The Pissarides Review into the Future of Work and Wellbeing

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A Disruption Index:

the geography of technological transformations across England

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1. Introduction: Measuring technological disruption

As automation and data-driven AI technologies are adopted across more firms and sectors and impact more job roles, the labour market in the UK is experiencing profound and ongoing changes. If we are to tailor intelligent responses to these changes precipitated by the complex interplay between technology adoption and work – whether through regulation, policy, investment, or otherwise – we ideally need a measure of the scale of these changes, and their geographic distribution.

Towards this, we have developed the 'Disruption Index' (DI), an innovative analytical tool that offers a nuanced perspective on the multifaceted nature of technological transformation across the regions of the country. This first report delves into the findings of the DI.

At the core of our investigation here are the relationships between investments in technology, innovation, and the underlying enablers that facilitate or impede technological transformation. The DI aggregates data from a range of sources, providing a panoramic view of technological transformation at a regional level. This analysis not only enhances our understanding of the current state of technological transformation throughout the initial stages of the technology life cycle (research and development, introduction and growth) but also provides the foundations for a deeper exploration of its implications for the workforce and people's wellbeing in our forthcoming research.

Our Disruption Index is divided into two main dimensions. The first dimension of this index, the Technological Transformation Index (TTI), describes the extent of technological transformation that is being experienced across counties (and groups of counties) in England. This follows the statistical division of International Territorial Level 2 regions - or ITL2 - previously known as NUTS2 regions. The TTI sheds light on the different capacities of these regions to invest in, adopt, and adapt to new technologies. Measuring this is crucial because, ultimately, technological transformation and innovation are key drivers of productivity.

The second dimension, the Readiness Index (RI) emphasises the crucial role of human capital and infrastructure as enablers of this transformation. In this report, we provide a brief overview of the indicators included in each dimension. Further detailed technical information about specific indicators can be found in the accompanying Disruption Index Technical Report.

Our results shed light on important regional disparities across the country and on the evolution of these factors over time. We have found significant regional disparities related to technological transformation factors. Helping to drive that disparity are incoming flows of venture capital investments, Research and Development (R&D) expenditure and the creation of patented technology – all of which are concentrated in a very small number of regions.

Our Disruption Index shows that, as well as disparities in Technological Transformation, there are also significant disparities in Readiness. These are mainly associated with the educational levels of the workforce, skill levels, and the required infrastructure. However, these disparities are not as those observed in relation to the Technological Transformation factors.

In this report, as we navigate through the main findings from our analysis, we offer insights that help us understand the current UK economic geography and regional inequalities. We identify potential drivers of regional inequalities, how different factors interact and compound each other, and - in a companion briefing - we propose implications for policy.

In parallel research at the Institute for the Future of Work (IFOW), the Good Work Time Series[1] examines multiple dimensions of good work and how these are being shaped over time across 203 Local Authorities in England, Scotland and Wales. Our goal is that the Disruption Index, along with accompanying work in the Pissarides Review and at IFOW, can together be used as a foundation for deeper thinking into how regions can leverage their unique strengths and address challenges to harness the full potential of technological advancement that promotes good work and worker wellbeing.

This report is structured as follows:

- ***Section 2*** *discusses the Technological Transformation Index and the results for England.*
- ***Section 3*** *provides the scores for the Readiness Index and examines how this varies across regions.*
- ***Section 4*** *explores the relationships between these two indices.*

[1] See https://www.ifow.org/resources/the-good-work-time-series-2024

2. How is the technological transformation happening across England?

2.1 Technological Transformation Index

The Technological Transformation Index is an integral part of the Disruption Index and encompasses the development, adoption and implementation of automation and other new technologies in the workplace. It goes beyond the conventional focus on innovation and R&D, emphasising the significance of other factors such as the funding possibilities for firms and the adoption and diffusion of technologies in practice.

The Technological Transformation Index is divided into two dimensions, each of which is subsequently divided into subdimensions and further down into indicators. The full structure is shown in Table 1.

Table 1 – Technological Transformation Index structure

Dimension	Subdimension	Indicators
Investments	Private sector funding to tech sectors	Venture capital to tech companies
	R&D expenditure	Business expenditure in R&D
		Non-business expenditure in R&D
	Innovation activity	Businesses undertaking innovation activities
		Employment in R&D
Technology creation and adoption	Patents and Technology adoption	Patent applications
		New to market goods and services
		Number of start ups in tech sectors
		Employment in technology and knowledge-intensive sectors
	Demand for technology skills	Demand for tech skills (%)
		Demand for tech skills (count)

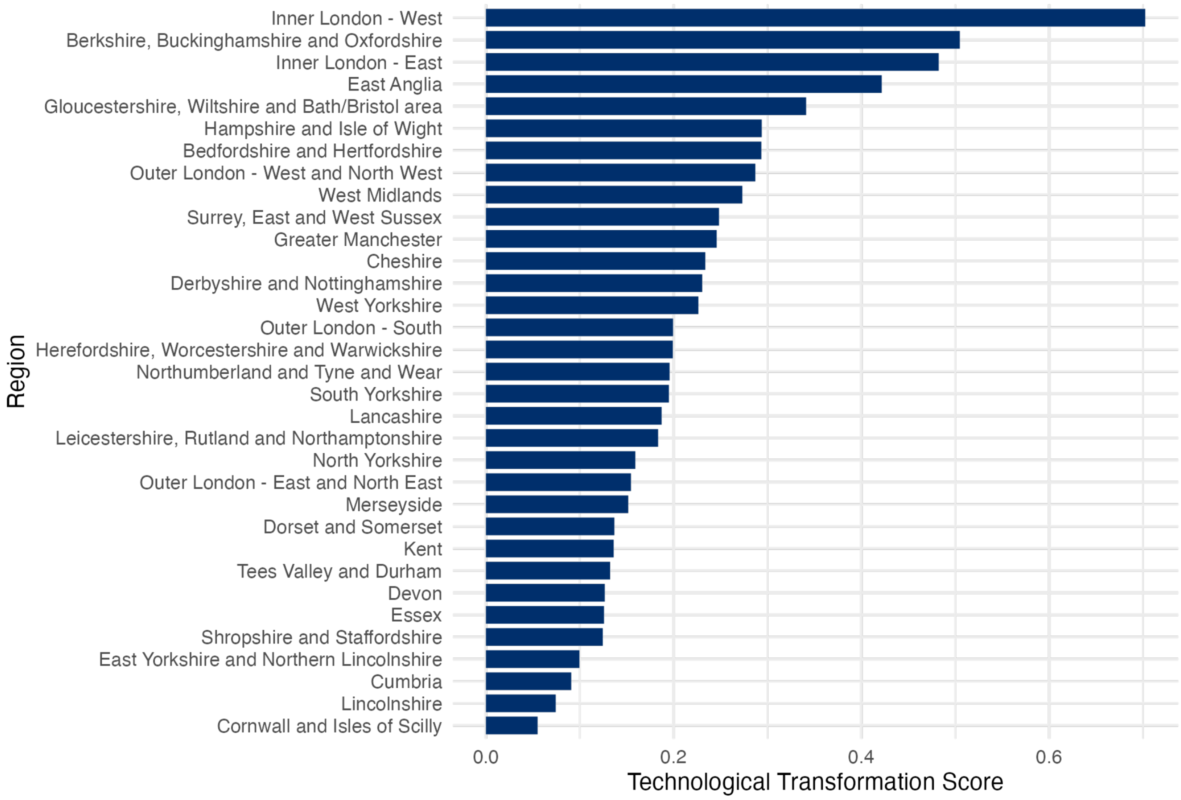
Note: We use a min-max normalisation to transform all indicators to a 0-1 scale. Outlying values were not removed. Detailed information can be found in the Disruption Index Technical Report

2.2 Technological Transformation scores

In this section, we present the aggregated scores for the Technological Transformation Index (TTI) and discuss the evolution of these scores over time. Figure 1 presents the results for 2020, our most recent complete year. Unfortunately, the impact of the COVID-19 pandemic in 2020 cannot be isolated, as a suitable counterfactual does not exist. Whenever possible with the data at our disposal, we seek to examine trends in our key indicators beyond 2020, to better understand recent developments.

As shown in Figure 1, Inner London West is the leading region in 2020, with a high score of 0.70. Its prominent position can be attributed to its leading performance across all subdimensions of the index. Following closely are Berkshire, Buckinghamshire, Oxfordshire with a score of 0.50, Inner London East scoring 0.48, East Anglia with 0.42, and Gloucestershire, Wiltshire, and Bath/Bristol area at 0.34. A common feature among the top-performing regions is their consistent high scores across all key areas: R&D expenditure, innovation activity, and venture capital funding.

Figure 1 – Technological Transformation scores in 2020

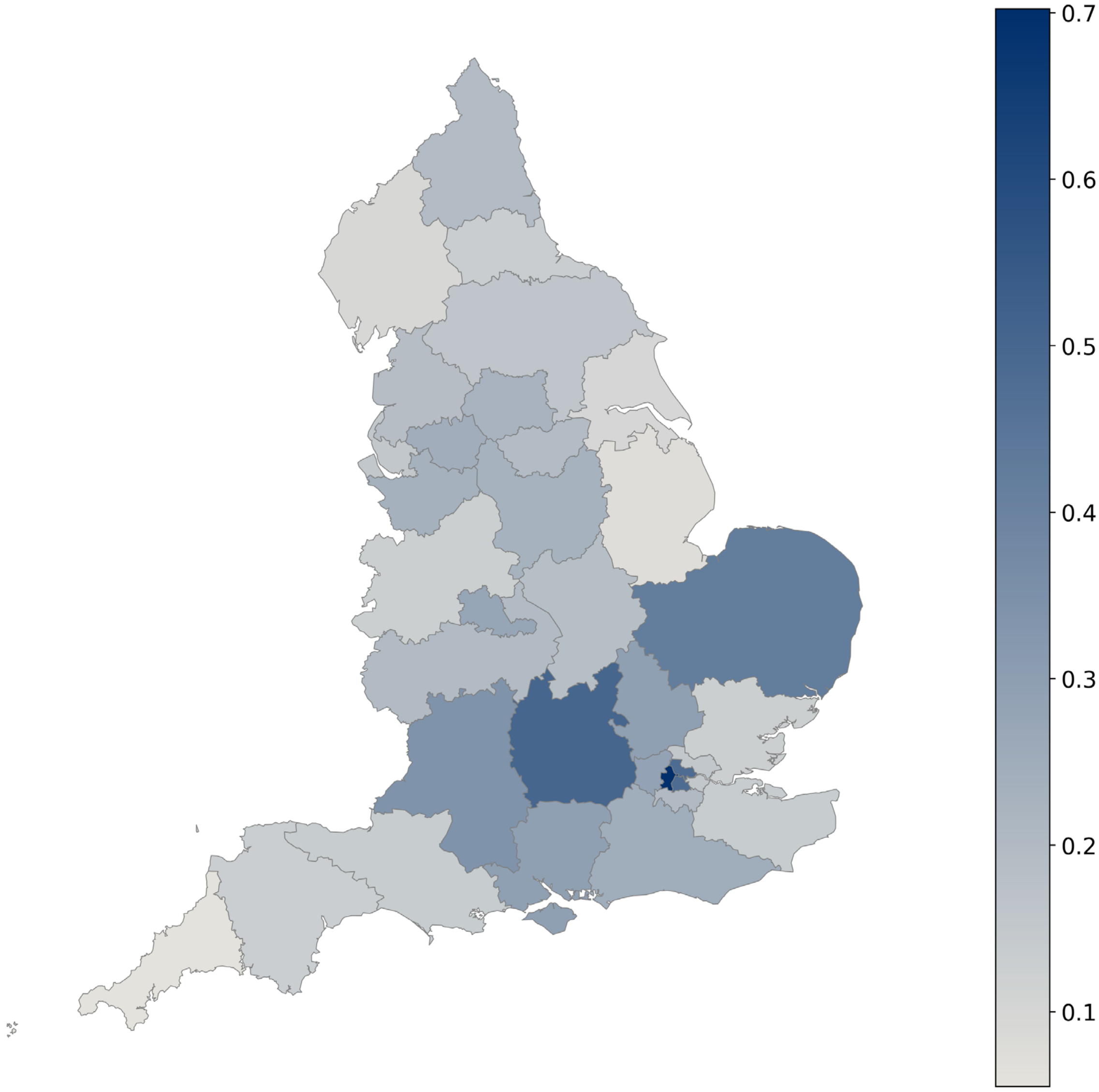


Source: Technological Transformation Index based on data from various sources.
For more information, see Disruption Index Technical Report.

At the other end of the spectrum, some regions have much lower scores of Technological Transformation. Cornwall and Isles of Scilly are at the very bottom of the distribution with a score of just 0.06. This low performance can be attributed to its minimal levels of private sector funding in tech sectors and R&D expenditure. This may be linked to a higher concentration of business in sectors like hospitality and food services, which are traditionally not associated with high levels of technological innovation and investment towards this objective. Other regions that score in the low range include Lincolnshire at 0.07, Cumbria scoring 0.09, East Yorkshire/Northern Lincolnshire with 0.10, and Shropshire and Staffordshire at 0.12. These regions share similar challenges in attracting investments for the development of technologies.

Geographically, these numbers paint a picture of a great divide between the three regions with greater innovation capacity – London, Berkshire, Buckinghamshire, Oxfordshire and East Anglia – and the rest of the country. This is reflected in the total scores, as shown in Figure 2, but also in its subcomponents (subdimensions) and will be a recurrent theme throughout this report.

Figure 2 - Geographical distribution of Technological Transformation scores in 2020



Source: Technological Transformation Index based on data from various sources.
For more information, see Disruption Index Technical Report.

Drivers of regional disparities in Technological Transformation

As widely discussed in the literature, the UK faces a problem of weak investment, which is believed to be one of the potential drivers for the UK's sluggish productivity growth (e.g. Coyle, van Ark & Pendrill, 2023, Carella et al. 2023). When investment does happen, it is very unevenly distributed across regions and does not necessarily reflect local strengths and ambitions.

The first dimension of the TTI emphasises the role of targeted investment and high innovation capacity in driving regional technological transformations across the country. This corresponds to the first subdimension analysed, which encompasses venture capital investments to technology firms, R&D expenditure and innovation activities. The three parts of this puzzle – private investments, R&D expenditure and innovation activity – are deeply interconnected.

Private sector funding, particularly venture capital investments, are important for firms that aim to be highly innovative. This form of financing can provide the necessary resources for these firms to innovate, expand and compete with others, and is often needed to foster a dynamic tech sector. These types of investments tend to be directed to places where the 'right conditions' for innovative firms to operate are already in place, such as the presence of adequate infrastructure and a skilled local workforce. As investments in areas of the country that have attractive conditions can lead to even *more* attractive conditions for future investments, through positive agglomeration effects and knowledge spillovers, we risk facing a situation in which venture capital investments are more and more concentrated in a few regions.[2] We delve deeper into the data on venture capital investments in section 2.3.

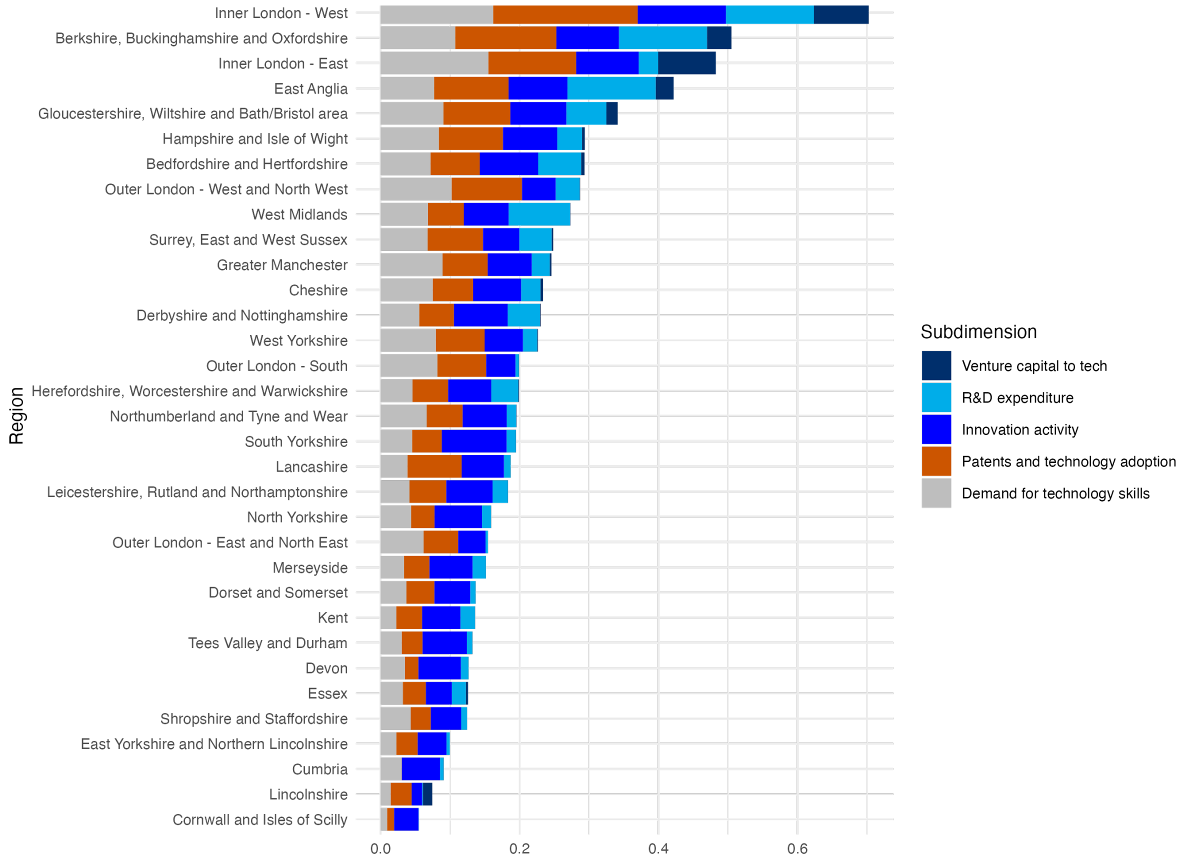
Another important factor is R&D expenditure, which is crucial for the development of frontier technologies and also to facilitate the absorption of technologies produced elsewhere. Investments in R&D (performed by private and public organisations) are often directed to regions with established academic institutions or ones that have a more dynamic technology-intensive sector. As with other types of investment, other work has shown (e.g. Jones, 2023) that business and non-business R&D expenditure tend to follow each other and are complements, rather than substitutes.

