously been explained only in terms of workforce skills or technology, investment and connectivity.[40] This report is the first exploration of whether worse health in the North also has a bearing.

Chapter 2: Regional Health Inequalities and the UK Productivity Gap

This chapter looks at the impact on productivity of regional health inequalities. Looking at productivity in terms of employment rates, wage levels and number of hours worked, this chapter explores the impact of poorer rates of morbidity and mortality on wider economic outcomes and examines regional differences in these relationships between the north and the rest of England.

Chapter 3: Long-Term Health Conditions and the UK Productivity Gap

This chapter examines the impact of ill health on the productivity of people living in the Northern Powerhouse compared to the rest of England. It looks at what happens to people's wages, hours worked and employment rates when they develop a long-term health condition.

The chapter also explores how people with long-term health conditions in the Northern Powerhouse can be supported back into the labour market.

Chapter 4: The NHS and the UK Productivity Gap

This chapter looks at the impact on productivity of the Northern Powerhouse's giant health services sector which is worth some £30 billion and employs over half a million people.[41] Looking at productivity in terms of employment rates, wage levels and number of hours worked, this chapter explores the impact of NHS spending on wider economic outcomes and examines regional differences in these relationships between the North and the rest of England.

Chapter 5: Increasing UK Productivity by Reducing Regional Health Inequalities

This chapter estimates how much poorer health in the Northern Powerhouse contributes to the regional productivity gap as measured by differences in the employment rate and the Gross Value Added (GVA) per-head between the Northern Powerhouse and the rest of England.[42]

It also discusses how reducing regional health inequalities through public health and prevention strategies could close England's productivity gap and increase UK growth.

The concluding **Chapter 6: Health for Wealth in the Northern Powerhouse** summaries the key findings and presents recommendations to national and local policy and practice agencies.

Notes

[1] Office for National Statistics (2015), Regional and sub-regional productivity in the UK, https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/labourproductivity/articles/regionalandsubregionalproductivityintheuk/jan2017

[2] In this report "the North" and "The Northern Powerhouse" are used interchangeably. The Northern Powerhouse comprises the following 77 local authorities in the North East, North West, Yorkshire and Humber and the Northern Midlands: Hartlepool, Middlesbrough, Redcar and Cleveland, Stockton-on-Tees, Darlington, Halton, Warrington, Blackburn with Darwen, Blackpool, Kingston upon Hull, East Riding of Yorkshire, North East Lincolnshire, North Lincolnshire, York, County Durham, Cheshire East, Cheshire West and Chester, Northumberland, Allerdale, Barrow-in-Furness, Carlisle, Copeland, Eden, South Lakeland, Bolsover, Chesterfield, Derbyshire Dales, North East Derbyshire, Burnley, Chorley, Fylde, Hyndburn, Lancaster, Pendle, Preston, Ribble Valley, Rossendale, South Ribble, West Lancashire, Wyre, Craven, Hambleton, Harrogate, Richmondshire, Ryedale, Scarborough, Selby, Bassetlaw, Bolton, Bury, Manchester, Oldham, Rochdale, Salford, Stockport, Tameside, Trafford, Wigan, Knowsley, Liverpool, St. Helens, Sefton, Wirral, Barnsley, Doncaster, Rotherham, Sheffield, Newcastle upon Tyne, North Tyneside, South Tyneside, Sunderland, Bradford, Calderdale, Kirklees, Leeds, Wakefield, Gateshead.

[3] Centre for Cities (2015) Cities Outlook 2015 http://www.centreforcities.org/wp-content/uploads/2015/01/15-01-09-Cities-Outlook-2015.pdf

[4] Gross value added (GVA) is a measure of the increase in the value of the economy due to the production of goods and services. It is measured at current basic prices, which include the effect of inflation, excluding taxes (less subsidies) on products (for example, Value Added Tax). GVA plus taxes (less subsidies) on products is equivalent to gross domestic product (GDP). (Office for National Statistics, 2016).

[5] Northern Health Science Alliance (2018) The Northern Powerhouse in Health Research - A Science and Innovation Audit, http://www.thenhsa.co.uk/case-studies/uk-science-innovation-audit/

[6] ONS (2016), Population and Migration https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration

[7] ONS (2015), Gross Value Added (GVA), https://www.ons.gov.uk/economy/grossvalueaddedgva

[8] ONS (2015), Regional and sub-regional productivity in the UK, https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/labourproductivity/articles/regionalandsubregionalproductivityintheuk/jan2017

[9] Northern Health Science Alliance (2018) The Northern Powerhouse in Health Research - A Science and Innovation Audit, http://www.thenhsa.co.uk/case-studies/uk-science-innovation-audit/

[10] ONS (2016), Annual Survey of Hours and Earnings, https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/bulletins/annualsurveyofhoursandearnings/2016provisionalresults

[11] May to July, 2018 (seasonally adjusted) NOMIS (2018) Labour Force Survey Headline Statistics https://www.nomisweb.co.uk/reports/lmp/gor/contents.aspx

[12] End Child Poverty (2013) Poverty Map of the UK. http://www.endchildpoverty.org.uk/images/ecp/130212%20ECP%20local%20report%20final(2).pdf

[13] Department of Energy and Climate Change (2013) Fuel Poverty Report. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/226985/fuel_poverty_report_2013.pdf

[14] Jobs density is defined as the number of jobs in an area divided by the resident population aged 16-64 in that area. For example, a job density of 1.0 would mean that there is one job for every resident aged 16-64.
The total number of jobs is a workplace-based measure and comprises employee jobs, self-employed, government-supported trainees and HM Forces. Nomis (2012) Job density https://www.nomisweb.co.uk/articles/649.aspx

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[16] Nomis (2015) Labour market Profile data 2015 https://www.nomisweb.co.uk/reports/lmp/gor/2013265927/report.aspx#tabwab

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[18] The Northern Powerhouse Independent Economic Review (2016) http://www.sqw.co.uk/files/5414/6723/8824/16987_-_TfN_-_NPH_IER_-_Executive_Summary_-_Final_24_June_2016.pdf

[19] The Northern Powerhouse Independent Economic Review (2016) http://www.sqw.co.uk/files/5414/6723/8824/16987_-_TfN_-_NPH_IER_-_Executive_Summary_-_Final_24_June_2016.pdf

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[33] Whitehead et al (2014) Due North: report of the inquiry on health equity for the North University of Liverpool and Centre for Local Economic Strategies, Liverpool and Manchester

[34] Public Health England (2013). Longer Lives http://longerlives.phe.org.uk/

[35] Public Health England (2013). Longer Lives http://longerlives.phe.org.uk/

[36] Whitehead et al (2014) Due North: report of the inquiry on health equity for the North University of Liverpool and Centre for Local Economic Strategies, Liverpool and Manchester

[37] Defined as the 20% most deprived of the English local authorities in the North compared to 20% most deprived in the rest of England

[38] More information on the Northern Powerhouse Partnership is available here: http://www.northernpowerhousepartnership.co.uk/

[39] The potential links between health and productivity in the north east region are discussed in the 2016 NECA (North East Combined Authority) report Health and Wealth - Closing the Gap in the North East Executive Summary of the Report of the North East Commission for Health and Social Care Integration https://www.ntw.nhs.uk/content/uploads/2017/02/Agenda-item-9-i-c-Executive-Summary-Health-and-Wealth-Closing-the-Gap-in-the-North-East.pdf

[40] The Northern Powerhouse Independent Economic Review (2016) http://www.sqw.co.uk/files/5414/6723/8824/16987_-_TfN_-_NPH_IER_-_Executive_Summary_-_Final_24_June_2016.pdf

[41] Northern Health Science Alliance (2018) The Northern Powerhouse in Health Research - A Science and Innovation Audit, http://www.thenhsa.co.uk/case-studies/uk-science-innovation-audit/

[42] We also looked at how much poorer health in the North contributes to the regional productivity gap as measured by differences in hours worked and wages. However, the models suggested that all of the impact of health seemed to operate via employment. Please see technical appendix for further information.

Regional Health Inequalities and the UK Productivity Gap

2

This chapter looks at the effects on productivity of regional health inequalities. Looking at productivity in terms of employment rates, wage levels and number of hours worked, this chapter explores the effects of poorer rates of morbidity and mortality on wider economic outcomes and examines regional differences in these relationships between the North and the rest of England.

2.1 Introduction

There is considerable policy interest in the relationship between health and wider economic outcomes, such as employment status, pay, and productivity. Past research has often focussed on how these wider outcomes can affect health, but in this chapter we are interested in the converse relationship: how does population health affect measures of economic performance.

We argue that this is an important relationship as improving population health is often a key policy goal. If it can be demonstrated that higher levels of population health also have 'knock-on' effects to other parts of the economy, then this can strengthen the calls to improve health.

Whilst it is informative to look at this relationship from the national perspective, it is also very policy relevant to examine it from an inequalities point of view. It is well documented that there are large health inequalities between regions of England, particularly between the North and the rest of England.[43 44] Yet what is not known is whether, and if so how, differences in health across regions translate into disparities in wider economic outcomes – such as productivity. Should disparities in wider economic outcomes prevail then arguably resources to enhance population health could be more effectively targeted to areas where improvements lead to greater economic productivity. This could be vital information for policy makers trying to improve UK productivity.

2.2 Key Research Questions

1. To estimate the effects of health on wider national economic outcomes.
2. To examine regional differences in these relationships; between the north and the rest of England.

2.3 Methods

2.3.1 Data

We constructed a longitudinal dataset at Local Authority District (LAD) level over a period from 2004 to 2017. There are 326 LADs in England; these districts are responsible for running local services in the area, which include education, transport and social care. We collected a wide range of information from various sources, which are outlined below. Further details on data sources are available in the chapter technical appendix A (Table A2.1.1).

Economic Activity Variables (Outcome variables)

We obtained data on measures of economic activity from NOMIS[45] the official labour market statistics portal. We collected information on employment and productivity, including measures of the employment rate, and the economic inactivity rate. Additionally, we collected information on the median weekly wages, and adjusted them for inflation (using the Retail Price Index). We further obtained data on productivity, proxied by Gross Value Added (GVA) per-head.

Health Variables

For a measure of population health, we obtained data on the number of individuals receiving incapacity benefit. This had been shown to be strongly correlated with more detailed measures of morbidity obtained in the census[46 47] and we verified that there was a high correlation in our data too ($r=0.98$; $p<0.001$). We also obtained death rates from Office of National Statistics (ONS).

Additional Variables

We obtained data on population size and age structure, the ratio of wage to unemployment benefit levels, and the percentage of the adult population with no formal educational qualifications.

2.3.2 Statistical Methods

We constructed a longitudinal dataset consisting of repeated annual observations for each local authority. We used fixed effects regression to exploit variation over time and identify the effect of changes in mortality or morbidity on changes in economic outcomes. This provides greater confidence in the results. We additionally allowed for year fixed-effects to account for nationwide shocks that happened in specific years. As the time frame of our analysis included the recession, these year fixed-effects will absorb its impact on economic outcomes.

We estimated the effects of population level morbidity on wider economic outcomes separately. We estimated models for the whole country and for the Northern Powerhouse and the rest of England separately.

Finally, we considered the possibility that health (morbidity) and wider outcomes could be jointly determined and/or influenced by external factors that we were unable to account for. To overcome these issues we considered two stage models.
Finally, we considered the possibility that health (morbidity) and wider outcomes could be jointly determined and/or influenced by external factors that we were unable to account for. To overcome these issues we considered two stage models.
Further details on the statistical methods are available in the technical appendix A.

2.4 Results

2.4.1 Key Findings

1. Decreasing the number of people with morbidity by 1% will increase employment rates by 0.4 percentage points in the North as well as reducing the rate of economic inactivity in the North by 0.3 percentage points. Further, it will increase GVA per-head by 0.4%.[48]
2. Decreasing the number of deaths per 1,000 population will increase employment rates by 0.4 percentage points in the North as well as decreasing the rate of economic inactivity by 0.5 percentage points.[49]

Fig 2.1: The effect of ill-health (morbidity) on employment and productivity related outcomes [55]

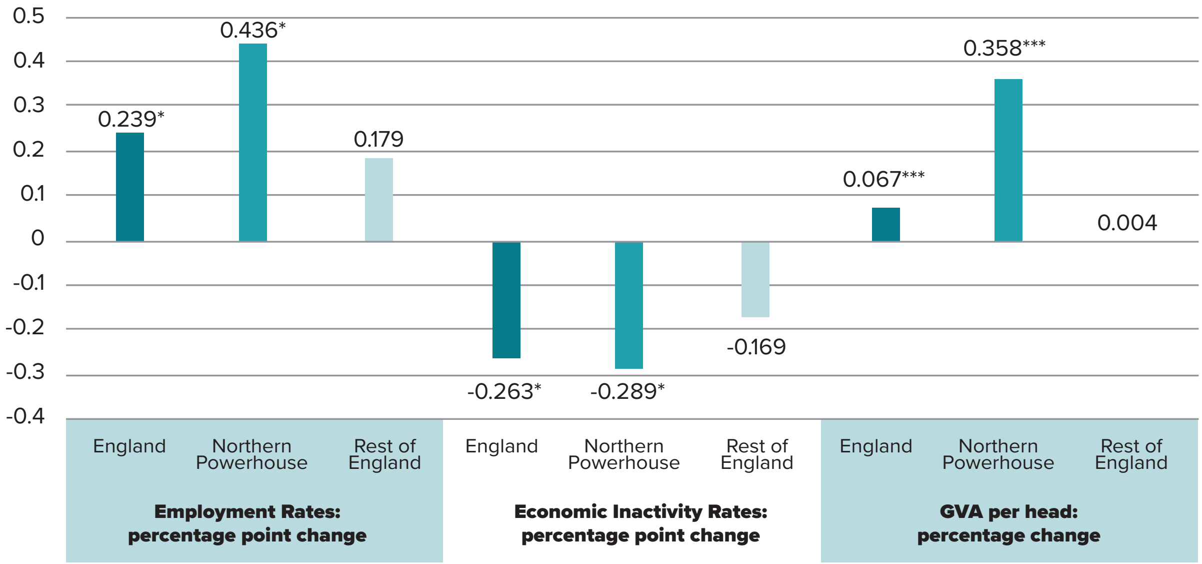
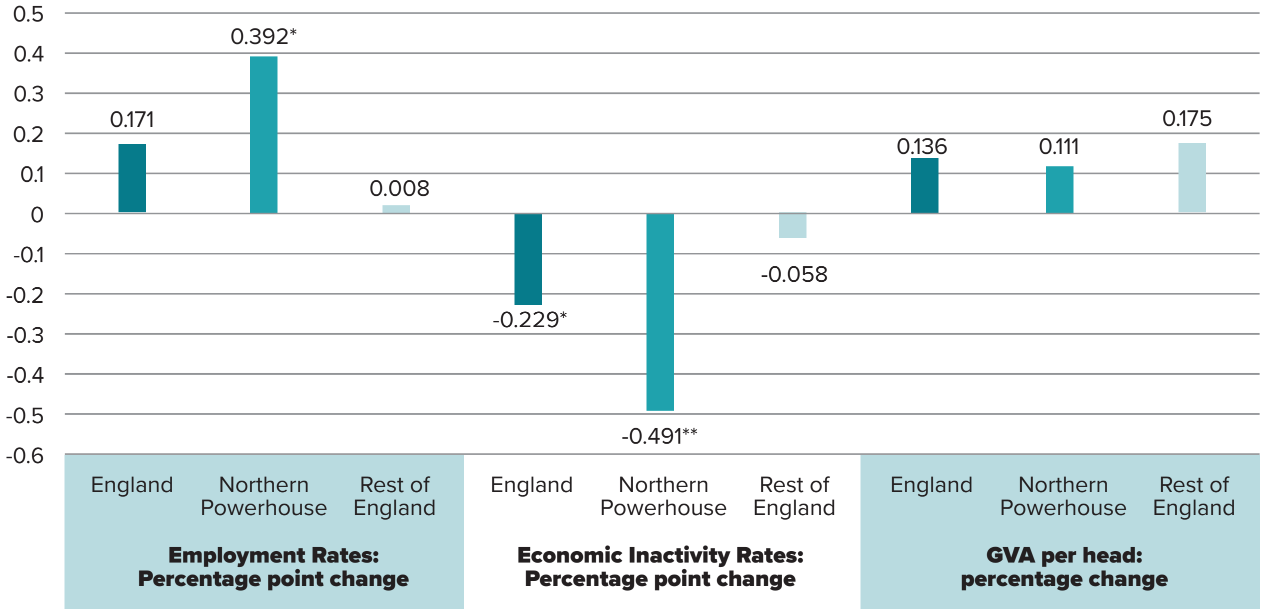


Fig 2.2: The effects of mortality on employment and productivity related outcomes [60]



3. Decreasing the number of people with morbidity by 1% will increase median weekly pay by £43 in the North. Additionally, decreasing mortality per 1,000 population in the North will increase median weekly pay by £3.50 in the North.[50]
4. Corresponding results estimated for the rest of England consistently lead to lower effects of morbidity and mortality on relevant economic outcomes.
5. Improvements in health are likely to lead to greater gains in wider economic outcomes when targeted to the North of England compared to the rest of England

2.4.2 Detailed Results

Figure 2.1 shows the effects that ill-health has on employment rates, rates of economic inactivity, and GVA per-head:

- A 1% decrease in morbidity increased employment by 0.44 percentage points in the North and by 0.18 percentage points in the rest of England (Column 1).[51]
- A 1% decrease in morbidity reduced economic inactivity by 0.29 percentage points in the North and by 0.17 percentage points in the rest of England (Column 2).[52]
- A 1% decrease in morbidity would increase GVA per-head by 0.36% in the North and by just 0.004% in the rest of England (Column 3).[53 54]

Figure 2.2 shows the effects that morbidity (deaths per 1,000 population) has on employment rates, rates of economic inactivity, and GVA per-head:

- A reduction of one death per 1,000 population increased employment by 0.39 percentage points in the Northern Powerhouse region and by 0.008 percentage points in the rest of England (Column 1).[56]
- A reduction of one death per 1,000 population reduced economic inactivity by 0.49 percentage points in the Northern Powerhouse region and by 0.06 percentage points in the rest of England (Column 2).[57]
- A reduction of one death per 1,000 population increased GVA per-head by 0.11% in the Northern Powerhouse region and by 0.18% in the rest of England (Column 3) .[58]

Figure 2.3 shows the effects when we considered median weekly pay as a measure of economic activity:

- A 1% decrease in morbidity increased median weekly pay by £43 in the Northern Powerhouse region and by £40 in the rest of England (Column 1).[59]
- A reduction of one death per 1,000 population increased median weekly pay by £3.50 in the Northern Powerhouse region and by £0.20 in the rest of England (Column 2). When considering mortality, there was a much more pronounced difference between the two regions, with substantially higher returns in the Northern Powerhouse.

2.5 Discussion

2.5.1 Summary of Key Findings

Reducing morbidity leads to better economic outcomes in terms of higher employment rates, lower rates of economic inactivity, higher GVA per-head, and higher median weekly pay.

These relationships are consistently stronger in the North than compared in the rest of England, indicating there are potential higher economic returns to improving population health in the North.

The results were mainly robust to considering mortality as a measure of health and to the use of models that allowed health and economic outcomes to be jointly determined.

2.5.2 Implications for Policy and Practice

The percentage of people of working age who are out of work because of their health is much higher in the North than in the rest of England.[62]

Therefore, strategies for economic growth are only likely to be effective if they address this major barrier to employment, particularly in the North.

