

REPORT

HEALTH INNOVATION

BREATHING LIFE INTO THE NORTHERN POWERHOUSE

Luke Raikes

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Institute for Public Policy Research

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SUMMARY

60-SECOND SUMMARY

Health science is one of the four most dynamic and productive sectors in the northern economy. The sector comprises fast-growing, private sector companies in pharmaceuticals, medtech and digital health with strong exports to Europe and beyond, combined with global expertise in clinical and health research led by northern universities and hospitals. These sectors are inextricably linked to public health systems employing over half a million people. Their strengths are brought together in interconnected, place-based clusters that stretch across the North's geography, from Liverpool's world leading infectious disease expertise, Manchester and Cheshire's health technology and pharmaceuticals corridors, through to Leeds's and Yorkshire's thriving health technology and advanced manufacturing sector, to the North East's world-leading hub for ageing, innovation and bio-processing.

However, to maximise the potential of northern health innovation, the government's new industrial strategy must tackle a number of challenges posed by existing patterns of research funding, the consequences of Brexit, and the ongoing problems of transport connectivity and skills retention. We make three key proposals: a place-based approach to industrial strategy for the health science sector; catch-up capital for research funding; and a series of more local interventions to keep health sciences at the cutting edge of northern productivity.

KEY FINDINGS

The health science sector is one of the four 'prime capabilities' for an industrial strategy in the North of England identified in the 2016 Northern Independent Economic Review (NIER). The NIER found that numerous areas in the North have significant specialisms in subsectors such as pharmaceuticals, life sciences, medical devices and technologies, and wider healthcare services. This report builds on the review in two ways:

- first, it makes a closer investigation into the strengths and specialisms that characterise the health science sector in the North and identifies the precise nature of their productivity potential
- second, it explores how this potential can be nurtured in the context of the new government's drive for a place-based industrial strategy.

Health sciences 'strand'	Productivity 'potential'	
Biopharmaceuticals	Rapid growth	Clustering & collaboration
Medical technologies		
Clinical & health research	Global expertise	
Universities		
Healthcare services	Size & scale	

The health science sector can be subdivided into five separate strands of interlinked activity. The North has particular strengths relating to each of these strands, each with its own type of ‘productivity potential’ as illustrated in the above diagram.

Clustering and collaboration

The overall potential of the health science sector in the North cannot be captured by exploring the specialisms of its subsectors in isolation. The real strength in northern health sciences lies in its more place-based clusters, their local assets, and the interrelationships between them. These are exemplified in the following clusters.

- Manchester and Cheshire life sciences corridors, which combine the assets in Alderley Park – originally a large AstraZeneca site but now home to over 150 small biotech firms; many spin-offs from the University of Manchester; the Health E-Research Centre (HeRC); the Antimicrobial Resistance Centre; Precision Medicine Catapult Node; Salford Lung Study; and the new Medicines Discovery Catapult.
- This is linked in turn with the Liverpool city-region’s biologics cluster, with the world-renowned Liverpool School of Tropical Medicine and Europe’s largest biologic manufacturing clusters in Speke.
- In the North East, the universities of Newcastle and Durham have developed an international reputation for work on ageing and photonics, while Darlington is host to the Biologics Factory of the Future and the National Biologics Manufacturing Centre.
- In Yorkshire and the Humber there is a strong medtech cluster with key medical equipment, prosthetics and tissue repair manufacturers linked closely with innovation and knowledge hubs at Leeds and Bradford universities; the Advanced Manufacturing Research Centre near Sheffield; and NHS Digital, the NHS Data Spine, bioinformatics and cancer therapeutics specialisms in Leeds.

CHALLENGES

Despite its many strengths and its huge growth potential, the North of England’s health science sector faces a number of significant challenges.

- **Research funding** in the UK is heavily skewed towards the so-called ‘golden triangle’: London, the South East and the East of England garner 60.7 per cent of all public and charity funding. This is exacerbated by the fact that the North’s potential is in applied research, for which there is less funding available, and that research excellence needs to be built up over time.
- **Exiting the European Union** threatens not only the funding that Northern universities receive to support health research but also their ability to attract research expertise from the EU, to be involved in EU-wide research collaborations, and to link into clinical trial and patent regulations where scale can be key to attracting global companies and foreign direct investment.
- The health science sector depends on a good supply of **highly skilled workers**. Although Northern universities have a strong reputation for producing excellent biomedical and health science graduates, **poor east–west transport connectivity** undermines

the North's ability to sustain a broad labour pool and attract and retain talent across the North.

RECOMMENDATIONS TO CENTRAL GOVERNMENT

- As it develops its new industrial strategy, **the government should pay particular attention to the significant strengths of the health science sector in the north of England, beginning by rolling out a science and innovation audit across the whole of the North, and also by establishing better processes for strategic collaboration between government and subnational stakeholders.**
- **Government should aim to move towards investing 20 per cent of its health science research funding in the North over the next five years** – this would match the estimated R&D investment from the private sector, and would enable northern health economies to catch up with those in the golden triangle, or at least compete on a more level playing field.
- **Government should ensure northern health science sector interests are explicitly accounted for by the steering committee currently working on the impact of Brexit on the health science sector.**
- **Government should invest in the northern life science capability that sits within the Department for International Trade, so that the team's resources on the ground in the UK and abroad in post are in line with those of the UK's devolved administrations, and reflect the scale of opportunity in this sector and the northern market size.** Over time the life sciences sector should spearhead an approach to trade and investment in the North which is equivalent to those of the devolved administrations, and should develop its own special relationship with the North's key partners abroad – countries such as the US, Japan, Singapore, India and China as well as the growing opportunities from and with the commonwealth.

RECOMMENDATIONS TO LOCAL AND REGIONAL STAKEHOLDERS

- **Health service commissioners should develop new approaches to health procurement to maximise regional clusters and supply chains and drive up local economic multipliers. They should pull through research into practice more efficiently to maximise healthcare gains.**
- **Local enterprise partnerships and growth hubs should support health science startups and match-fund 'corporate accelerator' partnerships between big UK and multinational firms and universities.**
- **Local transport authorities – working closely with Transport for the North – should develop strategic transport plans around health service and complementary tech clusters, and support initiatives to broaden intercity connections to expand the highly skilled northern labour pool.**

1. INTRODUCTION AND CONTEXT

1.1 THE STRENGTHS OF THE NORTHERN HEALTH SCIENCE SECTOR

The health science¹ sector's importance for the North is well recognised.

- **The sector generates significant economic output.** Health science accounts for £17.5 billion² of the North's £304 billion output (GVA) and is forecast to grow by 44.6 per cent by 2030 (NIER 2016a). If this rate of growth is realised, this would be outstanding performance relative even to the North's other prime capabilities: this would be faster than the energy or advanced manufacturing sectors; albeit slower than the digital sector, which is forecast to double in size during that period (ibid).
- **The sector employs a large number of people.** In total 570,000 people are employed in health sciences across the North – 7.5 per cent of the region's workforce – with 48,000 supported in the private sector and its supply chain (ibid, BIS 2016). Although employment growth is forecast to be lower than across all sectors – 2.5 per cent compared to 4.5 per cent – it remains significant from such a large base.
- **It is a vital hub for health research.** In 2014 the north of England was in receipt of £273 million in research funding, and with recent investments in biomedical research, antimicrobial resistance and the Connected Health Cities big data programme the region is a burgeoning centre of global expertise in health innovation. This is only 13.5 per cent of the UK total, and represents a missed opportunity to benefit from the North's assets (see chapter 6.1).
- **The North needs the health benefits a thriving sector can generate.** The North has poor health outcomes and high health inequality in comparison with other parts of the country (IPHENE 2014). The combination of high health burden and stable population has resulted in the North becoming a leading centre for clinical trials. This leads to improved patient outcomes, in turn saving on healthcare costs from trial investment. There is also an inverse correlation between NHS hospital research spend and mortality rates – higher research spend means lower mortality – so there is direct benefit from investment in health research in a population with a high level of need and potential for benefit (Ozdemir et al 2015).³ The North undertakes a large proportion of clinical trials – such as experimental cancer medicine trials in Manchester and end-of-life care research in Newcastle. In this sense the North is at

1 We use the term health science to refer to 'health innovation' from this point – the sector is often called 'life sciences' in economic terms, but this doesn't include some key areas of research in the scientific context.

2 In 2011 prices.

3 Risk adjusted mortality for acute admissions.

the forefront of new treatments – and the North needs these new treatments urgently.

1.2 THE NORTHERN INDEPENDENT ECONOMIC REVIEW

It is unsurprising, then, that in the recent Northern Independent Economic Review (NIER), ‘health innovation’ was identified as one of four ‘prime capabilities’ (NIER 2016a). The review set out to identify economic sectors that were deemed to be of ‘pan-northern significance’. Its criteria included:

- **sectoral and capability specialisms** where the North is genuinely **differentiated and distinctive**, and can compete at **national and international scales**
- sectors that are important in **multiple city-regions/local areas across the North**, avoiding simplistic ‘one sector per area’ thinking
- highly productive sectors, where the North can offer a **comparative advantage in terms of productivity**, and so help to close the North’s productivity gap with the wider economy
- sectors and areas of economic activity where there is a robust economic rationale for – and added value from – collaboration/ connectivity at the pan-northern level (ibid).

Based on these criteria, the NIER identified two specialisms that are evident in multiple areas in the north of England:

- **life sciences, including pharmaceuticals** – for example in Cheshire and Warrington, Hull and Humber, Greater Manchester, and the North East
- **healthcare technologies** – such as e-health/assisted living in Liverpool, medical devices in the Leeds and Sheffield city-regions, and health analytics and clinical research in Liverpool, Manchester and Sheffield (ibid).

Together, these are identified as a ‘health innovation’ prime capability, but it is crucial to recognise that the North’s prime capabilities are not separate: it cuts across a number of the North’s prime sectors – especially digital and advanced manufacturing – and is supported by a number of enablers, especially higher education and financial and professional services.

1.3 THE NORTHERN POWERHOUSE AND PLACE-BASED INDUSTRIAL STRATEGY

The NIER has been carried out at a crucial moment for the north of England. Since 2014 the government has recognised the potential of the northern economy and the previous chancellor, George Osborne, championed the idea of a ‘northern powerhouse’ built upon rapid transport links between a number of the North’s big cities.

The result of the EU referendum has sharpened the focus on regional rebalancing and making sure that all regions of the UK feel the benefits of national prosperity. The new government has built upon the northern powerhouse vision by establishing a new Department for Business, Energy and Industrial Strategy (BEIS) under the leadership of Greg Clark who has emphasised that any new industrial strategy will be necessarily ‘place-based’.

Historically, industrial strategy has come in different forms. Prior to the 1980s, governments adopted interventionist, sector-specific or ‘vertical’ approaches: subsidising, even owning, key economic sectors and assets from transport to energy supply to key areas of British manufacturing. In recent years, however, government intervention has not been industry-specific; rather, the government has adopted ‘horizontal’ interventions, which are intended to benefit the whole economy rather than any particular firm or sector. There have been similar approaches adopted with regional policy.

This is quite different from other developed nations where more vertical approaches have been common and regional policy more decentralised. German länder such as North Rhine Westphalia – a region often compared to the North (IPPR North/NEFC 2016, Swinney 2016) – and Bavaria and Baden-Wurtemberg have intervened to modernise their industries (TUC 2009). The Italian province of Emilia-Romagna is another important example in which regional government has, since the 1980s, taken a collaborative but interventionist approach, alongside with universities and other actors, in order to upgrade the technology of its manufacturing sector with great success (Chang 2009, Bianchi and Labori 2011).

However, it would be wrong to think that the apparent lack of UK industrial strategy or regional policy in recent years has had a neutral effect. In fact, the government has intervened in a small number of key sectors, not least in propping up the banking sector at the height of the global financial crisis. But even apparently benign tax policies or ‘spatially-blind’ education and skills policies have benefited some cities and regions much more than others (Cox et al 2014).

A new approach to place-based industrial strategy opens up huge opportunities for the north of England. In general terms, a modern industrial strategy must be sensitive to place in two ways: first, in its analysis of industry strengths and clusters; and second, in how it harnesses local assets and local governance when this is most effective. It is important to recognise that some sectors may be important for particular places or regions even if not for the whole country. Comparative advantage is a relative concept, with economic strengths being distributed and clustered in different ways in different areas.