In turn, directly related to investments and R&D spending are innovation activities (the share of businesses undertaking these type of activities) and the engagement of workers in R&D jobs. These indicators indicate what actions firms are taking to generate innovation and new technological developments.

Figure 3 disaggregates the scores of Technological Transformation in 2020 into its components. This decomposition reveals that the geographical disparities observed in Technological Transformation scores are largely driven by marked inequality in venture capital funding to technology sectors, R&D expenditure and technology creation and adoption. This is perhaps unsurprising, as innovation often happens as a cumulative process and knowledge spillovers tend to be highly spatially concentrated (Audretsch & Feldman, 1996; Jaffe et al., 1993; Rosenthal & Strange, 2020). Regions where these activities have been successful attract even more funding because that is where the chances of success are higher and the risks lower.

[2] The dominance of Silicon Valley for this kind of investment in the United States is a good example of what we are claiming.

Figure 3 – Decomposition of Technological Transformation scores by subdimensions (2020)



Source: Technological Transformation Index based on data from various sources.
For more information, see Disruption Index Technical Report.

As mentioned, the concentration of venture capital flows is a great source of disparity in technological transformation scores between regions. It is particularly striking that private sector funding to tech sectors is almost exclusively concentrated in the Golden Triangle regions and along the M4 corridor. In more detailed analysis below, we show that these investments have become more geographically concentrated over the period analysed.

R&D expenditure is also very unequally distributed across regions. In 2019/2020, the top five regions with the highest R&D expenditure accounted for approximately 42% of total investments in R&D, a notable increase from 35% in 2016.[3] In addition, in most regions, the greater share of R&D investment is funded and performed by businesses (Business Enterprise Research and Development, BERD) rather than non-business entities like government, higher education, and non-profit organisations. However, there are considerable differences across regions, as shown in Figure 4.

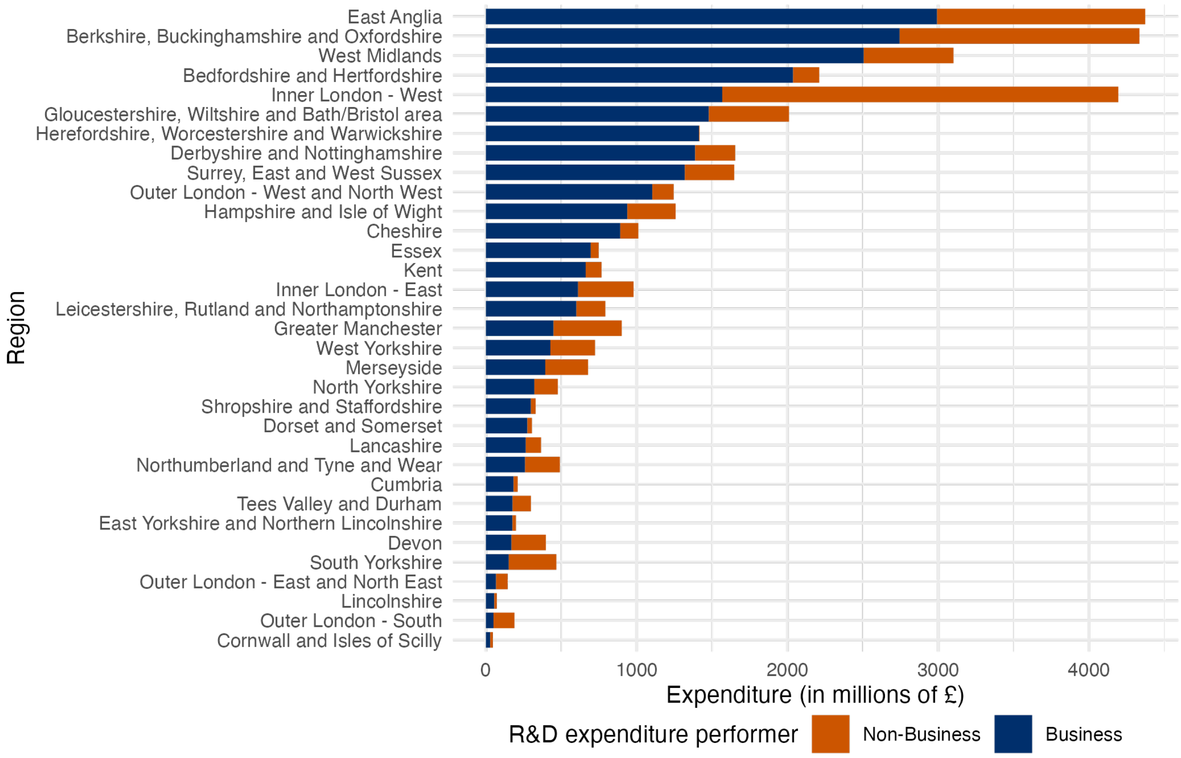
This concentration of R&D activities is not just a product of the geographical distribution of research excellence across the country, but also reflects the types of industries present in the different regions. For example, regions with a higher concentration of pharmaceutical industries, motor vehicles and software will likely demonstrate more R&D investments. However, this concentration would not be such a big contributor to regional inequalities if the findings and products of this research were diffused more equally across the country and benefited regions beyond the ones doing the research. Our discussion of our findings

[3] These numbers are subject to revision. The methodology for R&D expenditure calculations has been revised by the ONS in 2022 but the regional breakdown with the new methodology has not been made available at the time of writing. The most recent year that includes a regional breakdown at this level is 2019.

with respect to venture capital, however, do not indicate that this is happening. The simple correlation between total R&D spending and private venture capital investments is 0.53, and even more remarkably, the concentration of such investments is bigger than that of R&D.

We also see a high correlation (0.6) between business and non-business gross domestic expenditure on research and development (GERD), which suggests that R&D activities across different sectors are interconnected. Given the strong regional concentration that we find in R&D activities, should governments aim for a more even distribution of its own funded R&D to achieve better regional balance? The answer to that question can only be given with information of the sectors that government is operating. If, for example, government funded R&D is in the health sector, it might be preferable to choose the hospitals with the top scientists for the R&D and ensure hospitals throughout the country benefit from the outcomes of their research. But this may not apply if R&D is for defence purposes.

Figure 4 – Gross domestic R&D expenditure by type of performer



Source: ONS (special release) Notes: Values for 2019/20. Expenditure in millions of £ in 2021 constant prices.

Universities play an important role as R&D hubs, often being central in the networks of National and Regional Innovation Systems and influencing the technological transformation of their surrounding areas. Their contribution to local innovation ecosystem extends well beyond the direct investments in R&D activities. These academic institutions can also attract businesses to the area, which are eager to tap into the local skilled workforce, and have an important role in fostering collaborative networks, facilitating knowledge spillovers (e.g. Abramovsky & Simpson, 2011; D'Este et al., 2013, Scandura, 2016).

Although it is good to know how R&D expenditure and employment are distributed, we emphasise the obvious, that the discovery of new technologies is not enough to drive higher productivity across the country. It is the adoption and diffusion of new technologies that creates opportunities for firms to develop new processes, products and services and improve productivity.

In the second dimension of the Technological Transformation Index - *Technology Creation and Adoption* - we look at patent applications, start-up creation, employment in tech sectors and demand for technology-related skills.

In our analysis of patent applications, we observe that only four regions – Inner London West, East Anglia, Buckinghamshire and Oxford and Gloucestershire, Wiltshire and Bath/Bristol - account for over 50% of applications made annually. This is true in all years analysed, with the sole exception of 2017, when their contribution was 48%.
In addition, the emergence of new start-ups in the technology sectors shows a similar pattern of regional concentration. These are defined here as companies founded within the past five years from the year of observation. The highest concentration of start-ups is in Inner London (East and West), where the number of new tech start-ups is four to five times greater than in the region with the third highest count.

There are also stark regional differences in the demand for technology skills across the country. Some areas such as Inner and Outer London and tech hubs such as Berkshire, Buckinghamshire and Oxford and the Bath/Bristol area show a high concentration of employers that require technology skills, suggesting adoption of new technologies is more widespread in these regions. In contrast, regions such as Cornwall, East Yorkshire and Lincolnshire have markedly lower levels of tech skills demand, suggesting that the pace at which new technologies are embraced is slower. We explore the data on demand for technology skills further in section 2.3. It is anticipated that these trends highlight the varying economic (occupational and industrial) compositions across regions. For example, regions with a strong traditional manufacturing or tourism sector may have less immediate demand for advanced tech skills than those with a burgeoning tech sector or industries that are adopting new technologies more rapidly.

Looking now at the overall Technological Transformation scores, we see that although there is some evidence of a North-South and urban-rural divide, this is not the whole story. There are important exceptions, as when we find pockets of low scores situated close to high-scoring ones. For example, some areas in the South-East, on the outskirts of South and East London, Kent and Essex, perform poorly despite their geographical proximity to high-scoring regions.

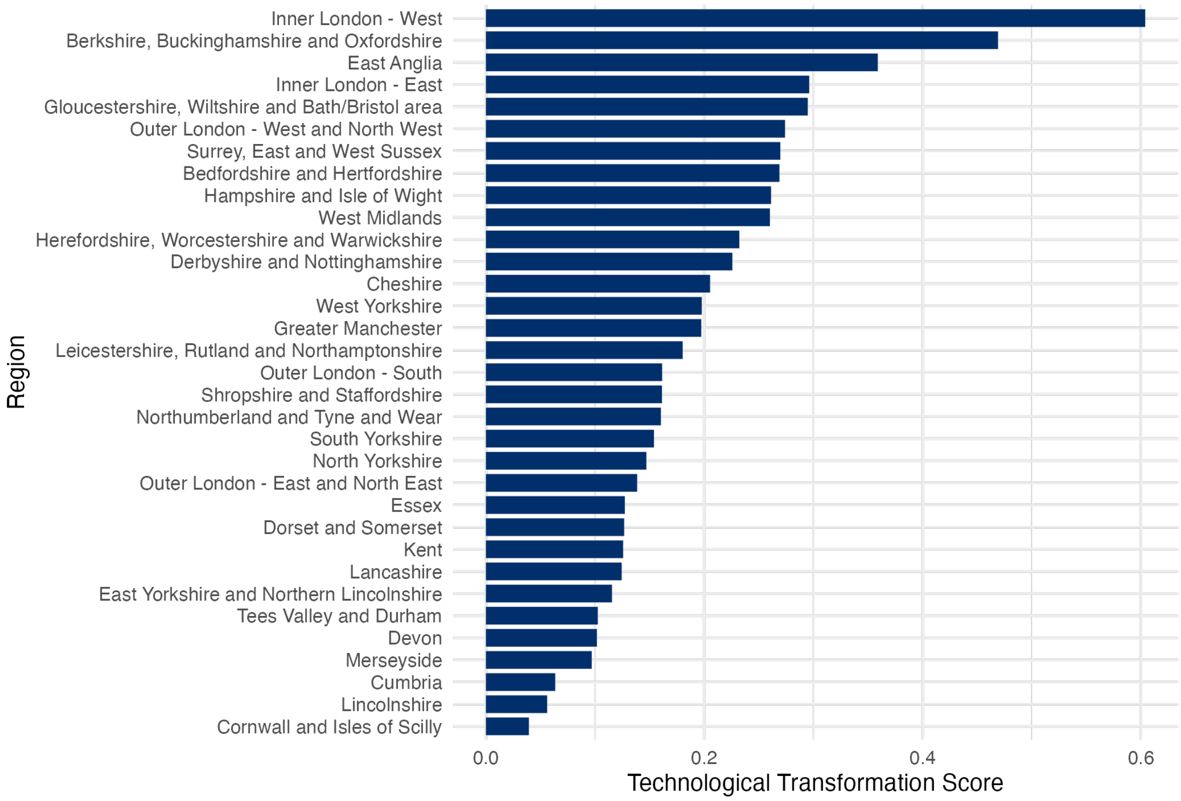
Evolution of Technological Transformation scores over time

We now examine in more detail the changes in scores and ranks of regions, as well as the reasons for these changes. Looking back at the first year for which the DI is calculated, Figure 5 shows the total scores of Technological Transformation in 2016.

The five highest-scoring regions remain unchanged between 2016 and 2020. Inner London West and Berkshire, Buckinghamshire and Oxfordshire retain the first and second positions respectively, while East Anglia and Inner London East switch places as the third and fourth highest scoring regions. Gloucestershire, Wiltshire and Bath/Bristol area is placed fifth in both years.

At the other end of the distribution, the three lowest-scoring regions in 2016 (Cornwall and Isles of Scilly, Lincolnshire and Cumbria) remain in the same position in 2020. Merseyside and Devon leave the bottom 5 by 2020, having been replaced by East Yorkshire/Northern Lincolnshire and Shropshire and Staffordshire.

Figure 5 – Technological Transformation scores in 2016

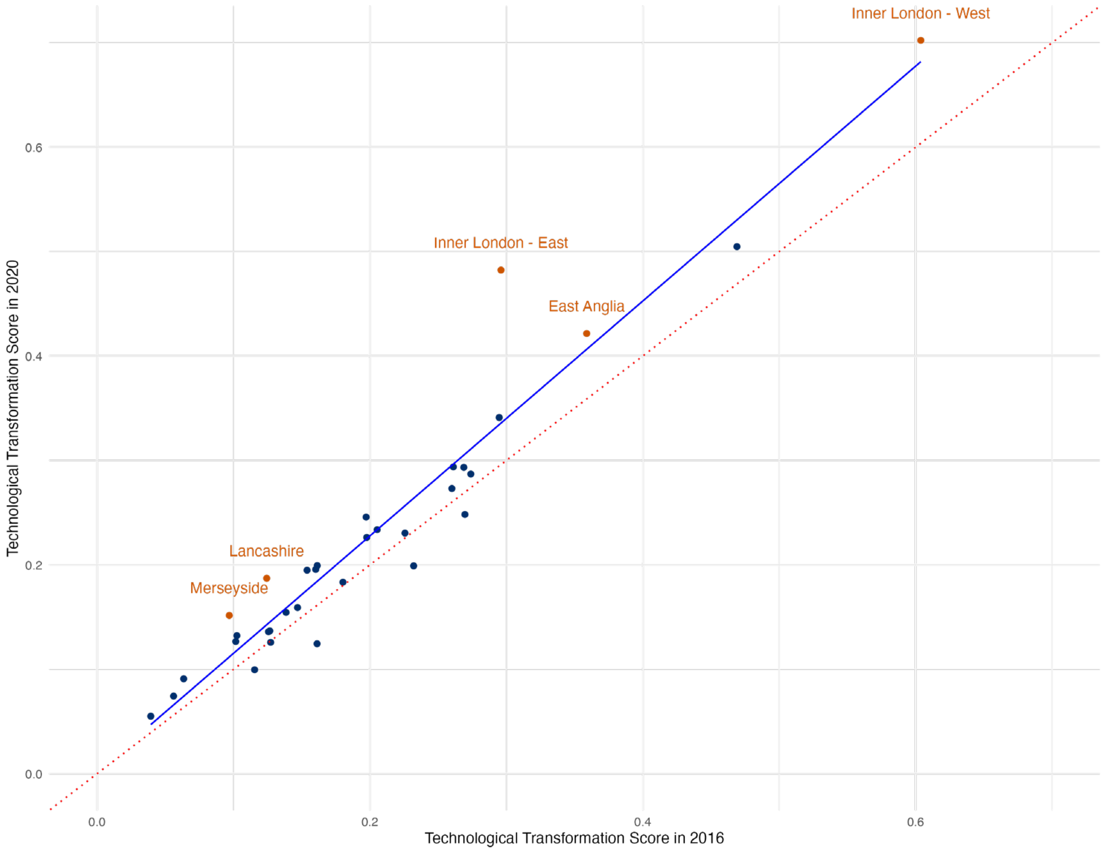


Source: Technological Transformation Index based on data from various sources.
For more information, see [Disruption Index Technical Report].