Our findings demonstrate that improving health should be at the centre of local growth strategies.

In this section we draw on wider evidence to discuss the actions that could be to improve health. Improving population health in the North requires more investment in prevention and in 'place based' public health interventions that focus on changing the social and environmental determinants of health inequalities.

Expenditure on public health and prevention services has always lagged behind spend on the treatment of existing conditions. In 2017/18 in England, £3.4 billion was spent by local authorities on public health.[63]

This was dwarfed by Department of Health and Social Care in England spend of over £124 billion, the vast majority of which went on hospital-based treatment services.[64]

Further, public health budgets have been significantly reduced in recent years: spending on public health fell by £200 million in 2015/16, and by further real-terms cuts averaging 3.9 per cent each year between 2016/17 and 2020/21.[65] So there is a clear need to invest more in public health and prevention activities - now.[66]

A recent evidence review found that a wide range of public health policy interventions had potential for improving health and health behaviours in more deprived communities.[67]

These included taxes on unhealthy food and drinks, food aid programmes for low-income women, government incentive schemes for childhood vaccination uptake, universal cancer screening programmes, controlling tobacco advertising, water fluoridisation, regulating traffic speeds, dental education programmes for children, and nutrition programmes targeted at low-income families.

Furthermore, an evidence review of the effects of upstream interventions based on changing the social determinants of health[68] suggested that the workplace may be an important setting in which health can be improved and inequalities may be addressed.[69]

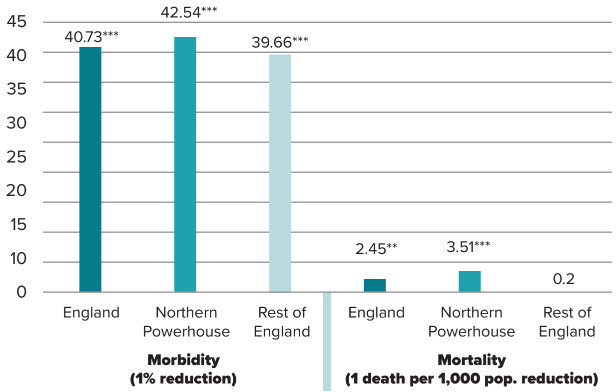
Similarly, improving housing quality and tenure may positively affect physical and mental health.

Additionally, there is evidence that public health can be improved by strategies that increase community participation and control – whereby people engage more within their local community and shape the local social determinants of health – can improve mental and physical health as well as promote health-enhancing behaviours through non-health activities.[70 71]

For example, a recent pilot study in Salford has shown that community-participation interventions can be an effective vehicle for improving health in a very deprived Northern city.[72]

Such approaches could also be effective in improving health and health behaviours in other Northern communities – although more research to identify interventions that are effective in improving health in the North and particularly in deprived Northern communities is required.

Fig 2.3: The effect of ill-health on median weekly pay [61]



There is therefore a need to move towards investing more of the UK health science research funding budget into prevention. Furthermore, more of this research budget should be allocated to the Northern Powerhouse – where the health need is greatest and where there is significant research expertise across the eight research-intensive Northern universities in applied health sciences.[73]

Despite the clear potential of the North in health innovation, it has seen significant underinvestment from the public sector in clinical, healthcare and applied public health research compared both to other regions and the private sector.

For example, the North received only 13.6% of public medical and health research funding across the UK in 2014.[74] Studies have shown public investment in health science R&D leverages private sector investment, with every £1 of public money stimulating an additional £2.20-£5.10.[75]

Higher NHS hospital research spend is associated with lower mortality rates.[76]

Therefore, increased investment in health research in the North is likely to contribute to improved health outcomes.

This is vital, as we have shown in this chapter that improving population health can result in significant knock-on effects to the wider economy in terms of boosting productivity via higher employment rates and higher wages.

Both of these factors will benefit the treasury in terms of lower benefit receipts and higher potential taxation revenues.

2.6 Conclusion

This chapter has provided evidence that improving population health is associated with better economic outcomes in terms of higher employment rates, lower rates of economic inactivity, higher GVA per-head, and higher median weekly pay.

The effects of reductions in ill health on productivity were consistently stronger in the Northern Powerhouse than in the rest of England, indicating that there are higher potential productivity returns from improving population health in the North. Improvements in public health through place-based approaches are therefore likely to lead to greater economic gains in the North – potentially helping to reduce the productivity gap with the rest of England.

Notes

[43] Hacking et al (2011) Trends in mortality from 1965 to 2008 across the English north-south divide: comparative observational study. British Medical Journal, 342, d508
[44] Whitehead et al (2014) Due North: report of the inquiry on health equity for the North University of Liverpool and Centre for Local Economic Strategies, Liverpool and Manchester
[45] https://www.nomisweb.co.uk/
[46] Bambra and Norman (2006) What is the association between sickness absence, mortality and morbidity? Health and Place, 12, pp. 728 – 733
[47] Norman and Bambra (2007) The utility of medically certified sickness absence as an updatable indicator of population health, Population, Space and Place, 13: 333-352
[48] The p-values are, respectively, p=0.040; p=0.014; and p<0.001.
[49] The p-values are, respectively, p=0.043; and p=0.007.
[50] The p-values are, respectively, p=0.001; and p<0.001
[51] We conducted an additional regression where we interacted a binary variable for the Northern Powerhouse with all variables. The coefficient on the interaction between morbidity and Northern Powerhouse was positive and statistically significant (p=0.035) indicating higher potential returns in the Northern Powerhouse. See Table A2.2.4 for further information.
[52] We conducted an additional regression where we interacted a binary variable for the Northern Powerhouse with all variables. The coefficient on the interaction between morbidity and Northern Powerhouse was positive and statistically significant (p=0.046) indicating higher potential returns in the Northern Powerhouse (Table A2.2.4).
[53] The p-value on the interaction tern was p<0.001 (Table A2.2.4).
[54] All of the differences by region were statistically significant.
[55] The size of the bar shows what happened to the outcomes considered if the rate of morbidity was reduced by 1%. The bars display coefficients from fixed-effects regression models, where we additionally controlled for the age structure of the population, the log of the total population of each LAD, the percentage of people who have no qualifications, the wages to unemployment benefit ratio, and year effects. Tables showing the number of observations, statistical significance (p-values) and R-squared value for each bar are available in the supplementary appendix (Table A2.2.1). * p<0.05; ** p <0.01; *** p<0.001.
[56] From a regression model with interactions, this difference between the two regions was statistically significant (p=0.016) (Table A2.2.4).
[57] Again, this difference between regions was statistically significant (p=0.008) (Table A2.2.4).
[58] The p-value on the interaction term was 0.871 (Table A2.2.4).
[59] The p-value in this case was p=0.040 (Table A2.2.4).
[60] The size of the bar shows what happened to the outcomes considered if the mortality rate was reduced by 1%.
The bars display coefficients from fixed-effects regression models, where we additionally controlled for the age structure of the population, the log of the total population of each LAD, the percentage of people who have no qualifications, the wages to unemployment benefit ratio, and year effects. Tables showing the number of observations, statistical significance (p-values) and R-squared value for each bar are available in the supplementary appendix (Table A2.2.2). * p<0.05; ** p <0.01; *** p<0.001.
[61] The size of the bar shows what happened to median weekly pay if the health variables changed by the stated amount. The outcome is a monetary value and can be interpreted in terms of monetary gains (pounds per-person-per-month).
The bars display coefficients from fixed-effects regression models, where we additionally controlled for the age structure of the population, the log of the total population of each LAD, the percentage of people who have no qualifications, the wages to unemployment benefit ratio, and year effects.
Tables showing the number of observations, statistical significance (p-values) and R-squared value for each bar are available in the supplementary appendix (Table A2.2.3). * p<0.05; ** p <0.01; *** p<0.001.
[62] https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/disability/articles/disabilityinenglandandwales/2013-01-30
[63] https://www.kingsfund.org.uk/projects/nhs-in-a-nutshell/spending-public-health
[64] https://www.kingsfund.org.uk/projects/nhs-in-a-nutshell/nhs-budget
[65] https://www.kingsfund.org.uk/projects/nhs-in-a-nutshell/spending-public-health
[66] NECA (North East Combined Authority) (2016) Health and Wealth - Closing the Gap in the North East Executive Summary of the Report of the North East Commission for Health and Social Care Integration https://www.ntw.nhs.uk/content/uploads/2017/02/Agenda-item-9-i-c-Executive-Summary-Health-and-Wealth-Closing-the-Gap-in-the-North-East.pdf
[67] Thomson et al (2018) The effects of public health policies on health inequalities in high income countries: Umbrella review, BMC Public Health, 18:869
[68] The social determinants of health are the conditions in which people are born, grow, live, work and age. These circumstances are shaped by the distribution of money, power and resources at global, national and local levels https://www.who.int/social_determinants/sdh_definition/en/
[69] Bambra et al (2010). Tackling the wider social determinants of health and health inequalities: evidence from systematic reviews. Journal of Epidemiology and Community Health, 64: 284-291.
[70] Milton et al (2012) The impact of community engagement on health and social outcomes: A systematic review. Community Development Journal. 47: 316–34
[71] Popay et al (2007) Community engagement in initiatives addressing the wider social determinants of health: A rapid review of evidence on impact, experience and process. Soc Determ Eff Rev, 1–226.
[72] Munford et al (2017) Associations of participation in community assets with health-related quality of life and healthcare usage: a cross-sectional study of older people in the community, BMJ Open, 2017;7:e012374.
[73] Northern Health Science Alliance (2018) The Northern Powerhouse in Health Research - A Science and Innovation Audit, http://www.thenhsa.co.uk/case-studies/uk-science-innovation-audit/
[74] Northern Health Science Alliance (2018) The Northern Powerhouse in Health Research - A Science and Innovation Audit, http://www.thenhsa.co.uk/case-studies/uk-science-innovation-audit/
[75] Northern Health Science Alliance (2018) The Northern Powerhouse in Health Research - A Science and Innovation Audit, http://www.thenhsa.co.uk/case-studies/uk-science-innovation-audit/
[76] Ozdemir et al (2015) 'Research Activity and the Association with Mortality', PLoS ONE 10(2)

3 Long-Term Health Conditions and the UK Productivity Gap

This chapter examines the effects of ill health on the productivity of people living in the Northern Powerhouse compared to the rest of England. It looks at what happens to people's wages, hours worked and employment rates when they develop a long-term health condition. The chapter also explores how people with long term health conditions in the Northern Powerhouse can be supported back into the labour market.

3.1 Introduction

The removal of the default retirement age has led to growing numbers of workers with chronic health conditions and disabilities in the UK labour market,[77] yet they face significant employment inequities. In 2015, only 47% of disabled individuals were in employment compared with 80% of individuals without disabilities, giving an employment differential of 33 percentage points.[78]

This disability employment gap is the fourth highest among the European Union nations and significantly higher than that observed in Finland (19%), Sweden (18%) and France (18%)[79]. International health-related employment inequalities are due to variations in healthcare systems and national welfare and employment policies and their ability to support work retention and return-to-work for people with long-term health conditions and disabilities.

Aggregate employment rates, however, mask the social inequalities in employment opportunities that exist within countries for specific population sub-groups. People with chronic ill-health and low education, for example, have lower employment rates than their counterparts with high education, and this inequality can be worse for women.[80 81]

Employment rates also vary by type of health condition, with musculoskeletal and mental health conditions the main reasons for claiming health-related benefits in the UK. The socioeconomic and geographic patterning of employment rates for people with poor health or disabilities is inequitable, yet this patterning also indicates health-related worklessness is tractable and can be addressed through interventions focusing on the underlying structural, institutional and individual factors driving it.

However, aggregate employment rates mask the social inequalities in employment opportunities that exist within countries for specific population sub-groups. People with chronic ill-health and low education, for example, have lower employment rates than their counterparts with high education, and this inequality can be worse for women.[82 83]

Employment rates also vary by type of health condition, with musculoskeletal and mental health conditions the main reasons for claiming health-related benefits in the UK.

The socioeconomic and geographic patterning of employment rates for people with poor health or disabilities is inequitable, yet this patterning also indicates health-related worklessness is tractable and can be addressed through interventions focusing on the underlying structural, institutional and individual factors driving it.

The North of England has experienced higher rates of unemployment than the rest of England since the 1990s due to deindustrialisation and higher rates of disability.[84] In this chapter, we examine what happens to an individual's economic activity following a spell of ill-health. We use longitudinal data to observe individuals both before and after this spell of ill-health.

As well as considering national figures, we split our analysis by North versus the rest of England to see if the results differ by region. It was expected that the Northern Powerhouse would fare worse than the rest of England given the recent evidence on the productivity gap between the two regions.[85]

3.2 Research Questions

1. How are individuals' employment status, hours worked and household income affected following the onset of ill-health?
2. Are there differences between the Northern Powerhouse and the rest of England?

3.3 Methods

3.3.1 Data

We used data from Understanding Society: The UK Household Longitudinal Study (UKHLS),[86] which tracks around 40,000 UK households each year. We used the first seven waves of available data in the period 2008 – 2016. UKHLS contains a rich set of socio-economic and demographic information on respondents, including details on education level, employment outcomes and health status. Further details on data definitions are available in technical appendix B (Table B3.1.1).

Economic Outcomes

We examined three employment outcomes: (i) whether an individual was in employment; (ii) household income adjusted for household size and composition; and (ii) the number of hours worked per week.

Health Variables

Our main indicator of health is self-reported health status. Individuals were asked: "In general, would say your health is excellent, very good, good, fair or poor?" From this we classified people into "good health" if an individual responded with excellent, very good or good, and into "bad health" if they responded with fair or poor.

A second indicator of health, used as a robustness check, is the presence of a long-standing illness or impairment. Individuals were asked "Do you have any long-standing physical or mental impairment, illness or disability?

By long-standing illness or impairment I mean anything that has troubled you over a period of at least 12 months or that is likely to trouble you over a period of at least 12 months."

We used this variable to create a binary indicator which was equal to one if they responded yes and zero if they responded no.

Additional Variables

We used several widely-used socio-economic variables to adjust for other influences on economic outcomes: age, gender, highest educational qualification, number of children, marital status, and ethnicity.

Additional detail on the methods are available in Technical Appendix B.

3.3.2 Statistical Methods

We examined the effect of having a period of "bad health" on employment outcomes and how this differed for individuals in the North compared to the rest of England. We defined ill-health in two ways:

1. If an individual's self-reported health fell from "good" to "bad"
2. If an individual did not have a limiting condition in the first wave and did have a limiting condition in a subsequent wave

The first method is used in the primary analysis, and the second in robustness checks.

We used a statistical technique called 'doubly robust' estimation. What this does is: (1) match an individual in employment in the first who experienced an onset of ill-health in a subsequent wave to a similar individual who did not report a spell of ill-health using propensity score matching and then (2) estimate the probability that individuals will remain in employment (or other outcomes listed above). We then obtained estimates for the North and the rest of England and then tested to see if they were statistically different.

In order to account for differences in education status, we estimated these models for individuals who attained GCSE's or below and those with A Levels or higher levels of educational. We did this as we expected a change in health status to affect the two groups differently. We further estimated these models separately by gender, as it is possible that change in health status could affect employment outcomes differently.

3.4 Results

3.4.1 Key Findings

1. Ill-health reduced the probability of remaining in employment by 4.9% in the Northern Powerhouse compared to 3.5% in the rest of England.[87]
2. Ill-health reduced relative weekly wages by 32.4% in the Northern Powerhouse compared to 19.5% in the rest of England.
3. Ill-health reduced household income by 13.3% in the Northern Powerhouse but had no effect in the rest of England.
4. Amongst those who remained in employment, ill-health reduced hours worked by 5.6% in the Northern Powerhouse compared to 7.9% in the rest of England.[88]

3.4.2 Detailed Results

The first column of Figure 3.1 presents the probability that an individual remained in employment following a period of ill-health. For the whole of England sample, ill-health reduced the probability of remaining in employment by 3.90%. The corresponding figure for the North (-4.88%) is considerably larger than in the rest of England (-3.52%). The difference between the North and the rest of England is 38.64% (Figure 3.4). Information regarding sample sizes, goodness of fit, and statistical significance is provided in the Tables in Technical Appendix B.

When we broke the analysis down by educational attainment (Figure 3.1; middle and right most sub-panels), we observed that the results were much more stark for those with lower levels of education. A person with GCSE or lower levels of education in the North is 11.96% less likely to remain in employment following a period of ill-health. The value for the North was 135.43% higher than in the rest of England and was statistically meaningful (Figure 3.4). When considering higher levels of education (A-levels or above) there are negative effects of ill-health on employment, but these were much less pronounced. Also there was no evidence of a meaningful difference between the Northern Powerhouse and the rest of England, demonstrated by the similar sized bars.

In Figure 3.2 we considered the effects of ill-health on an individual's weekly pay. Whilst there were substantial pay reductions following ill-health, these reductions were not statistically significant at the standard $p<0.05$ level. However, we consistently observed larger pay reductions for individuals in the Northern Powerhouse compared to similar individuals in the rest if England. In further analysis (not shown here) we used total household income instead of an individual's own weekly pay. In this scenario, household income in the North fell by 13.34% yet had no effect on household income in the rest of England. Again, the biggest effects were found for those individuals with lower levels of education.