It is in this context that the health science sector is so vital to the idea of a northern powerhouse. The health science sector is clustered in unique and important ways in the north of England and plays a vital economic role in particular towns and cities. It relies on place-based assets and local skills supplies to thrive and although bearing some superficial similarities it is quite different in nature from the health science sector found in the so-called ‘golden triangle’. A one-size-fits-all national approach to health sciences risks overlooking the potential of certain clusters or local specialisms – a more place-based approach could harness its more diverse local strengths.

1.4 THE HEALTH SCIENCE SECTOR – AN OVERVIEW

Despite the absence of anything approaching a comprehensive industrial strategy, there has been a national sectoral strategy for this sector with the government's Office for Life Sciences (OLS) and its Ministerial Industry Strategy Group involving key figures from industry alongside the health secretary and the life sciences minister. There is a life sciences strategy of sorts with a number of broad objectives and limited action plan detailing a small number of research investments totalling nearly £400 million (BIS 2011); and the Department of Health also seeks to harness the economic benefit of its activity (see DH 2011). But it made no attempt to understand how different parts of the UK could contribute to, and therefore benefit from, the strategy.

The sector itself is very broadly defined and industrial classifications have varied over time. At present standard industrial classification (SIC) codes concerning the sector are set out as follows.

The private element of the health science sector includes:

- 21: manufacture of basic pharmaceutical products and pharmaceutical preparations
- 266: manufacture of irradiation, electromedical and electrotherapeutic equipment
- 325: manufacture of medical and dental instruments and supplies
- 7211: research and experimental development on biotechnology.

The public sector includes:

- 86101: hospital activities
- 86102: medical nursing home activities
- 86210: general medical practice activities
- 86220: specialist medical practice activities
- 86230: dental practice activities
- 86900: other human health activities.

For the purposes of this report, however, we have divided the health science sector into five different 'strands' covered by the following:

- **biopharmaceutical** and **medical technology** sectors and their supply chains – these are generally private companies and relatively small in terms of employment but they are rapidly growing in the north of England and they represent significant export strengths (these are the subject of chapter 2)
- **university research** as well as wider **clinical and health research** – where the North is demonstrating some global expertise in particular specialisms, not least in applied research (these will be considered in chapter 3)
- the previous four strands are inextricably linked to the size and scale of the North's giant **health services sector**, which is worth some £30 billion and employs over half a million people (this is the subject of chapter 4).

The relationships between these five strands are critical to the success of health sciences in the North as a whole with **collaborations and place-based clusters** driving innovation and economic success. The nature and potential of these clusters is explored in chapter 5.

The report concludes with an analysis of the key **challenges** facing the health science sector in the North (chapter 5) followed by a series of **recommendations to central government** that inform how a place-based industrial strategy might work in relation to the health science sector, together with **recommendations to local and regional stakeholders** to maximise existing economic potential (chapter 6).

2. RAPID GROWTH: THE NORTH'S HEALTH SCIENCE INDUSTRY

The North's private health science sector is strong and growing. This chapter first sets out the breadth of the sector and its supply chain, before concentrating on its clusters and specialisms within a more focused definition, and finally analyses its significant export strengths.

2.1 BIOPHARMACEUTICALS AND MEDICAL TECHNOLOGIES: CORE AND SUPPLY CHAIN

The North has an average share of health science companies – if taken as a single region. The government takes a broad view of the sector – analysing the activity of businesses rather than a formal standard industrial classification (SIC) (BIS and OLS 2016a). Such an analysis is essential for analysing dynamic and emerging sectors that often defy standardised sector boundaries. Based on this analysis, the North is home to 1,165 companies in health sciences – either directly in the 'core' activities of biopharmaceutical or medical technologies, or in their supply chain (BIS and OLS 2016b). This is 20.7 per cent of the UK total – a slight overrepresentation compared to businesses generally (the North accounts for 19.2 per cent of all firms) (ibid, ONS 2016a).

As table 2.1 reveals, this supply chain involves a range of companies from sectors not conventionally thought of as being in the health science sector: 77 professional, scientific and technical companies would fall out of a strict sector definition, but serve the sector directly (ibid). In total the North has:

- 93 companies in the biopharmaceutical core (14 per cent UK), and 268 are in its service and supply chain (20.9 per cent of UK)
- 594 companies in medical technology core (22.1 per cent of UK) and 210 are in its service and supply chain (21.0 per cent of UK) (BIS and OLS 2016b).

Northern companies account for a similar share of the sector's employment, but there is a high concentration in the North West. The North accounts for 47,800 jobs including service and supply, 17.5 per cent of the UK total (ibid). If the North were one region it would be second only to the South East in number of employees; it also has more employees in medical technology core and its supply chain than even the South East does. The North West has a particularly high concentration: it has the third-highest number of jobs in health sciences and its supply chain in total; and has a higher than average concentration in medical technology's service and supply chain, and biopharmaceutical core. As figure 2.1 demonstrates, these are clustered in and around the major cities – especially (but not exclusively) in the North West and around Leeds. It is clear also that the North as a whole

has a significant share of each of the four components – this makes the improvements to connectivity that underpin the northern powerhouse all the more important.

TABLE 2.1

Companies in the health science sector core and service & supply chain within the North

	Biopharmaceutical core	Biopharmaceutical service & supply	Medical technology core	Medical technology service & supply	Grand Total
Manufacture of medical & dental instruments & supplies	3	1	91	7	102
Other professional, scientific & technical activities	2	28	26	21	77
Other human health activities	3	3	50	12	68
Research & experimental development on biotechnology	19	30	10	1	60
Other business support service activities n.e.c.*	4	16	23	12	55
Other research & experimental development	6	24	17	8	55
Other manufacturing n.e.c.		4	36	11	51
Manufacture of basic pharmaceutical products	18	19	10	1	48
Management consultancy activities	0	21	3	11	35
Wholesale of pharmaceutical goods	7	8	15	4	34
Top 10 total	62	154	281	88	585
Other	31	114	313	122	580
North total	93	268	594	210	1,165
<i>North per cent</i>	<i>14.0%</i>	<i>20.9%</i>	<i>22.1%</i>	<i>21.0%</i>	<i>20.7%</i>
UK total	664	1,284	2,683	1,002	5,633

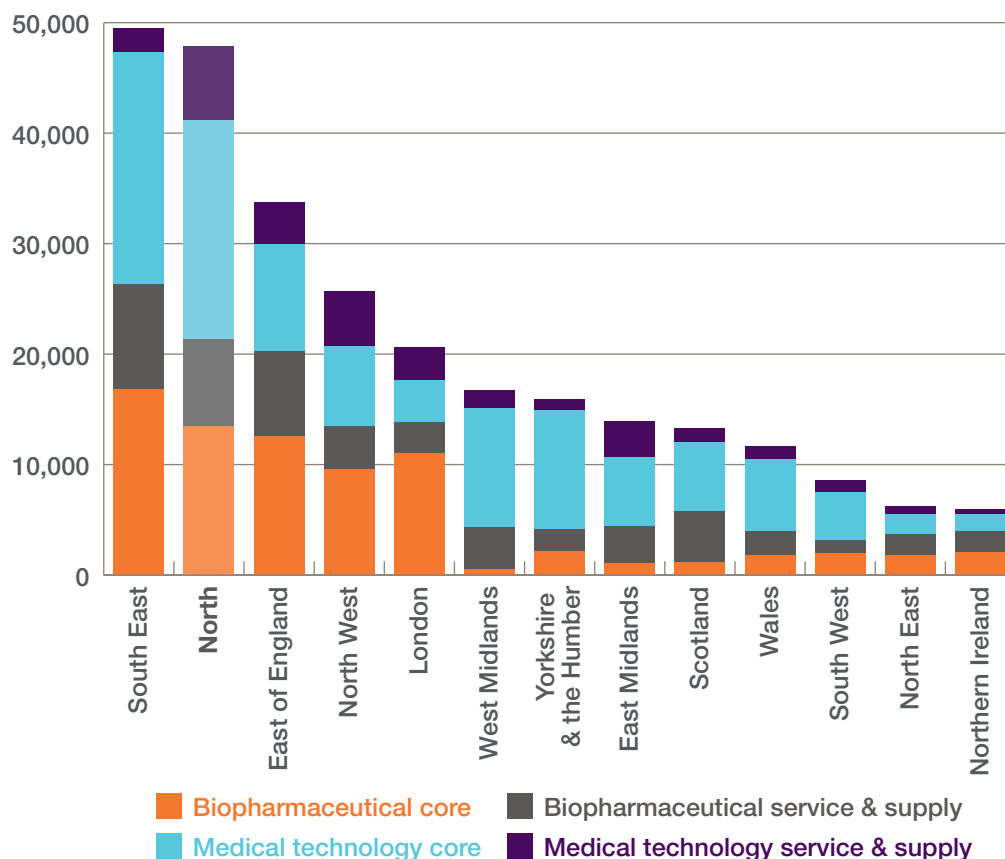
Source: BIS and OLS, *Strength and Opportunity 2015: the data behind the charts* (BIS and OLS 2016b)

*Definition: not elsewhere classified.

FIGURE 2.1

Taken as a whole the North is second only to the South East in health science employment

Employees in life sciences core and service & supply chain by region



Source: BIS and OLS, *Strength and Opportunity 2015: the data behind the charts* (BIS and OLS 2016b)

2.2 COMPARATIVE ADVANTAGE

The North’s subregions have a strong comparative advantage in the core health science sectors. Under the standard SIC definition of the sector, the North reveals subregional comparative advantage and disproportionate growth. The North has a particularly strong specialism in pharmaceuticals – although there is also some specialism in the manufacture of medical equipment in Cheshire and Warrington. As figure 2.3 shows, the North has a comparative advantage (using location quotient analysis) in the following subregions.

- **Cheshire and Warrington** is the most specialised in health sciences generally, with a location quotient value of 2.1; it is second only to the Humber for its specialism in manufacturing pharmaceuticals (4.4)⁴; and manufacture of irradiation, electromedical and electrotherapeutic equipment (3.4).

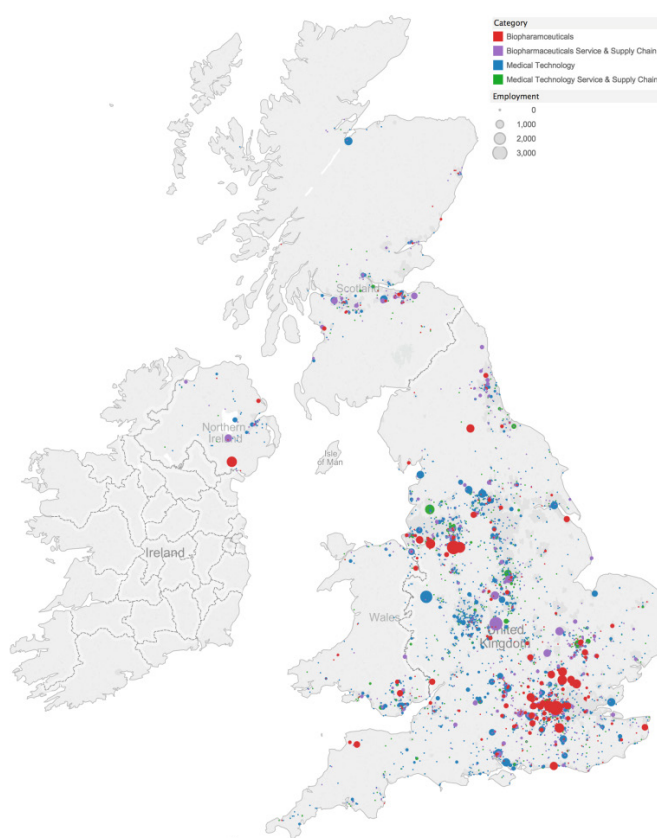
4 Technical definition: manufacture of basic pharmaceutical products and pharmaceutical preparations

- **The Humber** is similarly specialised, with a location quotient value of 2.0; it is the LEP which specialises most in manufacturing pharmaceuticals (4.5).
- **The North East** is the next most specialised in the sector generally, with a location quotient value of 1.7 overall, and 2.6 in manufacturing pharmaceuticals.
- **Liverpool city-region** is next with a location quotient value of 1.5 across health sciences, and 3.2 in manufacturing pharmaceuticals.
- **York, North Yorkshire and East Riding** also specialises, with a location quotient value of 1.3 across all health sciences, and 2.2 in manufacturing pharmaceuticals (author’s analysis of ONS 2016b).