Comparing the scores for 2016 and 2020, we observe little variation in the rank of regions over this period. This is further supported by a Spearman's rank correlation coefficient of 0.94, indicating very high persistence. The Gini coefficient remained similar at 0.29 in 2016 and 0.30 in 2020, also consistent with the stability of scores over time.

However, despite the relative stability of ranks, changes in the total scores indicate that certain regions have performed relatively better than the average in the period analysed. In Figure 6, which plots the Technological Transformation scores of 2020 against those of 2016, the dotted red line is the 45-degree line, indicating points where the scores for both years are equal. Points above it show an improvement in the scores, whereas points below it shows a deterioration. The solid blue line is the "regression" line, roughly showing the average 2020 scores relative to the 2016 scores. The figure shows that on average there has been an improvement in the scores, with the regions highlighted in orange experiencing the biggest improvements. But despite this overall improvement, four regions regressed (Shropshire and Staffordshire, Herefordshire, Worcestershire and Warwickshire, Surrey, East and West Sussex, and East Yorkshire and Northern Lincolnshire).

Figure 6 – Technological Transformation Index: 2016 vs 2020



Source: Technological Transformation Index based on data from various sources.
For more information, see Disruption Index Technical Report.
Note: points in orange (labelled) have the largest positive distance to the 45 degree line.

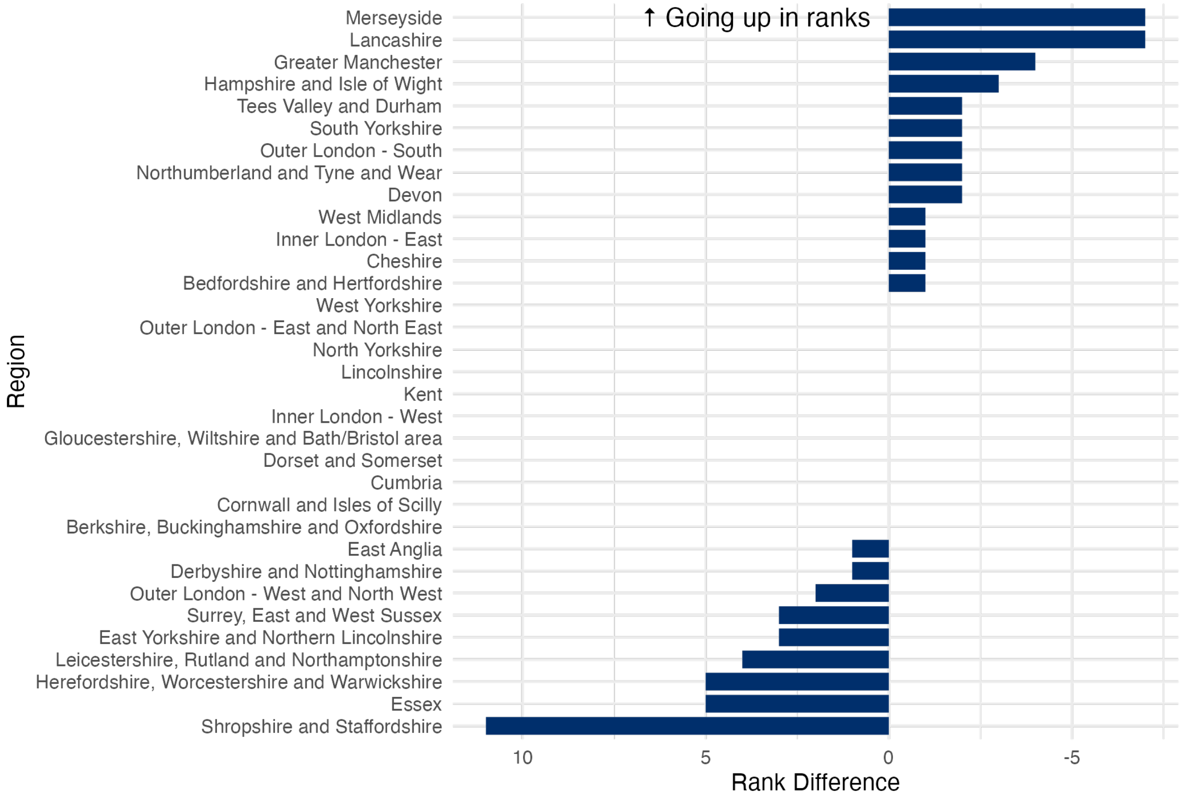
To gain deeper insights into the relative progress of regions, it is useful to focus on regions that have experienced large score changes, as well as those that have gone up or down in terms of rank positions. Figure 7 illustrates the changes in rank positions from 2016 to 2020, while Figure 8 shows the changes in technological transformation scores in the same period. For a more detailed understanding of the factors behind these large shifts, Figure 9 breaks down the score changes according to the subdimensions of the index. Examining these three figures collectively allows us to get a comprehensive perspective of the most significant trends and identify which indicators are driving these changes.

In Figure 7, a negative number in the x-axis is indicative of a region going up in the ranks towards number 1, representing an improvement in position. Looking at the largest improvements in ranks, we find that Merseyside and Lancashire are the regions that gained most positions over the period analysed, improving 7 positions in the rank.

Merseyside started in the 30th place in 2016 and had a consistent upward trajectory, reaching 23rd by 2020, with a score of 0.15. This change also corresponded to a large increase in terms of scores (+0.05). From the decomposition in Figure 9, it is possible to see that this movement is primarily the result of an increase in its innovation activity score, particularly driven by a sharp increase in the percentage of innovation active businesses, followed by an increase in patent applications.

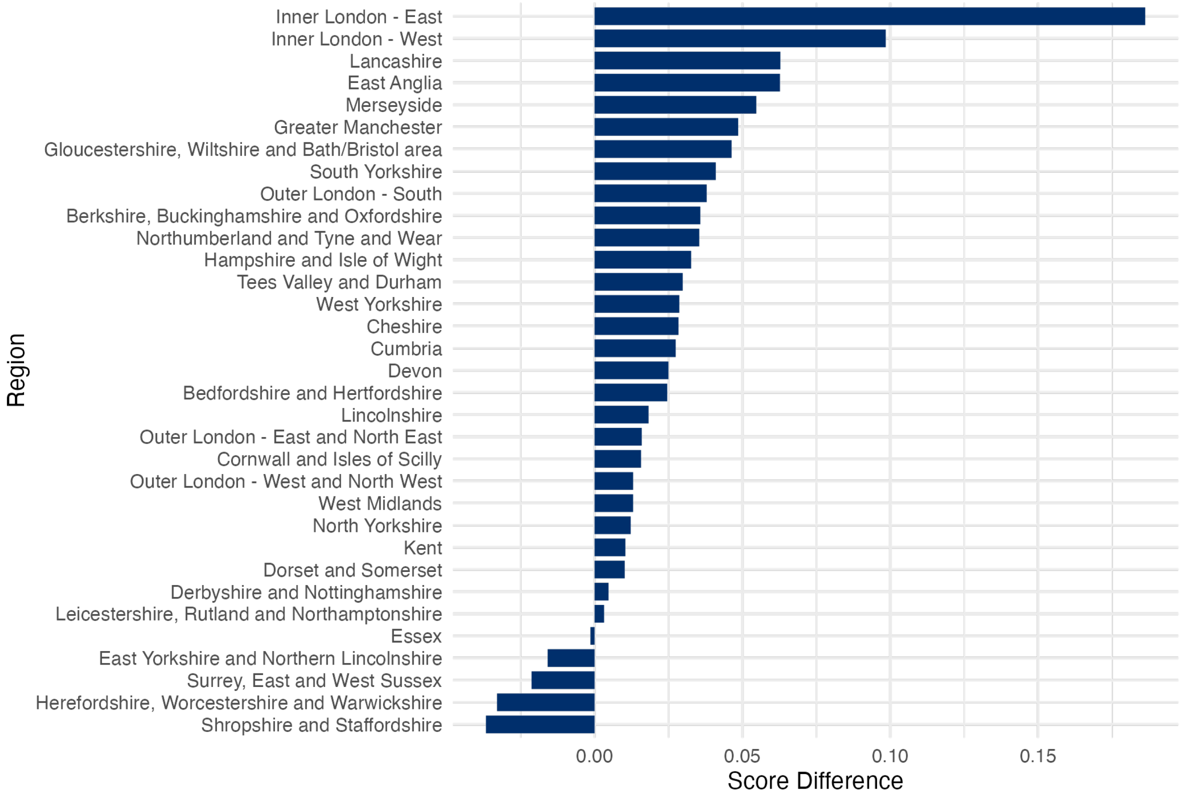
Lancashire, which started in the 26th place in 2016 with a score of 0.12 reached the 19th position by 2020, with a score of 0.19. This positive change in the total score of technological transformation is explained by an increase in the indicators of technology creation and adoption – the largest observed for all the regions in this subdimension.

Figure 7 – Changes in Technological Transformation Ranks



Note: negative values on the x-axis show an improvement in rank positions (falling rank number, with 1 the highest rank.)
Source: Technological Transformation Index based on data from various sources.
For more information, see [Disruption Index Technical Report](#).

Figure 8 – Changes in Technological Transformation Scores



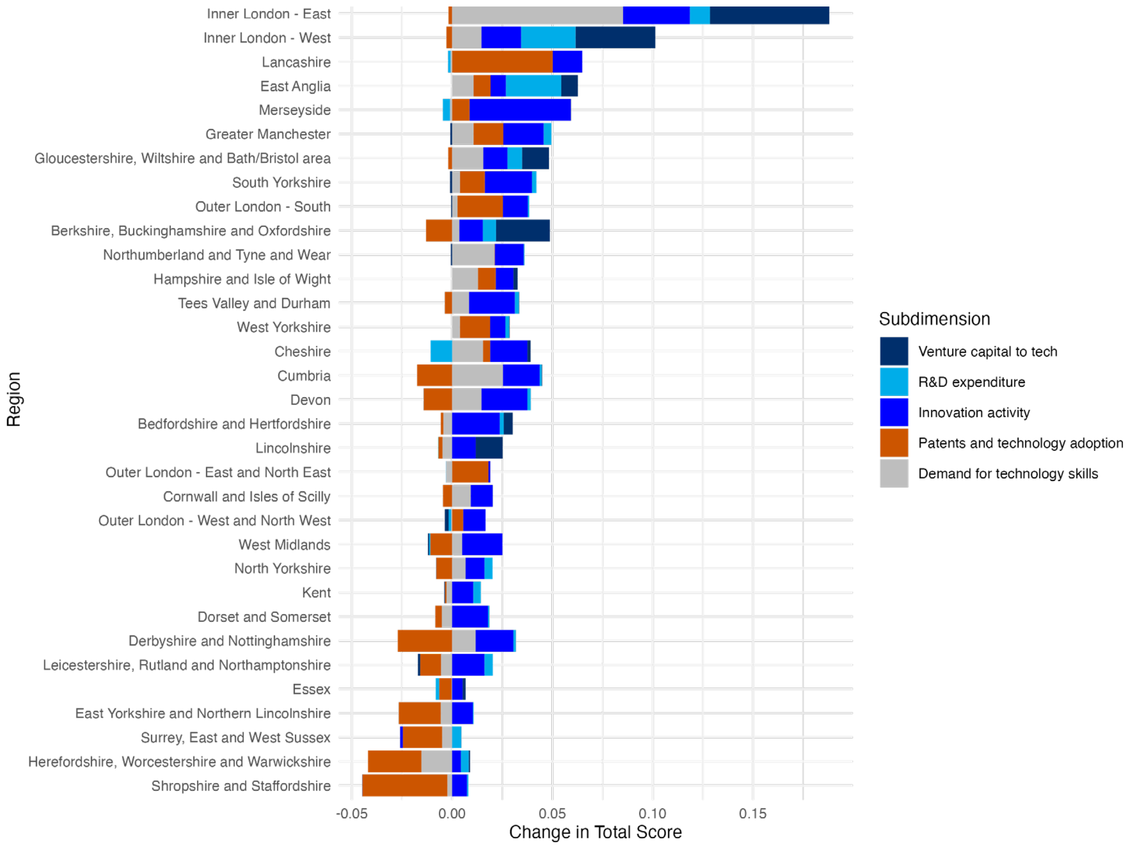
Source: Technological Transformation Index based on data from various sources.
For more information, see [Disruption Index Technical Report](#).

Interestingly, the region that most improved in terms of actual scores, is Inner London East, going from a score of 0.30 in 2016 to 0.48 in 2020. This change is largely explained by an increase in venture capital funding, which surged by 253% in this region, and by an increased demand for tech skills, which indicates that technologies are being widely used by workers in the local labour market. Because of this increase in its total score, the region improved its rank by one position (from 4th to 3rd) and got closer to the top performers. Considering changes in the rank distribution only allows us to observe movements across the 'steps of the ladder' but does not tell us how far apart the steps are. This is why it is important to simultaneously consider both the distribution of scores and of ranks.

Other regions that improved in terms of scores are East Anglia, Greater Manchester and South Yorkshire, all gaining more than 0.04 points – although these changes were only reflected more modestly in ranks, as larger absolute changes are needed to move positions towards the top end of the distribution. In Greater Manchester innovation activity and tech creation and adoption were the main contributors to the observed changes. In East Anglia, however, the main contributor was a surge in R&D expenditure, which increased by 33% from business sources and 18% from non-business sources in this period.

As shown in Figure 9, some regions have experienced improvements in some subdimensions, but these were not reflected in improved total scores as they were offset by a decline in other subdimensions. This shows that changes in subdimensions are not always resulting in noticeable net changes. For example, in Berkshire, Buckinghamshire and Oxfordshire, the improvement in total scores from an increase in venture capital inflows was partly offset by a decline in the tech creation and adoption subdimension.

Figure 9 – Decomposing Changes in Scores



Source: Technological Transformation Index based on data from various sources.
For more information, see Disruption Index Technical Report.

This is also evident in the regions that are falling behind. Shropshire and Staffordshire experienced the biggest losses over this period. This region lost approximately 0.04 in total score, and dropped 11 positions in the ranking, going from 18th to 29th. This large decline was largely a result of a decrease in technology creation and adoption in this period. Herefordshire, Worcestershire and Warwickshire also lost positions, dropping from 11th in 2016 to 16th in 2020, losing 0.03 in their total score, mostly due to a decline in technology adoption but also because of a reduced demand for technology skills.

2.3 A closer look at subdimensions of Technological Transformation

Private investments to tech companies

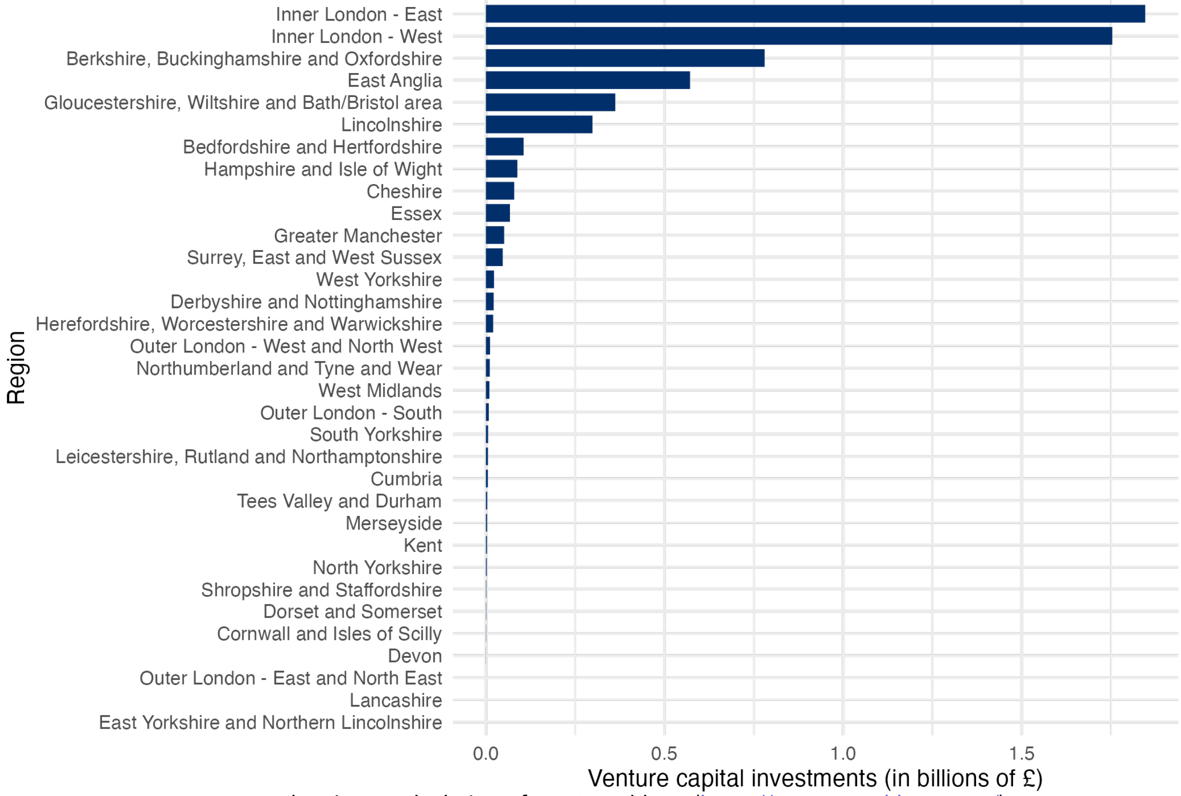
This subdimension considers venture capital funding to firms in advanced technology sectors. Venture capital funding can be particularly important for firms developing or actively deploying new advanced technologies, as it provides the necessary resources to innovate, bringing ground-breaking ideas to reality, particularly in high-risk scenarios (e.g. see Kortum and Lerner, 2000). Beyond innovation, this type of funding is also used in the diffusion of technology, helping firms expand and compete, for example by scaling up the use of technology in start-ups or adopting technology existing in one sector to another.