Fig 3.1: The effects of ill-health on the probability of staying employed [89]

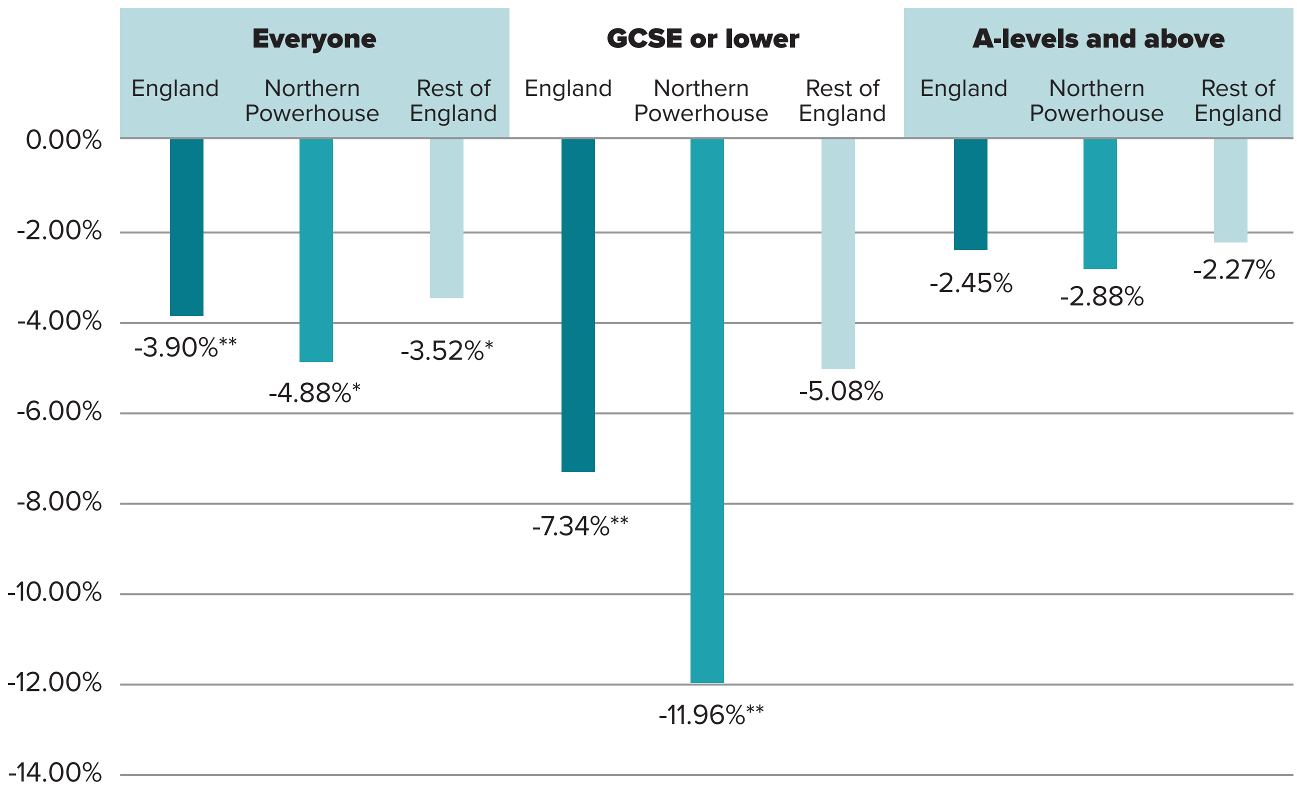
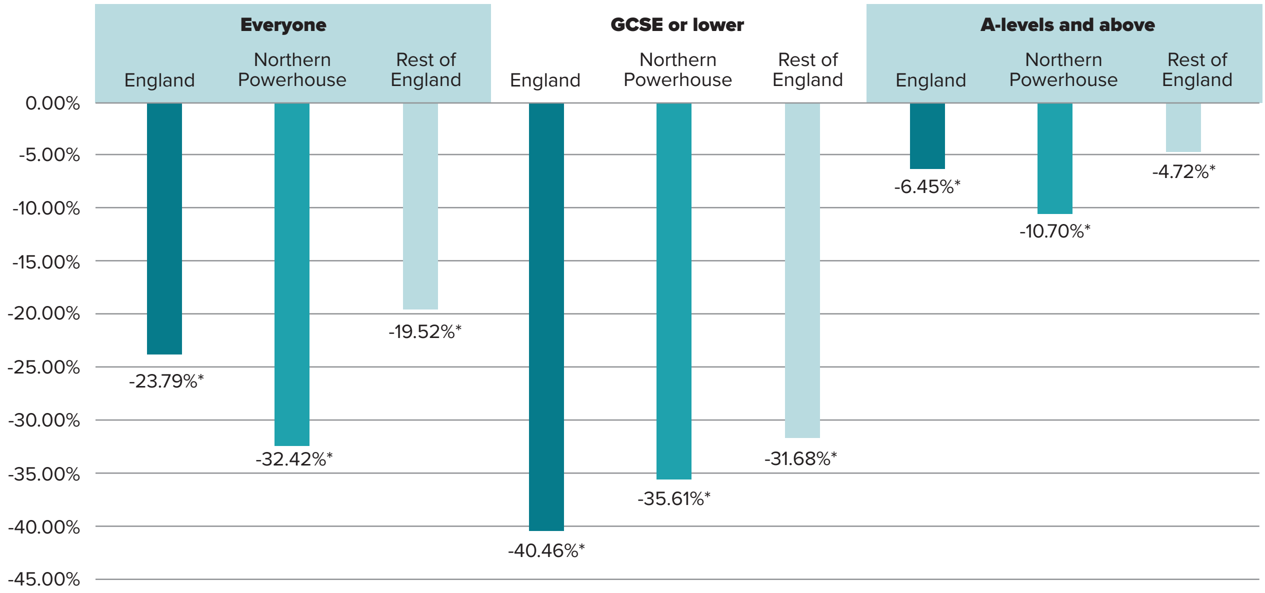


Fig 3.2: The effects of ill-health on the relative weekly pay [90]



When we considered the effects of ill-health on an individual's relative weekly hours worked (Figure 3.3) it was seen that ill-health reduces labour supply by 7.08% in the pooled sample but in this case the effects were larger in the rest of England (-7.91%) than in the Northern Powerhouse (-5.59%). The effect in the North was 29.33% (Figure 3.4) less than in the rest of England. The results appeared to be mainly driven by those with lower levels of education, where the difference was 10.56%. However, there was less of a pronounced difference when we split by educational attainment in this case.

3.5 Discussion

3.5.1 Summary of Key Findings

Ill-health leads to higher unemployment in the North compared to the rest of England but reduced working hours in the rest of England compared to the North. This suggests that people in the North are more likely to completely drop out of the labour force when ill, whereas people in the rest of England reduce their working hours.

3.5.2 Implications for Policy and Practice

There is firm evidence that unemployment adversely affects health and wellbeing, which can in turn pose a barrier to return-to-work. Preventing health-related worklessness requires adopting an upstream approach: implementing interventions to promote the health of the workforce and strengthening work retention in employees with health conditions or disabilities whose employment is precarious. Addressing existing health-related worklessness requires supporting people who have left employment due to ill-health to return-to-work. Both areas of intervention require action from national and local government, the health service and employers.

In this section we draw on wider evidence to discuss the actions that could be taken by national and local government, the health service and employers to reduce the adverse employment consequences of poor health.

Stemming the flow: supporting work retention

Improving the health of the workforce helps prevent health-related job loss. Organisational interventions that adopt whole-system approaches, with visible leadership and commitment to addressing health and wellbeing at senior management level, have demonstrated positive impacts on employees' physical health and wellbeing.[93] Improving workers' level of control over the pace of their work - such as through flexible working interventions - has also been shown to significantly improve their mental and physical health as have in-work progression and good job quality.[94 95 96 97] However, comprehensive workplace interventions that address both physical and psychosocial working conditions simultaneously tend to be more successful in improving physical and mental health than interventions with a single focus.[98]

With regards to government actions, investment thus far has been focussed on welfare-to-work schemes such as the Work Programme, the Work and Health Programme and their predecessors. Less effort has been spent preventing health-related worklessness. Strengthening work retention in vulnerable groups requires prioritising upstream interventions that prevent health-related job loss.

One way to do this is to increase pressure on employers to recruit and retain individuals with long-term health conditions or disabilities. The UK Equality Act 2010 obliges employers to make reasonable adjustments[99] to their workplaces and practices to support employees with health conditions or disabilities to retain or enter employment.[100]

Reasonable adjustments, such as phased return, light or modified duties and reduced working hours, have been demonstrated to improve employment outcomes for individuals[101] as well as their physical and mental health.[102] Reasonable adjustments and organisational flexibility also enable organisations to retain experienced and skilled staff with health conditions, and support the retention and wellbeing of older workers and staff with caring responsibilities.

However, many employers fail to implement reasonable adjustments to support the recruitment and retention of workers with disabilities and long-term conditions, contributing to their high rates of early retirement and unemployment.[103 104 105 106] Research has shown there is considerable variation in line managers' interpretation of organisational recruitment, retention and sickness absence policies and their willingness to implement them, which affects the ability of workers with health conditions or disabilities to stay in or return-to-work.[107] Moreover, organisational sickness absence policies can penalise workers with fluctuating conditions who may experience multiple spells of sick leave.[108]

Indeed, in a study of long-term sickness absence, organisational and social factors were cited by employees as the greatest barriers to their returning to work, rather than their medical condition or their ability to manage it.[109] Cost-benefit studies have already identified work adjustments that are cost-effective in preventing and managing musculoskeletal disorders,[110] while Business in the Community's 'toolkit for employers' (2017)[111] on musculoskeletal health[112] has started the process of tailoring the business case for workplace adjustments according to organisational size and sector, but further work is needed to expand this resource to other common health conditions.

In addition, firmer action is needed on employers who fail to meet their responsibilities under the Equality Act. Employers' practice could be monitored by requiring organisations to regularly provide data on the proportion of their workforce with long-term health conditions or disabilities, which roles they occupy within the organisation, how many have been granted workplace adjustments, and reasons for their leaving the organisation.

Line managers need training in the interpretation and implementation of recruitment, retention and sickness absence management policies for them to be effective.

Providing line managers with training in how to promote good mental health, for example, has been shown to improve their knowledge of mental health and how they support employees experiencing mental health problems, although more studies are needed to establish if this translates into improving mental health outcomes for employees.[113]

Work retention for people with chronic illness or disabilities can also be supported by action taken within the healthcare system. International evidence reviews of the impact of having a musculoskeletal disorder on work participation have noted that a lack of work-focused healthcare and poor communication between the healthcare system and other relevant stakeholders are obstacles to employment.[114 115]

A UK evidence review on workplace interventions to support work retention of employees with disabilities and long-term conditions noted that employees in the Nordic countries and the Netherlands have better access to rehabilitation and work-focused healthcare than their UK counterparts.[116]

Providing work-focused healthcare enables the delivery of early intervention to support workers who are at risk of job loss due to poor health. Vocational rehabilitation focussed on job retention includes: the assessment of ability to complete work tasks; identifying why the individual is at risk of having to stop working; implementing adjustments to the role and workplace; and providing vocational counselling.

Vocational rehabilitation is generally only available for individuals employed in larger organisations. The Fit for Work service offers support to employees who are off sick for at least four weeks; those in work but experiencing difficulties can only access self-help on-line advice or telephone support. The availability of work-related services in the NHS is patchy and referrals to occupational therapists is low.

Randomised controlled trials have shown job retention vocational rehabilitation can have a positive impact on the work outcomes of employed people with inflammatory arthritis[117 118] and other health conditions.

For example, a feasibility trial[119] of job retention vocational rehabilitation implemented by occupational therapists demonstrated a positive impact on presenteeism, absenteeism, coping skills and confidence in the ability to work.

However, despite calls to do so,[120] studies have shown that employment status and work difficulties are still not routinely discussed with patients with musculoskeletal disorders and other long-term conditions, especially in secondary care.[121 122] Work retention and return-to-work can be supported by embedding work retention and return-to-work as clinical outcomes in primary and secondary care, in treatment guidelines and outcome frameworks.

A screening system is needed requiring clinicians to record details of employment status, work difficulties and whether work-related help is needed, such as that developed for clinicians by the Dutch Rheumatology Association.[123]

There is also a role for employers to play in job retention amongst the workforce by acting to prevent the onset of ill-health. This can be done through work place improvements such as increasing job control, providing social support for employees, and making changes' to work place organisation such as implementing flexible working. It can also be done through health promotion activities such as by providing healthy lifestyle interventions.

These can mitigate risk factors and reduce ill-health as well as reducing the direct and indirect costs of ill-health to employers, NHS and society. An example of the latter is the North East Better Health at Work Award - a regional workplace health programme which has been implemented since 2009 and is delivered locally through workplace health promotion specialists.

Pilot research suggested that the award, which provided a structured programme which combines changes to the work environment with healthy lifestyle promotion interventions, could be a cost-effective way of improving employee health and reducing sickness absence.[124 125]

Supporting return to work: a 'health-first' approach

Supporting people who have left employment due to ill-health back into good quality employment can have health and financial benefits for individuals, reduce welfare costs for the government and - as this chapter has shown – potentially increase UK productivity.

Active labour market policies (ALMPs) aim to support people with disabilities and chronic health conditions back into the labour

Fig 3.3: The effects of ill-health on the relative weekly hours worked [91]

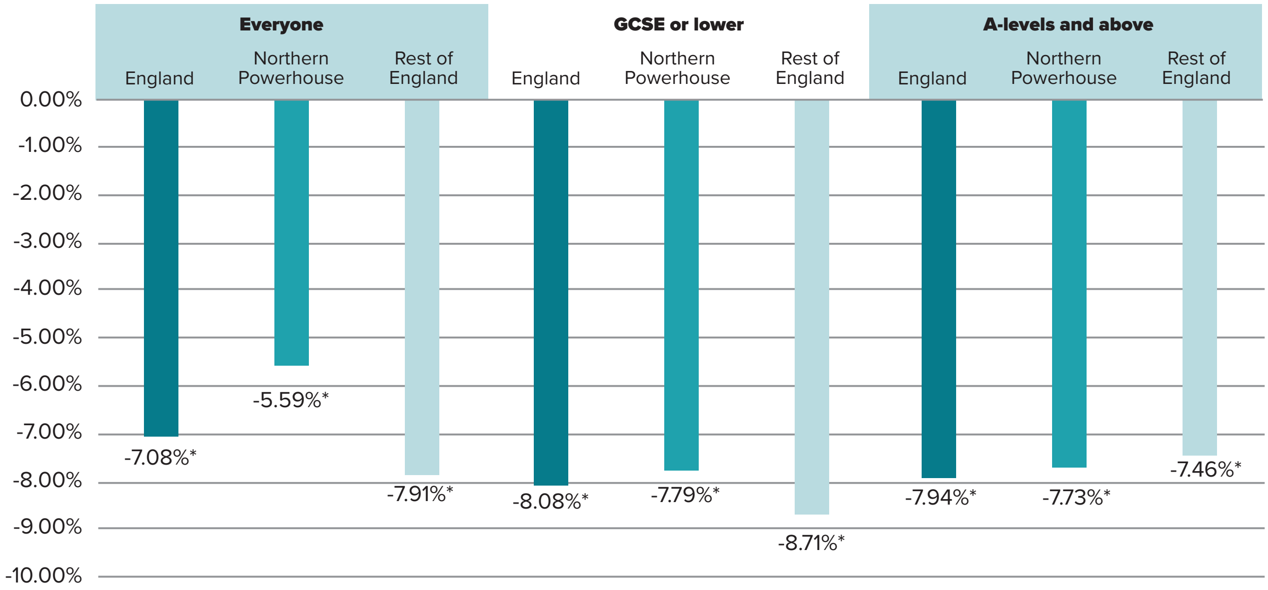
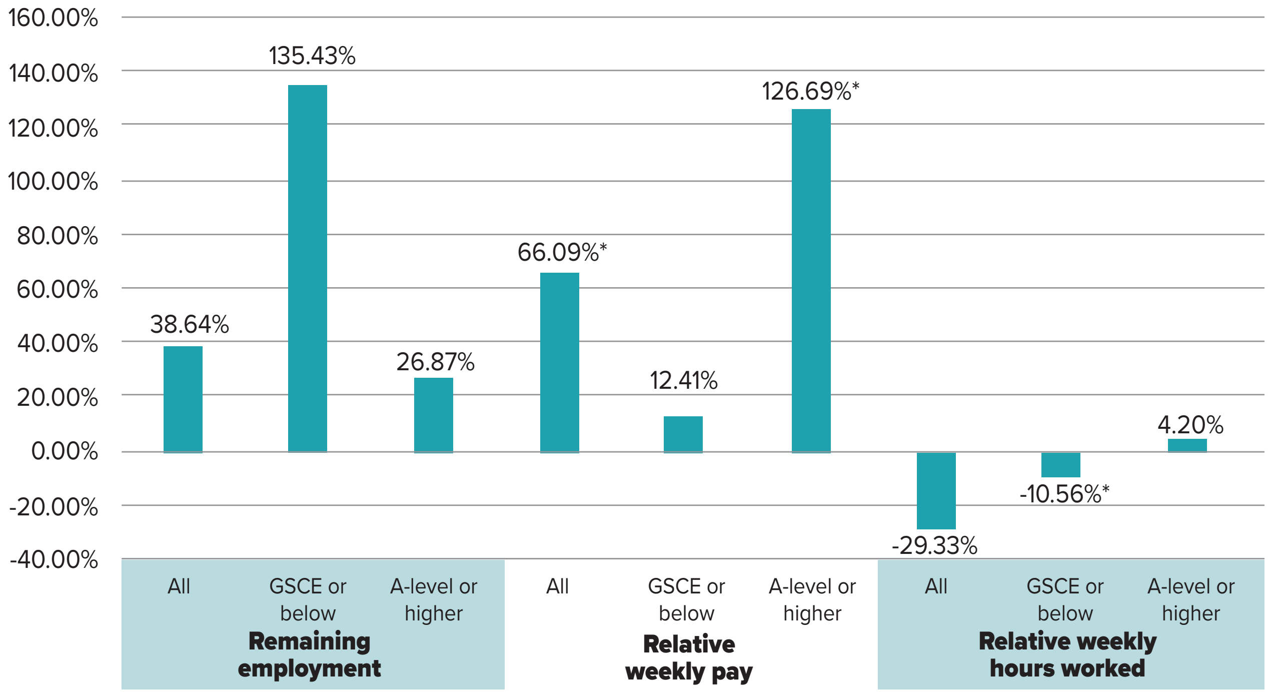


Fig 3.4: The percentage differences in effect size between the Northern Powerhouse and the rest of England [92]



market. ALMPs vary markedly in their provision and can include mandatory or voluntary work-focused interviews, job search assistance, training and in-work support. International evidence regarding the effectiveness of ALMPS in improving work participation is positive but modest and varies by how they are implemented.[126]

For example, a Danish scheme that provided job training for sick-listed workers found that subsidised job training had a large, positive effect on the transition into employment from economic inactivity.[127]

ALMPs in the UK though have particularly focused on supply-side, employability interventions (e.g. education, training and work placement schemes, vocational advice and support services, and in-work benefits) but their effectiveness in the UK has been rather limited.[128]

A possible reason is that there has been very little attention given to the health needs of this population, who, after all, are workless in the first place as a result of ill-health. They have multiple and complicated long-term illnesses, and the vast majority (up to 95%) cite ill-health as their biggest barrier to gaining employment.[129 130]

Tackling these underlying health issues could be the first step to a successful return to work – and a move towards closing the regional productivity gap.

Whilst medical and psycho-social rehabilitation has been a common feature of interventions in some other countries – where it has beneficial impacts on both employment rates and health outcomes – it has seldom featured in the UK.[131 132 133] Evidence-based guidance produced by England's National Institute for Health and Clinical Excellence (NICE) recommended such a 'health first' approach to improving the health and employment of people with a chronic illness.[134]

'Health first' approaches are differentiated from other ALMP because they focus on improving/managing the ill-health of participants before then addressing any employability issues.

The NICE guidance recommends that integrated programmes which combine traditional vocational training approaches, financial support, and health management on an ongoing case management basis should be commissioned to help health-related benefit recipients enter or return to work.

NICE considers these integrated approaches to be the most effective ways of enhancing the employment of people who are workless due to ill-health.[135]

Following NICE guidance, a 'health first' case management approach was piloted in County Durham.

This programme had some promising results suggesting that improving the health of people out of work due to severe chronic ill-health (the majority of whom were in receipt of incapacity-related benefits such as the Employment and Support Allowance) through case management and self-management techniques was effective and cost-effective in improving the health of participants, thereby increasing potential participation in mainstream ALMP employability initiatives, with the knock on effects down the line for increased labour market participation.[136]

The County Durham initiative was a small-scale local pilot and, whilst its success may not be replicable in different contexts, it does offer a potential model for local partnership working.

It is one example of how local NHS Clinical Commissioning Groups, third sector agencies and local authorities could work together in the future to reduce the regional productivity gap by reducing health-related worklessness in the North.

NHS integrated care systems and devolved city regions, as both major employers and commissioners of services, could have a major positive impact on reducing the productivity gap by acting at scale to reduce health–related worklessness.[137]

Indeed, the effects on employment and productivity should be integrated into future evaluations of condition management and self-management interventions that are increasingly being delivered by the NHS for chronic diseases such as COPD.[138 139]

Investing in health and work oriented ALMPs are likely to offer benefits for wellbeing and increase likelihood of return-to-work.

3.6 Conclusion

This chapter has shown that ill-health leads to higher rates of economic inactivity in the Northern Powerhouse when compared to the rest of England as people in the North are more likely to drop out of the labour force when they develop a long-term health condition.