This compares well with the rest of England, and places the North’s local enterprise partnerships (LEPs) alongside Oxfordshire, Swindon and Wiltshire, Hertfordshire and Solent: the LEP areas listed above have similar location quotient values across health sciences generally, and are particularly strong in the manufacture of pharmaceuticals. Beyond the North there are particular specialisms in the manufacture of irradiation, electromedical and electrotherapeutic equipment in Coast to Capital (11.6) and Oxfordshire (10.7) (ibid).

FIGURE 2.2

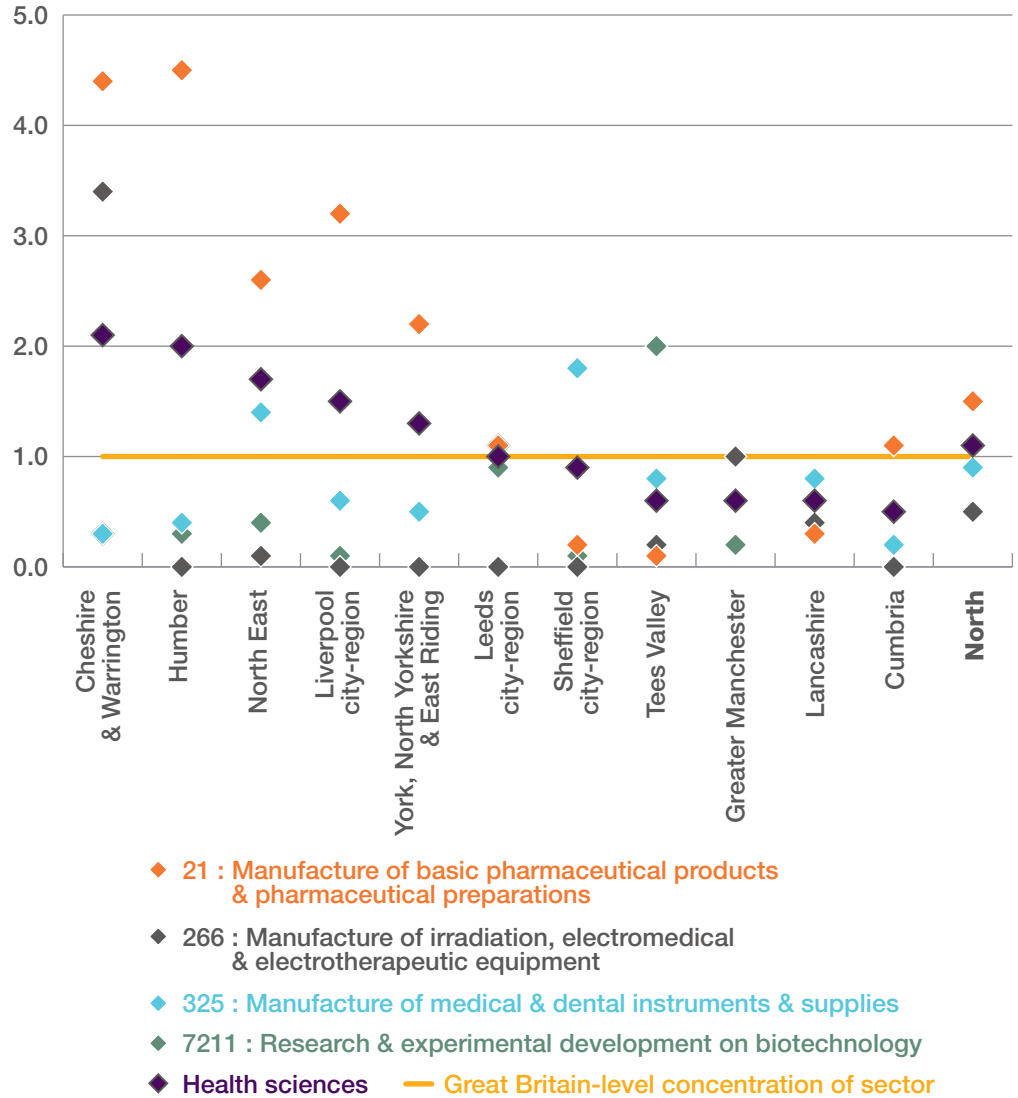
The North’s health science sector is significant in size, and clusters around Manchester, Liverpool and Leeds
Health science and supply chain employment



Source: Reproduced from BIS and OLS, *Strength and Opportunity 2015: geographical data maps* (BIS and OLS 2016c)

FIGURE 2.3

Several northern LEPs have specialisms in health science
Location quotients of employment by subsector in health science, 2015



Source: ONS, 'Business Register and Employment Survey 2015' (ONS 2016b)

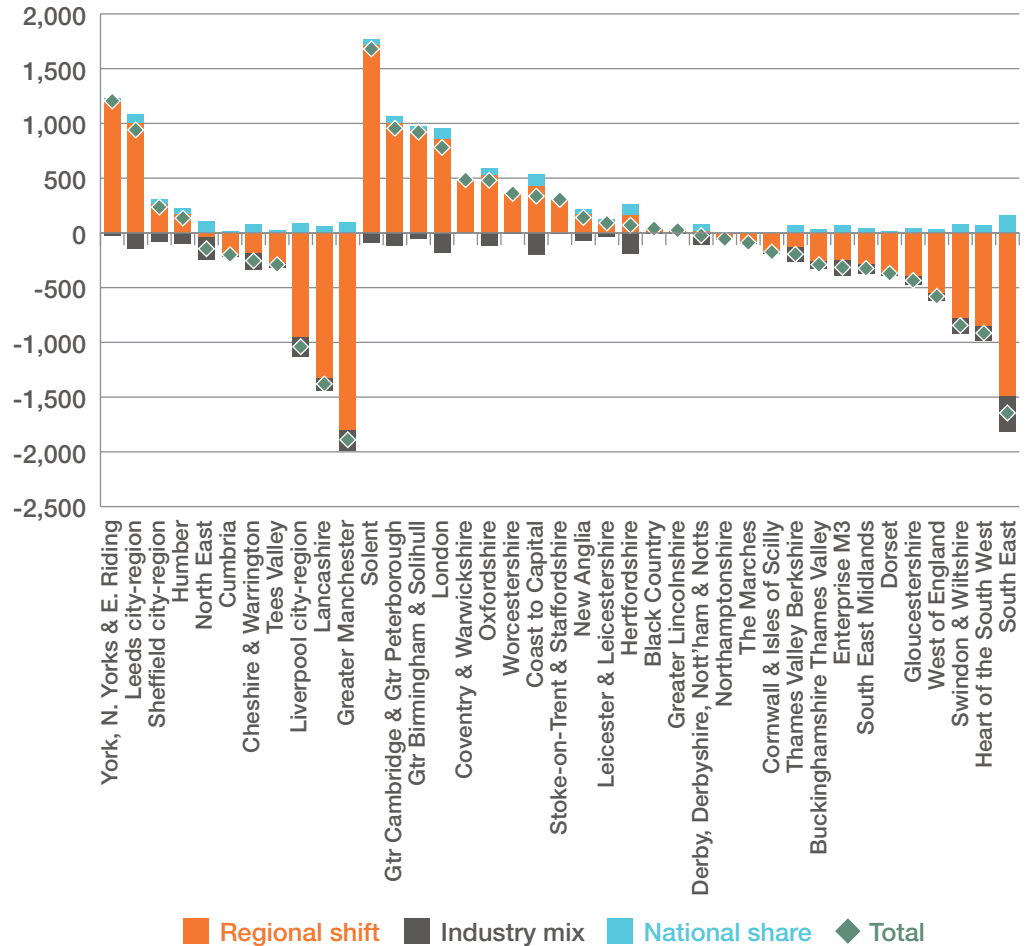
Not only do some places show comparative advantages, crucially many of the northern subregions are seeing rapid private sector growth in the health science sector. Using 'shift-share' analysis, our research shows that particular regions have grown at a rate which is disproportionate to national or sector trends in recent years (see figure 2.4):

- York, North Yorkshire and East Riding grew most – by 1,250 jobs
- Leeds city-region grew by 940 jobs
- Sheffield city-region grew by 480 jobs (author's analysis of ONS 2016b).

FIGURE 2.4

Many of the North’s subregions grew much faster than other parts of the country

Shift-share analysis of the health science sector, 2009–2015



Source: Author’s analysis of ONS, ‘Business Register and Employment Survey 2015’ (ONS 2016b)

2.3 EXPORTS

The North is also a key driver of national export performance in pharmaceutical and medicinal products. £7.3 billion worth of medicinal and pharmaceutical products were exported from the North in 2015 – this is 44.7 per cent of UK exports in this category, and a share which is growing (HMRC 2016). In the last 10 years, the value of this category’s exports from the North grew by 53.8 per cent⁵ compared to 42.3 per cent across the UK as a whole, although it has slipped from a high point of £8.1 billion in 2010 (ibid). A large proportion of this growth was driven by firms in Yorkshire and the Humber. Export values in the category – largely to the US – rose from a low point of £280 million in 2012 almost tenfold to £2.5 billion in 2015. The North East’s exports in the category also grew significantly during this period – by 50.4 per cent – though this was from a low base and so had less of an effect on pan-northern exports. Exports

5 In nominal terms.

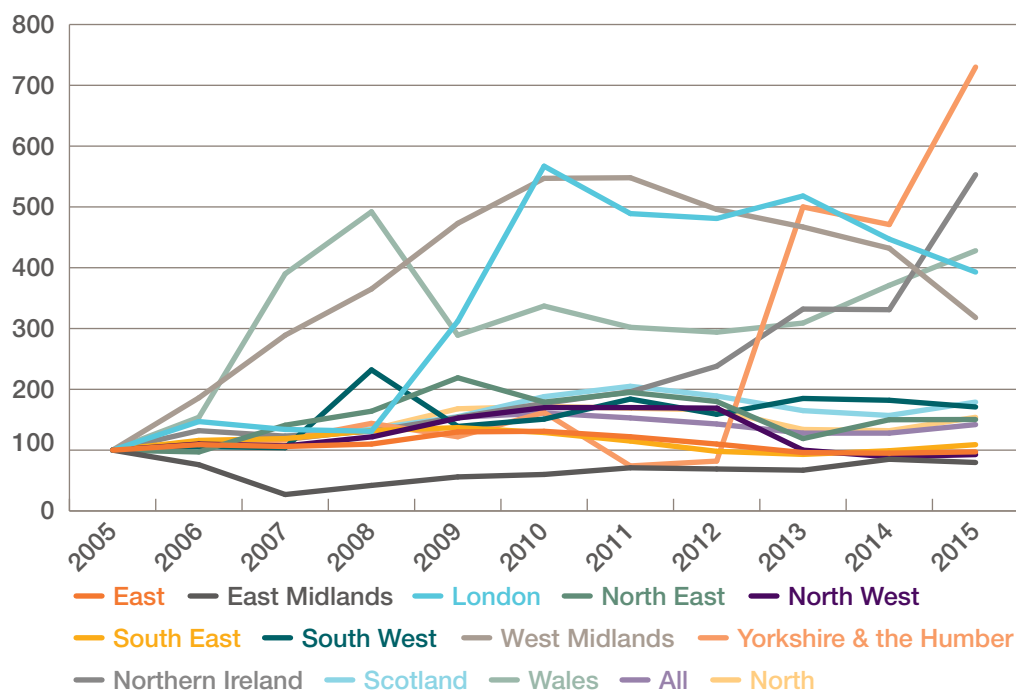
in the category from the North West, however, declined during this period by 7.3 per cent (ibid).

The North exports the majority of goods in this category to non-EU countries – more so than the rest of the UK. The North exports £5 billion of medicinal and pharmaceutical goods to non-EU countries – more than two-thirds (69.5 per cent) of exports in this category, compared to 58.8 per cent in the rest of the UK. Yorkshire and the Humber exports by far the highest proportion in the country, with 91.1 per cent of exports going to non-EU countries (ibid). This is very significant in relation to ensuring economic resilience at a time when the UK is planning its departure from the European Union.

FIGURE 2.5

Exports in pharmaceutical and medicinal products have shot up in Yorkshire and the Humber, risen modestly in the North East and fallen in the North West

Exports in pharmaceutical and medicinal products by value from 2005 (£, nominal)



Source: HMRC, 'UK Regional Trade' (HMRC 2016)

3.