Our data on venture capital (VC) comes from Crunchbase, which provides business information about private and public companies, including details on investment and funding received. To identify venture-backed technology companies, we relied on the industry categorisation available in Crunchbase and keywords associated with specific advanced technologies of interest, such as AI, data and analytics, science and engineering, software, among others.

In 2020, the total investment from venture capital to tech firms was £6.1B (in 2021 constant prices). However, this amount was geographically unequally distributed. The average investment stood at approximately £188 million, but this number is heavily skewed by a few regions, mainly London and the wider South-East, which received a large inflow of VC investments. The median investment was closer to £11 million, revealing a more modest landscape for most regions.

Figure 10 shows the significant concentration of venture capital investment in technology in Inner London (East and West). This area, which hosts a large share of company headquarters, has attracted more than 65% investments raised for technology organisations in every year analysed. Beyond Inner London, substantial funding flows into regions around the Golden Triangle - specifically Berkshire, Buckinghamshire and Oxfordshire and East Anglia. This suggests that venture capital funding is an important driver of regional technological disparities in our index. There is, however, an important caveat about this data set, which cannot be resolved with the information at our disposal. The Crunchbase data typically links received investments with the registered addresses of companies' headquarters, which may not necessarily reflect where the investment is utilised.

Figure 10 – Venture capital investments to technology in 2020



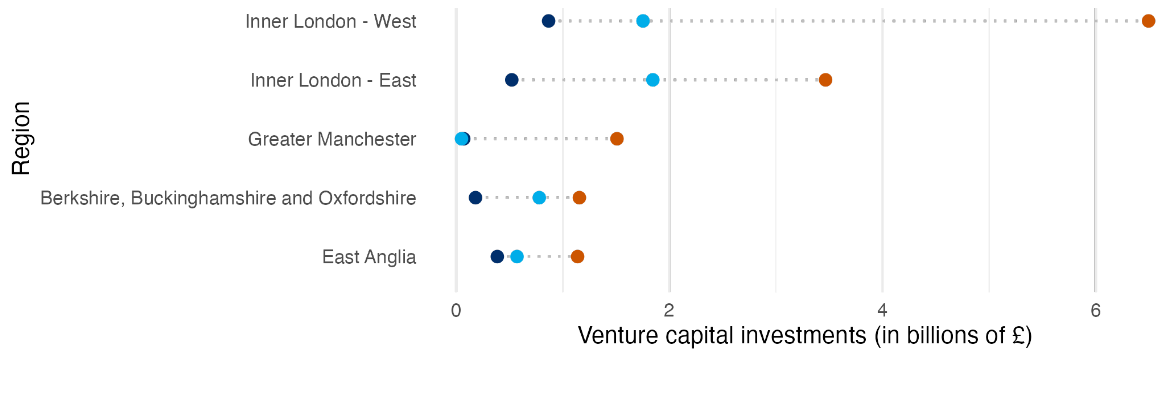
Source: Authors' own calculations, from Crunchbase (https://www.crunchbase.com/)
Investments in billions of £ in 2021 constant prices

There has been a rapid growth in venture capital flows for the whole country since 2016. In that year, the total investment to tech firms was £2.5B. We observe that while venture capital investments are increasing across most regions analysed since 2016, the pace of growth is very different. In some regions, such as the leading Inner London East, venture capital investments increased by more than 250% from 2016 to 2020, and continued growing thereafter, reaching £6.4B in 2021. In contrast, other regions, such as Surrey, East and West Sussex, have seen much slower growth (around 2%), and others, such as North Yorkshire, have experienced a decline (-40%) in venture capital flows during this period.

Venture capital investments are also becoming increasingly more concentrated into the top regions over time. In 2016, the top 5 regions accounted for 81% of the total venture capital investment, while in 2020 the same regions accounted for 85% of the total – a bigger share of a bigger pie.

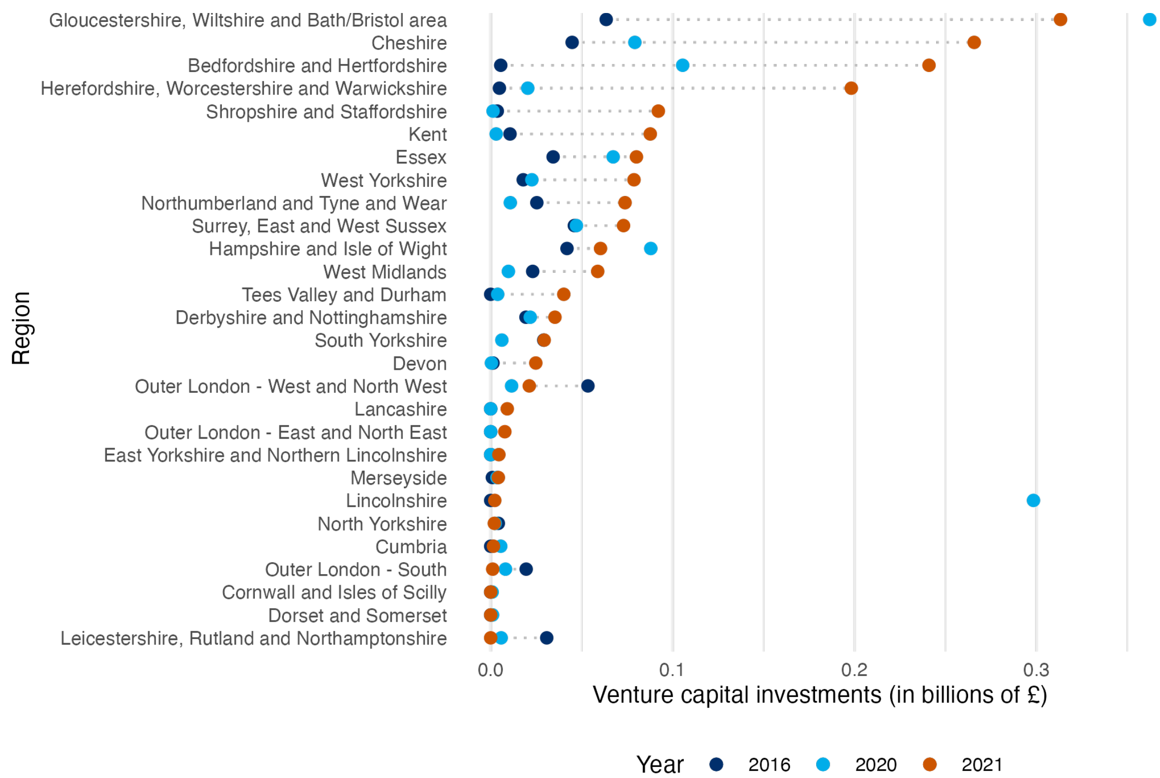
Examining the more recent data points for this indicator, beyond 2020, allows us to examine trends since the year of the pandemic. Figures 11a and 11b show the change in venture capital investments for all regions from 2016 to 2021. While the more established tech hubs around the golden triangle continued to receive significant investments, some under-the-radar regions have experienced some relatively large inflows of venture capital since 2016. For instance, Cheshire, Bedford and Hertfordshire and Herefordshire, Worcestershire and Warwickshire all received large inflows of VC, particularly so after 2020.

Figure 11a – Changes in venture capital flows 2016-2021: top 5 receiver regions



Source: Authors' own calculations, from Crunchbase (https://www.crunchbase.com/)
Investments in billions of £ in 2021 constant prices

Figure 11b – Changes in venture capital flows 2016-2021: remaining regions



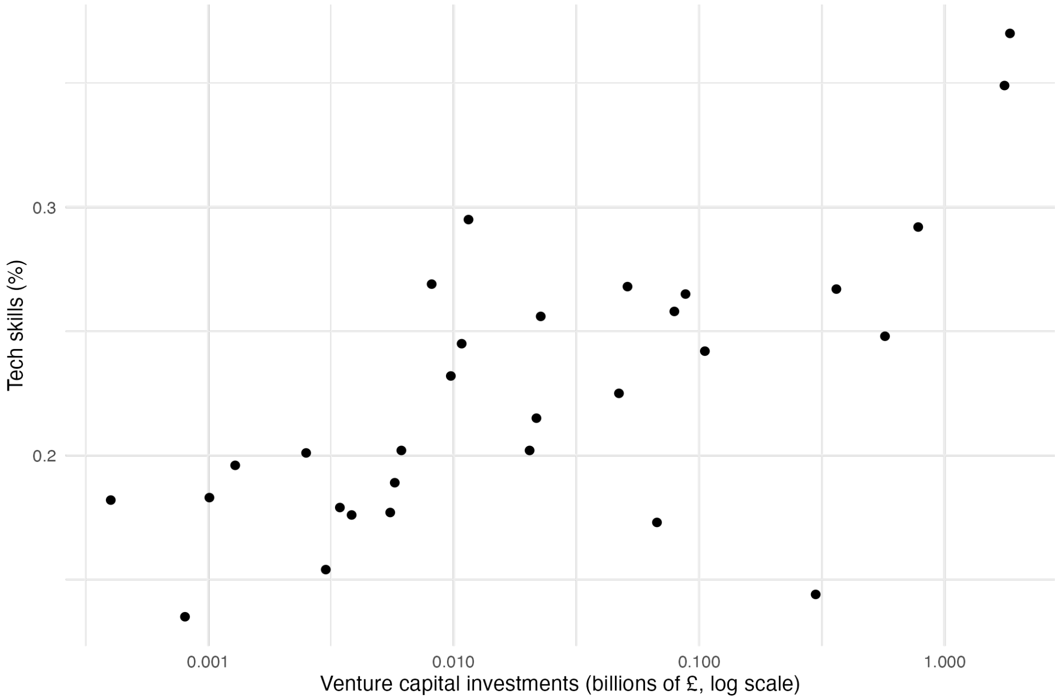
Source: Authors' own calculations, from Crunchbase (https://www.crunchbase.com/)
Investments in billions of £ in 2021 constant prices

It becomes clear that the venture capital landscape in England is made up of two extremes: dynamic tech hubs and regions that cannot seem to attract venture capital investments.

Existing literature indicates that regions receiving significant inflows of venture capital investments are typically those that already have more vibrant technology sectors (e.g. Jeng & Wells, 2000; Lerner & Tåg, 2013). Our data corroborates this, reflecting the path dependency of investment flows. Among key factors discussed in the literature as those that contribute to the development of entrepreneurial ecosystems, we have access to finance, human capital and markets (World Economic Forum, 2013; Stam 2015). Conversely, regions lacking these factors struggle to attract investors and with their inadequate investments cannot catch up with the leading regions. Encouraging investments from private sources, including venture capital, might not only improve firm's access to finance but also contribute to their growth and, ultimately, overall productivity.

There is a notable positive correlation between venture capital investments and the demand for technology skills within the labour market, as shown in Figure 12. Regions that receive more of this type of investment are more likely to have more developed sectors that are more technology intensive. This suggests that rather than competing with skilled labour, venture capital investments complement them and stimulate the demand for this type of labour. This trend could be reflected in the availability of more tech-intensive local employment opportunities.

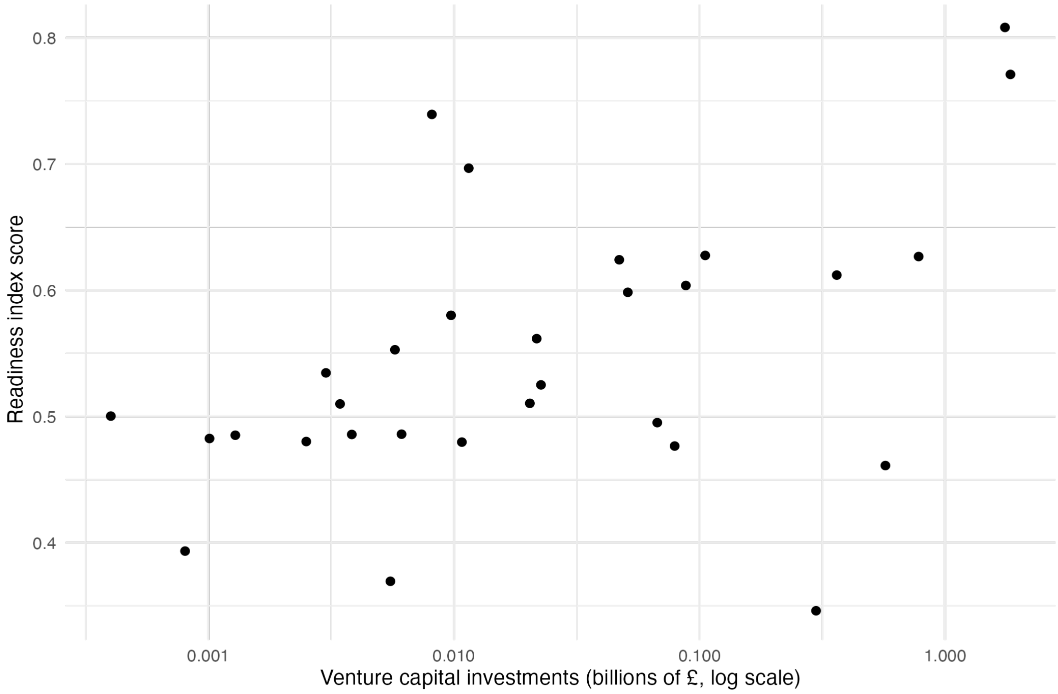
Figure 12 – Venture capital investments and demand for tech skills



Notes: venture capital investments in billions of pounds, shown on a logarithmic scale to better compare a wide range of values. 3 regions with zero values are excluded from this figure.
Source: Authors' own calculations, VC data from Crunchbase (https://www.crunchbase.com/)
Demand for technology skills based on data from Adzuna Intelligence (https://www.adzuna.co.uk/adzuna-intelligence/).

We also observe a positive association between receiving venture capital investments and regions scoring highly on the Readiness index (which will be presented in detail in Section 3), as shown in Figure 13, which reflects the presence of robust ICT infrastructure and of a more highly skilled workforce.

Figure 13 – Venture capital investments and enabling factors



Notes: venture capital investments in billions of pounds, shown on a logarithmic scale to better compare a wide range of values. 3 regions with zero values are excluded from this figure.
Source: Authors' own calculations, VC data from Crunchbase (https://www.crunchbase.com/)

Demand for technology skills

With technology rapidly advancing, how are the skills requirements of jobs changing? In this analysis, the demand for technology skills is used here as a proxy for the adoption of new technologies by firms. This indicator captures the extent to which firms are integrating new systems and tools, requiring a workforce that is equipped with the necessary skillsets to utilise them effectively.

To estimate the demand for technology skills, we use data on online job postings from Adzuna, a comprehensive online job search engine that aggregates information on the near universe of UK jobs posted online, to quantify the demand for technology-related skills.

By 'technology skills' we mean skills related to Advanced Data Analysis and Information Technology.[4] This covers a wide and crucial set of skills that are rapidly changing and particularly relevant in today's labour markets, particularly so for specialist technology jobs that are directly dealing with new technologies. Within these broad categories, we have a wide range of advanced specialised skills, for example:

- "Analysis": data analysis, data science, data visualisation, image analysis, maths and mathematical modelling, statistical software, NLP, business intelligence.
- "Information Technology": API, AI and machine learning, programming languages, cloud computing, computer science, data collection and storage, databases, IoT, IT automation, cybersecurity, network security, telecommunications.