Tackling such health-related worklessness in the North requires investing in upstream preventative approaches that promote the physical and mental health of the workforce, prevent job loss and premature retirement as well as developing 'health-first' ALMPs that support people with existing health problems to manage their chronic conditions and thereby return to the labour market.

Notes

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[87] The p-values are, respectively, p=0.046; p=0.038; and p=0.032
[88] The p-values are, respectively, p=0.037; p=0.025; and p=0.036.
[89] The size of the bar shows what happened to the probability of remaining in employment following a spell of ill-health for an individual who was initially employed and in good health. The bars display coefficients from 'double-robust' regression models, where we additionally controlled for the age, gender, highest educational qualification, number of children, marital status, and ethnicity of the individual. Tables showing the number of observations, statistical significance (p-values) and R-squared value for each bar are available in the supplementary appendix (Table B3.2.1). * p<0.05; ** p <0.01; *** p<0.001.
[90] Relative pay is defined as (pay in last period/pay in first period). The size of the bar shows what happened to the weekly wages of those individuals remaining in employment or returning to employment who experienced a period of ill-health after being initially employed and in good health. The bars display coefficients from 'double-robust' regression models, where we additionally controlled for the age, gender, highest educational qualification, number of children, marital status, and ethnicity of the individual. Tables showing the number of observations, statistical significance (p-values) and R-squared value for each bar are available in the supplementary appendix (Table B3.2.2). * p<0.05; ** p <0.01; *** p<0.001.
[91] Relative weekly hours is defined as (hours worked in last period/hours worked in first period). The size of the bar shows what happened to the weekly wages of those individuals remaining in employment or returning to employment who experienced a period of ill-health after being initially employed and in good health. The bars display coefficients from 'double-robust' regression models, where we additionally controlled for the age, gender, highest educational qualification, number of children, marital status, and ethnicity of the individual. Tables showing the number of observations, statistical significance (p-values) and R-squared value for each bar are available in the supplementary appendix (Table B3.2.3). * p<0.05; ** p <0.01; *** p<0.001.
[92] The percentage difference is calculated as 100*(North – Rest of England)/Rest of England. Therefore, positive values indicate that the outcomes for individuals in the north are worse compared to similar individuals in the Rest of England. P-values of coefficient differences were calculated from a 'suest' estimation and confirmed using manual calculations. Tables showing the number of observations, statistical significance (p-values) and R-squared value for each bar are available in the supplementary appendix (Tables B3.2.1, B3.2.2, and B3.2.3).
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The NHS and the UK Productivity Gap 4

This chapter looks at the effects on productivity of the Northern Powerhouse's giant health services sector which is worth some £30 billion and employs over half a million people.[140] Looking at productivity in terms of employment rates, wage levels, number of hours worked, and Gross Value Added per head, this chapter explores the effects of healthcare spending on wider economic outcomes and examines regional differences in these relationships between the north and the rest of England.

4.1 Introduction

In the previous chapters, we have focused on how public health interventions can improve health and boost productivity, as well as how reducing economic inactivity amongst people with long-term health conditions in the North could also close the UK's regional productivity gap. In this chapter though, we focus on the role of healthcare and the NHS. In 2017/18, the Department of Health and Social Care in England spent over £124 billion on the NHS - the vast majority of which was on hospital-based treatment services.[141][142] The NHS employs over 1.2 million staff in England.[143]

The traditional channel to improve health is to increase NHS spending. However, the effectiveness of health care spending at improving population health has been a contentious issue in the literature. The recent consensus, though, seems to be that more spending on healthcare leads to higher levels of health.[144][145][146][147]

However, although there is increasing interest in the role of the NHS as a major stakeholder in the local economy, particularly involved in local industrial strategy and growth plans, looking at how it can maximise its social value through employment and procurement policies,[148] there has been far less research attention paid to the wider issue of how higher spending on the NHS could impact on productivity, particularly in the North of England.

This chapter therefore examines the effects of NHS expenditure on economic outcomes (employment rate, economic inactivity rate, wages and GVA) in England and whether NHS expenditure is more effective in the North than the rest of England.

4.2 Key Research Questions

1. To estimate the effects of healthcare expenditure on economic outcomes in England
2. To examine for regional differences in these relationships; between the North and the rest of England.

4.3 Methods

4.3.1 Data

We constructed a longitudinal dataset at Local Authority District (LAD) level over a period from 2004 to 2017. There are 326 LADs in England; these districts are responsible for running local services in the area, which include education, transport and social care.

We collected a wide range of information from various sources, which are outlined below. Further details on data sources are available in technical appendix C (Table C4.1.1).

Economic Outcomes

We obtained data on measures of economic activity from NOMIS[149] the official labour market statistics portal. We collected information on employment and productivity, including measures of the employment rate, and the economic inactivity rate. Additionally we collected information on the median weekly wage in a LAD, and adjusted for inflation (using the Retail Price Index). We further obtained data on productivity proxied by Gross Value Added (GVA) per-head, available at LAD level.

Healthcare Spending Variables

To measure healthcare spending we used NHS budget allocation to primary care trusts (PCTs) prior to 2013 and clinical commission groups (CCGs) post 2013. We mapped allocations for these local commissioning organisations to local authority populations based on the proportion of their populations that lived in each local authority.

Additional Variables

We obtained data on LADs age structure in 10 year age bins starting from 16 years. We further collected data on the wage to unemployment benefit ratio which was inflationary adjusted and the percentage of population that had no qualification which was used as a measure of education level. We finally obtained annual population estimates for each LAD to control for population size.

4.3.2 Statistical Methods

We constructed a longitudinal (panel) dataset consisting of repeated annual observations for each LAD. Fixed effects regression models which control for the effect of time-invariant unobserved LAD influences were applied. This approach exploits within LAD variation to identify the effect of changes in healthcare spending on changes in economic outcomes.

This provides greater confidence in the results. We additionally allowed for year fixed-effects to account for system wide shocks that happened in specific years. As our analysis time frame included the recession, these year fixed-effects will absorb its impact on economic outcomes.

We estimated the effect of NHS budget allocations on wider economic outcomes separately. We estimated models for the pooled sample and also for the Northern Powerhouse and the rest of England separately.

Finally, we considered the possibility that healthcare and wider outcomes could be jointly determined and/or influenced by external factors that we were unable to account for. To overcome these issues we considered two stage models.

Further details on the statistical models applied here are available in technical appendix C.

4.4 Results

4.4.1 Key Findings

1. Increasing the NHS budget in the Northern Powerhouse by 1% will increase the employment rate by 0.3 percentage points and reduce the rate of economic inactivity by 0.3 percentage points in the Northern Powerhouse.[150]
2. Increasing allocated NHS spending in the Northern Powerhouse by 1% will increase GVA per-head by 0.07% or £14 per-head Northern Powerhouse.[151]
3. Increasing allocated NHS spending in the Northern Powerhouse by 1% will increase median weekly pay by 0.1% or £35 per-week Northern Powerhouse.[152]
4. Corresponding results estimated for the rest of England consistently lead to lower effects of healthcare expenditure on

relevant economic outcomes.
5. Greater resourcing of healthcare is likely to lead to greater gains in wider economic outcomes when targeted to the North compared to the rest of England.

4.4.2 Detailed Results

In Figure 4.1 we considered the effects of NHS allocated budgets on employment rates, economic inactivity, weekly pay, and GVA per head – for the whole of England and for the Northern Powerhouse compared to the rest of England.

For the whole of England, a 1% increase in NHS budget allocation would increase the employment rate by 0.12 percentage points. However, in the Northern Powerhouse there was evidence of a stronger, more pronounced, relationship; a 1% increase in NHS budget allocation would increase employment rates in the Northern Powerhouse by 0.28 percentage points. In the Rest of England (RoE) a 1% increase in budgets would increase employment rates by 0.16 percentage points. The difference in the effects between the two regions was statistically and economically meaningful.[153]

Information regarding sample sizes, goodness of fit, and statistical significance is provided in the Tables in Technical Appendix C.

In England, a 1% increase in allocated budgets would reduce the rate of economic inactivity by 0.27 percentage points and again this effect was seen to be larger in the North, where the corresponding reduction was 0.30 percentage points. In the RoE there was evidence of a negative relationship between healthcare spending and economic inactivity, but this was less pronounced. The difference in the effects between the two regions was statistically and economically meaningful.[154]

When we considered the effects of budget allocation on median weekly pay (in percentage increase terms) the results indicated that for the whole of England, a 1% increase in NHS budgets would increase median weekly pay by 0.05%. In the Northern Powerhouse, the effect was much larger (0.1%) compared to the Rest of England (0.04%), and the difference between the two regions was meaningful.[155]

Increasing the NHS budget allocation per-head increased GVA per-head by 0.05% in England and this effect was large in the Northern Powerhouse (0.07%) compared to the RoE (0.038%). The difference between the two regions was less pronounced in this analysis, but still meaningful.[156]

When we considered the effects of budget allocation on median weekly pay (in monetary terms; £ per week) the results indicated an increase of 1% in NHS budgets would increase weekly pay by £31 in England.

The corresponding increase for the Northern Powerhouse was £44 per week, compared to £26 per week for the RoE. The difference in the potential returns between the two regions was both economically and statistically large.[159]

Finally, we considered the effects of NHS budget allocation on GVA per-head (in monetary terms; £ per-person).

A 1% in NHS budgets would increase GVA per-head by £38 for the whole of England. In this case, however, there were larger gains for the RoE (£42) compared with the Northern Powerhouse (£14). This difference however, whilst appearing economically significant (large in nature) was not statistically different.[160] One way to explain the apparent larger gains in the RoE is that in that region there were already much larger levels of GVA per-head, and hence we argue that the percentage increases (Figure 4.1) are more informative here.

4.5 Discussion

4.5.1 Summary of Key Findings

We observed that increasing NHS resource allocation can lead to better economic outcomes in terms of higher employment rates, lower rates of economic inactivity, higher GVA per-head, and higher median weekly pay.[161] The results were consistently stronger in the North than compared to the RoE indicating there are potential higher returns to increasing NHS resource allocation and therefore expenditure in the North.

4.5.2 Implications for Policy and Practice

Our results suggest that investment in the NHS not only leads to improved health but also can have wider economic benefits for society. Previous work has indicated that the return on investment of government spending on healthcare is greater than investment in other sectors.[162]

Similarly we find that health investment leads to higher employment and wages and importantly that these effects were greater in the North compared to the rest of England. These findings have important implications for policies that aim to reduce the North-South economic divide. In this section we draw on wider evidence to discuss the actions that could be taken by national and local government and the health service.

There is increasing interest in the role of the NHS as a major stakeholder in the local economy, particularly involved in local industrial strategy and growth plans, looking at how it can maximise its social value through employment and procurement policies.[163]

Our results indicate that the share of funds allocated to the health sector and how these are distributed between geographical areas is likely to have an impact on economic inequalities. This potentially through improving the health of the local population via health services interventions, particularly preventive ones (such as social prescribing), decreased waiting times in hospitals and primary care, and improvements in the control of chronic conditions.[164]

Furthermore, NHS integrated care systems could have more leverage on place-based spending by allocating a greater proportion of available resources to tackling prevention and social determinants of health.

Fig 4.1: The effects of allocated NHS spending on employment rates, economic inactivity rates, percentage changes in median weekly pay, and percentage changes in Gross Value Added per head[157]

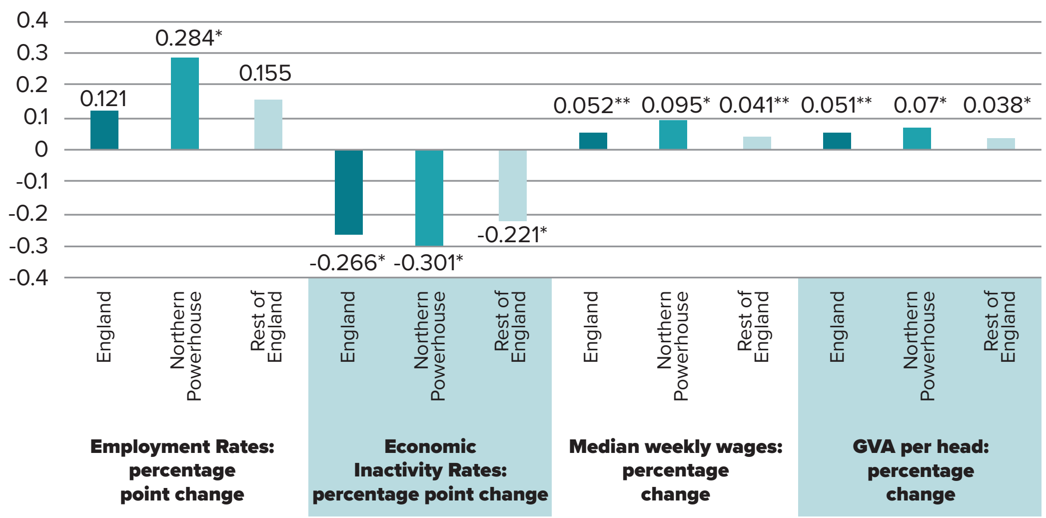
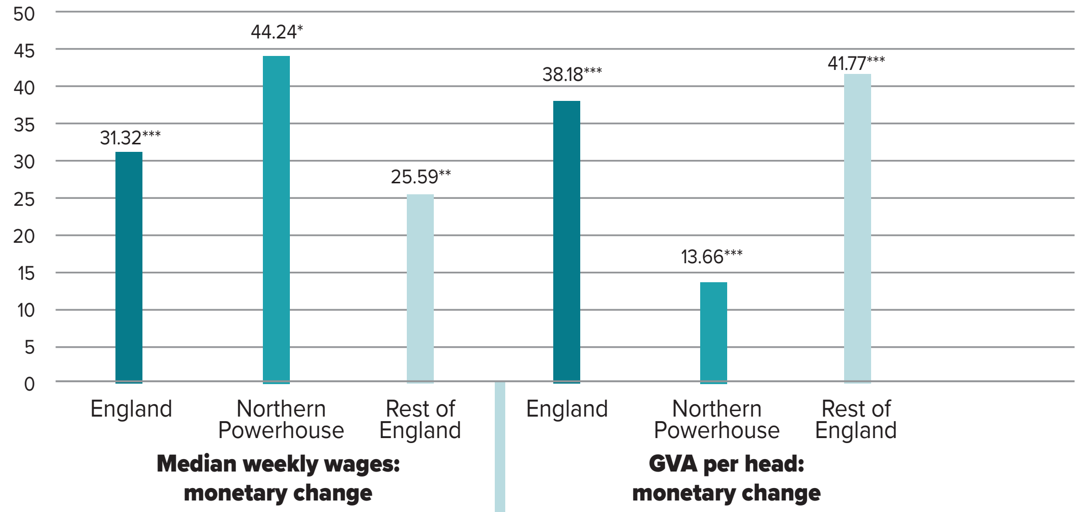


Fig 4.2: The effect of allocated NHS spending on median weekly pay (in pounds) and Gross Value Added per-head (in pounds) [158]



NHS funding was increased from 2001-2010 when a "health inequalities weighting" was added to the way in which NHS funds were geographically distributed so that areas of higher deprivation (a disproportionate number of which are in the Northern Powerhouse region) received more funds per head to reflect higher health need.

Analysis has shown that this policy of increasing NHS funding in more deprived areas was associated with a reduction in absolute health inequalities from 'causes amenable to healthcare'.[165 166] Increases in NHS resources to deprived areas accounted for a reduction in the gap between deprived and affluent areas in 'mortality amenable to healthcare' in men of 35 deaths per 100,000 and mortality of 16 deaths per 100,000 for women.

Each additional £10 million of resources allocated to deprived areas was associated with a reduction in 4 deaths per 100,000 men and 2 deaths per 100,000 women.[167]

Further, research has also shown that higher NHS hospital research spend is associated with lower mortality rates.[168]

Despite the clear potential of the North in health innovation, it has seen significant underinvestment from the public sector in clinical, healthcare and applied public health research compared both to other regions and the private sector. For example, the North received only 13.6% of public medical and health research funding across the UK in 2014.[169]

Studies have shown public investment in health science R&D leverages private sector investment, with every £1 of public money stimulating an additional £2.20-£5.10.[170] Therefore, increased investment in NHS research in the North is likely to contribute to improved health outcomes.So increasing NHS resources and research in the Northern Powerhouse could improve health and thereby boost productivity.

However, increasing healthcare spending alone is not enough to improve health in the North, wider public health interventions are also required (as described in chapters 2, 3 and 5).

4.6 Conclusion

This chapter has shown that increasing NHS budgets can lead to better economic outcomes in terms of higher employment rates, lower rates of economic inactivity, higher GVA per-head, and higher median weekly pay. The effects of increasing NHS budgets on productivity were consistently stronger in the Northern Powerhouse than in the rest of England indicating there are potential higher productivity returns in the North.

Greater resourcing of healthcare are therefore likely to lead to greater economic gains in the North – potentially helping to reduce the productivity gap with the rest of England.

Notes

[140] Northern Health Science Alliance (2018) The Northern Powerhouse in Health Research - A Science and Innovation Audit, http://www.thenhsa.co.uk/case-studies/uk-science-innovation-audit/

[141] https://www.kingsfund.org.uk/projects/nhs-in-a-nutshell/nhs-budget

[142] For example, in North East Combined Authority Area (NECA) over 60% over the £5.2 billion is spend on tackling the consequences of ill health through hospital and specialist care, over 20 times the 3% devoted to public health. See: NECA (North East Combined Authority) (2016) Health and Wealth - Closing the Gap in the North East Executive Summary of the Report of the North East Commission for Health and Social Care Integration https://www.ntw.nhs.uk/content/uploads/2017/02/Agenda-item-9-i-c-Executive-Summary-Health-and-Wealth-Closing-the-Gap-in-the-North-East.pdf

[143] https://fullfact.org/health/how-many-nhs-employees-are-there/?gclid=EAIaIQobChMItozRvpec3gIVDLTtCh3tGgNWEAAYASAAEgJnrvD_BwE

[144] Martin et al (2008) Does health care spending improve health outcomes?: Evidence from English programme budgeting data, Journal of Health Economics, 27, pp.826 – 842

[145] Barr et al (2014) "The Impact of NHS Resource Allocation Policy on Health Inequalities in England 2001-11: Longitudinal Ecological Study." BMJ 348, g3231–g3231.

[146] Martin et al (2012) Comparing costs and outcomes across programmes of healthcare. Health Economics, 21(3): 316-337.

[147] Including investments in prevention and public health

[148] NHS Confederation (2017) https://www.nhsconfed.org/supporting-members/integration-and-new-care-models/local-planning/growing-local-economies/nhs-and-local-economies

[149] https://www.nomisweb.co.uk/

[150] The p-values are, respectively, p=0.036 and p=0.023.

[151] The p-values are, respectively, p=0.022 and p<0.001.

[152] The p-values are, respectively, p=0.034 and p=0.032.

[153] We conducted an additional regression where we interacted a binary variable for the Northern Powerhouse with all variables. The coefficient on the interaction between NHS expenditure and Northern Powerhouse was positive and statistically significant (p=0.026) indicating higher potential returns in the Northern Powerhouse. See (Table C4.2.3) for further details.

[154] In this case, the p-value on the interaction term was p=0.036 (Table C4.2.3).

[155] The p-value on the interaction term was p=0.022 (Table C4.2.3).