SIZE AND SCALE: PUBLIC INVESTMENT IN HEALTH SCIENCE

As in the country at large, the public sector represents the majority of the health science sector in the North. This has a substantial impact on the wider economy, with the NHS having a direct impact through employment and investment. While this activity is not directed primarily towards economic growth, it does have clear economic effects. This chapter focuses only on spending on health services, and therefore excludes the vital role of the NHS in research (see chapter 4).⁶

3.1 NHS PROFILE IN THE NORTH

NHS delivery is perhaps the most conspicuous section of the health science economy, and has a significant economic impact on the north of England. There are 80 NHS trusts and 68 clinical commissioning groups in the North (Tech North 2016). Of £128.4 billion public money spent nationally on medical care, £30.6 billion is spent in the North (HMT 2015). This amounts to £2,000 per head in the North – about the same proportion as nationally, but this makes up a larger share of the North’s economy (10.1 per cent) than of the national economy (8.1 per cent) (ibid, ONS 2016c).

Employment is also relatively high – especially in certain areas. There are 550,000 people working in the health provision in the North (ONS 2016b). Two-thirds (360,000) are employed in hospitals; this is followed by other human health activities (88,000) and general medical practice activities (59,000). The North has a notably higher proportion of employment in medical nursing home activities – 1.2 times the national proportion (although this is largely due to concentrations in Tees Valley, North Eastern and Sheffield city-region LEPs) – and in hospital activities (especially in Tees Valley, Liverpool city-region, Sheffield city-region and Lancashire), some of which have ageing populations, often with poor health.

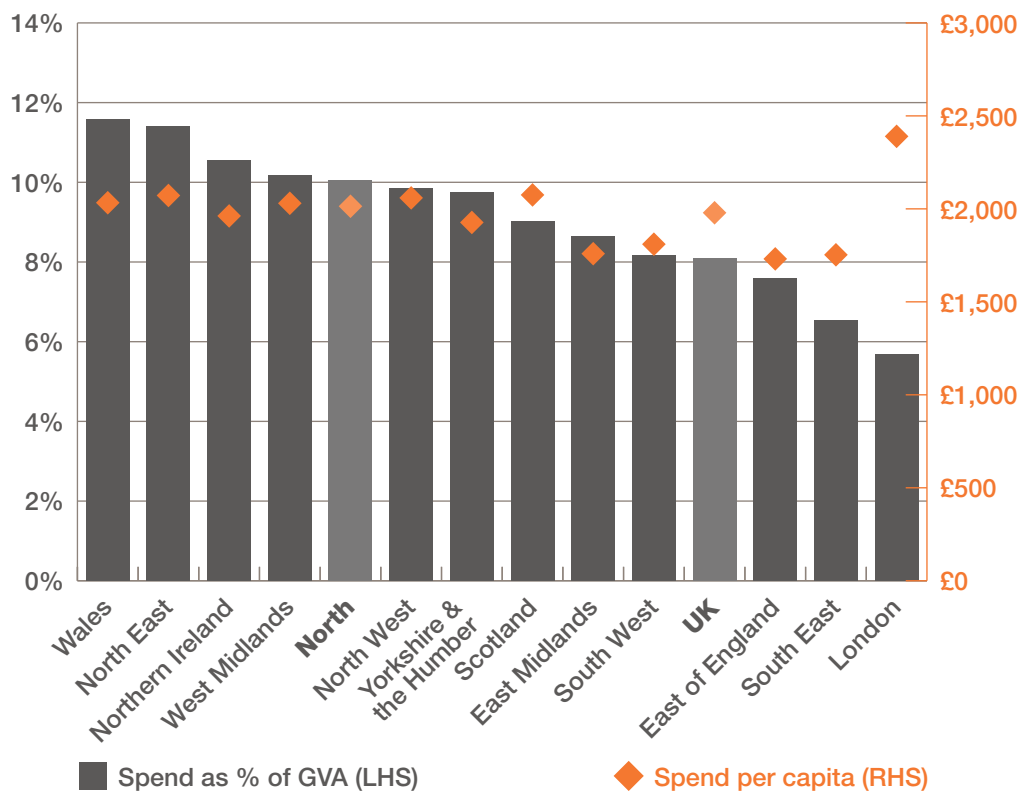
Employment has gone up at a slower rate than nationally – by 7 per cent between 2009 and 2015, an increase of 36,000 jobs (ibid). This is not uniform across the whole sector, as it has been driven by a large increase in hospital employment (41,000), while employment in other areas – such as medical nursing home activities and ‘other human health activities’ fell by 11,000 and 8,000 respectively. Nor is this change uniform across the North’s geography: North Eastern and Tees Valley LEPs saw increases of 22.5 per cent and 16.5 per cent respectively, while Humber’s employment declined by 9.6 per cent (ibid).

⁶ The health impacts are not within the scope of this research, though research has a positive impact on health outcomes – see chapter 4.2.

FIGURE 3.1

Health spending is a larger proportion of the North’s economy, but London receives more per capita

Public spending on medical services per capita and as a proportion of GVA



Source: Author’s analysis of HM Treasury, ‘Country and Regional Analysis 2015 (HMT 2015), ONS, ‘Regional Gross Value Added (Income Approach)’ (ONS 2015a) and ONS, ‘Population estimates’ (ONS 2016c)

3.2 ECONOMIC IMPACT OF HEALTH SPENDING

The impact of this on the economy will be significant – especially in some parts of the North. Several studies have demonstrated the impact of hospitals on the local economy. This ‘multiplier’ effect results from a range of activities, primarily through staff re-spending their wages, but also through capital spending and purchasing. The economic impact of hospitals tends to be quite large – a meta-analysis of the impact of hospitals on the US economy estimated multipliers of 2.8 on employment, 2.4 on earnings and 3.3 on output (AHA 2013). We have not found UK estimates for the economic impact of health spending, but Buck and Jabbal (2014) estimate a multiplier effect of between 2 and 4 based on cross-country analysis (3.6) and the impact of Medicaid in the US (2.1).

The *local* economic impact is more limited, however: research has shown that while expenditure on staff wages and services tends to stay within the region (and therefore has the biggest local economic impact), a large proportion of expenditure goes on pharmaceutical products and health material – the vast majority of which tend to be procured from outside. Therefore while national economic multipliers are significant, *local*

economic multipliers tend to be less than one because this ‘leakage’ isn’t compensated for by the re-spending of staff wages in the local economy (Watson 2006, Bartik and Erickcek 2008).

This local impact could be maximised via procurement policy. Given that the North has a strong private sector, and undertakes a great deal of research, there is scope to improve its local procurement. Watson (2006) shows how health procurement can be used to improve health and human capital, via stimulating local businesses, increasing local employment, and improving local skills, wellbeing and social cohesion.

- In 2004 Northumbria county council found that local suppliers re-spent on average 76 per cent of their contracts locally, and therefore split their contract into smaller lots to enable local businesses to compete (ibid).
- In 2001/02 Wirral Hospitals NHS Trust spent 32 per cent with local suppliers (almost half of this (49 per cent) was on professional services); while Aintree spent 29 per cent locally (36 per cent of which was on facilities management) (SQW 2004).

4. GLOBAL EXPERTISE: CLINICAL AND HEALTH RESEARCH

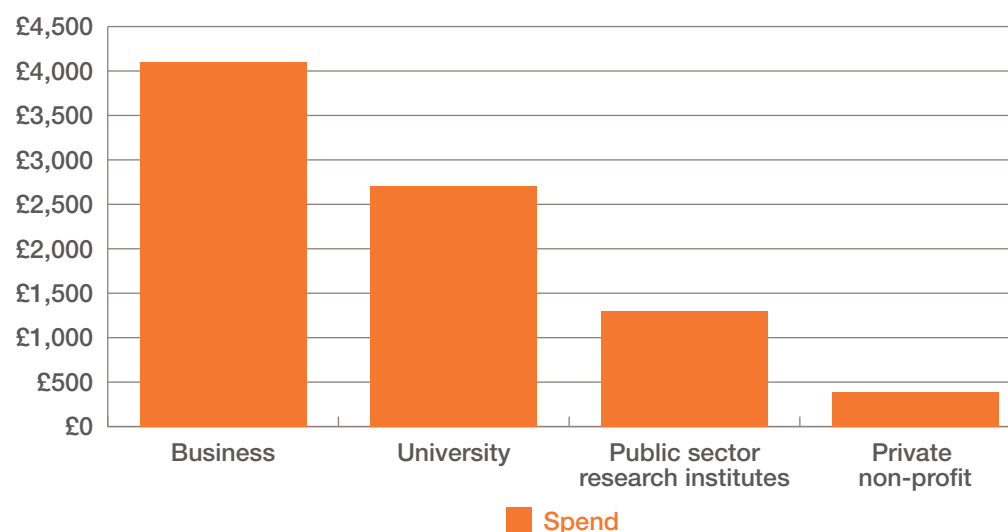
Clinical and health research drives forward innovation in the public and private sector: this is unique and extremely valuable to health sciences. This activity involves a range of sectors in different places across the country: universities are the catalysts that enable innovation throughout, but the process originates from their basic research; companies develop new treatments; hospitals trial these new treatments; these are then commercialised, manufactured and sold (see figures 4.1a and 4.1b).

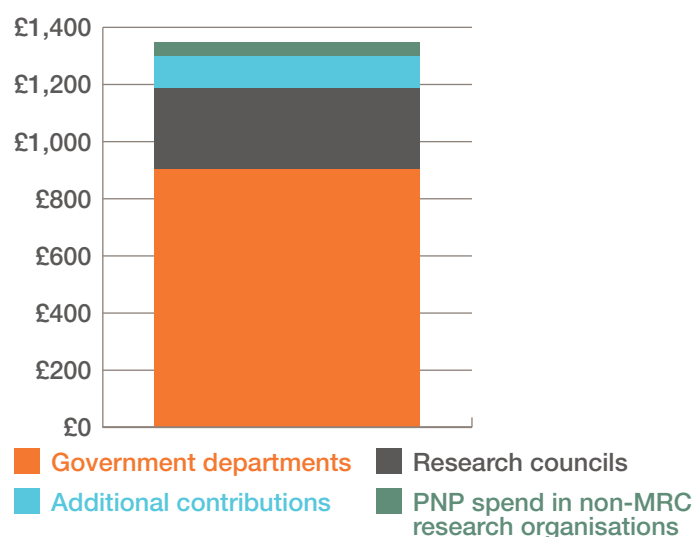
4.1 HEALTH SCIENCE RESEARCH

The government has protected the overall science and research budget in real terms – currently £4.7 billion in revenue and £6.9 billion in capital – although there will be changes to how this is spent: a new Research UK body will create and manage a fund which cuts across research councils (BIS 2016). The UK is a centre of global excellence in health research, and 30 per cent of all EU clinical trials are run in the UK (Witty 2016).

FIGURES 4.1A AND 4.1B

Business provides the majority of funding for clinical research
Sources of funding for clinical research





Source: UKCRC, *UK Health Research Analysis 2014* (UKCRC 2015)

Research funding is drawn from various sources and is directed towards a range of activities. In 2014, £8.5 billion was spent nationally on clinical research from all sources. The private sector provided almost half (48.2 per cent), followed by universities (31.9 per cent), public sector research institutes – that is, government departments and research councils – (15.3 per cent), and private non-profit organisations (0.4 per cent) (UKCRC 2015).

This funding is heavily weighted towards the more ‘basic’ (that is, less applied) end of the research spectrum – although these are all connected:

- about half of this funding (51.2 per cent) was directed towards the ‘basic’ research activities of underpinning and aetiology, which have little direct economic impact – although this is absolutely essential for more applied activity, and does have a significant indirect impact on the economy and society (EPSRC 2015, Russel Group 2010)
- one-third (32.9 per cent) of this spending is directed towards activities that begin to move from basic to applied R&D: detection and diagnosis, treatment development and treatment evaluation
- a further 9.8 per cent is spent on disease management and health services and 5.2 per cent is spent on prevention (ibid).

The economic impact of health research is significant:

- studies have shown that public investment in health science R&D leverages in private sector investment too: one study found that for every £1 of public money spent on health research, there was an additional £0.83–£1.07 spent by the private sector (Sussex et al 2016)
- over a longer period this impact is even greater – over eight years, the impact of every £1 was estimated at between £2.20 and £5.10 (HERG et al 2008)
- the wider economic impact is also notable: government and charity funding of medical research was found to have a total economic rate of return of 24–28 per cent – including 15–18 per cent of economic impact and a further 9–10 per cent via improved health (Sussex et al 2016)

- the economic impact of such R&D is most effective when it is collaborative: collaborative R&D in bioscience has been found to generate £3.97 in GVA for every £1 spent – significant, but not as high as in other fields such as advanced materials and micro- and nanotechnologies (£15.41) (TSB 2014)
- research-active health trusts also see better health outcomes – lower rates of patient mortality following emergency admissions (Ozdemir et al 2015) – vital for the North, where health outcomes are poor (IPHENE 2014).