[4] This classification comes from mapping the skills extracted from job descriptions by Adzuna to Lightcast's Open Skills taxonomy, for analytical purposes. This classifies individual skills into 32 thematic categories. More details on this mapping can be found in Costa et al. (2024).

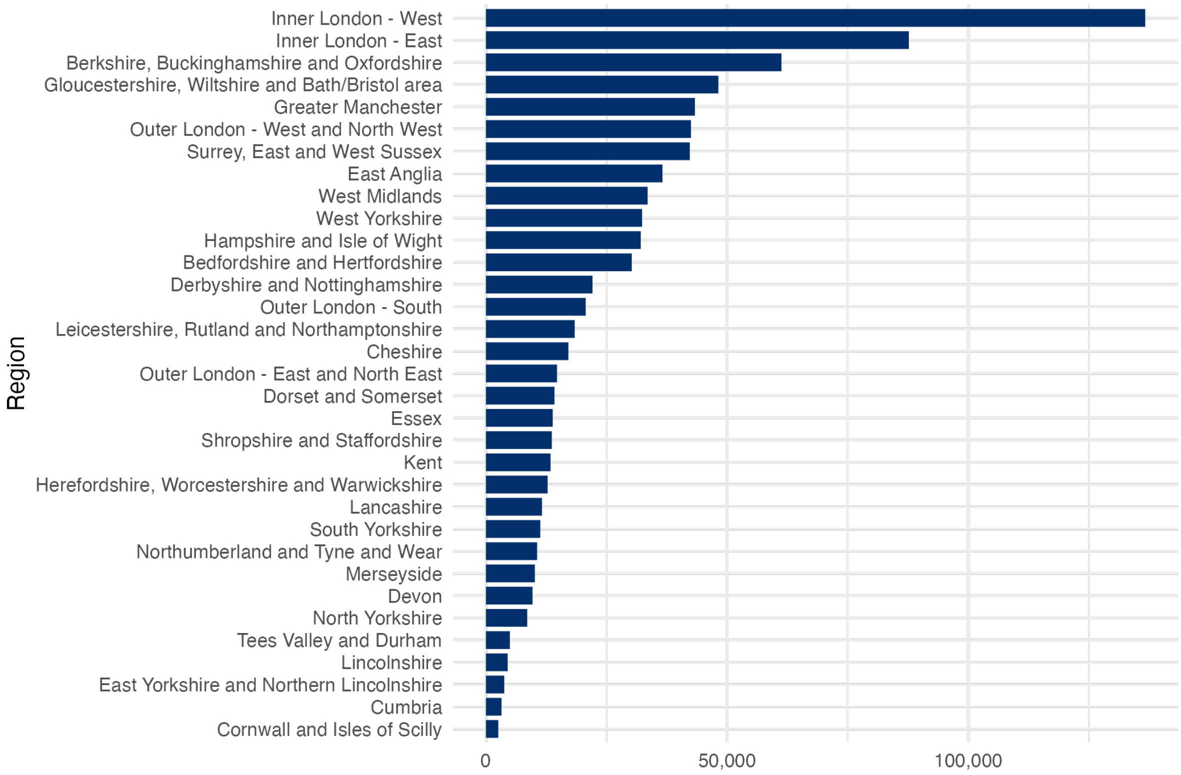
This subdimension of the index, ‘demand for technology skills’, is made up of two individual indicators, (i) the percentage of job postings containing tech skills (to all job postings in a region) and (ii) the absolute count of these job postings. Tech job postings are defined as those that mention at least two individual skills belonging to ‘technology skills’ categories. In addition to the count of these jobs, examining the share of these tech job postings in relation to the total number of jobs advertised in a region is useful to gauge the technology intensity of the local job markets. We note that while the very top and bottom regions are largely the same across the two indicators, it seems the distributions differ a lot in the middle, relating to the size of the workforce and also the sectoral mix and economic diversity of each place.

There are significant disparities in the demand for technology skills across the country, which indicate a very polarised landscape (Figures 14 and 15). Some regions - such as Inner and Outer London and Berkshire, Buckinghamshire and Oxford - are the most dynamic areas where such skills are required, indicating a more widespread adoption of these new technologies, while other regions, such as East Yorkshire and Lincolnshire are less active, with respect to both measures.

The increasing intensity of the demand for technology skills is indicative of a very dynamic and rapidly evolving job market. Figure 16 illustrates the changes in the proportion of job postings mentioning tech skills in 2016, 2020 and 2022. From 2016 to 2020, a notable surge in the demand for technology skills is observed across some regions. The largest increase is seen in Inner London East, with a remarkable +12 percentage points, reaching over 35% in 2020. In addition, Outer London (East and West), the North East, Merseyside and East Anglia have all experienced increases exceeding 5 percentage points. It is noteworthy that the regions with the largest increases generally overlap with those scoring highly in the other subdimensions of the technological transformation index.

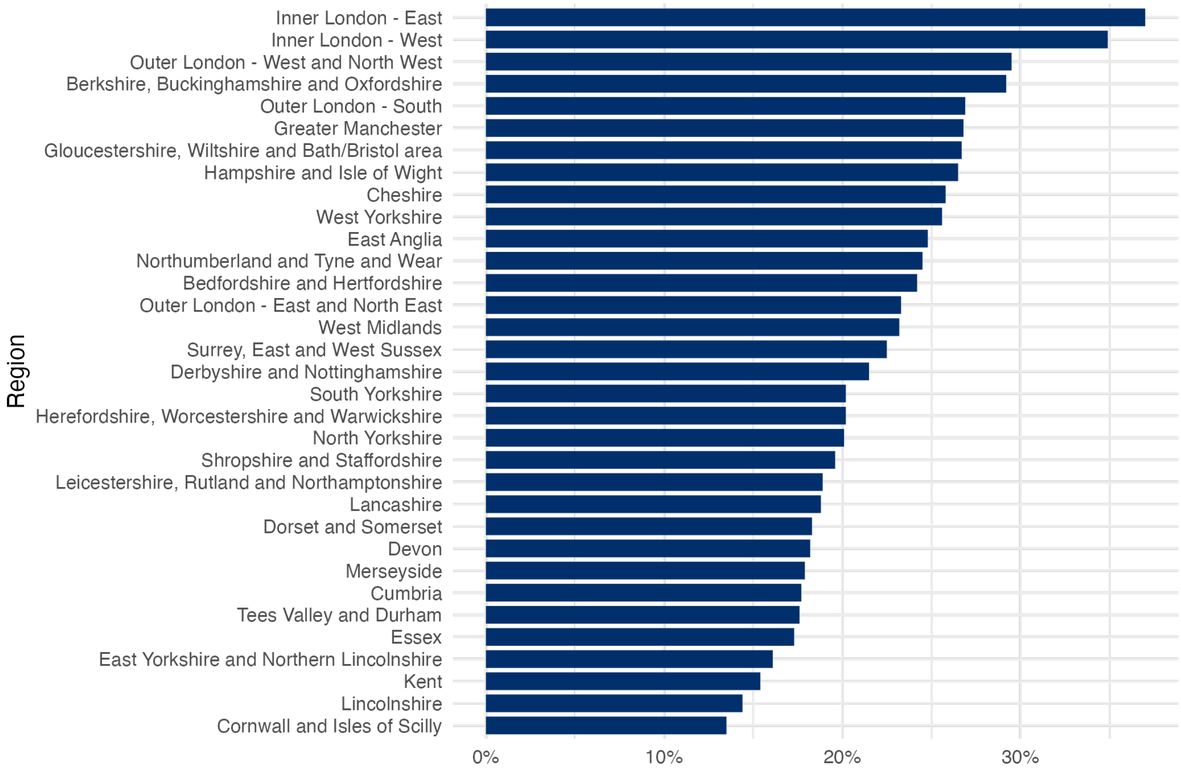
We have data for this indicator until 2022, allowing us to examine what happened since the pandemic. This data suggests that while some regions have seen a decline in the percentage of job adverts mentioning tech skills in 2020, a recovery or additional growth took place in 2022. For instance, Herefordshire, Worcestershire and Warwickshire have seen a decline of approx. 2.5 percentage points from 2016 to 2020, but this rebounded to 24% by 2022. Meanwhile, some regions like Inner London, Greater Manchester, East Anglia, Northumberland, Merseyside and Derbyshire, not only maintained but increased their growth in the demand for tech skills. The varied rates of tech skill changes across regions from 2020-2022 suggest an uneven recovery in the job market, which could relate to the presence of technology-intensive industries and the general economic resilience of regions.

Figure 14 – Number of job postings mentioning tech skills



Source: Calculations based on data from Adzuna Intelligence (https://www.adzuna.co.uk/adzuna-intelligence/)

Figure 15 – Percentage of jobs postings mentioning tech skills



Source: Calculations based on data from Adzuna Intelligence (https://www.adzuna.co.uk/adzuna-intelligence/)

Figure 16 – Changes in demand for technology skills, 2016-2022

Source: Calculations based on data from Adzuna Intelligence (https://www.adzuna.co.uk/adzuna-intelligence/)

In another comprehensive study prepared for the Pissarides Review (Costa et al., 2024), we delve deeper into the evolution of skills requirements from 2016 to 2022 in the UK labour market, with a particular focus on IT and advanced data analysis. This report identifies skills that are rapidly emerging and disappearing and quantifies the rapid pace of change of skills (skill turnover) at the very detailed level of 4-digit Standard Occupational Classification (SOC) occupations. This analysis contributes to a better understanding of the nuanced shifts in skills requirements, particularly in the context of technological advancements. The study highlights the need for workforce development strategies that can be adapted to these rapid changes.

3. Factors that enable the technological transformation

3.1 Readiness Index

The Readiness Index highlights the crucial role of human capital and infrastructure as enablers of technological transformation. Technology development and adoption thrive best in environments that support and nurture entrepreneurs, businesses and people, enabling them to fully leverage advanced technologies. Here we focus on the key external enabling factors of technological transformation for firms, beyond financing and investments. These factors drive innovation and widespread adoption of new technologies, such as the availability of skilled human capital and robust connectivity infrastructure.

Table 2 – Readiness index indicators

Dimension	Subdimension	Indicators
Human Capital	Basic skills	Population with NVQ4+ attainment
		GSCE attainment
		Teacher-pupil ratio state funded schools
	Investment in education	Government investment in education (total)
		Government investment in education (per pupil)
	Post-secondary education	ICT apprenticeships
		Enrolment in tertiary education
		Number of postgraduates
	Adult education	Lifelong learning (participation in education or training)
		On the job training
	Workforce	Labour force participation rates
		Working age population 16-64
Infrastructure	ICT	4G mobile coverage
		Internet download speed
		Ultrafast internet availability
		Number of internet users

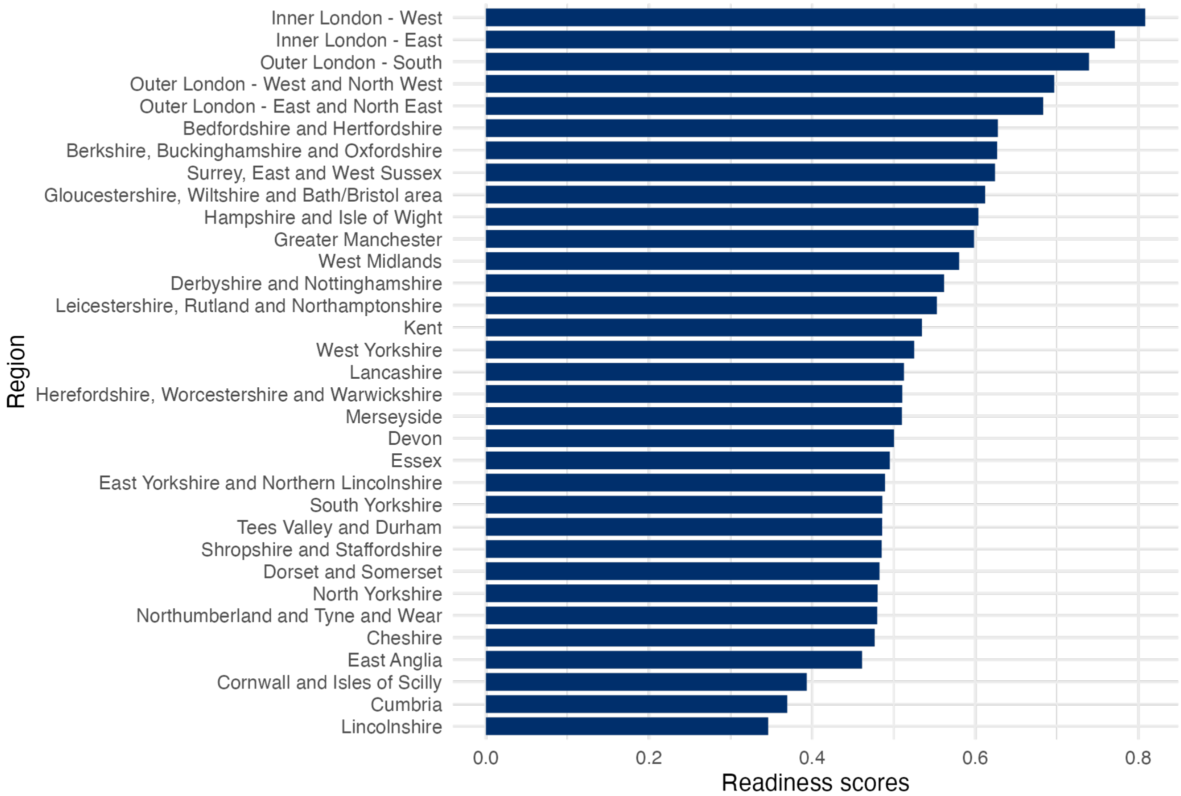
Note: We use a min-max normalisation to transform all indicators to a 0-1 scale. Outlying values were not removed. Detailed information can be found in the Disruption Index Technical Report.

3.2 Readiness Index scores

In this section, we examine the aggregated scores for Readiness, their geographic distribution and their evolution over time.

Starting with the scores in 2020, Inner London West emerges as the top region with a score of 0.81. It excels across various subdimensions, notably in areas within the human capital dimension. At this point, it is worth remembering that Inner London West was also the top scoring region for Technological Transformation in all years analysed. We will examine the relationships between the two core indices in the next section. Following closely behind Inner London West, the other top regions for readiness are also regions of London. All these have a very strong performance in infrastructure.

Figure 17 – Readiness scores in 2020

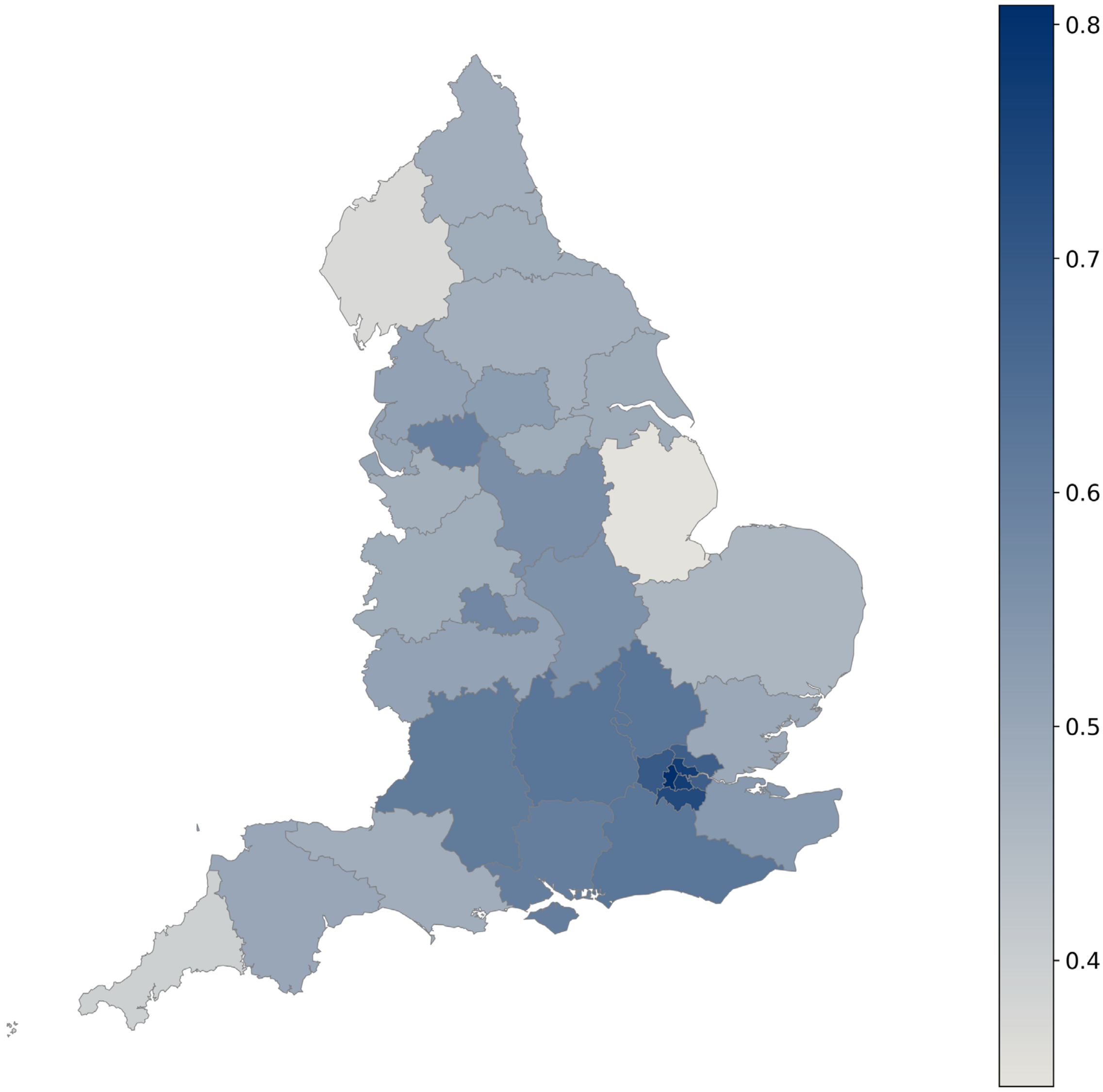


Source: Readiness Index based on data from various sources. For more information, see [Disruption Index Technical Report]

Drivers of regional disparities in Readiness

Unlike the dominance of Inner London in terms of *Technological Transformation*, the *Readiness* index has a much more equal (or less unequal) and mixed distribution of scores across the country. Inner London West and Inner London East are again leaders, but the margin of their lead is smaller and the distribution of scores is far more equal, with a Gini index of 0.11 for Readiness compared to 0.30 for Technological Transformation. The Technological Transformation score for Inner London West (0.70) is more than double the score for 29 of the 32 remaining regions. In contrast, in terms of Readiness, Inner London West's score is more than double only in 3 out of 32 regions.