[156] The p-value here was p=0.056, which is slightly larger than the usual threshold of p<0.05 (Table C4.2.3).

[157] The size of the bar shows what happened to the outcomes considered if NHS expenditure was increased by 1%. The bars display coefficients from fixed-effects regression models, where we additionally controlled for the age structure of the population, the log of the total population of each LAD, the percentage of people who have no qualifications, the wages to unemployment benefit ratio, and year effects. Tables showing the number of observations, statistical significance (p-values) and R-squared value for each bar are available in the supplementary appendix (Table C4.2.1). * p<0.05; ** p <0.01; *** p<0.001.

[158] The size of the bar shows what happened to the outcomes considered if NHS expenditure was increased by 1%. The bars display coefficients from fixed-effects regression models, where we additionally controlled for the age structure of the population, the log of the total population of each LAD, the percentage of people who have no qualifications, the wages to unemployment benefit ratio, and year effects. Tables showing the number of observations, statistical significance (p-values) and R-squared value for each bar are available in the supplementary appendix (Table C4.2.2). * p<0.05; ** p <0.01; *** p<0.001.

[159] The coefficient on the interaction term had a p-value of p=0.035 (Table C4.2.3).

[160] The p-value on the interaction term was p=0.287 (Table C4.2.3).

[161] Although this was not always statistically significant.

[162] Reeves et al (2013) Does Investment in the Health Sector Promote or Inhibit Economic Growth? Globalization and Health, 9, 43.

[163] NHS Confederation (2017) https://www.nhsconfed.org/supporting-members/integration-and-new-care-models/local-planning/growing-local-economies/nhs-and-local-economies

[164] Barr et al (2014) The impact of NHS resource allocation policy on health inequalities in England 2001-2011: longitudinal ecological study. BMJ, 348:g3231

[165] Mortality amendable to health care is mortality from causes for which there is evidence that they can be prevented given timely, appropriate access to high quality care.

[166] Barr et al (2014) The impact of NHS resource allocation policy on health inequalities in England 2001-2011: longitudinal ecological study. BMJ, 348:g3231

[167] Barr et al (2014) The impact of NHS resource allocation policy on health inequalities in England 2001-2011: longitudinal ecological study. BMJ, 348:g3231

[168] Ozdemir et al (2015) 'Research Activity and the Association with Mortality', PLoS ONE 10(2)

[169] Northern Health Science Alliance (2018) The Northern Powerhouse in Health Research - A Science and Innovation Audit, http://www.thenhsa.co.uk/case-studies/uk-science-innovation-audit/

[170] Northern Health Science Alliance (2018) The Northern Powerhouse in Health Research - A Science and Innovation Audit, http://www.thenhsa.co.uk/case-studies/uk-science-innovation-audit/

5 Increasing UK Productivity by Reducing Regional Health Inequalities

This chapter estimates how much poorer health in the Northern Powerhouse contributes to the regional productivity gap as measured by differences in the employment rate and the Gross Value Added (GVA) per-head between the Northern Powerhouse and the rest of England.[171] It also discusses how reducing regional health inequalities through public health and prevention strategies could close England's productivity gap and increase UK growth.

5.1 Introduction

The UK's productivity is lagging behind the other G7 economies as is illustrated in Figure 4.1 below.

Part of this slowdown in UK productivity may be attributed to huge regional productivity differences in the UK and a heavy reliance on London for pushing the country's growth cannot be sustainable in the long run.[173]

As Chapter 2 has suggested, health could be an essential component of the productivity gap between the Northern Powerhouse and the rest of England. Across all social groups and among both men and women those in the North are consistently found to be in poorer health than those in the South.[174 175] A lower level of health is expected to impact on a person's ability to work (e.g. from fatigue) as well as increase the likelihood that they will face discrimination in the labour market.[176 177] This chapter quantifies how the regional health divide contributes to the regional productivity gap and how much health would need to improve in the Northern Powerhouse to increase UK productivity.

5.2 Research Questions

1. To measure how much of the gap in productivity, measured by GVA per-head, can be attributed to differences in health.
2. To identify how much health contributes to regional productivity differences as measured by the employment rate between the Northern Powerhouse region and the rest of England.
3. To determine how much health would need to improve in the Northern Powerhouse region to reduce inequalities in productivity by 10% between the Northern Powerhouse region and the rest of England.

5.3 Methods

5.3.1 Data

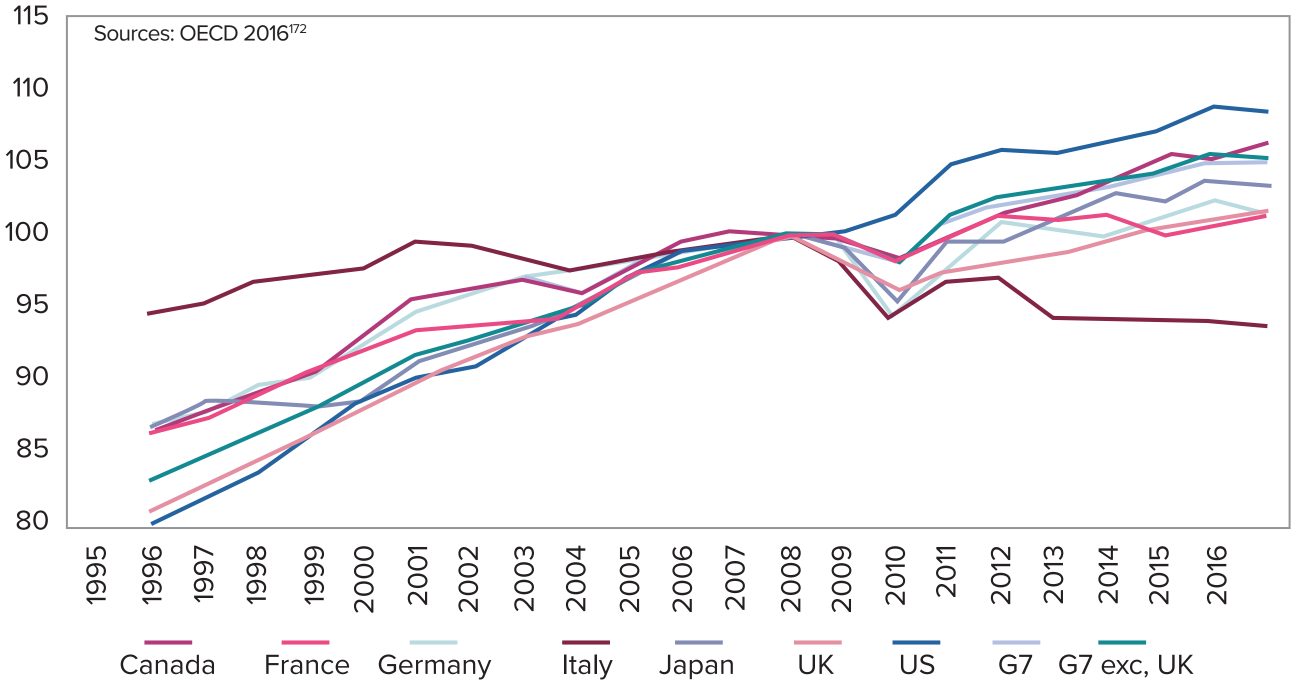
Aggregate Level Analysis

As the smallest geographic level at which GVA per-head is reported in Local Authority District (LAD). We therefore start by analysing the data outlined in Chapters 2 and 4 to examine how much of the gap in GVA per-head can be attributed to health (morbidity and mortality). Further details of the variables considered can be found in Chapters 2 and 4 and are available in technical appendix D (Table D5.1.1).

Individual Level Analysis

We then supplemented the aggregate level analysis described

Fig 4.1: International comparisons of productivity (constant price GDP per worker)



above by performing an individual level analysis. To do this, we used data from Understanding Society: The UK Household Longitudinal Study (UKHLS),[178] which tracks around 40,000 UK households each year. We used the first seven waves of available data in the period 2008 – 2016. UKHLS contains a rich set of socio-economic and demographic information on respondents, including details on education attainment, employment outcomes, health status and the region in which they live. Further details on data definitions are available in technical appendix D (Table D5.1.2).

Economic Outcomes

We focus on productivity as measured by the employment gap. This was measured by a binary indicator of whether a person was in employment (=1) or not (=0).

Health Variables

In this section, we look at physical and mental health. We use two indicators of physical health. Firstly, Self-reported health status. People were asked: "In general, would say your health is excellent, very good, good, fair or poor?" From this we classified people into "good health" if an individual responded with excellent, very good or good, and into "bad health" if they responded with fair or poor.

Our second indicator of physical health is the presence of a long standing illness or impairment. People were asked "Do you have any long-standing physical or mental impairment, illness or disability? By Long-standing illness or impairment I mean anything that has troubled you over a period of at least 12 months or that is likely to trouble you over a period of at least 12 months." We used this variable to create a binary indicator which was equal to one if they responded yes and zero if they responded no.

Our indicator for mental health is the GHQ-12 which is a validated measure of mental health in a UK general population sample.[179] People were asked 12 questions designed to identify minor psychiatric disorders and also to investigate psychological health more generally. Each of the questions was answered on a 0-3 scale, meaning that the cumulative score takes values between 0-36. Where 0 is the best possible mental health and 36 is the worst possible mental health. For the estimation model, we utilised a binary variable for poor mental health if an individual had a GHQ-12 score of 12 or over and is equal to zero if they have a score of 11 or less.[180]

Additional Variables

We used a set of well-known socio-economic controls in order to isolate the effect of health on the independent variable. We obtained information on age, gender, highest educational attainment, number of children, marital status, and urbanity of where the respondent lives.

Restrictions and Estimation Sample

The only restriction we placed on our estimation sample is that respondents were of working age 16-65 years. We have data on 7,388 people living in the Northern Powerhouse region and 18,533 people living in the rest of England.

5.3.2 Statistical Models

We modelled the role of health in explaining the productivity difference between the Northern powerhouse and the rest of England. In the aggregate level analysis, morbidity and mortality were combined to give a total measure of the effects of health on the productivity gap. In the individual level analysis, mental and physical health and long-term conditions were combined to give a total measure of the effects of health on the productivity gap. Productivity was measured as the difference in GVA per-head between the Northern Powerhouse region and the rest of England in the aggregate level analysis and as the employment gap between the Northern Powerhouse region and the rest of England in the individual level analysis.

We started by using a statistical technique called decomposition models. This breaks down how much of the GVA/employment gap between the Northern Powerhouse and the rest of England can be explained by the respective measures of health. Next, to determine how much health would need to be improved to reduce the productivity gap between the Northern Powerhouse and the rest of England by 10%, we estimated the association between mental and physical health, long-term conditions and employment status. This figure was then divided by the total contribution of health to the productivity difference between the Northern Powerhouse and the rest of England minus the productivity gap multiplied by 10% (to account for the change we are looking for). A more detailed discussion of the estimation model can be found in technical appendix D.

5.4 Results

5.4.1 Key Findings

- Rates of ill-health are 5-15% higher in the Northern Powerhouse
- The gap in the GVA per-head between the Northern Powerhouse and the rest of England was approximately £4,750 (or around 20%).
- The gap in employment rates between the Northern Powerhouse and the rest of England was approximately 2.1 percentage points.
- 30% of the GVA gap between the Northern Powerhouse and the rest of England can be attributed to poorer health in the North
- 33.6% of the employment gap between the Northern Powerhouse and the rest of England can be attributed to poorer levels of health in the North.
- In the Northern Powerhouse region, being in good health compared to poor health increases the probability of being in employment by 17.9%.
- To reduce the regional gap in GVA per-head by 10%, morbidity would need to reduce by 1.2% and mortality reduce by 0.7% in the Norther Powerhouse region.
- In order to decrease the regional gap in employment by 10%, health would need to increase by 3.5% in the Northern Powerhouse region.

5.4.2 Detailed Results

Table 5.1 shows that GVA per-head is substantially smaller in the Norther Powerhouse compared to the rest of England, and that rates of morbidity and mortality are larger. The gap in GVA per-head is £4,754.43, and the differences in the morbidity and mortality rates are 2.92 percentage points and 1.12 percentage points, respectively.

Table 5.1 additionally shows that poor general health is 2.4 percentage points worse in the Northern Powerhouse with similar health gaps for mental health (-2.1%) and limiting long term conditions (-2.1%). This means that rates of ill health are 5-15% higher in the North depending on the measurement used. Table 5.1 also shows that the employment rate in the Northern Powerhouse region over our study period (2008-2016) is 69.3%, a difference of 2.1 percentage points with the rest of England, which is 71.4%.

At the aggregate level (Figure 5.1), our modelling found that 30% of this productivity gap between the Northern Powerhouse and the rest of England can be attributed to poorer health in the North, of the health component, this can be broken down into 17.1% being explained by morbidity and 12.8% being explained by premature mortality.

At the individual level (Figure 5.2), 33.6% of the regional employment difference can be explained by the higher levels of poor health in the Northern Powerhouse. This can be broken down by 24.4% from higher rates of physical ill-health and 9.1% from higher rates of mental ill-health.

When we consider the association between participating in employment and our indicators for physical and mental health for people living in the Northern Powerhouse region, having good general health is associated with a 9.2% higher likelihood of being in work in the Northern Powerhouse region and having good mental health is associated with a 3.7% higher likelihood of being

Table 5.1: Percentage contribution of health to the difference in employment between the Northern Powerhouse and the rest of England [181 182]

	Northern Powerhouse	Rest of England	Regional Difference
		Aggregate level	
Morbidity	11.01%	8.09%	2.92
Deaths per 1,000 pop.	10.08	8.96	1.12
GVA per-head	£18,322.93	£23,077.36	-£4,754.43
		Individual level	
Poor General Health	18.1%	15.7%	-2.4
Poor Mental Health	43.7%	41.6%	- 2.1
Long Term Limiting Condition	28.3%	26.2%	- 2.1
Employed	69.3%	71.4%	-2.1

in work, whilst having a long-term limiting condition is associated with a 5% lower likelihood of being in work. Summing these three measures of health together means that being in good mental and physical health is associated with a 17.2% higher likelihood of being in work in the Northern Powerhouse.

At the aggregate level, using the results from Figure 5.1 and Table 5.2, we observe that in order to reduce the gap in GVA per-head between the Northern Powerhouse region and the rest of England by 10%, morbidity and mortality would need to be reduced by around 2%. This can be broken down into a 1.2% decrease in morbidity and 0.7% decrease in mortality.

Using the results from Figure 5.2 and Table 5.3, at the individual level, tells us that in order to reduce the employment gap by 10% in the Northern Powerhouse region compared to the rest of England, physical and mental health and associated long terms conditions

Table 5.2: Association between health and GVA per head in the Northern Powerhouse [185]

Health changes	Impact on Being in Employment
1% Morbidity reduction	3.7%
1% Mortality reduction	2.2%

Table 5.3: Association between health and labour market participation in the Northern Powerhouse [186]

Health condition	Impact on Being in Employment
Good General Health	9.2%
Good Mental Health	3.7%
Long Term Limiting Condition	-5.0%

would need to increase by 3.5%.

5.5 Discussion

5.5.1 Summary of Key Findings

From the results presented above, health contributed over 30% to the difference in both the aggregate level GVA per-head (difference of £4,754.43) and in employment rates (difference of 2.1 percentage points) between the Northern Powerhouse and the rest of England. In the Northern Powerhouse region those in better health are 17% more likely to be in employment.

To reduce the gap in GVA per-head between the Northern Powerhouse and the rest of England by 10%, morbidity would need to be reduced by 1.2% and mortality reduced by 0.7

To reduce the employment gap between the North and the rest of England by 10%, those reporting good mental and physical health in the North would need to increase by 3.5%.

5.5.2 Implications for Policy and Practice

This chapter provides firm evidence that poor health impacts on labour productivity as measured in terms of GVA per-head and employment rates. If a similar proportion of health explained the gap in GVA of £4 per person per hour,[187] between the Northern Powerhouse and the rest of England, then improving health would reduce this gap by £1.20.

This figure is robust to the level of analysis considered.[188] Thus, improving both mental and physical health can make a real contribution to reducing regional productivity differences and help the UK recover its relative international standing.

This section draws on wider evidence to examine how reducing the regional productivity gap through improving public health could be achieved.

In 2014, Public Health England commissioned an independent inquiry into how to reduce the North-South health divide in England - the resulting Due North report set out four sets of recommendations for national and local government agencies - supported by evidence and analysis.[189] These are worth restating here given the links we have established between poorer health and lower productivity in the North:

Fig 5.2: The effects of health care expenditure in explaining the productivity gap (GVA per-head) at the aggregate level[183]

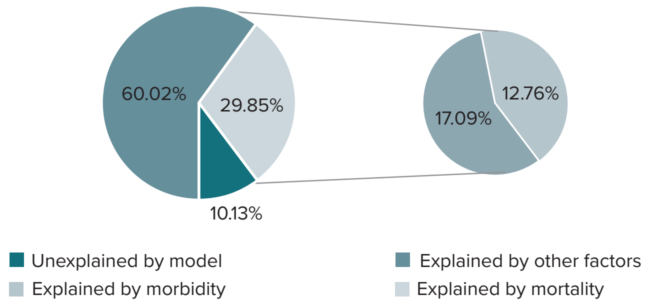
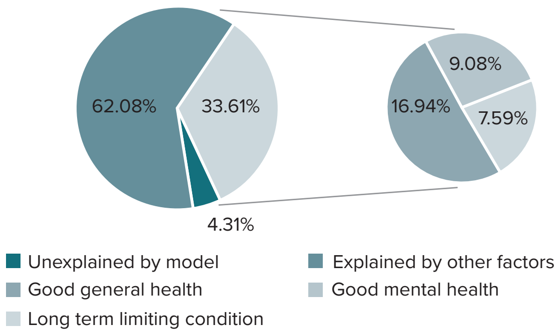


Fig 5.2: The effects of health in explaining the employment gap at the individual level [184]



● **Tackle poverty and economic inequality within the North and between the North and the rest of England:** National government and agencies in the North should/can work together to: embed health focused approaches into local economic development strategy and delivery; work together across the public sector to adopt a common progressive procurement approach to promote health; and assess the impact in the North of changes in national economic and welfare policies.

Northern agencies should/can lobby central government to: extend the national measurement of the wellbeing programme to better monitor progress and influence policy on inequalities; develop a national industrial strategy that reduces inequalities between the regions; assess the impact of changes in national policies on health inequalities in general and regional inequalities in particular; expand the role of Credit Unions and take measures to end the poverty premium; introduce a licensing scheme to improve private housing stock; end in-work poverty by implementing and regulating a real living wage; ensure that welfare systems provide a Minimum Income for Healthy Living (MIHL);[190] advocate for City and County regions to be given greater control over the use of the skills budget and to make the Work Programme more equitable and responsive to differing local labour markets; develop a new deal between local partners and national government that more fairly allocates the total public resources for local populations.

● **Promote healthy development in early childhood:** National government and agencies in the North should/can work together to: monitor and incrementally increase the proportion of overall expenditure allocated to giving every child the best possible start in life, and ensure that the level of expenditure on early years development reflects levels of need; provide good quality universal early years education and childcare with greater emphasis on those with the greatest needs to ensure that all children achieve an acceptable level of school readiness; maintain and protect universal integrated neighbourhood support for early child development, with a central role for health visitors and children's centres that clearly articulates the proportionate universalism approach.[191]

Agencies in the North should/can lobby central government to: embed a rights based approach to children's health; reduce child poverty through the measures advocated by the Child Poverty Commission which includes investment in action on the social determinants of all parents' ability to properly care for children, such as paid parental leave, flexible work schedules, living wages, secure and promising educational futures for young women, and affordable high quality child care; reverse recent falls in the living standards of less advantaged families; commit to carrying out a cumulative impact assessment of any future welfare changes to ensure a better understanding of their impacts on poverty and to allow negative impacts to be more effectively mitigated; invest in raising the qualifications of staff working in early years childcare and education; increase the proportion of overall expenditure, allocated to the early years and ensure expenditure on early years development is focused according to need; provide universal support to families through parenting programmes, children's centres and key workers, delivered to meet social needs; provide good quality early years education and childcare proportionately according to need.