The previous allocation of research funding (for 2011/12–2014/15) set out how each research council would have a wider economic impact – although the Medical Research Council (MRC) does not set out specifically how it aims to do so (see BIS 2010). The current allocation of research funding (2016/17–2019/20) notably doesn't reference economic impact as an objective at all (see BIS 2016).

4.2 INVESTMENT IN NORTHERN RESEARCH

The North received £273 million in health research funding from various sources in 2014 (excluding business funding) (UKCRC 2015). Thirty-nine per cent of its funding came from research councils (almost a quarter of its total from the MRC); 36.1 per cent from charities (Cancer Research UK and Wellcome Trust together make up a quarter of the North's total funding); and 24.9 per cent from government departments (almost entirely the Department of Health) (ibid).

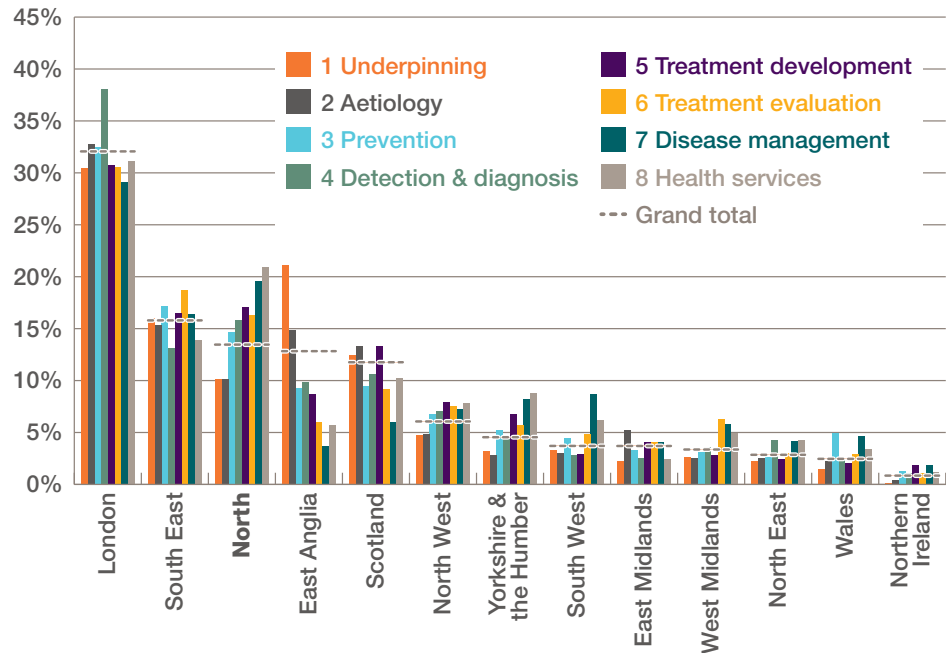
Data on the private sector's R&D spending in health sciences isn't available at the regional level. However, in the chemical sector, of which pharmaceuticals is a component, the private sector spends 19.7 per cent of UK spend in the North. If this proportion is applied to the national figure for pharmaceutical spending (£3.9 billion), then an estimated £770 million is spent by the private sector on pharmaceutical R&D in the North (ONS 2015b).

In the North, the sector also appears to be geared towards the more applied areas of research – although there are clear specialisms in basic research too. In 2014 the North received the highest proportions in the following (more applied) areas of research: 20.9 per cent of UK funding for health services, 19.6 per cent of funding in disease management and 17.1 per cent of funding in treatment development (ibid).

While the North receives a large proportion of these funding pots, the pots themselves are small: this means the North actually receives most of its funding from its small share of the larger funding pots. These funding pots tend to be towards the basic end of the research spectrum. For example, the North brings in £60 million in aetiology, which is 22 per cent of its total funding, but only 10.1 per cent of UK spend; likewise, it brings in £47 million in underpinning research, which is 17.1 per cent of North funding, but only 10.2 per cent of UK funding. This is clearly a challenge for the North – explored further in chapter 6.1 (ibid).

FIGURE 4.2

London dominates the health research landscape, followed by the South East – the North taken as a whole follows closely behind
Geographical distribution of combined research funding in the UK (64 funders) – per cent of each area



Source: Author's analysis of UKCRC, *UK Health Research Analysis 2014* (UKCRC 2015)

TABLES 4.1A AND 4.1B

Northern successes in attracting research funding by activity – top 10 by northern proportion of UK-wide funding in that area (4.1a, top) and by absolute size (4.1b, bottom) (top three in each column highlighted)

	UK total	North	% of UK funding	% of North's funding	North East	North West	Yorkshire & the Humber
6.8 Complementary	£1,217,539	£629,150	51.7%	0.2%	£0	£128,406	£500,744
7.2 End-of-life care	£3,280,899	£1,409,366	43.0%	0.5%	£438,568	£114,075	£856,723
1.3 Chemical & physical sciences	£29,482,021	£9,193,354	31.2%	3.4%	£1,212,705	£4,224,603	£3,756,046
6.3 Medical devices	£14,440,132	£4,391,253	30.4%	1.6%	£806,557	£1,401,350	£2,183,346
5.3 Medical devices	£18,416,074	£4,980,405	27.0%	1.8%	£1,011,747	£1,549,252	£2,419,406
5.6 Psychological & behavioural	£3,929,206	£1,048,861	26.7%	0.4%	£207,583	£719,982	£121,296
5.9 Resources & infrastructure (development of treatments)	£54,872,830	£14,184,940	25.9%	5.2%	£2,213,668	£7,116,418	£4,854,854
2.5 Research design & methodologies (aetiology)	£15,098,361	£3,850,540	25.5%	1.4%	£2,297,534	£1,065,210	£487,796
8.4 Research design & methodologies	£20,316,119	£4,820,167	23.7%	1.8%	£296,496	£2,536,214	£1,987,457
8.1 Organisation & delivery of services	£56,012,789	£12,490,383	22.3%	4.6%	£4,034,394	£3,182,466	£5,273,524
Subtotal	£217,065,969	£56,998,419	26.3%	20.9%	£12,519,253	£22,037,975	£22,441,191
Grand total	£2,025,045,454	£272,620,770	13.5%	100.0%	£57,782,661	£122,802,772	£92,035,337

	UK total	North	% of UK funding	% of North's funding	North East	North West	Yorkshire & the Humber
2.1 Biological & endogenous factors	£376,220,066	£36,871,866	9.8%	13.5%	£7,086,124	£17,847,836	£11,937,906
1.1 Normal biological development & functioning	£344,832,918	£25,139,662	7.3%	9.2%	£6,158,191	£11,638,069	£7,343,402
5.9 Resources & infrastructure (development of treatments)	£54,872,830	£14,184,940	25.9%	5.2%	£2,213,668	£7,116,418	£4,854,854
5.1 Pharmaceuticals	£121,652,219	£13,854,350	11.4%	5.1%	£1,844,116	£7,090,938	£4,919,295
8.1 Organisation & delivery of services	£56,012,789	£12,490,383	22.3%	4.6%	£4,034,394	£3,182,466	£5,273,524
4.1 Discovery & preclinical testing of markers & technologies	£88,120,307	£11,867,010	13.5%	4.4%	£3,435,865	£5,423,577	£3,007,568
6.1 Pharmaceuticals	£85,550,063	£11,341,039	13.3%	4.2%	£2,328,687	£6,039,124	£2,973,227
4.2 Evaluation of markers & technologies	£60,834,222	£10,211,784	16.8%	3.7%	£2,749,028	£3,589,646	£3,873,111
1.3 Chemical & physical sciences	£29,482,021	£9,193,354	31.2%	3.4%	£1,212,705	£4,224,603	£3,756,046
5.2 Cellular & gene therapies	£45,181,019	£8,530,981	18.9%	3.1%	£783,947	£3,632,026	£4,115,008
Subtotal	£1,262,758,453	£153,685,370	12.2%	56.4%	£31,846,725	£69,784,703	£52,053,941
Grand total	£2,025,045,454	£272,620,770	13.5%	100.0%	£57,782,661	£122,802,772	£92,035,337

Source: Author's analysis of UKCRC, *UK Health Research Analysis 2014* (UKCRC 2015)

Biomedical research centres

The National Institute for Health Research (NIHR) funds biomedical research centres in the UK – it is the largest public funder of health research in the country (NIHR 2015a). Biomedical research centres (BRCs) are funded by the NIHR to foster collaboration between NHS organisations and universities. These prioritise translating lab-based discoveries into new treatments and direct benefit to patients.

The 2012 allocation distributed £218 million across the country, with just £16.6 million going to the North – to Newcastle, in order to fund a range of research around ageing (DH 2012). Under the 2017 allocation £55 million will be received by northern university–hospital partnerships for the already established BRC in Newcastle (£16 million), followed by new BRCs in Manchester (£29 million) Leeds (£7 million) and Sheffield (£4 million) – while this is more than three times as much as in the previous allocation, the sum available nationally went up by more, meaning that the North's share actually slipped – from 7.6 per cent of the total, to 6.8 per cent (DH 2016).

This funding drives up innovations and improves health, but also has an economic impact: bringing in foreign direct investment (FDI); driving international competitiveness in research; producing more cost-effective treatments; and finally – perhaps most importantly – via a healthy workforce that results from good healthcare (NIHR 2015b). The Department of Health estimates that for every £1 it invests in

BRCs, hospitals and universities will generate £6 from public funders of research, charities and industry partners (DH 2016).

4.3 UNIVERSITIES

Universities form a major part of many local economies – especially in the North. Directly they spend revenue and capital within the local economy: paying staff, buying goods and building or repairing structures; they also attract large numbers of students from across the world, who in turn spend locally. This has a knock-on effect when people or companies spend this again within the local economy (though some inevitably leaks out of the area).

Universities UK estimates that for every 100 full-time jobs in a university, there are *another* 117 full-time equivalent jobs as a result; and for every £1 million spent a *further* £1.35 million is generated in the wider economy, £1.03 million of which is in other industries (Kelly et al 2014). While northern universities are dwarfed by the other sectors that make up an economy, they contribute a small but significant amount.

- Research by the N8 Partnership⁷ found that the North's eight most research-intensive universities have a research income of £1.2 billion a year (88 per cent of all northern higher education research income) (N8 2016). This research income had a regional economic impact of generating £12.2 billion (4 per cent of GVA) a year and creating 119,000 jobs (1.6 per cent of all full-time equivalent jobs).
- This economic impact varies by sector: Leeds University estimated its own impact on the wider economy was £772 million, of which £136 million was in manufacturing, £121 million was in business activities, and £71 million was in wholesale and retail trade (Leeds University 2015).
- There were also 969 spin-offs (in all sectors) from northern universities in 2014/15 – 21.5 per cent of the UK total – largely graduate startups (907) (HESA 2016).
- EU funding was found to add £173 million of GVA, and 3,100 jobs to the North (Kelly 2016).
- Perhaps most importantly, universities are enablers of wider growth – they underpin the North's prime economic capabilities through knowledge and skills, and through internationalisation (NIER 2016).

University activities in or around the health science sector can have a particularly strong economic effect. The box below shows the role of Newcastle University and its local pharmaceutical sector in regeneration. However, numerous studies in the UK and abroad have highlighted the specific impact of health sciences:

- Southampton University's research income brought in £37.5 million, which was converted to £51 million to the national economy: a social return on investment of £1.38 for every £1 spent (Biggar 2015)

⁷ The N8 Research Partnership is a collaboration of the eight most research-intensive universities in the north of England: Durham, Lancaster, Leeds, Liverpool, Manchester, Newcastle, Sheffield and York.

- in the US, Texas Tech University Health Sciences Centre's annual operations had a multiplier effect of 1.3 on local economic growth, and 1.5 on employment – this means that for every £1 spent an additional 30p was generated in the wider economy, and for every two jobs there is one generated in the wider economy (Reyes et al 2016)
- Tennessee's Health Science Sector was found to generate an additional 80 cents for every \$1 spent, and to generate tax revenue equivalent to 14.7 per cent of initial spending (Fox et al 2010)
- Canada's faculties of medicine and health science partners were found to have a multiplier effect of 2.5 on the national economy (Umbach 2014).