Figure 18 - Geographical distribution of Readiness scores in 2020



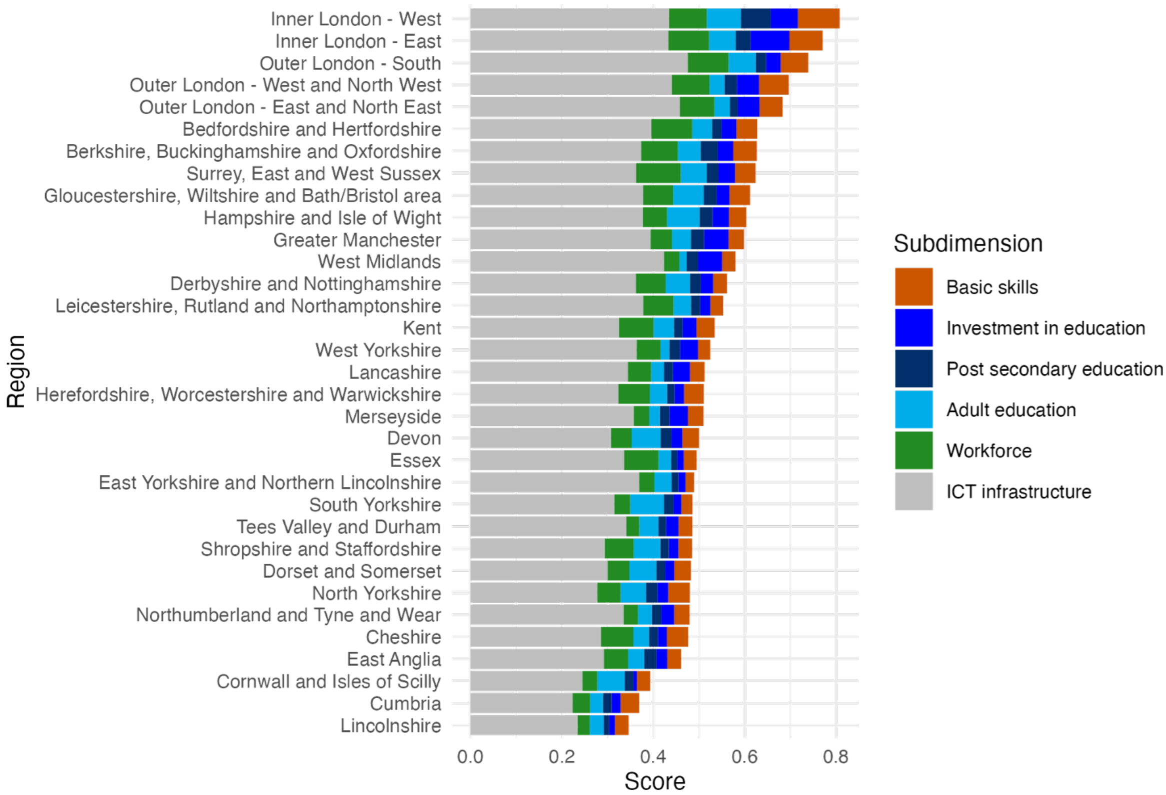
Source: Readiness Index based on data from various sources. For more information, see [Disruption Index Technical Report]

Scores for London and the South East are boosted by the *Workforce* subdimension, with several densely populated regions near one another and collectively possessing a large pool of potential workers from which to draw. Inner London West also scores far ahead of other regions in Post-Secondary education, driven by being home to several large, leading universities with large postgraduate populations. The Basic Skills and Investment in Education subdimensions generally favour urban areas over more rural areas (also accounting for per-pupil figures), with Greater Manchester and the West Midlands ahead of the Outer London areas in terms of government investment in education.

Adult Education bucks the general trend, with many less urban areas such as Devon and Hampshire and the Isle of Wight scoring highly and outperforming urban areas such as Merseyside and the West Midlands, which are amongst the lowest scoring. This might be related to industrial composition and the variation in the availability of on-the-job training and opportunities for adult education related to the predominant economic activities. Even in this case, Inner London West scores highest, driven by having the highest participation rate in adult education nationally.

Overall, *ICT infrastructure* is the most equal of all dimensions in the index, (Gini = 0.10) driven by widespread mobile phone and high-speed internet availability across England. Urban areas perform slightly better than rural regions. However, these differences are mostly small, especially when compared to other subdimensions within the Readiness Index, and are far smaller than those observed in all subdimensions of Technological Transformation.

Figure 19 – Decomposition of Readiness scores by subdimension (2020)



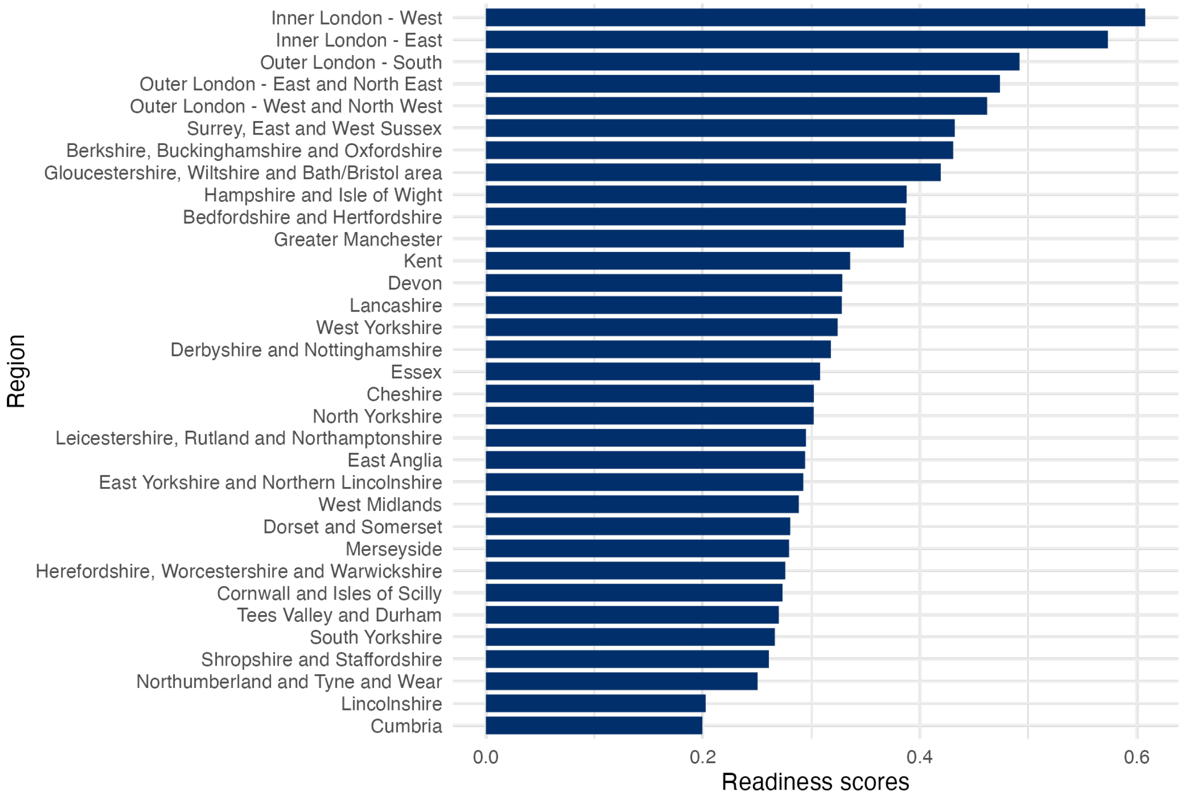
Source: Readiness Index based on data from various sources. For more information, see Disruption Index Technical Report

Evolution of readiness scores over time

Figure 20 presents the Readiness scores across England in 2016. In that year, the top five regions are the five London regions, with Inner London West and Inner London East occupying first and second places. These top-ranking regions remain unchanged until 2020. On the other hand, the lowest (Cumbria) and second lowest (Lincolnshire) scoring regions, switch positions by 2020, although with very similar scores. Northumberland and Merseyside leave the bottom six, with Merseyside moving up ten places, largely because of increases in its ICT infrastructure score.

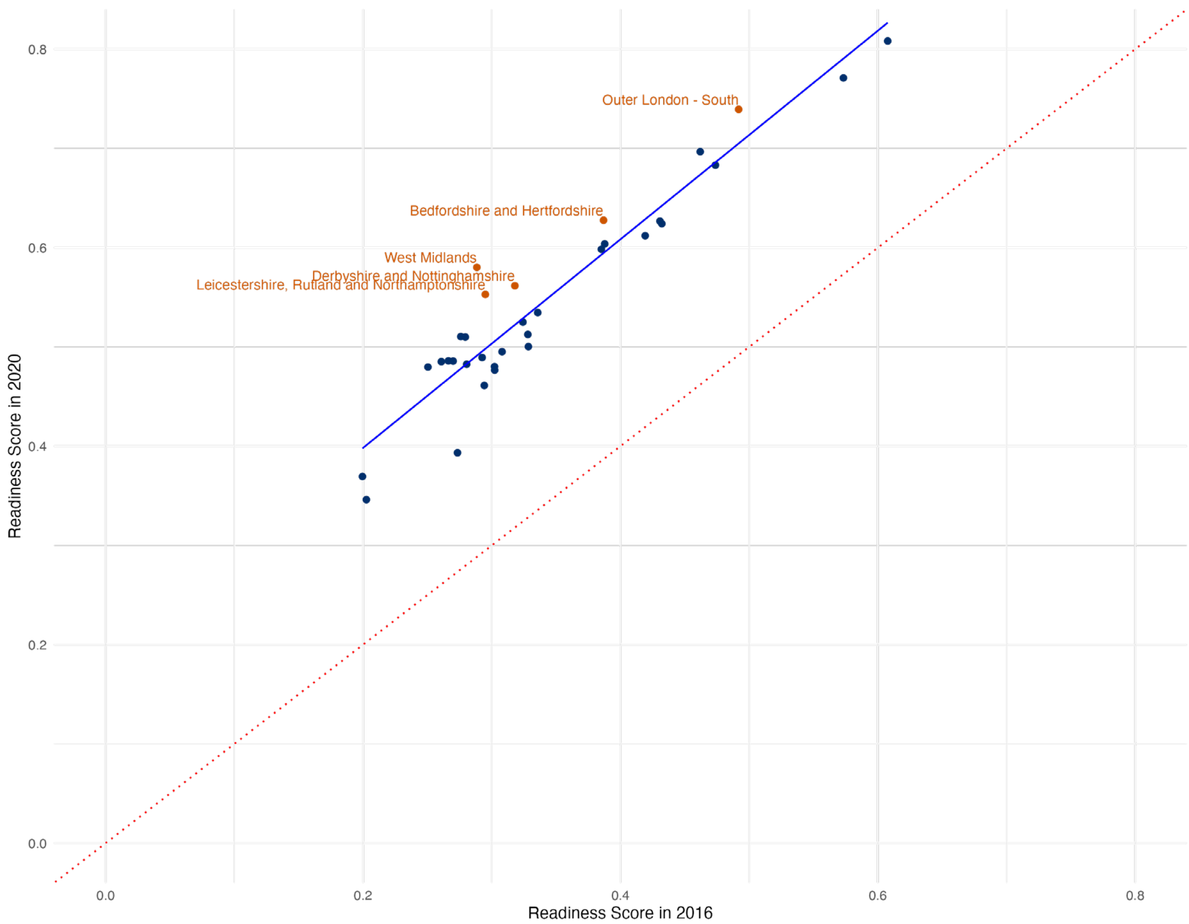
Total scores for Readiness increased significantly from 2016 to 2020, driven largely by improvements in IT infrastructure, particularly access to high-speed internet. This increase is observed across all regions (Figure 22), but rankings in 2016 are largely preserved in 2020 (Spearman's rank correlation coefficient = 0.88). Over this period, Gini inequality in the Readiness domain fell from 0.15 to 0.11, driven largely by a more equal distribution of IT infrastructure (Gini inequality falling from 0.20 to 0.10).

Figure 20 – Readiness scores in 2016



Source: Readiness Index based on data from various sources. For more information, see Disruption Index Technical Report.

Figure 21 – Readiness scores 2016 vs 2020

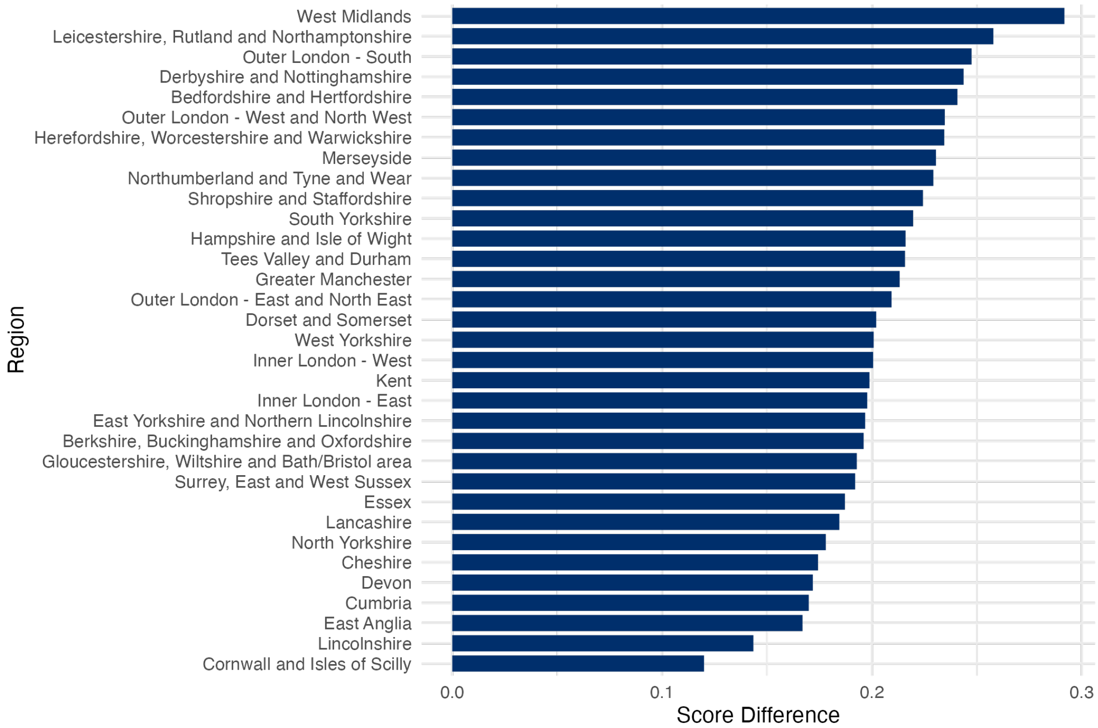


Note: points in orange have the largest positive distance to the 45 degree line.

Source: Readiness Index based on data from various sources. For more information, see Disruption Index Technical Report.