● **Share power over resources and increase the influence that the public has on how resources are used to improve the determinants of health:** Agencies in the North should/can work together to: develop community led systems for health equity monitoring and accountability; expand the involvement of citizens in shaping how local budgets are used; increase the provision of services by participative and representative organisations that are based on 'mutual' models of public ownership; develop the capacity of communities to participate in local decision-making and developing solutions which inform policies and investments at local and national levels; develop deep collaboration between Combined Authorities in the North to develop a Pan-Northern approach to economic development and health inequalities; re-vitalise Health and Wellbeing Boards to become stronger advocates for health both locally and nationally.[192]

Agencies in the North should/can lobby central government to: give local government a greater role in deciding how public resources are used to improve the health and wellbeing of the communities they serve; revise national policy to give greater flexibility to local government to raise funds for investment and use assets to improve the health and wellbeing of their communities.

● **Strengthen the role of the health sector in promoting health equity:** Public Health England should conduct a cumulative assessment of the impact of welfare reform and cuts to local and national public services; support local authorities to produce a Health Inequalities Risk Mitigation Strategy; establish a cross-departmental system of health impact assessment; support the involvement of health and wellbeing boards and public health teams in the governance of Local Enterprise partnerships[193] and Combined Authorities; contribute to a review of current systems for the central allocation of public resources to local areas; develop a network of Health and Wellbeing Boards across the North of England with a special focus on health equity; lead the development of a charter to protect the rights of children; work with Health Watch[194] and health and wellbeing boards across the

North of England to develop community led systems for health equity monitoring and accountability.

Clinical Commissioning Groups[195] and other NHS agencies in the North should work together to: lead the way in using the Social Value Act to ensure that procurement and commissioning maximises opportunities for high quality local employment, high quality care, and reductions in economic and health inequalities; pool resources with other partners to ensure that universal integrated neighbourhood support for early child development is developed and maintained; Clinical Commissioning Groups and the local area teams of NHS England should develop a community orientated model of primary care; work with the Department for Work and Pensions (DWP) to develop 'health first' employment support programmes for people with chronic health conditions;[196] work more effectively with Local Authority Directors of Public Health and PHE to address the risk conditions (social and economic determinants of health) that drive health and social care system demand; support health and wellbeing boards to Integrate budgets and jointly direct health and wellbeing spending plans for the NHS and local authorities; provide leadership to support health services and clinical teams to reduce children's exposure to poverty, and its consequences.

However, local authorities in the Northern Powerhouse have been faced with disproportionally larger spending cuts than their counterparts in the rest of England: averaging 7.8% compared with 3.5%.[197] Further, a report commissioned by Oxfam and the Joseph Rowntree Foundation found that the reductions to the welfare system since 2010[198] have also had more of an impact in the North – particularly in the older industrial areas in the North West and the North East of England.[199] In contrast, most of southern England (outside London) is much less acutely affected.[200]

For example, Blackburn and Blackpool local authorities in Lancashire will each lose £560 per working age adult as a result of the post-2015 welfare reforms, compared to just £150 in Guildford in Surrey.[201] Austerity presents a real challenge for local agencies in the North to implement systematic place-based approaches to improve health and reduce regional health and productivity inequalities.

5.6 Conclusion

Reducing the regional productivity gap is essential to improving the productivity of the UK and reducing regional inequalities. The results from this chapter suggest that 30% of both gap in GVA per-head and the employment gap between the Northern Powerhouse and the rest of England can be attributed to (ill) health. Those in the Northern powerhouse in good health compared to being in poor health are 17% more likely to be in employment. To reduce the regional productivity gap by 10%, morbidity would need to reduce by 1.1% and mortality reduce by 0.7%. To reduce the regional employment gap by 10%, health would need to improve in the North by 3.5%. Achieving this will require investment in a variety of public health, healthcare, social policy and employment initiatives.

Notes

[171] We also looked at how much poorer health in the North contributes to the regional productivity gap as measured by differences in hours worked and wages. However, the models suggested that all of the impact of health seemed to operate via employment. Please see technical appendix for further information.
[172] OECD, International Comparisons of Productivity (2016). https://www.ons.gov.uk/economy/economicoutputandproductivity/productivitymeasures/datasets/internationalcomparisonsofproductivityfirstestimates
[173] The Northern Powerhouse Independent Economic Review (2016) http://www.sqw.co.uk/files/5414/6723/8824/16987_-_TfN_-_NPH_IER_-_Executive_Summary_-_Final_24_June_2016.pdf
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[178] https://www.understandingsociety.ac.uk/
[179] Goldberg (1988) User's guide to the General Health Questionnaire." Windsor.
[180] Goldberg (1978) Manual of the general health questionnaire. NFER Nelson
[181] Estimates from Oaxaca-Blinder Decomposition Models. Data from Understanding Society Waves 1-7. N*T=148,040. Full output is shown in the chapter technical appendix.
[182] Information on the macro-level analysis is described in Chapter 2. GVA per-head is taken from NOMIS and the ONS, available at https://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/regionalgvaibylocalauthorityintheuk
[183] The Figure shows the percentage of the difference in the GVA per-head across the two regions which can be explained by various components of the model. The percentage figures are obtained from an Oaxaca-Blinder decomposition analysis. All terms are strongly statistically significant ($p<0.001$). Taken from an aggregate level analysis at LAD level. Tables showing the number of observations, statistical significance (p-values) and R-squared value for each bar are available in the supplementary appendix (Table D5.2.1).
[184] The Figure shows the percentage of the difference in the employment rates across the two regions which can be explained by various components of the model. The percentage figures are obtained from an Oaxaca-Blinder decomposition analysis. All terms are strongly statistically significant ($p<0.001$). Taken from an individual level analysis. Tables showing the number of observations, statistical significance (p-values) and R-squared value for each bar are available in the supplementary appendix (Table D5.2.1).
[185] Estimates from a Random Effects linear regression model. All variables are statistically significant at $p<0.001$. For a more in-depth summary of the model including additional controls see the technical appendix.
[186] Estimates from a Random Effects General Probit Model. Marginal effects are shown. Data from Understanding Society Waves 1-7. N*T=46,201. All variables are statistically significant at $p<0.001$. For a more in-depth summary of the model including additional controls see the technical appendix
[187] The Northern Powerhouse Independent Economic Review (2016) http://www.sqw.co.uk/files/5414/6723/8824/16987_-_TfN_-_NPH_IER_-_Executive_Summary_-_Final_24_June_2016.pdf
[188] An almost identical figure is obtained using aggregate data on GVA and individual data on employment
[189] Whitehead et al (2014) Due North: report of the inquiry on health equity for the North University of Liverpool and Centre for Local Economic Strategies, Liverpool and Manchester
[190] Bambra et al (2010) Reducing health inequalities in priority public health conditions: Developing an evidence based strategy? Journal of Public Health, 32: 496–505.
[191] Marmot (2010) health and social policy interventions should be provided universally 'but with a scale and intensity that is proportionate to the level of disadvantage' (p.15).
[192] Health and Wellbeing boards bring together the NHS, public health, adult social care and children's services, including elected representatives and Local Health Watch, to plan how best to meet the needs of their local population and tackle local inequalities in health (see Kings Fund: https://tinyurl.com/y824e8g7)
[193] There are 38 Local Enterprise Partnerships across England. They are local business led partnerships between local authorities and businesses and play a central role in determining local economic priorities and undertaking activities to drive economic growth and the creation of local jobs (see: https://www.lepnetwork.net/)
[194] Health Watch - independent national champion for people who use health and social care services (see: https://www.healthwatch.co.uk/)
[195] Clinical Commissioning Groups (CCGs) are clinically-led statutory NHS bodies responsible for the planning and commissioning of health care services for their local area. There are now
[195] CCGs in England. (see: https://www.nhscc.org/ccgs/)
[196] Bambra (2014) Tackling Health-Related Worklessness: A 'Health First' Approach, in 'If you could do just one thing …? Nine local actions to reduce health inequalities, London, British Academy.
[197] https://www.gov.uk/government/statistics/country-and-regional-analysis-2017
[198] such as to restrictions to the Local Housing Allowance, the Under-occupation charge (popularly called the 'bedroom tax'), the Benefit cap, Benefit freeze, the Personal Independence Payment and greater conditionality for Employment and Support Allowance, freeze in Child Benefit, and 1 per cent benefit up-rating (see: https://tinyurl.com/ybstoplh).
[199] Beatty and Fothergill (2016) The uneven impact of welfare reform: The financial losses to places and people, Centre for Regional Economic and Social Research Sheffield Hallam University
[200] Beatty and Fothergill (2016) The uneven impact of welfare reform: The financial losses to places and people, Centre for Regional Economic and Social Research Sheffield Hallam University
[201] Beatty and Fothergill (2016) The uneven impact of welfare reform: The financial losses to places and people, Centre for Regional Economic and Social Research Sheffield Hallam University

6 Conclusion: Health for Wealth

There is a well-known productivity gap between the Northern Powerhouse and the rest of England of £4 per-person-per-hour. There is also a substantial health gap between the Northern Powerhouse and the rest of England, with average life expectancy 2 years lower in the North. Given that both health and productivity are lower in the Northern Powerhouse, the NHSA commissioned this report from six of its eight university members (Newcastle, Manchester, Lancaster, Liverpool, Sheffield and York) to understand the impact of poor health on productivity and to explore the opportunities for improving UK productivity by unlocking inclusive, green, regional growth through health improvement. Our report shows the importance of health and the NHS for productivity in the Northern Powerhouse. So, as it develops its post-Brexit industrial strategy, central government should pay particular attention to the importance of improving health in the Northern Powerhouse as a route to increased wealth.

6.1 Key Findings

- Productivity is lower in the North.
- A key reason is that health is also worse in the North.
- Long-term health conditions lead to economic inactivity.
- Spells of ill-health increase the risk of job loss and lead to lower wages when people return to work.
- Improving health in the North would lead to substantial economic gains.
- Improving health would reduce the £4 gap in productivity per-person per-hour between the Northern Powerhouse and the rest of England by 30% or £1.20 per-person per-hour, generating an additional £13.2 billion in UK GVA.

6.2 Summary of Detailed Findings

- Health is important for productivity: improving health could reduce the £4 gap in productivity between the Northern Powerhouse and the rest of England by 30% or £1.20 per-person per-hour, generating an additional £13.2 billion in UK GVA.
- Reducing the number of working aged people with limiting long-term health conditions by 10% would decrease rates of economic inactivity by 3 percentage points in the Northern Powerhouse.
- Increasing the NHS budget by 10% in the Northern Powerhouse will decrease economic inactivity rates by 3 percentage points.
- If they experience a spell of ill-health, working people in the Northern Powerhouse are 39% more likely to lose their job compared to their counterparts in the rest of England. If they subsequently get back into work, then their wages are 66% lower than a similar individual in the rest of England.
- Decreasing rates of ill-health by 1.2% and decreasing mortality rates by 0.7% would reduce the gap in gross value added (GVA) per-head between the Northern Powerhouse and the rest of England by 10%.
- Increasing of the proportion of people in good health in the Northern Powerhouse by 3.5% would reduce the employment gap between the Northern Powerhouse and the rest of England by 10%.
- So, given the relationship between health, healthcare and productivity in the Northern Powerhouse, in order to improve UK productivity, we need to improve health in the North.

6.3 Challenges

Although these findings demonstrate the scale of the health and economic challenges facing the Northern Powerhouse, they also provide a blueprint to overcome the problem: in order to improve UK productivity, we need to improve health in the North. However, there are challenges which need to be addressed:

- Expenditure on public health and prevention services has always lagged behind spend on the treatment of existing conditions. In 2017/18 in England, £3.4 billion was spent by local authorities on public health. This was dwarfed by Department of Health and Social Care spend of over £124 billion, the vast majority of which went on hospital-based treatment services. Public health budgets are estimated to experience real-terms cuts averaging 3.9 per cent each year between 2016/17 and 2020/21.
- Austerity presents a real challenge for Northern agencies to implement approaches to improving health. Local Authorities have faced disproportionally larger cuts and reductions in social welfare since 2010 have also had more of an impact in the Northern Powerhouse.
- Exiting the European Union is a challenge for the NHS in terms of the supply of highly skilled workers. Uncertainties over post-Brexit NHS and local authority public health budget settlements are also a challenge for planning prevention and health and social care services particularly in the Northern Powerhouse.
- Health research funding in the UK is heavily concentrated in the so-called ‘golden triangle’: London, the South East and the East of England receive over 60% of funding. This is exacerbated by the fact that the Northern Powerhouse’s strengths are in applied health research, for which there is high need in the region but much less funding available nationally and regionally.
- Uncertainty around the effectiveness of public health interventions means that more applied research is needed to develop, pilot and evaluate and scale-up interventions to improve health – particularly in areas of high need such as the Northern Powerhouse.
- Green and Inclusive Growth is required given the well-documented threats posed by climate change. It cannot be the case of ‘business as usual’ for an industrial strategy to increase productivity in the North, innovation is required to ensure carbon-free growth. Growth in the North also needs to be socially inclusive - reaching all places in the region and people from all social backgrounds.

6.4 Recommendations to Central Government

As it develops its post-Brexit industrial strategy, central government should pay particular attention to the importance of health for productivity in the Northern Powerhouse. Specifically, we make four key proposals to central government:

1) To improve health in the North by increasing investment in place-based public health in Northern Powerhouse local authorities: Improving population health in the North requires national government to increase the public health budgets in Northern Powerhouse local authorities to facilitate their development and delivery of effective ‘place based’ public health.

2) To improve labour market participation and job retention

amongst people with a health condition in the Northern Powerhouse: Active labour market programmes should take a 'health first' approach, NHS staff should discuss work and work difficulties with patients, and work retention interventions are required to prevent ill-health resulting in economic inactivity.

3) To increase NHS funding in the Northern Powerhouse – to be spent on prevention services and health science research: NHS funding should be increased, more of the budget should be invested into public health, condition management and prevention services, and health science research funding allocated to the Northern Powerhouse should increase.

4) To reduce economic inequality between the North and the rest of England by implementing an inclusive, green industrial strategy: a national green industrial strategy that reduces inequalities between the regions should be implemented that is socially inclusive - reaching all places and people from all social backgrounds.

6.5 Recommendations to Northern Powerhouse Local and Regional stakeholders

We make four key proposals to Northern Powerhouse local and regional Stakeholders:

1) Health and Wellbeing boards and the emerging NHS integrated care systems should commission more health promotion, condition management and prevention services: Local NHS and local authority commissioners should commission services that promote the health and wellbeing of the workforce in the Northern Powerhouse and help people manage their long-term health conditions.

2) Local enterprise partnerships, local authorities and devolved Northern regions should develop locally tailored 'health-first' programmes in partnership with the local NHS and third sector providers: Locally tailored active labour market interventions that take a 'health first' approach to reduce economic inactivity should be developed that incorporate condition management programmes alongside vocational activities.

3) Local enterprise partnerships, local authorities and devolved Northern regions should scale-up their place-based public health programmes across the life course: 'starting well', 'living well' and 'ageing well': Improving productivity through enhancing population health in the North requires local authorities to invest more in prevention and in 'place based' public health interventions that address the social and environmental determinants of health inequalities.

4) Local businesses should support job retention and health promotion interventions across the Northern Powerhouse workforce and Northern city regions and Northern NHS integrated care systems should lead by example: Employers should promote the health of their workforce through occupational health activities and implement job retention interventions to support employees with health conditions or disabilities remain in work.

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Technical appendicies

Appendix A: For Chapter 2
A2.1 Statistical and Econometrics models: Further details

We estimated the effect of area-level health (H) on area-level wider economic outcomes (Y), controlling for area level characteristics known to be correlated with health, including the age structure of the population, population size, education levels, etc. (denoted by the vector X):

$$Y_{it} = \beta_0 + \beta_1 H_{it} + \pi X_{it} + u_{it} \qquad (A2.1)$$

where subscript i refers to local authority district (LAD; the geographical area under consideration here), t refers to the year, and u is an idiosyncratic error term that is assumed to be normally distributed.

Equation (A2.1) could have been estimated using pooled ordinary least squares (POLS). However, this type of estimator would not utilise the longitudinal nature of the dataset nor would it allow us to account (control) for individual LAD-specific effects. These LAD specific effects are assumed to be time invariant (i.e. fixed over time). They could pick up the attitudes of individuals living in specific LADs say, or how close an LAD is to a big city/hospital.

It is possible to incorporate these individual LAD specific fixed-effects into the above model as follows:

$$Y_{it} = \beta_0 + \beta_1 H_{it} + \pi X_{it} + c_i + e_{it} \qquad (A2.2)$$

where the error term (u) has been split into a LAD specific component (c) and a general idiosyncratic term (e). The residual term e is assumed normal as before. The strict exogeneity assumption (below; A2.3) is now satisfied.

$$E(u_{it}|\boldsymbol{x}_i, c_i) = 0, \;\; T = 1, 2, \dots, T \; (A2.3)$$

In this setup, the effects of health on wider outcomes is the parameter β_1.

We take the natural logarithm of the rates of people claiming incapacity benefit (as a proxy for morbidity) and health care expenditure per head to account for the skewed nature of the data. This further allowed us to express results in terms of percentage increases/decreases in these variables. As employment and economic inactivity are reported as rates, we did not log these variables. We did not log median wages either. To ease interpretation, we divided our regression results by 100. This allowed us to interpret the coefficients more easily such that, for example, a 1% decrease in morbidity leading to an X percentage point change in the rate variables and a Y change in wages.

A2.2 Regression Tables from Chapter 2

Here we present selected output from the models. These numbers were used to create the Figures shown in the main report. Due to brevity, we report only the values of interest. Full output is available on request.

Table A2.2.1: The effect of ill-health (morbidity) on employment and productivity related outcomes

	Employment Rates			Economic Inactivity Rates			Gross Value Added GVA) per head		
	England	NP	RoE	England	NP	RoE	England	NP	RoE
Decrease number of people with morbidity by 1%:	0.239*	0.436*	0.179	-0.263**	-0.289*	-0.169	0.067***	0.358***	0.004
	(p=0.030)	(p=0.040)	(p=0.183)	(p=0.010)	(p=0.014)	(p=0.170)	(p<0.001)	(p<0.001)	(p=0.389)
Additional information included#	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4096	966	3130	4096	966	3130	4096	966	3130
R-squared	0.27	0.35	0.26	0.17	0.22	0.17	0.75	0.75	0.77

Notes: Coefficients in the first row have been divided by 100 so they can be interpreted as changes in percentage point terms. p-values * p<0.05; ** p <0.01; *** p<0.001. NP = Northern Powerhouse; RoE = Rest of England.
#: additional information includes the age structure of the population, the log of the total population, the percentage of people who have no qualifications, the wages to unemployment benefit ratio, and year dummies.