Newcastle University and the pharmaceutical sector

Universities are particularly important for the North East's economy. As sources of knowledge and spending, they are clearly an asset for any area, but they have proven especially vital as catalysts of economic activity in post-industrial areas. These areas of course spread across the developed world, but in the UK especially, they have lacked any strategic response from government (see chapter 1). In the absence of such an intervention, universities – rooted in their communities – can be principal actors in regeneration. In the North East they have been vital: a source of innovation and investment in an economy that is often lacking in both (Benneworth and Hospers 2008).

Newcastle University has been actively engaged in encouraging pharmaceutical activity. It has promoted new spin-off companies, developed relationships with firms already there, and invested in its own research expertise in areas likely to be commercialised. The effect has been subtle but important. This is a smaller-scale intervention than elsewhere in the country, and so the impact on the industrial base has been muted – though modernisation does seem to have occurred. However, the university has had a more significant impact on collaboration within the region, and on the ability of actors within the region to respond to crises. The university has also prioritised social exclusion as part of each of its main research themes (ibid).

Perhaps its greatest impact has been in rehabilitating the region's image as a location where innovative research can be done. This bucked the trend of the time that was focused almost exclusively on attracting inward investment (ibid). Newcastle has seen recent success and recognition for research related to ageing: a partnership between Newcastle upon Tyne Hospitals NHS Foundation Trust and Newcastle University was the only place in the North to receive funding for a biomedical research centre and was awarded again in 2016 – this focuses on themes closely related to ageing such as dementia, liver disease, musculoskeletal disease, neuromuscular disease, and skin and oral disease (DH 2012, DH 2016).

5. OPPORTUNITIES: CLUSTERS AND COLLABORATIONS

The real strength of the health science sector in the North is not found in its separate subsectoral strengths or in its particular assets but in the way in which they form clusters linked to the wider economy. The health science sector has important linkages with the wider economy, which has critical assets for enabling the North's health science sector to flourish. Furthermore, health and social care devolution in Greater Manchester represents an opportunity to maximise the potential of cross-sectoral collaboration.

5.1 CLUSTERS OF INNOVATION

The North's private and public strengths cluster – often together – in its cities and towns. The advantage of place is compounded when other companies make similar choices and base themselves nearby. The Northern Independent Economic Review, supported by our own analysis, has identified a significant number of important clusters across the north of England.

- Cheshire and Warrington stands out nationally and internationally as a centre of pharmaceutical excellence:
 - it has a long history of expertise in life sciences – especially around Alderley Park – and high-profile firms include: AstraZenica, Advanced Medical Solutions Group, Sanofi, Peckforton Pharmaceuticals, Sinclair Pharmaceuticals, Life Technologies, Phenomenex, Cyprotex, Medtrade, Claris Lifescience, and Lupin Europe Ltd (NIER 2016b); AstraZenica's R&D site was recently repurposed by Manchester Science Partnerships, and is set to capitalise on its linkages into Manchester (see box below).
- Greater Manchester provides an urban focal point for the sector in the North, and as an economically diverse city is able to provide the enabling services that the sector needs to thrive:
 - like the other urban areas, the public sector is an asset to the private and this generates a significant number of firms engaged in high-value 'health innovation' activities: there are a number of leading universities – not least the University of Manchester – and research-intensive hospitals – notably the Christie, which is Europe's largest single-site cancer centre
 - devolution to Greater Manchester opens up significant opportunities for collaboration, and Health Innovation Manchester (HIM) has been set up to accelerate innovation within the city-region

- Greater Manchester specialises in pharmaceuticals, biotechnology, health analytics, drug discovery and diagnostics, medical devices, clinical trials and cancer research/treatment; its assets also include Manchester Science Park, a node of Innovate UK’s Precision Medicines Discovery Catapult Citylabs and the MedTECH Centre
- but its real strength is its geographical position, and its other economic assets – it is close to Alderley Park, and lies between Liverpool and Leeds city-regions; it has a major airport, and a diverse and growing wider economy (NIER 2016b).
- Liverpool city-region has a range of public and private sector assets:
 - it has specialisms in: infectious disease, stratified medicine, E-health and assisted living, biologics manufacturing, paediatrics, pancreatic disease, cancer (pancreatic, lung, ovarian, and head and neck), clinical pharmacology and nutraceuticals
 - it is also home to the Medicines for Children Research Network hub for the UK, and one of the UK’s leading centres for drug safety science, with interest in drug bioanalysis, cell systems, genetic screening capabilities (through the Wolfson Centre) and immunoassay development
 - the area is home to some major corporates in the health and life sciences sector including Eli Lilly/Elanco, Actavis, AstraZeneca and Novartis; it is home to Europe’s largest biologic manufacturing site in Speke
 - Liverpool Health Campus is a major asset, and includes the Royal Liverpool Hospital, Clatterbridge Cancer Hospital, Life Sciences accelerator and expansion of the Liverpool School of Tropical Medicine (NIER 2016b)
 - the area also has some of the poorest health outcomes in the country – this means that new treatments can be trialled effectively, and it enables the population to benefit from the results.
- The North Eastern LEP has a diverse health science sector:
 - it specialises in formulation, manufacturing, packaging and distribution activities
 - leading global firms located in the area including GSK, MSD, Piramal Pharma Solutions and Aesica Pharmaceuticals, but there are also smaller innovative firms engaged in biopharmaceuticals, custom syntheses and supply firms in medical technology, bioprocessing, drug discovery and medical devices
 - it has a strong research and clinical base with an international reputation for ageing-science, the universities of Newcastle and Durham, and Newcastle is also home to the International Centre for Life Science ‘village’
 - recent investments include the creation of the National Centre for Healthcare Photonics to develop and commercialise photonics-based therapies; the Newcastle Life Sciences Incubation Hub; the National Centre for Ageing Science and Innovation at Newcastle University; and Newcastle’s forthcoming University Technical College – set to specialise in health and IT.

- Leeds city-region has a concentration of knowledge-based innovative health sciences organisations, alongside broader healthcare industries and recognised strengths in digital health innovation and the manufacture of medical and dental instruments:
 - its public sector assets – hospitals and universities again double up as assets for the private sector; it is also home to NHS England and the NHS Data Spine
 - it is home to medical equipment manufacturers such as Brandon Medical, Smith and Nephew, and DePuy International Ltd; leading pharmaceutical companies Thornton & Ross and Galpharm (International) Ltd); research-driven analytical service companies such as Covance, Unilabs, Emis and TPP; tissue repair companies Tissue Regenix Group plc and Neotherix
 - major assets include the Medical Technologies Innovation and Knowledge Centre at Leeds University; plus Medipex Healthcare Innovation Hub and Medilink connecting the NHS with industry and academia
 - recent investments include BioVale, an innovation cluster for biotechnology firms, providing flexible laboratory and pilot-scale business incubation space, a Bio-renewables Development Centre – Industrial Scale-up Facility, and a Bioeconomy Support Centre. There are also University Enterprise & Innovation Centres such as the Bradford University-BT Health Zone, plus initiatives on big open data, regenerative medicine, bioinformatics and cancer therapeutics in Leeds (ibid).

These form the majority of the North's private sector strengths, but other subregions are important nodes in the supply chain, or reveal niche specialisms:

- the Humber manufactures health-related products, and is home to firms such as Smith & Nephew, Novartis and Reckitt Benckiser; while the health hub for the Hull-York Medical School is under development
- Tees Valley houses a Biologics Factory of the Future at the CPI located at Central Park, Darlington, adjacent to the National Biologics Manufacturing Centre
- York's centre for health economics (CHE) and Sheffield's Health Economics and Decision Science (HEDS) undertake important research which relates to the strengths outlined above
- in Lancashire, Lancaster University is working with the government and local partners to develop a healthy ageing innovation campus – a regeneration project which promises to deliver a new innovation space, with £246 million benefit to the economy via entrepreneurial and SME growth (RIO 2015).

5.2 ECONOMIC ASSETS AND TALENT POOL

By its very nature, smart specialisation is not sector-specific – the health science sector has important linkages with the wider economy, which has critical assets for enabling the North's health science sector to flourish.

First, taken together, it is of significant scale: £304 billion of output – if it were a country it would be the eighth-largest economy in the EU (ONS 2015a, Eurostat 2016). And the health science sector does not exist in isolation from the other prime sectors that drive this economy forward – the thriving digital, advanced manufacturing and energy companies; it is in turn supported by the enabling capabilities – financial and professional services, logistics and higher education (NIER 2016a). Many of these overlap with the health science sector: especially higher education (as discussed earlier), digital and financial and professional services. These sectors are often involved in the supply chain of health sciences – whether delivering services for the NHS (see chapter 3.2) or for the private companies (see chapter 2.1).

The North's health science sector has a significant talent pool on which it can draw. The qualification level of its labour force is generally a little lower than the national average, but there are large masses of qualified labour within its major cities and high concentrations in some of the more rural areas: 31.6 per cent are qualified to degree level or higher in the North, but there are 2.2 million qualified to this level in its five core city-regions together, and high concentrations in Cheshire and Warrington (39.7 per cent) and York, North Yorkshire and East Riding (YNYER) (36.7 per cent) (ONS 2016b). However, poor transport links mean that this hasn't formed a single talent pool – this is one of the key objectives of the northern powerhouse (see chapter 6.4).

The North's universities graduate large numbers in clinical subjects. In the years 2008/09 to 2013/14, for example, there were significant numbers of graduates in these subjects from Greater Manchester (38,000), Leeds city-region (37,000), North Eastern (27,000) and Liverpool city-region (20,000) (HEFCE 2015). Graduates (across all subjects) whose home is in the North tend to stay in their own area – especially in the major cities: Liverpool city-region has the highest rate of graduate retention in the country (83.4 per cent), and Greater Manchester came joint third with London (81.7 per cent); even Lancashire (80.5 per cent) and the North Eastern LEP (79.9 per cent) aren't far behind.⁸

Local industrial strategy in action

Alderley Park is an important example of local intervention. In 2014, AstraZeneca decided to move around 1,600 R&D jobs from Alderley Park to Cambridge, it was first seen as a blow to the region.⁹ This negativity didn't last: Manchester Science Parks (MSP) stepped in almost immediately. This joint venture, in which Manchester city council and the University of Manchester each own a 12 per cent share, is concentrated in the 'Corridor Manchester'. MSP purchased the site and set out to develop a campus environment, of smaller firms, to foster an innovative cluster.

8 Six-month retention rate.

9 AstraZeneca retains its significant manufacturing site in Cheshire.

The project then attracted further public resources: the Greater Manchester and Cheshire and Warrington LEPs stepped in to provide £50 million in funding for businesses located there. This local intervention has leveraged in central government support: it recently became home to the Medicines Discovery Catapult, and in 2016 was designated an enterprise zone. The Alderley Park site is now transformed. Instead of housing a big pharma giant, it is an incubator for 150 small innovative firms in biotech and life sciences.

The Antimicrobial Resistance Centre now based at this site is truly world-leading. This is a joint public–private initiative to combat a global threat – that of microbes’ resistance to antibiotics. The purpose of this centre is to radically shorten the time it takes to develop a new drug and bring it to market (see AMR Centre 2016). The intention is to have 100 scientists working on site by 2017.

This is an important demonstration of pragmatic local industrial strategy – from the private and public sector working together. Despite AZ’s decision, the place itself hadn’t lost its value – both in its facilities, and in its connectivity to Manchester city centre, Manchester airport and to London. Furthermore, due to the geography of the sector’s supply chain, MSP, based in the centre of Manchester, saw the need for a facility in rural Cheshire to be sustained. It then worked with local and central government to support the site.

5.3 RESEARCH EXPERTISE AND OPPORTUNITY

The North’s universities provide a wealth of knowledge and innovation on which the sector can draw. There are more world-class universities in the North than in Spain, Italy and France combined (Tech North 2016). Many of the North’s universities excel at health- and life-science-related subjects, and have some of the highest research ‘power’ in the country:¹⁰

- in allied health professions, dentistry, nursing and pharmacy: Manchester ranked first, Sheffield Biomedical science came sixth and Lancaster came eighth – of 94 universities that submitted (Times Higher Education 2014b)
- in public health, health services and primary care: Sheffield came fourth and York seventh – of 32 that submitted (ibid)
- in clinical medicine: Newcastle came ninth, although Liverpool (joint with LSTM) came eleventh and Manchester twelfth – of 31 that submitted (ibid).