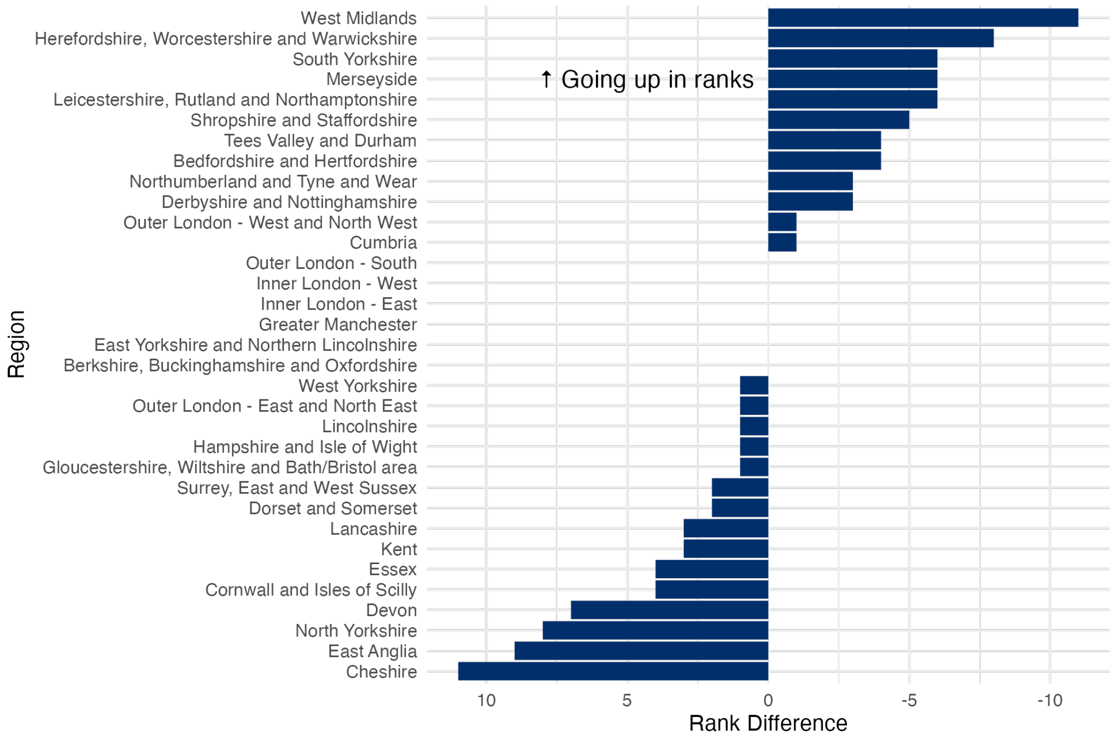
Notable changes in ranks from 2016 to 2020 include the West Midlands moving up 11 positions in the rankings, from 23rd to 12th. This movement was driven largely by increases in their ICT score and reflected in the change in overall scores, which increased by almost 0.3. In second place of top movers, we have Herefordshire, Worcestershire and Warwickshire, which went from 26th to 18th, moving up 8 positions. Among the regions that have seen the largest declines, Cheshire fell 11 positions from 18th to 29th, and East Anglia fell from 21st to 30th.

Figure 22 – Changes in Readiness scores: 2016-2020



Source: Readiness Index based on data from various sources. For more information, see Disruption Index Technical Report

Figure 23 – Changes in Readiness ranks: 2016-2020



Note: negative values in the x-axis mean an improvement in rank positions (towards the 1st place).
Source: Readiness Index based on data from various sources. For more information, Disruption Index Technical Report

Figure 24 – Decomposing changes in Readiness scores

Source: Readiness Index based on data from various sources. For more information, see Disruption Index Technical Report

3.3 A closer look at subdimensions of human capital and infrastructure

Human capital

The Human Capital dimension of the Disruption Index examines the characteristics of a region's workforce with respect to its size, skills and qualifications, and the investment made in education to further advance those skills. Divided into five subdimensions of 'Basic Skills', 'Workforce', 'Investment in Education' 'Post-Secondary Education' and 'Adult Education', it aims to capture the readiness of a region in terms of its workforce and educational opportunities that would enable firms in a place to adopt automation technologies effectively and competitively or adapt more quickly in response to technological progress.

Basic skills

The attainment of basic skills, determined by the GCSE attainment scores of pupils and the attainment of NVQ4+ qualifications of residents, and supported by the teacher-pupil ratio of state schools is positively correlated with investment in education (0.49). Within this subdimension, GCSE attainment and teacher-pupil ratios are relatively invariant, save for higher teacher-pupil ratios in Inner London and slightly higher GCSE attainment in West and South London. The main driver of variation in this domain is NVQ4+ attainment, in which the five London regions have the five highest proportions, with four out of five being above 50%, compared to a median of 38% across all regions.[5]

[5] In this case, NVQ4+ attainment is strongly correlated with attainment of tertiary education (in the 'Post-Secondary education' subdimension 0.88) and for which there is likely to be some degree of overlap in data owing to a university degree corresponding to NVQ level 4.

Table 3 - The five highest scoring regions for Basic Skills in 2020

Region	Teacher : pupil ratio	Average Attainment 8 score	% aged 16 - 64 with NVQ4+	Basic skills score
Inner London - West	0.061 (1:16.4)	54.9	68.1	0.092
Inner London - East	0.059 (1:16.9)	51.4	63.9	0.073
Outer London - West and North West	0.053 (1:18.9)	54.7	57.7	0.065
Outer London - South	0.052 (1:19.2)	54.8	54.2	0.060
Berkshire, Buckinghamshire and Oxfordshire	0.052 (1:19.2)	53.0	48.9	0.052

Table 4 - The five lowest scoring regions for Basic Skills in 2020

Region	Teacher : pupil ratio	Average Attainment 8 score	% aged 16 - 64 with NVQ4+	Basic skills score
East Yorkshire and Northern Lincolnshire	0.051 (1:19.6)	47.1	31.8	0.019
South Yorkshire	0.052 (1:19.2)	47.3	37.2	0.024
West Yorkshire	0.052 (1:19.2)	48.0	37.6	0.027
Leicestershire, Rutland and Northamptonshire	0.051 (1:19.6)	48.8	38.3	0.028
Essex	0.051 (1:19.6)	50.1	34.7	0.028

Investment in education

This subdimension combines a measure of the total government investment in maintained schools in a region and one measure of this investment per pupil. In doing so, it aims to capture both the scale of investment and the intensity of investment in schools.

The highest scoring areas are dominated by urban regions of London, Greater Manchester, the West Midlands, Merseyside and West Yorkshire, where their larger populations of young people drive higher overall spending. An exception to this is Inner London – West, where its overall high score is driven by higher spending per pupil on a par with its neighbour Inner London – East.

For the remaining areas, investment in education per pupil is relatively invariant and thus variation in the overall subdomain score is driven by differences in the scale of overall education investment in turn determined by the size of the population of school-age children in the area. Consequently, the lowest-ranking areas are those with particularly small school populations coupled with lower-than-average investment per pupil.

Table 5 – The five highest-scoring regions for Investment in Education in 2020

Region	Total government investment in education (£m)	Government investment in education per pupil (£)	Investment in education score
Inner London - East	1764	8286	0.085
Inner London - West	557	8545	0.059
Greater Manchester	1696	5870	0.053
West Midlands	1507	6164	0.053
Outer London - West and North West	1174	6496	0.049

Table 6 – The five lowest-scoring regions for Investment in Education in 2020

Region	Total government investment in education (£m)	Government investment in education per pupil (£)	Investment in education score
Cornwall and Isles of Scilly	80	5337	0.008
Lincolnshire	191	5480	0.012
Essex	395	5258	0.014
East Yorkshire and Northern Lincolnshire	258	5597	0.015
South Yorkshire	368	5520	0.017

Post-Secondary education

Inner London – West scores far higher than any other region in the Post-Secondary education subdimension, with a score of 0.065, almost double Berkshire, Buckinghamshire and Oxfordshire in second place (0.038). This is predominantly driven by its 12500 postgraduate students currently enrolled full-time in local universities [6], which is more than double that of Berkshire, Buckinghamshire and Oxfordshire (5900) and East Anglia (5100).

[6] Postgraduate student numbers for 2020 are based on the most recently available data from 2018, while the percentage of residents with tertiary education or above is derived from 2019 data

Greater Manchester scores highly here through striking a balance between mid-table rates of tertiary education and ICT Apprenticeships coupled with the fourth largest pool of postgraduate students; a product of its disproportionately large student population. In contrast, Hampshire and the Isle of Wight achieve a ranking of fifth highest because of their relatively high rates of completion of tertiary education and ICT Apprenticeships, despite a small population of postgraduate students.

Of all the subdimensions in the Readiness index, post-secondary education is the most highly correlated with Technological Transformation (0.81) and is generally more closely correlated with indicators in the Technological Transformation index than within the Readiness index.

Table 7 – The five highest scoring regions for Post-secondary Education in 2020

Region	% Working Age Population Completed Tertiary Education	Number of postgraduate students	% Working Age Population Completed an ICT Apprenticeship	Post secondary education score
Inner London - West	72.8	12575	0.12	0.065
Berkshire, Buckinghamshire and Oxfordshire	53.0	5905	0.26	0.038
Inner London - East	63.8	2005	0.17	0.032
Greater Manchester	41.2	4455	0.37	0.029
Hampshire and Isle of Wight	46.8	2185	0.41	0.029

Table 8 – The five lowest-scoring regions for Post-secondary Education in 2020

Region	% Working Age Population Completed Tertiary Education	Number of postgraduate students	% Working Age Population Completed an ICT Apprenticeship	Post secondary education score
Lincolnshire	34.4	275	0.36	0.013
Essex	36.7	825	0.29	0.013
East Yorkshire and Northern Lincolnshire	29.9	525	0.51	0.015
Herefordshire, Worcestershire and Warwickshire	41.9	50	0.32	0.016
Tees Valley and Durham	31.8	1285	0.46	0.017

This emphasises the key role universities play in shaping the human capital of a region and, as previously discussed, contributing to direct investments in innovation, collaboration and knowledge spillovers. Universities have a crucial role in equipping students with essential skills and competencies required in the workforce. Particularly in light of the rapid changes in skills demanded in the UK labour market - as illustrated in Costa et al. 2024 - the continuous evolution of university programs, in response to technological advancements, is fundamental to enable the adaptation and employability of workers.

Also within the post-secondary education subdimension, completion of ICT Apprenticeships is inversely correlated (-0.67) with the percentage of the population who have completed tertiary education, and to a lesser extent the number of postgraduates enrolled at universities in each region (-0.16), indicating that a focus on university education alone may ignore important capabilities of the workforce in areas where attainment of a university degree is less common.

In the lowest-scoring regions, while ICT Apprenticeship achievements are higher than many of the highest-scoring regions, low numbers of postgraduate students and low rates of completion of tertiary education lead to lower scores overall.

Adult education

This subdimension examines participation in education or training for those aged 25 to 64 and participation in recent ‘on-the-job’ training. Unlike many of the other Readiness subdimensions, the highest-performing regions are not dominated by London and the Home Counties. Notably, on-the-job training is particularly common in more affluent and more rural regions including North Yorkshire, Hampshire and Isle of Wight and Gloucestershire, Wiltshire and Bath/Bristol area and less common in less affluent and more urban areas of West Yorkshire, Merseyside and the West Midlands. This may reflect regional differences in industrial and occupational composition, with rates of training in Education & Health, Finance, and Energy & Water industries being more likely in those with a high skilled or professional occupation (Li et al. 2020). However, the area with the lowest proportion of on-the-job training is Cumbria, potentially reflecting a missed opportunity for skills enhancement compared to regions with similar geography and industrial composition.

Similarly, participation in education or training is not focused in London and the South East. Some of the lowest performing regions include parts of Outer London, alongside Merseyside, Northumberland and Tyne and Wear, West Yorkshire and the West Midlands. Essex’s above average rates of on-the-job training are not enough to offset their low rates of participation in adult education, leaving them as the fourth lowest scoring region.

Despite regions outside of London and the South East scoring highly, Inner London – West still scores highest, driven by having the highest participation rate in adult education nationally. Collectively, this subdimension points towards opportunities to enhance uptake of adult education, so that lower performing regions are able to match levels attained by peers with similar industrial, economic and geographic characteristics.

Table 9 – The five highest-scoring regions for Adult Education in 2020

Region	Participation in education or training (25-64) (%)	On the job training in last 13 weeks (%)	Adult education score
Inner London - West	19.6	18.6	0.074
South Yorkshire	18.7	20.2	0.074
Hampshire and Isle of Wight	17.6	21.4	0.071
Gloucestershire, Wiltshire and Bath/Bristol area	17.2	20.9	0.067
Devon	17.4	19.4	0.064

Table 10 – The five lowest-scoring regions for Adult Education in 2020

Region	Participation in education or training (25-64) (%)	On the job training in last 13 weeks (%)	Adult education
West Midlands	11.4	15.7	0.016
West Yorkshire	12.3	15.0	0.019
Merseyside	13	14.9	0.023
Essex	12.1	18.0	0.027
Lancashire	13.6	15.4	0.028

Workforce

This subdimension incorporates the size of the workforce living in and around a region with the percentage of residents of a region who are economically active. Surrey, East and West Sussex score highest, through a combination of a large resident population located close to London, along with the highest rates of economic activity in the country (82.6%). Regions in London also score highly, largely due to their large resident and nearby workforce, while economic activity in these areas (ranging from 81.4% to 77.8%) lags behind more affluent regions of Surrey, East and West Sussex, Gloucestershire, Wiltshire and Bath/Bristol, Cheshire and Berkshire, Buckinghamshire and Oxfordshire, all of which have economic activity of above 82%.

Coastal and rural areas, e.g. East Yorkshire, Lincolnshire and Cornwall make up the bottom five regions for this subdimension, where their relatively low populations within commuting distance are coupled with low rates of economic activity.

The conurbations of the West Midlands and Merseyside are 6th and 7th lowest respectively, driven by relatively small nearby workforce compared to the South East, and the lowest rates of economic activity nationally (74.8% and 75.5% respectively). In this context, areas in the South East have a double advantage over the rest of the country; a large workforce within easy commuting reach, and an often higher rate of economic activity, particularly when compared to urban regions outside of the South East.

ICT Infrastructure

This subdimension consists of four indicators examining the internet and mobile phone connectivity of regions. In an economy increasingly reliant upon digital communications and high-speed connections to other parts of the country and the world, access to high-speed internet and mobile phone connections are crucial factors for competition across industries.

London has the highest overall ICT scores, followed by the urban centres of the West Midlands, Bedfordshire and Hertfordshire and Greater Manchester. Within London, it is the outer regions that score highest, driven by higher internet speeds than inner London regions. Across London, mobile phone coverage is better than anywhere else in the country.

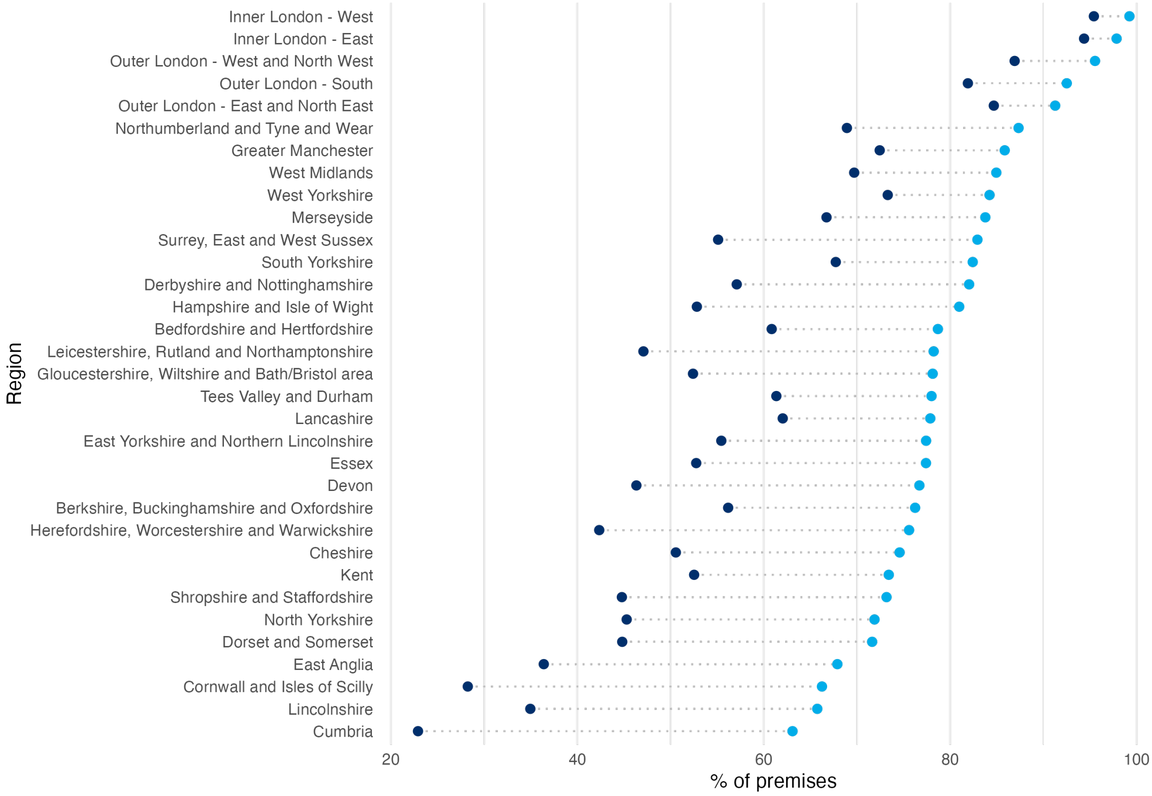
Conversely, predominantly rural areas lag well behind cities in their ICT infrastructure. The five lowest ranking regions are all predominantly rural areas located in remote or coastal parts of England. In all cases these regions score poorly in both mobile coverage and internet speed, suggesting two distinct but related challenges in improving the ICT infrastructure of these regions.