Table A2.2.2: The effect of mortality on employment and productivity related outcomes

	Employment Rates			Economic Inactivity Rates			Gross Value Added GVA) per head		
	England	NP	RoE	England	NP	RoE	England	NP	RoE
Decrease number of deaths per 1000 population:	0.171	0.392*	0.008	-0.229*	-0.491**	-0.058	0.136	0.111	0.175
	(p=0.189)	(p=0.043)	(p=0.962)	(p=0.047)	(p=0.007)	(p=0.703)	(p=0.473)	(p=0.443)	(p=0.444)
Additional information included#	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4096	966	3130	4096	966	3130	4096	966	3130
R-squared	0.27	0.36	0.26	0.17	0.23	0.17	0.65	0.61	0.68

Notes: Coefficients in the first row can be interpreted as changes in percentage point terms. p-values * p<0.05; ** p <0.01; *** p<0.001. NP = Northern Powerhouse; RoE = Rest of England.
#: additional information includes the age structure of the population, the log of the total population, the percentage of people who have no qualifications, the wages to unemployment benefit ratio, and year dummies.

Table A2.1.1: Description of data used in analyses in Chapter 2

Variable	Definition	Source	Notes
Dependent variables			
Employment rate	The employment rate of individuals aged between 16 and 64 in an LAD.	NOMIS [a]	We focus only on the employment rate of the working age population in this report.
Economic inactivity rate	The rate of individuals who are economically inactive (neither employed nor unemployed) aged between 16 and 64 in an LAD.	NOMIS [a]	Economic inactivity is defined by the ONS as "People not in employment who have not been seeking work within the last 4 weeks and/or are unable to start work within the next 2 weeks." [b]
GVA per-head	A measure of the value of goods and services produced in an LAD.	ONS [c]	Calculated using the income approach. For further detail on the methodology used to allocate regional GVA to LADs, see the ONS website. [c]
Median weekly pay	The median value of weekly pay (in pounds) for individuals living in an LAD.	NOMIS [a]	
Key explanatory variables			
Morbidity	This variable is proxied by the number of people, aged between 16 and 64, who are claiming incapacity benefit in an LAD.	NOMIS	The correlation between this measure and the number of people reporting they have a long standing limiting health conditions in census years (2001 and 2011) is r=0.98 (p<0.001). this has also been verified in e.g. Bambra and Norman (2006)
Mortality	The death rate (per thousand population) in an LAD	ONS	Any notes
Additional explanatory variables			
Age bands	The percentage of people living in an LAD who were aged between the respective thresholds	NOMIS a	We use the following age bands: 16-19; 20-24; 25-34;35-49; and 50-64. We additionally had information on those aged 65 and above, but did not use it here.
Total population	The population estimates for each LAD.	NOMIS a	This variable is estimated by the ONS using census data. Further information is available on the ONS website. d
% of people with no qualifications	The percentage of people aged 16 to 64 residing in a LAD who have no educational qualifications.	NOMIS a	This variable is used as a proxy for the average educational attainment of individuals living in an LAD.
Wage to unemployment benefit ratio	Average (mean) weekly income support payment (all claimants) in each LAD divided by mean weekly gross wage for workers in each LAD	NOMIS a (both wages and income support)	This variable is often used as a measure of the desirability of work. If benefits are relatively high compared to wages, then the incentives to work are ower.
Year fixed effects	Binary indicators for each year (2004 – 2017)		These year fixed-effects are phenomena that affect the included to account for macro whole country at the same time (such as recessions etc.)

a: NOMIS is the ONS official labour market statistics portal https://www.nomisweb.co.uk/
b: https://www.ons.gov.uk/employmentandlabourmarket/peoplenotinwork/economicinactivity
c: https://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/regionalgvaibylocalauthorityintheuk
d: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates

Table A2.2.3: The effect of ill-health on median weekly pay

	England	NP	RoE	England	NP	RoE
Decrease number of people with morbidity by 1%:	40.73*** (p<0.001)	42.54*** (p=0.001)	39.66*** (p<0.001)			
Decrease number of deaths per 1000 population:				2.45** (p=0.002)	3.51*** (p<0.001)	0.20 (p=0.86)
Additional information included	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4096	966	3130	4096	966	3130
R-squared	0.82	0.85	0.82	0.77	0.80	0.77

Notes: Coefficients can be interpreted as changes in percentage point terms due to appropriate rescaling. p-values * p<0.05; ** p <0.01; *** p<0.001. NP =

Table A2.2.4: Differences in potential benefits by region

	Interaction terms							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(Northern Powerhouse) x (Decrease morbidity by 1%):	0.257*	-0.121*	0.354***				2.88*	
	(p=0.035)	(p=0.046)	(p<0.001)				(p=0.040)	
(Northern Powerhouse) x (Decrease mortality by 1%):				0.384*	-0.433**	-0.064		3.31***
				(p=0.016)	(p=0.008)	(p=0.871)		(p<0.001)
Additional information included#	Yes	Yes	Yes	Yes	Yes	Yes		
Observations	4096	4096	4096	4096	4096	4096		

Notes: each column represents a separate regression where the Northern Powerhouse dummy was interacted with all key variables. The coefficient shown in each row is the interaction with respective health variable with this Northern Powerhouse variable. The coefficient can be thought of as the difference in potential effects between the two regions. A positive value (except columns 2 and 5) can be thought of as being evidence of higher returns in the Norther Powerhouse region. p-values * p<0.05; ** p <0.01; *** p<0.001. All additional variables, and their interactions, were also included.
Column (1) & (4): employment rates
Column (2) & (5): economic inactivity rates
Column (3) & (6): GVA per-head (%)
Column (7) & (8): median weekly pay (£)

Appendix B: For Chapter 3

B3.1 Statistical and Econometrics models: Further details

To estimate the effect of a period of bad health on wider outcomes at the individual level we used a treatment effects model and calculated the average treatment effect on the treated (ATET). Denote a period of ill-health as B and define B=1 if an individual experienced a spell of ill-health and B=0 if an individual remained healthy. What is important is that B is assigned; it is not random.

We want to estimate the differences in employment outcomes, Y, between those who experience a spell of ill-health and those that do not. Denote the outcome of those who do experience ill-health as Y1 and those who remain healthy as Y^0. Then the effect of ill-health is simply the difference:

$$\Delta = Y^1 - Y^0$$

However, we only ever observe Y^1 Y^0 for those individuals who become ill (are never ill).

We cannot observe the potential outcomes; that is we do not know what would have happened to the employment outcomes of an individual who became ill if they had not become ill (and vice-versa).

Therefore the estimate is not an unbiased estimate of the true 'treatment effect' of becoming ill.

That is so say to estimate the effect of B on employment outcomes, Y, we cannot just compare outcomes for the two groups due to the non-random nature of ill-health. There are other possible variables, denoted by the vector X (such as age, gender, education, etc.), that can influence the probability of an individual experiencing a spell of ill-health.

One potential way to overcome the issue above is to implement a regression adjustment model of the form:

$$Y = \alpha_0 + \alpha_1 B + \alpha_2 X + \varepsilon \qquad \text{(B3.1)}$$

and obtain the effect of B on Y through the parameter . If the model in equation B3.1 is correctly specified, then the parameter estimate is a good estimate of the true difference . However, this model will only identify the 'true' value of the treatment effect if the vector X contains all of the necessary information to explain Y; that is, there are no remaining unexplained confounders.

This is an unverifiable assumption and requires strong logical reasoning.

A second potential solution to the bias problem is to estimate a propensity score of the probability of experiencing ill-health. That is estimate a binary model of the form:

$$B = \beta_0 + \beta_1 X + e \qquad \text{(B3.2)}$$

using a logit estimator. This propensity score (parameters in the model) can then be used to (inverse-)weight average outcomes of the treated (Y1) and control (Y1) individuals. If the propensity score model (equation A3.2) is the correct propensity score mode, then the weighted estimate of $\Delta = Y^1 - Y^0$ is unbiassed. Essentially, these models match individuals in the treatment (ill-health) and control (good health) groups to be as observably similar as possible.

For example, they would try to match a 42 year old female with A-levels who experienced ill-health to a similar 42 year old female with A-levels who did not experience ill-health.

These models are only correct if equation (B3.2) is correctly specified and is a good approximation for the true value of the propensity score. Fortuitously, it emerged that the two techniques listed above can be combined in the so-called 'double robust' estimation. This gives extra protection against misspecification as it requires that only one of two stages must be correct.

Double robust estimation involved first estimating a treatment equation (equation B3.2) and obtaining weights (Stage 1). These can then be used to (inverse-)weight the regression model explained in equation (B3.1) (Stage 2). If either one of Stage 1 or Stage 2 is correct, then double robust methods will uncover the true, unbiased, value of the treatment effect . We implemented double robust estimation using inverse probability weighted regression adjusted (IPWRA).

The detailed algebra is omitted here, but interested readers are referred to the reading here. Information on the practical implementation of the models is available online.

Restrictions and estimation sample

We made several restrictions on the full dataset to obtain our estimation dataset. These include:
Individuals must be of working age, defined here as between 16 to 65 years of age.
Individuals who were present in all seven waves of the panel.
Individuals who were employed in the first wave of dataset.
Individuals who were in good health in the first wave of the dataset.
These restrictions were imposed to make individuals as comparable as possible.

Robustness Checks

Our main results are robust to a battery of checks. We have changed the definition of ill-health in a number of ways, including (1) using the onset of a limiting health condition; (2) stipulating that the period of ill-health should last at least two or three years (to remove reporting bias); and (3) used measures of mental and physical health separately. None of these made any qualitative difference to the main results presented above.

Our analysis sample was deliberately quite restrictive in nature to ensure as much consistency as possible.

However, our main results were robust to dropping selection criteria. For example, when we dropped the requirement that an individual must remain in the sample for the full seven years, our results were qualitatively similar.

Additionally, the results were robust to the removal of the self-employed sample.

Table B3.1.1: Description of data used in analyses in Chapter 3 a

Variable	Definition	How included	Outcome or treatment equation
	Dependent variables		
Employed in final wave	Employment status of individuals in the final wave of the study period; =1 if still employed; =0 if not employed.	As a binary outcome variable.	N/A (outcome variable)
Relative pay	The individual's own labour income (in pounds per month) at their last payment. Adjusted for inflation using the Retail Price Index (RPI).	As a continuous outcome variable. To create the relative difference, we compute pay in last period divided by pay in the first period.	N/A (outcome variable)
Relative labour supply (hours worked)	The number of hours worked per week by the individual.	As a continuous outcome variable. To create the relative difference, we compute hours worked in last period divided by hours worked in the first period.	N/A (outcome variable)
Relative household income	The gross household income (in pounds per month) at the last month prior to interview. Adjusted for inflation using the Retail Price Index (RPI). Additionally adjusted for household size using OECD equivalence scale.	As a continuous outcome variable. To create the relative difference, we compute household income in last period divided by household income in the first period.	N/A (outcome variable)
	Treatment variables		
Self-assessed health change	Self-assessed health status of the individual; =1 if an individual reports at least one period of bad health (self-reported health = fair or poor); =0 if health continues to be reported as good (excellent, very good, or good).	As a binary treatment variable. A value of one indicated an induvial was treated (had experienced ill-health).	N/A (treatment indicator variable)
Onset of limiting condition	Individuals were asked "Do you have any long-standing physical or mental impairment, illness or disability? By Long-standing illness or impairment I mean anything that has troubled you over a period of at least 12 months or that is likely to trouble you over a period of at least 12 months." Variable =1 if responded yes; =0 if responded no.	As a binary treatment variable. A value of one indicated an induvial was treated (had experienced ill-health).	N/A (treatment indicator variable)
	Explanatory variables		
Age	The age (in years) of a respondent	As a continuous variable	Both
Female	Binary variable =1 if female; 0 if male	As a binary variable	Both
Education	Individuals reported their highest educational attainment. From this we split the data into two categories; (1) those with GCSE level qualifications or below; (2) those with A-level qualifications or higher (including degree).	Used to split the data	N/A as splitting variable.
Marital status	Individuals reported their current legal marital status. We used this to create the following categories: (1) married or cohabiting; (2) single; (3) divorced or separated.	Each of the categories was included as a binary variable.	Both
Rurality	A variable that indicates in an individual's house is in a rural area (=0 for urban areas)	As a binary variable.	Both
Household size	The total number of people that live in the household (including children).	As a continuous variable.	Both
Number of children	The number of children in the household aged 16 years and under.	As a continuous variable.	Both
Ethnicity	The ethnicity of an individual. =1 if non-white; =0 if white.	As a binary variable.	Treatment
Income quartiles	Monthly income was broken down into quartiles, to rank individuals.	Each of the quartiles was included as a binary variable.	Treatment

Notes:
All variables are taken from UKHLS – Understanding Society, waves 1 – 7.
a: Recall that all individuals in the sample were both in employment and in good self-assessed health when initially first observed. Also, all individuals remained in the sample for the full study period.

B3.2 Regression Tables from Chapter 3

Here we present selected output from the models. These numbers were used to create the figures shown in the main report. Due to brevity, we report only the values of interest. Full output is available on request.

Table B3.2.1: The effects of ill-health on the probability of staying employed

	All		GCSE or lower		A leveles and above	
	Effect size	**p-value**	**Effect size**	**p-value**	**Effect size**	**p-value**
Overall	-3.90%	(p=0.007)	-7.34%	(p=0.001)	-2.45%	(p=0.656)
North	-4.88%	(p=0.046)	-11.96%	(p=0.005)	-2.88%	(p=0.362)
Rest of England	-3.52%	(p=0.038)	-5.08%	(p=0.052)	-2.27%	(p=0.302)
Difference#	38.64%	(p=0.032)	135.43%	(p=0.017)	26.87%	(p=0.354)

Notes: The percentage difference is calculated as 100*(North – Rest of England)/Rest of England. Therefore, positive values indicate that the outcomes for individuals in the north are worse compared to similar individuals in the Rest of England. P-values of coefficient differences were calculated from a 'suest' estimation and confirmed using manual calculations.

Table B3.2.2: The effects of ill-health on the relative weekly pay

	All	GCSE or lower	A Levels and above			
	Effect size	**p-value**	**Effect size**	**p-value**	**Effect size**	**p-value**
Overall	-23.79%	(p=0.393)	-40.46%	(p=0.247)	-6.45%	(p=0.877)
North	-32.42%	(p=0.239)	-35.61%	(p=0.315)	-10.70%	(p=0.673)
Rest of England	-19.52%	(p=0.633)	-31.68%	(p=0.501)	-4.72%	(p=0.941)
Difference#	66.09%	(p=0.043)	12.41%	(p=0.355)	126.69%	(p=0.049)

Notes: Relative pay is defined as (pay in last period/pay in first period). The percentage difference is calculated as 100*(North – Rest of England)/Rest of England. Therefore, positive values indicate that the outcomes for individuals in the north are worse compared to similar individuals in the Rest of England. P-values of coefficient differences were calculated from a 'suest' estimation and confirmed using manual calculations.

Table B3.2.3: The effects of ill-health on the relative weekly hours worked

	All	GCSE or lower	A Levels and above			
	Effect size	p-value	Effect size	p-value	Effect size	p-value
Overall	-7.08%	(p=0.018)	-8.08%	(p=0.067)	-7.94%	(p=0.044)
North	-5.59%	(p=0.037)	-7.79%	(p=0.046)	-7.73%	(p=0.111)
Rest of England	-7.91%	(p=0.025)	-8.71%	(p=0.037)	-7.46%	(p=0.154)
Difference#	-29.33%	(p=0.036)	-10.56%	(p=0.039)	4.20%	(p=0.521)

Notes: Relative weekly hours is defined as (hours worked in last period/hours worked in first period). The percentage difference is calculated as 100*(North – Rest of England)/Rest of England. Therefore, positive values indicate that the outcomes for individuals in the north are worse compared to similar individuals in the Rest of England. P-values of coefficient differences were calculated from a 'suest' estimation and confirmed using manual calculations.

Appendix C: For Chapter 4

C4.1 Statistical and Econometrics models: Further details

The statistical methodology employed in this chapter is identical to that in Chapter 2. The only difference is we consider the effects of healthcare expenditure (HC) not health (H). Therefore, readers should consult Appendix B, particularly B2.1, and replace the variable(s) H with HC.

We take the natural logarithm of healthcare expenditure per head to account for the skewed nature of the data. This further allowed us to express results in terms of percentage increases/decreases in these variables. As employment and economic inactivity are reported as rates, we did not log these variables. We did not log median wages either.

To ease interpretation, we divided our regression results by 100. This allowed us to interpret the coefficients more easily such that, for example, a 1% decrease in morbidity leading to an X percentage point change in the rate variables and a Y change in wages.

Table C4.1.1: Description of data used in analyses in Chapter 4

Variable	Definition	Source	Notes
	Dependent variables		
Employment rate	The employment rate of individuals aged between 16 and 64 in an LAD.	NOMIS [a]	We focus only on the employment rate of the working age population in this report.
Economic inactivity rate	The rate of individuals who are economically inactive (neither employed nor unemployed) aged between 16 and 64 in an LAD.	NOMIS [a]	Economic inactivity is defined by the ONS as "People not in employment who have not been seeking work within the last 4 weeks and/or are unable to start work within the next 2 weeks." b
GVA per-head	A measure of the value of goods and services produced in an LAD.	ONS [c]	Calculated using the income approach. For further detail on the methodology used to allocate regional GVA to LADs, see the ONS website. c
Median weekly pay	The median value of weekly pay (in pounds) for individuals living in an LAD.	NOMIS [a]	
	Key explanatory variables		
NHS allocated expenditure	The allocated expenditure to each LAD.	Authors' calculations from data available from multiple sources, including NHS Digital, ONS, and NOMIS.[d]	We used NHS budget allocation to primary care trusts (PCTs) prior to 2013 and clinical commission groups (CCGs) post 2013. We mapped allocations for these local commissioning organisations to local authority populations based on the proportion of their populations that lived in each local authority.
	Additional explanatory variables		
Age bands	The percentage of people living in an LAD who were aged between the respective thresholds	NOMIS [a]	We use the following age bands: 16-19; 20-24; 25-34;35-49; and 50-64. We additionally had information on those aged 65 and above, but did not use it here.
Total population	The population estimates for each LAD.	NOMIS [a]	This variable is estimated by the ONS using census data. Further information is available on the ONS website. [e]
% of people with no qualifications	The percentage of people aged 16 to 64 residing in a LAD who have no educational qualifications.	NOMIS [a]	This variable is used as a proxy for the average educational attainment of individuals living in an LAD.
Wage to unemployment benefit ratio	Average (mean) weekly income support payment (all claimants) in each LAD divided by mean weekly gross wage for workers in each LAD	NOMIS [a] (both wages and income support)	This variable is often used as a measure of the desirability of work. If benefits are relatively high compared to wages, then the incentives to work are lower.
Year fixed effects	Binary indicators for each year (2004 – 2017)		These year fixed-effects are included to account for macro phenomena that affect the whole country at the same time (such as recessions etc.)

a: NOMIS is the ONS official labour market statistics portal https://www.nomisweb.co.uk/
b: https://www.ons.gov.uk/employmentandlabourmarket/peoplenotinwork/economicinactivity
c: https://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/regionalgvaibylocalauthorityintheuk
d: Detailed information on data sources and the algorithm used to compute these estimates is available on request.
e:: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates

4.2 Regression Tables from Chapter 4

Here we present selected output from the models. These numbers were used to create the Figures shown in the main report. Due to brevity, we report only the values of interest. Full output is available on request.