The North also has a population that makes trialling new treatments easier. The 15 million population is diverse and stable, and encompasses most major diseases and health states. As a result a large number of trials take place in the North. In addition, three of the top five recruiting

¹⁰ As Times Higher Education states: ‘This is calculated by multiplying the institution’s overall rounded GPA by the exact total number of full-time equivalent staff it submitted to the REF. This is an attempt to combine volume and quality to produce a ranking that gives a more accurate indication than GPA of the relative amount of quality-related research funding each institution is likely to receive’ (Times Higher Education 2014a).

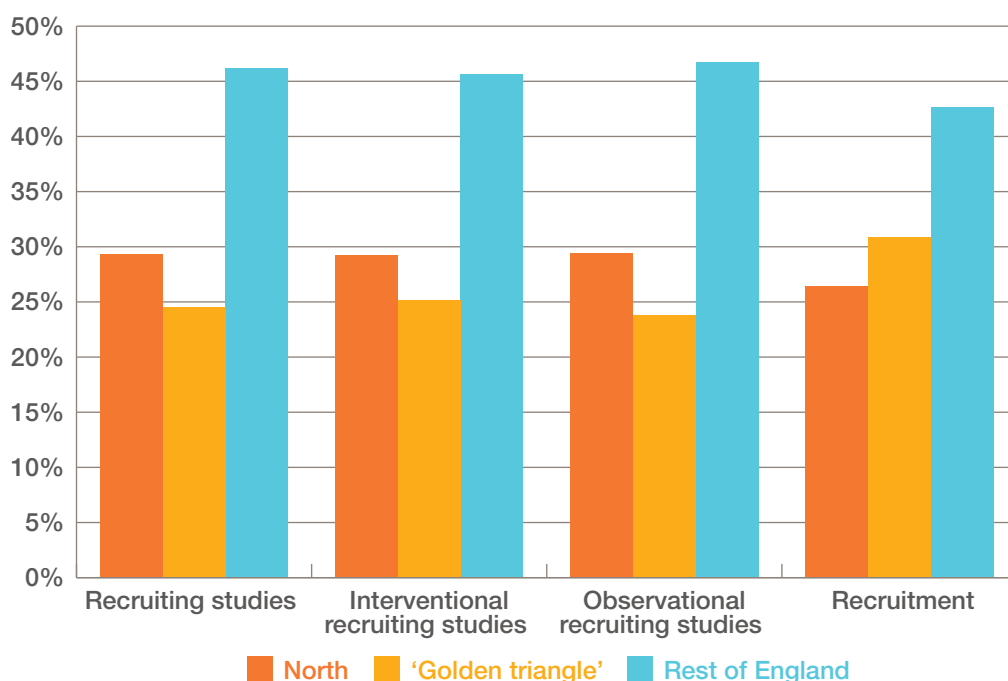
NHS trusts for clinical trials are in the North, and Manchester is the leading centre for industry-sponsored trials in the UK (UKTI 2016).

The North undertakes a large proportion of England’s NIHR-sponsored clinical trials – surpassing the golden triangle in some areas. As discussed earlier in this report, this is how the Department of Health funds research – it is an important, albeit small part of all health science research (see chapter 4). The golden triangle recruited a larger proportion of England’s patients (30.9 per cent) than the North (26.4 per cent), but the North conducted more of all types of study: recruiting studies (29.3 per cent compared to 24.5 per cent); interventional recruiting studies (29.2 per cent compared to 25.2 per cent); and observational recruiting studies (29.5 per cent compared to 23.8 per cent) (NIHR 2015c). The most recent data indicates that this proportion has been sustained in 2015/16 – provisional data for this year is in line with the above proportions (NIHR 2016).

FIGURE 5.1

The golden triangle recruited the most patients for clinical trials, but the North conducted more recruiting studies and interventional recruiting studies

NIHR-sponsored clinical trials (% of total), by area



Source: NIHR, *Clinical trials league table* (NIHR 2015c)

Rates of pay within the sector appear to reflect the specialisms of different regions. The North West has the highest average annual pay in the country for the manufacture of basic pharmaceutical products and pharmaceutical preparations – national average pay was £40,000, but in the North West it was £47,000 per annum (in the South East it was £43,000 per annum) (ONS 2016e). However, annual pay for scientific occupations generally is lower in the North – the UK average pay for

this occupation group is £40,000 per annum, but it was £37,000 in the North West and in Yorkshire and the Humber; pay was £47,000 and £42,000 in London and the South East respectively (ONS 2016f).

5.4 INNOVATION AND COLLABORATION

Innovation is being driven forward by collaboration – especially in the field of health data analytics. The Health North scheme has been established to push forward health and social care integration through the connected health cities (CHCs) scheme across the North. These initiatives use large-scale data to drive public sector reform in health and social care. These were allocated £20 million of funding for the first three years to pilot two care pathways in each region. This builds on a wide range of data capabilities in the North – including five of the top 10 computer science and informatics centres; super computers; Leeds’s Medical Bioinformatics Centre; and several Farr Institute centres, such as HeRC in Manchester.

There are four academic health science networks (AHSNs) in the North; Greater Manchester; the Innovation Agency (North West Coast); North East and North Cumbria; and Yorkshire and Humber. The objective of these organisations is to facilitate engagement between universities, the NHS and businesses, so that adoption of new innovations can be accelerated. Information submitted by the North’s AHSNs showed their success across a range of areas: in the North West Coast, the Innovation Agency has prevented 46 strokes and safeguarded or created 109 jobs; in Greater Manchester, the AHSN has helped more than 250 SMEs to access the NHS; the North East and Cumbria AHSN led a bid that secured £10 million in University Technical College funding for 14–18-year-old vocational training in health and IT; and in Yorkshire and the Humber, the AHSN reduced length of stay by up to 30 per cent and improved A&E breach targets from 60 per cent to 92 per cent across multiple trusts through the application of better patient flow.

Cross-sector collaborations

Collaboration is at the heart of the health science sector. There are several membership organisations that seek to leverage their networks and collaborations across the UK and in other countries. These tend to have a regional focus – reflecting the economies of place that enable the sector to thrive – for example: OneNucleus (Cambridge and London), MedCity (London and the South East), MediWales (Wales), BioQuarter (Edinburgh).

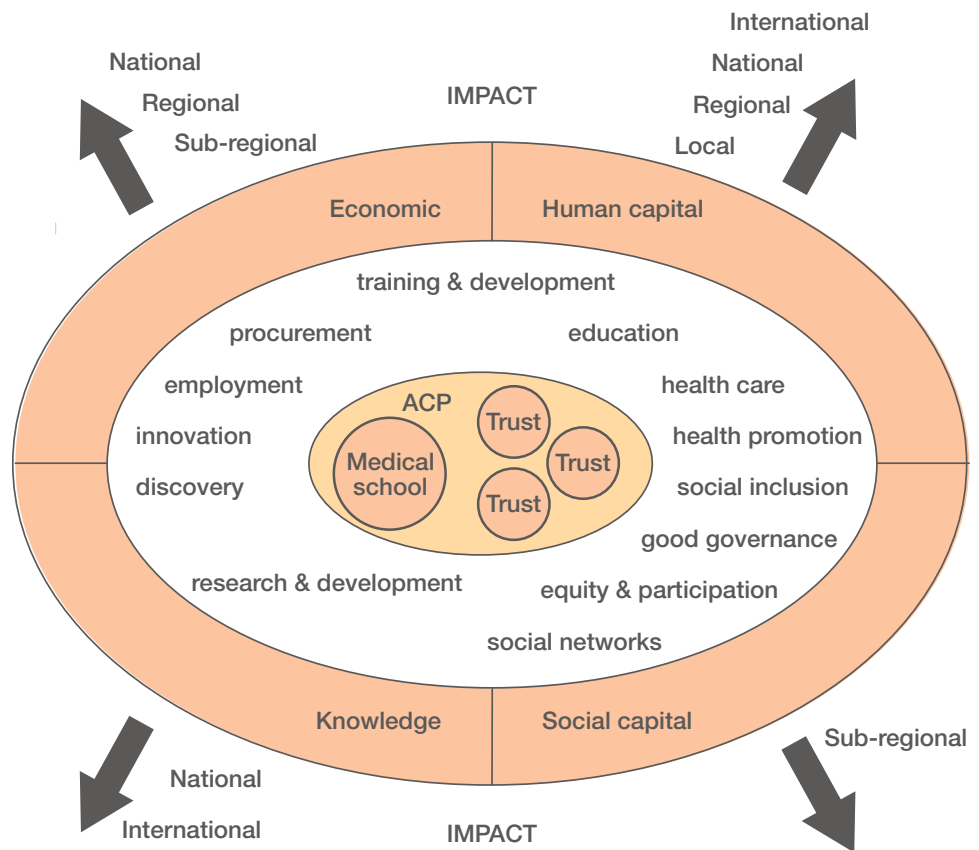
This isn’t isolated to the UK – regional clusters have representative bodies in the most successful areas of the world, although they do convene at the national level too: in the US, MassBio (Massachusetts) and BioCom (California); in the EU, BioValley (three regions in France, Germany and Switzerland); and in Asia, A*Star SG (Singapore) and ChinaBio (China).

These organisations appear to generate additional benefit for a cluster. Davies and Bennett (2008) conceptualise this impact into five domains: economic, human capital, social capital, knowledge and place – illustrated in figure 5.2 (see also box below on health tech in Leeds). Abreu et al (2008) observed that there is value in collaboration – especially formal collaboration – because it allows academic knowledge to be localised, applied and then fed back to the generic academic research.

The North has the Northern Health Science Alliance (NHSA) and BioNow. The NHSA represents the eight research-intensive universities (also known as the N8), eight NHS teaching trusts and four academic health science networks (AHSNs). BioNow focuses on supporting the North’s private sector – mainly small businesses – but is sponsored by some of the North’s universities.

FIGURE 5.2

Academic clinical partnerships have an important impact on their local economy
ACP impact and outputs: a holistic framework



Source: Davies and Bennett, *Understanding the economic and social effects of academic clinical partnerships* (Davies and Bennett 2008)

Health tech in Leeds

Medical technology is a thriving sector nationally, in the North, and especially in Leeds. The NHS spends £4.6 billion on technology every year, and Leeds is at the forefront of this – as recognised by the prime minister (EC 2015, Tech North 2016, May 2016). Yorkshire and the Humber provides 22 per cent of all UK digital health jobs – a close second to London (24 per cent) (OLS 2016).

Leeds has a cluster of public sector assets and there have been public interventions which have enabled the private sector to thrive. It is home to: NHS England, the NHS Data Spine, the Health and Social Care Information Centre; the Yorkshire and Humber Academic Health Science Network; a Digital Catapult; and Digital Health Enterprise Zone (ibid). There is a range of support on offer to the private sector: from business rate relief, to enabling new products to be spun out from universities, or trialled on local patients (ibid). Examples include Immedicare, which provides a telecare service linking care homes in Airedale with clinicians in the nearby hospital; and the Advanced Digital Institute (ADI) in Bradford created a ‘meds companion’ supporting patients to take their medicines on time – a device that is now being trialled with the Bradford Clinical Commissioning Group (ibid).

However, the private sector can also be an enabler of other private sector businesses – and the public sector supports this too. Dotforge in Leeds is a prime example. Started in 2012 by angel investors to sponsor ‘tech-for-good’ companies, Dotforge has a distinct health and data programme which began in early 2016 (Tech North 2016, Dotforge 2016). This is geared towards tech businesses with solutions in self-monitoring, early stage screening, remote monitoring and medicines adherence. Businesses are offered a convertible loan, business support, mentoring and office space (ibid). Again, however, there is some intervention from both the public sector support and other funding sources: it has been supported by the Cabinet Office’s Social Incubator Fund, KeyFund, the Big Lottery and the RSA. It also benefits from a close relationship with Yorkshire’s AHSN (ibid).

Public–private collaboration – in its various forms – is central to these new innovations. The UK has a global competitive advantage in many of these areas, especially telehealth and telecare (Deloitte 2015). There are some skills shortages within the sector that inhibit this growth, but government policy has a role to play in enabling this innovation to occur more effectively (see chapter 4).

5.5 DEVOLUTION

Greater Manchester is pioneering health devolution, and the governance and partnerships that enable it. ‘Devo Manc’ gained new prominence with the proposed devolution of health to Greater Manchester. It is proposed that the 10 constituent local authorities take greater control of and responsibility for the NHS budget within the city-region – an estimated £6 billion in 2016/17

(not to be confused with devolution to the soon-to-be-elected mayor of Greater Manchester).

As this has taken shape, it has become collaboration at the city-region level, rather than devolution of central government functions. The system will include: 10 local authorities, 12 CCGs, 14 hospital trusts, one ambulance trust and 1 NHS England team. Activity has focused on five work streams: a radical upgrade in population health; transforming community-based care and support; standardising acute hospital care; standardising clinical support and back office services; and enablers (Calvin-Thomas 2016). All organisations retain their responsibilities, and a seismic transfer of powers has therefore been eschewed for a model of close collaboration between organisations over the same geography.

Health Innovation Manchester is an important part of this, and aims to integrate the academic and clinical activity within the city-region. Devolution is seen as an opportunity for clinical research and research-driven implementation (HIM 2016).

Devolution in other policy areas also presents an opportunity for the health science sector. Transport for the North (TfN) is soon to gain statutory status, and alongside Rail North will take on more responsibility for the North's transport (and digital) connectivity. This new body has already demonstrated its wider value, and a desire to take a strong role in the broader economy in analysing and setting out the North's prime capabilities (see NIER 2016a). This could be an important development for the North's health science sector: as one of the prime capabilities TfN identifies, there is clearly an opportunity for the requirements of the sector to inform transport policy.

6. CHALLENGES

Despite its strengths and assets, the North's health science sector is not fulfilling its potential, and there are further challenges to come. This section outlines the four primary challenges to the sector in the North – some of these challenges (such as investment in research) are specific to the sector; others are shared with northern prime capabilities (such as Brexit and foreign direct investment [FDI]). These are the key challenges which a place-based industrial strategy should address.

6.1 PUBLIC INVESTMENT IN RESEARCH

Despite its strengths, the North doesn't receive the level of public investment that other parts of the country do. In a period of severe fiscal tightening, it is significant that the government has protected the science and research budget in real terms. This report has set out clearly how the North has: a thriving private sector; an innovative and joined-up public sector; and the research assets and experience needed.

But the North's research funding doesn't reflect this. The three northern regions together received just 13.5 per cent of health research funding, while London alone attracted almost one-third (31.1 per cent), followed by the South East (15.8 per cent). There are a number of reasons why this might be:

- the North brings in large shares of small funding pots, but only small shares of large funding pots (UKCRC 2015)
- charities or research councils account for a large share of research and these don't fund the North as generously – only 12.4 per cent of both charity funding and research council funding went to the North in 2014 (ibid).

Moreover, the case in favour of northern investment is made more challenging by the lack of investment in the past: expertise is built over time in a location. The North has historically lacked the research funding which would have enabled its clusters to build up expertise, and in turn attract further funding down the line: a virtuous circle of 'pump priming' for the golden triangle in the past, means the North loses out when competing for funding in current and future spending rounds.

Public investment has a knock-on effect on private investment (see section 2.2), but the North appears to have a private sector that's thriving without the public support other areas enjoy. It clearly doesn't make sense for government to invest where there is no expertise, but the North evidently holds some significant expertise across several sectors – as this report has already set out.

6.2 FDI AND INTERNATIONAL PROFILE

The UK is a health science leader, and its level of FDI reflects that. Within the Department for International Trade (formerly UKTI) there is a Life Sciences Organisation which has brought in £6 billion investment and 17,000 jobs between 2012 and 2016 (OLS and DIT 2016). In 2015/16 there were 178 life science FDI projects, supporting 4,505 jobs – while this is a relatively small number, the UK is especially good at attracting HQs and their related functions; while a quarter of these projects are linked to manufacturing, and almost a half involve an R&D element (DIT 2016).¹¹

6.3 BREXIT

It seems certain that the UK will leave the European Union, but it is unknown what ‘type’ of Brexit this will be, and what deals will be struck with the EU – and the rest of the world – afterwards. The nature of Brexit is of critical importance to the health science sector, and there are threats on several fronts.

- **Investment** is being held back by uncertainty. As this uncertainty runs on, deals may be cancelled, and as the UK–EU relationship becomes clear it could mean investors are put off altogether. The UK’s relationship with the EU is particularly important for the health science sector (for reasons explored below) so it stands to reason that uncertainty will be more damaging to the sector; the further risk to the North is that, in an uncertain environment, investors may go with the supposed ‘wisdom of crowds’ and invest where investment is already strong – in the case of health sciences, the golden triangle.
- **Exports** to the EU are vital – especially for the North’s health science sector. One of the fundamentals of the EU is of course free trade – the ability to trade anywhere in the EU on the same basis as within the host nation. Without this arrangement it will be more difficult and expensive for British firms to trade overseas, and for British customers (both citizens and public sector) to buy products. The North exports £2.3 billion of medicinal and pharmaceutical products to the EU – 30.5 per cent of its total. But the nature of trade deals means that even the non-EU trade is under threat from Brexit – on leaving, the UK will no longer be part of the EU-wide trade deals with other countries. That said, manufacturing standards are likely to remain unaffected – the UK will have to meet EU standards, but this is currently done nationally, with laws based on EU directives.
- **Skilled labour** is vital for the health science sector, and EU citizens make up: 4.1 per cent of full-time equivalent (FTE) workers in the NHS; 8.6 per cent of FTE doctors (Marley 2016). While the UK is a member of the EU these people are of course free to do so without restriction; once the UK leaves, it is expected that some of those already here will be unaffected (having been resident long enough to be exempt); while others within the NHS and academia may be granted citizenship – in reflection of how important their work is. However, (depending on the final deal) new employees will have to apply for work permits, and all

¹¹ The government doesn’t publish figures which break down FDI by sector and region within England.

those working in the private sector of health sciences may be exempt from the exceptions granted to NHS and academic staff.

- **Regulation and patents** have an important pan-EU component – and coming reforms are set to embed this further. The UK’s Medicines and Healthcare Products Regulatory Agency (MHRA) has a significant influence on EU regulations. As BIS et al (2016) explains: ‘Each new medicine product seeking approval in Europe through the Centralised Procedure has a Rapporteur and a co-Rapporteur appointed by the European Medicines Agency (EMA) to lead the assessment process. The Decentralised Procedure requires the applicant company to select a Reference Member State (RMS) to lead the assessment of the medicine during the procedure.’ The UK is Centralised Procedures Rapporteur/Co-rapporteur on 14 per cent; scientific advice coordinator on 24 per cent; and a UK Decentralised Procedures – Reference Member State on 44 per cent of cases (ibid). On leaving the EU, the UK could also lose influence over the European Medical Agency, which approves drugs for use in the EU, and companies would have to apply for separate permission to use a drug or technology in the UK. This in turn means that the UK would be less of a priority for new innovations – a company would likely prioritise the larger EU market over the UK. The UK would also be exempt from the pan-EU unitary patent – planned, from 2017, to allow inventors to be granted a patent that applies across the EU.
- **EU funding** for future framework programmes is at risk. Clearly the UK will no longer receive this funding from the EU once it leaves, but will also no longer contribute. The government has committed to maintain research funding for Horizon 2020 – provided the grant is made before the UK leaves the EU – but beyond that there is only uncertainty (HMT et al 2016).
- **Collaboration** between academics across the EU is well established and vital for health sciences. Pan-EU clinical trials regulations are set for a significant overhaul and this will now not apply to the UK – this will mean that multisite trials based wholly in the post-Brexit EU will have less of an administrative burden than those that include the UK.

A new Brexit steering committee for life sciences has been set up to investigate these issues, and is led by the industry itself – co-chaired by a minister, alongside Sir Andrew Witty (GlaxoSmithKline) and Pascal Soriot (AstraZenica), and in consultation with the industry itself (ABPI and BIA 2016). Its priorities are: the ability to trade and move goods and capital across borders; access to the best international talent; long-term, predictable government funding for scientific research, and continued ability to collaborate at scale across Europe and the world; and to achieve ‘a regulatory cooperation agreement with Europe to bring innovative, effective and safe medical technologies to UK patients quickly’ (Cookson 2016).

6.4 POOR TRANSPORT CONNECTIVITY

The North has lacked the long-term investment it needs in transport infrastructure. This is a historic problem, and one which is set to worsen in the immediate future: the infrastructure pipeline includes £1,900 per head on transport infrastructure in London, compared to £280 per head

in the North (Cox and Raikes 2015, IPPR North 2016). This clearly affects all sectors – the journey times between major cities, especially Leeds and Manchester, are far too long considering their proximity (Overman et al 2009). But the geography of the health science sector presents a unique challenge to transport planning: it thrives off interaction between the cities and their hinterlands – Manchester and Cheshire especially. Clusters, and the connectivity that supports them, can be important enablers of entrepreneurial activity in the sector. One entrepreneur, for instance, stated that:

‘a cluster is a low-risk environment for an individual to jump out of somewhere like GSK or the MRC and join a startup, knowing that it will probably fail, but when it fails they will be able to dial up and go into something else. You can only do that within the concentration, risk environment and culture that occur as, for example, in Cambridge and in elements of London, Oxford and Manchester.’

Andy Richards (STC 2012)

There are also new opportunities for the North’s health sciences to influence transport policy. Rail North and Transport for the North have been set up: the former is co-managing the North’s rail franchises, while the latter has already outlined a series of options for investment – including Northern Powerhouse Rail (sometimes known as HS3), which will improve connectivity times between major northern cities. Within cities, transport powers will soon be granted to new metro mayors, which will enable them to regulate and invest in a modern transport network. However, it will take some time for the benefit of these investments to be felt by the industries of the North. Transport for the North itself commissioned the NIER which set out the North’s industrial strengths – a good indication that industrial specialism could inform transport policy in future.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

The northern powerhouse needs to thrive, and will do so only with a strong and interventionist place-based industrial strategy. With the implications of the EU referendum already gathering momentum, now, more than ever, a focus on Northern economic capabilities is critical to maintaining national prosperity.

For these reasons, the North's health science sector is crucial. Our analysis has shown that the North's private sector is performing well and has significant assets, clusters and specialisms which rival the 'golden triangle': Alderley Park, Speke and other clusters in Cheshire and Warrington, Liverpool city-region, North Eastern and the Humber are growing strongly and quite independently of national and sector trends. Northern universities and hospitals are a catalyst for this innovation, and have a significant direct impact on their local economies through spending and indirectly through spillovers from R&D. Private sector strengths and research expertise are both intertwined with a £30 billion health services economy which is large and forecast to grow significantly in future, but devolved health and social care in Greater Manchester presents an opportunity to make sure that industry expertise can translate into better health outcomes for people living in the North.

However, to realise this potential, there are opportunities that need to be taken and challenges that need to be tackled. We need a fundamental step change in our policy approaches – both nationally and locally – if we are to harness the significant assets that currently exist and mitigate the looming risks.

7.2 RECOMMENDATIONS TO CENTRAL GOVERNMENT

- As it develops its new industrial strategy, **the government should pay particular attention to the significant strengths of the health science sector in the north of England, beginning by rolling out a science and innovation audit across the whole of the North, and also by establishing better processes for strategic collaboration between government and subnational stakeholders.**
- **Government should aim to move towards investing 20 per cent of its health science research funding in the North over the next five years** – this would match the estimated R&D investment from the private sector, and would enable northern health economies to catch up with those in the golden triangle, or at least compete on a more level playing field.

- **Government should ensure northern health science sector interests are explicitly accounted for by the steering committee currently working on the impact of Brexit on the health science sector.**
- **Government should invest in the northern life science capability that sits within the Department for International Trade, so that the team's resources on the ground in the UK and abroad in post are in line with those of the UK's devolved administrations, and reflect the scale of opportunity in this sector and the northern market size.** Over time the life sciences sector should spearhead an approach to trade and investment in the North which is equivalent to those of the devolved administrations, and should develop its own special relationship with the North's key partners abroad – countries such as the US, Japan, Singapore, India and China as well as the growing opportunities from and with the commonwealth.

7.3 RECOMMENDATIONS TO LOCAL AND REGIONAL STAKEHOLDERS

- **Health service commissioners should develop new approaches to health procurement to maximise regional clusters and supply chains and drive up local economic multipliers. They should pull through research into practice more efficiently to maximise healthcare gains.**
- **Local enterprise partnerships and growth hubs should support health science startups and match-fund 'corporate accelerator' partnerships between big UK and multinational firms and universities.**
- **Local transport authorities – working closely with Transport for the North – should develop strategic transport plans around health service and complementary tech clusters, and support initiatives to broaden intercity connections to expand the highly skilled northern labour pool.**

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