Table C.2.4.1: The effect of allocated NHS spending on employment rates, economic inactivity rates, percentage changes in median weekly pay, and percentage changes in Gross Value Added per-head

	Employment Rates			Economic Inactivity Rates			Median Weekly pay			Gross Value Added (GVA) per head		
	England	NP	RoE	England	NP	RoE	England	NP	RoE	England	NP	RoE
Increase allocation health spending by 1%:	0.121	0.284*	0.155	-0.266*	-0.301*	-0.221	0.052**	0.095*	0.041*	0.051**	0.070*	0.038*
	(p=0.189)	(p=0.036)	(p=0.284)	(p=0.026)	(p=0.023)	(p=0.349)	(p=0.002)	(p=0.032)	(p=0.024)	(p=0.006)	(p=0.022	(p=0.041)
Additional information included#	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4096	966	3130	4096	966	3130	4096	966	3130	4096	966	3130
R-squared	0.264	0.349	0.256	0.166	0.215	0.169	0.82	0.85	0.82	0.75	0.72	0.77

Notes: Coefficients for employment rates and economic inactivity rates can be interpreted as changes in percentage point terms due to appropriate rescaling. Coefficients for median weekly pay and GVA per-head can be interpreted as changes in percentage terms due to appropriate rescaling. p-values * p<0.05; ** p <0.01; *** p<0.001. NP = Northern Powerhouse; RoE = Rest of England.
#: additional information includes the age structure of the population, the log of the total population, the percentage of people who have no qualifications, the wages to unemployment benefit ratio, and year dummies

Table C.2.4.2: The effect of allocated NHS spending on median weekly pay (in pounds) and Gross Value Added per-head (in pounds)

	Median Weekly wage (£)			GVA per-head (£)		
	England	NP	RoE	England	NP	RoE
Decrease number of people with morbidity by 1%:	31.32***	44.24*	25.59**	38.18***	13.66***	41.77***
	(p<0.001)	(p=0.034)	(p=0.008)	(p<0.001)	(p<0.001)	(p<0.001)
Observations	4096	966	3130	4096	966	3130
R-squared	0.82	0.85	0.82	0.77	0.80	0.77

Notes: Coefficients can be interpreted as changes in monetary (pounds) terms due to appropriate rescaling. p-values * p<0.05; ** p <0.01; *** p<0.001. NP = Northern Powerhouse; RoE = Rest of England.
#: additional information includes the age structure of the population, the log of the total population, the percentage of people who have no qualifications, the wages to unemployment benefit ratio, and year dummies.

Table C4.2.3: Differences in potential benefits by region

	(1)	(2)	(3)	(4)	(5)	(6)
(Northern Powerhouse) x (Increase allocation health spending by 1%):	0.129*	-0.008*	0.054*	0.032*	18.65*	-28.11
	(p=0.026)	(p=0.036)	(p=0.022)	(p=0.056)	(p=0.035)	(p=0.287)
Additional information included	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4096	4096	4096	4096	4096	4096

Notes: each column represents a separate regression where the Northern Powerhouse dummy was interacted with all key variables. The coefficient shown in each row is the interaction with allocated health care expenditure with this Northern Powerhouse variable. The coefficient can be thought of as the difference in potential effects between the two regions. A positive value (except column 2) can be thought of as being evidence of higher returns in the Norther Powerhouse region. p-values * p<0.05; ** p <0.01; *** p<0.001. All additional variables, and their interactions, were also included.
Column (1): employment rates
Column (2): economic inactivity rates
Column (3): median weekly pay (%)
Column (4): GVA per-head (%)
Column (5): median weekly pay (£)
Column (6): GVA per-head (£)

Appendix D: For Chapter 5
D5.1 Statistical and Econometrics models: Further details
Decomposition:

The Oaxaca-Blinder decomposition model attempts to separate any differential in an outcome measure between groups into a component that is "explained" by group differences in observable characteristics, and a residual part that cannot be accounted for, and usually attributed to discrimination (Jann et al 2008). In our case the discrimination will be between the Northern Powerhouse region and the rest of England.

In our case, we are concerned about the difference (D) in productivity (proxied by either GVA per-hour or by employment; we have additionally considered hours worked and hourly wages) between the Northern Powerhouse (denoted by n) and the rest of England (denoted by s):

$$D = E(p_n) - E(p_s) \quad \text{(D5.1)}$$

The standard Oaxaca-Blinder decomposition is based on a linear regression model of the form:

$$p_i = \alpha_i + \beta X_i + \gamma H_i + \varepsilon_i \quad \text{(D5.2)}$$

In our case, p_i represents a proxy measure of productivity, a_i is a constant, X_i represents a vector of observable characteristics that could explain productivity (including our chosen measures of health) and ε_i represents the error term.

Following Oaxaca (1973)[205] and Blinder (1973)[206], it can be shown that:

$$D = E(p_n) - E(p_s) = E(\alpha_n + \beta X_n + \varepsilon_n) - E(\alpha_n + \beta X_n + \varepsilon_n) \quad \text{(D5.3)}$$

If we assume that E(ai) = ai and E (εi) = 0, (D5.3) can be arranged as:

$$D = [E(X_n) - E(X_s)]'\beta_s + E(X_s)'(\beta_n - \beta_s) + [E(X_n) - E(X_s)]'(\beta_n - \beta_s) \quad \text{(D5.4)}$$

This is known are the "threefold" decomposition, with the difference in the outcome variable divided into three separate components:

$$D = E + C + I \quad \text{(D5.5)}$$

The first component is the part of the differential that is due to group differences in the observable characteristics (including the chosen measures of health) between the Northern Powerhouse region and the rest of England (otherwise known as the "endowments effect"):

$$E = [E(X_n) - E(X_s)]'\beta_s \quad \text{(D5.6)}$$

The second component is the part of the differential that is due to differences in the coefficients between the Northern Powerhouse region and the rest of England:

$$C = E(X_s)'(\beta_n - \beta_s) \quad \text{(D5.7)}$$

The third component is the part of the differential that is due to the interaction between the differences in the "endowments" and the coefficients:

$$I = [E(X_n) - E(X_s)]'(\beta_n - \beta_s) \quad \text{(D5.8)}$$

This form of decomposition is only appropriate when using a continuous explanatory variable, as the underlying regression model is an Ordinary Least Squares (OLS) model. This is therefore acceptable when we considered GVA per-head at the aggregate level. However, in the individual level models where we used employment as our proxy measure of productivity, we used the correction proposed by Yun (2004) to adjust for the fact that underlying regression model was a Probit estimator (due to the binary nature of individual employment status).

In the individual level analysis where we assume that productivity is represented by a proxy such as a binary choice variable for employment status and that , where is the standard normal cumulative distribution function, the decomposition can therefore be shown as:

$$D = \sum_{k=1}^{K} W_{\Delta X}^{k} \left[\overline{\Phi(X_n\tilde{\beta}_n)} - \overline{\Phi(X_s\tilde{\beta}_n)}\right] + \sum_{k=1}^{K} W_{\Delta X}^{k} \left[\overline{\Phi(X_s\tilde{\beta}_n)} - \overline{\Phi(X_s\tilde{\beta}_s)}\right] \quad \text{(D5.9)}$$

where $\tilde{\beta}$ represent the transformed regression coefficients and W represents the weight given to a given variable k, which is obtained using an approximation of the value of the average of the function $\Phi\ (\overline{X\beta})$ and that of the exogenous variable in question $\Phi\ (\overline{X}\beta)$

Association between Productivity Proxies and Health

The econometric models we used to estimate the association of the different health conditions on productivity were based on a standard labour market specification, in which productivity (in this case proxied by either levels of employment, hours worked and log hourly wages) is determined by a number of demographic characteristics, including measures of health and levels of education (Mincer 1974).

Employment

As employment was measured using a binary variable, we used a non-linear estimation framework. Initially, we estimated a random effects Probit model to control for unobserved heterogeneity. However, because there is likely to be omitted variables impacting the coefficients, we also estimated Mundlak approach random-effects Probit. The Mundlak approach (Mundlak, 1978) acts as a proxy fixed effects models by including group means of the time varying explanatory variables as additional explanatory variables.

A fixed effects Probit model cannot be estimated due to the incidental parameters problem (Greene 2002).

Formally, the proxy fixed effects Probit model can be shown by:

$$\Pr(EMP_{it} = 1) = \Phi(\alpha_i + \gamma H_{it} + \beta X_{it} + \omega G_i + \vartheta \overline{H_{it}} + \delta \overline{X_{it}} + \mu_i + \varepsilon_{it}) \quad \text{(D5.10)}$$

where = 1, 2…n and = 1,2…n

In this specification, $\Pr\ (EMP_{it} = 1)$ represents the probability that individual i is employed in time period t. Φ represents the cumulative density function used to transform the regressors. H is a measure of health, X represents a matrix of time-variant observable characteristics such as age and educational attainment, and G represents gender, which is time-invariant. $\overline{H_{it}}$ represents individual time mean of the health variable and $\overline{X_{it}}$ represents the individual time means of the vector of time variant control variables. μ_i represents the individual specific component of the error term, and ε_i represents the stochastic component of the error term. Equations are estimated separately for the Northern Powerhouse and the rest of England.

Selection into Employment

To control for individuals choosing to participate in the labour market (selection into work), the Inverse Mills Ratio (IMR) was estimated using equation (10) above. The IMR is a weight based upon observed characteristics such as educational attainment that are likely to impact on an individual's decision to participate in the labour market. The IMR uses the theory of truncated normal distribution to control for those individuals who are not employed, and therefore do not report hours worked or an hourly wage (Heckman 1976). To calculate the IMR, we took the conditional expectation $E(EMP_{it} \mid EMP_{it} = 1, x_{it})$ from the probit equation D5.11 when to compute the unconditional expectation $E(EMP_{it} \mid x_{it})$. Given this, the IMR can therefore be represented as:

$$IMR = (-\delta_j x_{it}) = \frac{\phi(\beta_1 x_{it})}{\Phi(\beta_1 x_{it})} \quad \text{(D5.12)}$$

where for the IMR, $\beta_1 x_{it}$ indicates how the explanatory variables impact on EMP_{it}. Φ represents the standard normal distribution and Φ represents the normal cumulative distribution function. Therefore, the IMR is defined as the ratio of the standard normal probability distribution and the normal cumulative distribution function evaluated at $\beta_1 x_{it}$.

Including the IMR as an additional explanatory variable requires additional assumptions concerning the error term. The selection framework assumes that the error terms from the Probit model are normally distributed and not independent. For the framework to be formally identified, at least one explanatory variable from the participation equation must be excluded from the wage equation (Greene 2002). In this case, the variable that we only included in the participation equation was marital status, as it is predicted that this variable will directly impact the decision to enter the labour force but will not directly impact wages or the number of hours worked.

Hours Worked and Wages

To estimate the relationship between hours worked and log hourly wages and health we initially estimated generalized least squares (GLS) models to control for unobserved heterogeneity. However, as there is once more likely to be omitted variables impacting the coefficients, we estimated Mundlak approach random-effects models. The Mundlak approach reduces the likelihood of omitted variable bias and, unlike the traditional fixed effects model, does not remove time invariant variables, such as gender from the model.

$$p_{it} = \alpha_i + \gamma H_{it} + \beta X_{it} + \omega G_i + \vartheta \overline{H_{it}} + \delta \overline{X_{it}} + IMR_i + \mu_i + \varepsilon_{it} \qquad \text{(D5.13)}$$

where i = 1, 2…n and t = 1,2…n

In this specification, p_{it} represents productivity (proxied by either the number of hours worked per week or the log hourly wage of individual i) in time period. H_{it} is a measure of health, X_{it} represents a matrix of time variant observable characteristics (including variables measuring the size of the firm the individual works for, whether the individual works for a private company and the individual's occupational classification), and G represents gender. $\overline{X_{it}}$ represents the individual time mean of the vector of time variant control variables and $\overline{H_{it}}$ represents individual time mean of the health variable. IMR_i represents the inverse mills ratio, u_{it} represents the individual specific component of the error term, and ε_{it} represents the stochastic component of the error term. Equation (D5.13) is estimated separately for those living in the Northern Powerhouse and the rest of England.

Estimating how much health needs to be improved in the Northern Powerhouse for the employment gap only

To determine how much health would need to be improved in the Northern Powerhouse to reduce the level of inequality between the Northern Powerhouse region we estimated the following equation:

$$\frac{((Raw\ difference\ in\ employment\ rate) * 10\%)\ \div contribution\ of\ health\ to\ employment\ gap}{marginal\ effects\ of\ health\ on\ \ the\ likelihood\ of\ being\ in\ employment}$$

Table D5.1.1: Description of data used in aggregate level analyses in Chapter 5

Variable	Definition	Source	Notes
Dependent variables			
Employment rate	The employment rate of individuals aged between 16 and 64 in an LAD.	NOMIS [a]	We focus only on the employment rate of the working age population in this report.
Economic inactivity rate	The rate of individuals who are economically inactive (neither employed nor unemployed) aged between 16 and 64 in an LAD.	NOMIS [a]	Economic inactivity is defined by the ONS as "People not in employment who have not been seeking work within the last 4 weeks and/or are unable to start work within the next 2 weeks." [b]
GVA per-head	A measure of the value of goods and services produced in an LAD.	ONS [c]	Calculated using the income approach. For further detail on the methodology used to allocate regional GVA to LADs, see the ONS website. [c]
Median weekly pay	The median value of weekly pay (in pounds) for individuals living in an LAD.	NOMIS [a]	
Key explanatory variables			
Morbidity	This variable is proxied by the number of people, aged between 16 and 64, who are claiming incapacity benefit in an LAD.	NOMIS	The correlation between this measure and the number of people reporting they have a long standing limiting health conditions in census years (2001 and 2011) is r=0.98 (p<0.001). this has also been verified in e.g. Bambra and Norman (2006)
Mortality	The death rate (per thousand population) in an LAD	ONS	Any notes
	Additional explanatory variables		
Age bands	The percentage of people living in an LAD who were aged between the respective thresholds	NOMIS [a]	We use the following age bands: 16-19; 20-24; 25-34;35-49; and 50-64. We additionally had information on those aged 65 and above, but did not use it here.
Total population	The population estimates for each LAD.	NOMIS [a]	This variable is estimated by the ONS using census data. Further information is available on the ONS website. [d]
% of people with no qualifications	The percentage of people aged 16 to 64 residing in a LAD who have no educational qualifications.	NOMIS [a]	This variable is used as a proxy for the average educational attainment of individuals living in an LAD.
Wage to unemployment benefit ratio	Average (mean) weekly income support payment (all claimants) in each LAD divided by mean weekly gross wage for workers in each LAD	NOMIS [a] (both wages and income support)	This variable is often used as a measure of the desirability of work. If benefits are relatively high compared to wages, then the incentives to work are lower.
=Year fixed effects	Binary indicators for each year (2004 – 2017)		These year fixed-effects are included to account for macro phenomena that affect the whole country at the same time (such as recessions etc.)

Notes:
a: NOMIS is the ONS official labour market statistics portal https://www.nomisweb.co.uk/
b: https://www.ons.gov.uk/employmentandlabourmarket/peoplenotinwork/economicinactivity
c: https://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/regionalgvaibylocalauthorityintheuk
d: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates

Table D5.1.2: Description of data used in individual level analyses in Chapter 5

Variable	Definition	How included
	Dependent variables	
Employed	Employment status of the individual; =1 if employed; =0 if not employed.	As a binary outcome variable.
	Key explanatory variables	
Self-reported health status	Individuals were asked "In general, would you say your health is excellent, very good, good, fair or poor?". Variable =1 if responded excellent, very good or good; 0= if responded with fair or poor	As a binary variable.
Onset of limiting condition	Individuals were asked "Do you have any long-standing physical or mental impairment, illness or disability? By Long-standing illness or impairment I mean anything that has troubled you over a period of at least 12 months or that is likely to trouble you over a period of at least 12 months." Variable =1 if responded yes; =0 if responded no.	As a binary variable.
Mental health	Individuals were asked to complete the GHQ-12, which includes 12 questions designed to identify minor psychiatric disorders and investigate psychological health. The cumulative score takes values between 0-36. Variable =1 if GHQ-12>11; =0 if GHQ-12 ≤ 11	As a binary variable.
	Other Explanatory variables	
Age	The age (in years) of a respondent	As a continuous variable
Female	Binary variable =1 if female; 0 if male	As a binary variable
Education	Individuals reported their highest educational attainment. The following categories were included: (1) Degree level education; (2) A-Level equivalent education; (3) O-Level equivalent education; (4) no qualification	Each of the categories was included as a binary variable.
Marital status	Individuals reported their current legal marital status. We used this to create the following categories: (1) married or cohabiting; (2) single; (3) divorced or separated.	Each of the categories was included as a binary variable.
Rurality	A variable that indicates in an individual's house is in a rural area (=0 for urban areas)	As a binary variable.
Household income	Monthly income, equivalised to take into account the size and composition of the household.	As a continuous variable.

D5.2 Regression Tables from Chapter 5

Here we present selected output from the models. These numbers were used to create the Figures shown in the main report. Due to brevity, we report only the values of interest. Full output is available on request.

Table D5.2.1 (panel a): Decomposition of the differences in levels of GVA per-head between the Northern Powerhouse and the rest of England - difference explained by total decomposition model

GVA per-head in Northern Powerhouse	£18,322.93
GVA per-head in Rest of England	£23,077.36
Difference in GVA per-head	£4,754.43
Difference explained by decomposition model	£4,234.77
Explained %	89.87%
Unexplained %	10.13%

Table D5.2 (panel b): Decomposition of the differences in levels of GVA per-head between the Northern Powerhouse and the rest of England - difference explained by individual variables

	Coefficient	p-Value	% Contribution (if p-Value<0.05)
Health Variables			
Morbidity	812.53***	p<0.000	17.09%
Mortality	606.78***	P<0.000	12.76%
Other variables included?	Yes		

Notes: Estimates from Oaxaca-Blinder Decomposition Models. Data at Local Authority District level taken from various sources over the period 2004 to 2017. N=4,096. Explained = Related to a difference in the endowments, Unexplained = Related to a difference in coefficients. % Contributions displayed if P-value <0.05. Additional variables included were age structure of the population, the log of the total population, the percentage of people who have no qualifications, the wages to unemployment benefit ratio, and year dummies. * p<0.05; ** p <0.01; *** p<0.001.

Table D5.2.2 (panel a): Decomposition of the differences in levels of labour market participation between the Northern Powerhouse and the rest of England - difference explained by total decomposition model

Employment in Northern Powerhouse	0.693
Employment in Rest of England	0.714
Difference in employment	0.021
Difference explained by decomposition model	0.020
Explained %	95.69%
Unexplained %	4.31%

Table D5.2 (panel b): Decomposition of the differences in levels of labour market participation between the Northern Powerhouse and the rest of England - difference explained by individual variables

	Coefficient	p-Value	% Contribution (if p-Value<0.05)
Health Variables			
General Health	0.004***	P<0.000	16.94%
Mental Health	0.002***	P<0.000	9.08%
Long-term limiting condition	0.002***	P<0.000	7.59%
Other variables included?	Yes		

Notes: Estimates from Oaxaca-Blinder Decomposition Models. Data at individual level taken from Understanding Society Waves 1-7. N=148,040. Explained = Related to a difference in the endowments, Unexplained = Related to a difference in coefficients. % Contributions displayed if P-value <0.05. Additional variables included were gender, age (and age squared), indicators on marital status, an urban/rural identifier, measures of education, and information on household income. * p<0.05; ** p <0.01; *** p<0.001.