Dorset and Somerset have the 7th highest number of internet users per capita, despite having the worst availability of ultra-fast broadband nationally and the second lowest internet speed, while Tees Valley and Durham has the highest internet speed and the lowest percentage of internet users nationally. Collectively, this suggests a mismatch between the ICT infrastructure of a region and the need or access of its residents to the facilities.

When looking back to 2016, the rankings of regions are largely unchanged, Inner London West and East are notable for their absolute and relative rise in internet speeds, increasing from 19.2 Mbps, (25th) and 18.7 Mbps, (27th) respectively in 2016 to 58.3 Mbps (11th) and 58.1 Mbps (12th) cementing their position as leaders in ICT infrastructure nationally.

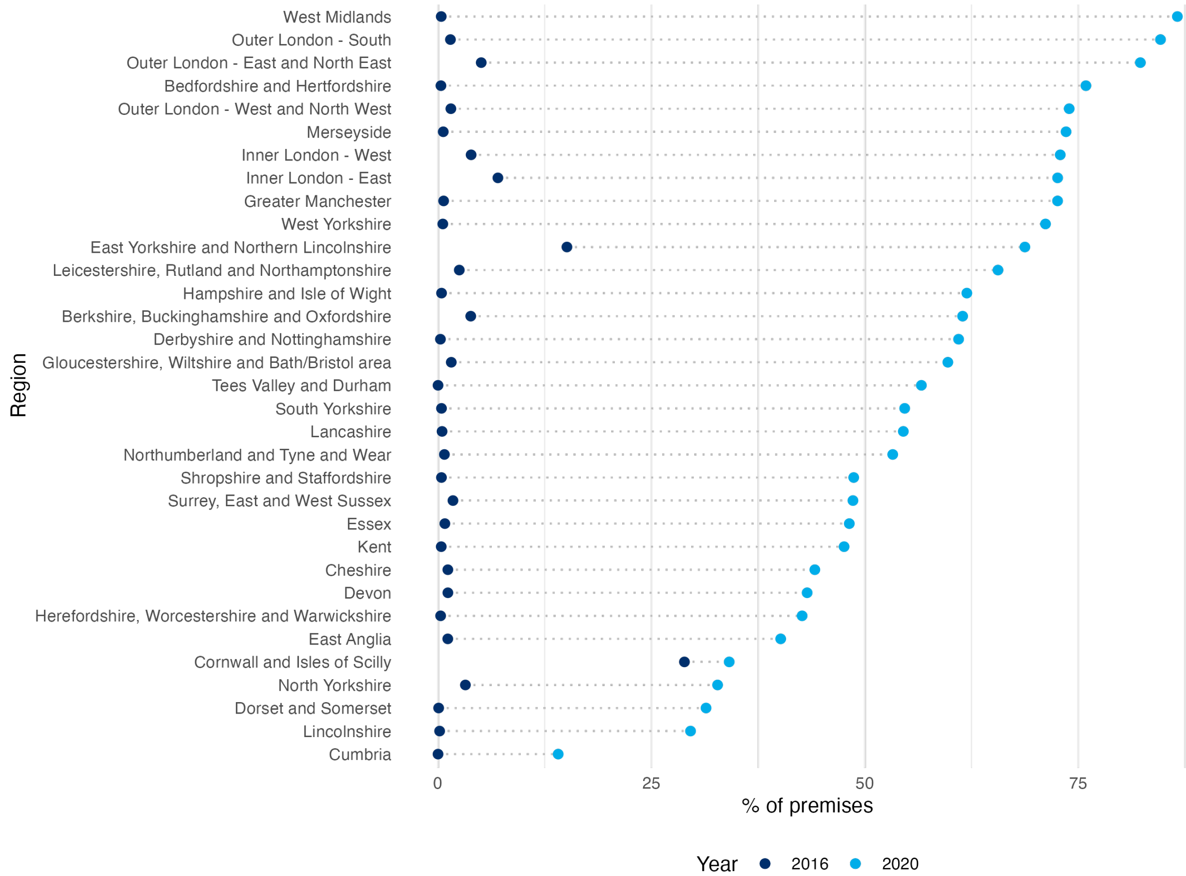
Between 2016 and 2020 we see the reduction of one inequality in ICT infrastructure and the emergence of another. Mobile phone coverage improved across all regions over this period, but by the most in rural areas. Coverage in both Cumbria and Dorset and Somerset increased from around 25% to 60% over this period, but still lags well behind central London with almost 100% coverage already achieved by 2016.

Figure 25 – Access to 4G coverage, 2016 and 2020



Source: Ofcom.

Figure 26 – Availability of ultrafast broadband, 2016 and 2020



Source: Ofcom.

While stark inequalities in mobile phone coverage have somewhat narrowed, access to ultrafast broadband has emerged as a new source of inequalities in digital infrastructure. In 2016, access to ultrafast broadband was rare, with the exception of Cornwall and the Isles of Scilly which already had over 28% coverage, resulting from the 'Superfast Cornwall' project, and East Yorkshire and North Lincolnshire with 15%. Urban centres of Inner London (West: approx. 4%, East 7%) and Greater Manchester (<1%) lagged well behind. By 2020, access to ultrafast broadband has increased in all regions, but the improvement in availability happened faster in urban centres. Access to ultrafast broadband in the West Midlands increased from 0.4% in 2016 to 86.6% in 2020, while rural regions lag well behind (Cumbria 0.0% to 14.1% and Dorset and Somerset 0.1% to 31.4%). Even Cornwall, the early rural leaders in ultrafast broadband, has barely changed from 2016 to 2020 (28.9% to 34.1%).

Examining the percentage of the population who use the internet reveals the extent to which a region's residents are able to take advantage of their local digital infrastructure. While use of the internet is high across the country, significant differences emerge that are at odds with local ICT infrastructure, and are more aligned with the socioeconomic deprivation of a region. As of 2020, three regions lag behind the rest of the country in internet use: Merseyside, Lincolnshire and Tees Valley and Durham, with around 87% of the population using the internet compared to more than 95% in London. These three regions are amongst the most socioeconomically deprived in the country, and the low uptake in Merseyside and Tees Valley and Durham contrasts with their very high broadband speeds. Internet use seems to be demand-driven, and the high-quality digital infrastructure of these urban areas remains a partially underutilised resource.

Another study for the Pissarides Review (Hayton, 2023) draws on a survey of UK firms to examine the motivations behind AI and robotics adoption in UK firms and its implications for employment. The study uses the Readiness index to examine the extent to which human capital and infrastructure enabling factors are a moderating factor of the relationship between favourable perceptions of technology (a major factor driving actual adoption) and work outcomes related to skills, job creation and the quality of work. The findings suggest that variations in readiness across regions significantly alter this relationship, with more positive associations observed in high-scoring regions.

4. Examining the relationship between Technological Transformation and Readiness

Figure 27 shows the scores for Technological Transformation against the Readiness scores in 2020. A clear linear trend is visible for most regions, with high technological transformation scores associated with higher readiness scores. Surrounding this distribution are many interesting outliers. Regions such as Cumbria, Lincolnshire and Cornwall and the Isles of Scilly are separated from other regions by very low scores in both indices, while Inner London stands out.

Within the bulk of the distribution, a subtle gradient with respect to urban concentration and socioeconomic deprivation is seen, with areas rural areas and those furthest from London scoring lowest, while scores increase in both domains with greater proximity to London. Two areas bucking this trend are Greater Manchester and the West Midlands who both score similarly to the Home Counties, partly reflecting their status as conurbations of their own. In contrast, the conurbations of the Tees Valley and Durham and Merseyside lag behind in both domains, scoring more similarly to the more rural areas of East Yorkshire and Northern Lincolnshire and Shropshire and Staffordshire.

Both Berkshire, Buckinghamshire and Oxfordshire and East Anglia score very highly in Technological Transformation, but less so in Readiness, particularly East Anglia. Both of these regions are home to world-leading Universities, namely the University of Oxford and the University of Cambridge respectively and have well-developed innovation ecosystems that have grown both directly and indirectly from the presence of these institutions. The concentration of funding, business innovation activities and patent applications within these two cities, and also in the M4 Corridor helps these regions compete with Inner London in Technological Transformation.

Their lower scores in terms of readiness may partly reflect the use of ITL2 regions as our main unit of analysis, which are relatively large areas, of varying sizes, and with considerable internal differences. East Anglia encompasses large rural areas, and that may dilute some of the potential Readiness scores of Cambridge, particularly when considering IT infrastructure.

Conversely, areas of Outer London lag behind much of London and the South East in Technological Transformation, despite having some of the highest Readiness scores. This discrepancy may indicate opportunities for the growth of innovative businesses in the periphery of London have not yet been realised, with much of these activities being concentrated in the centre of London.

Over the period from 2016 to 2020, the slope of the positive correlation between technological transformation and readiness scores fluctuated. By 2020, the slope was at a similar level to that of 2016, indicating a consistent strength in the positive correlation over this period.

Figure 27 – Technological Transformation and Readiness scores in 2020

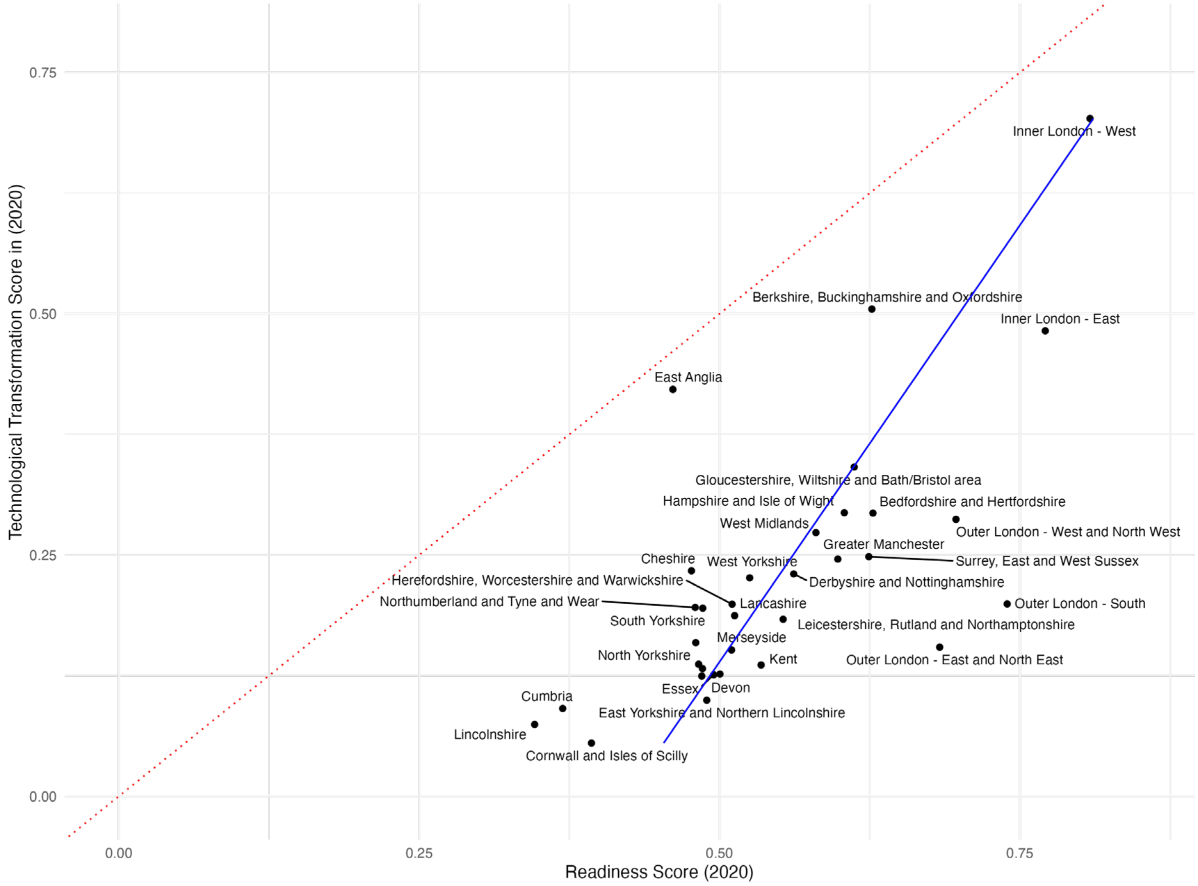


Figure 28 – Technological Transformation and Readiness scores in 2016

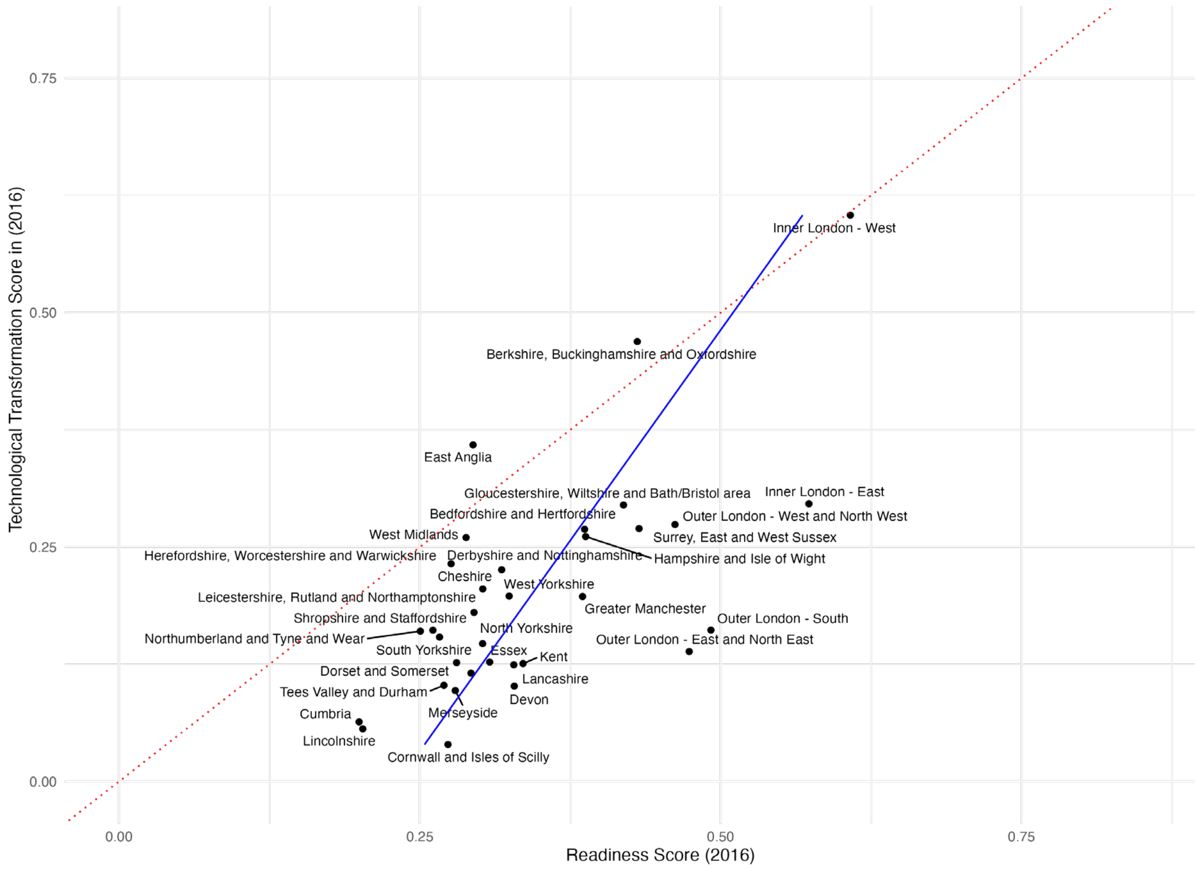


Figure 29 – Technological Transformation against Readiness score changes from 2016 to 2020

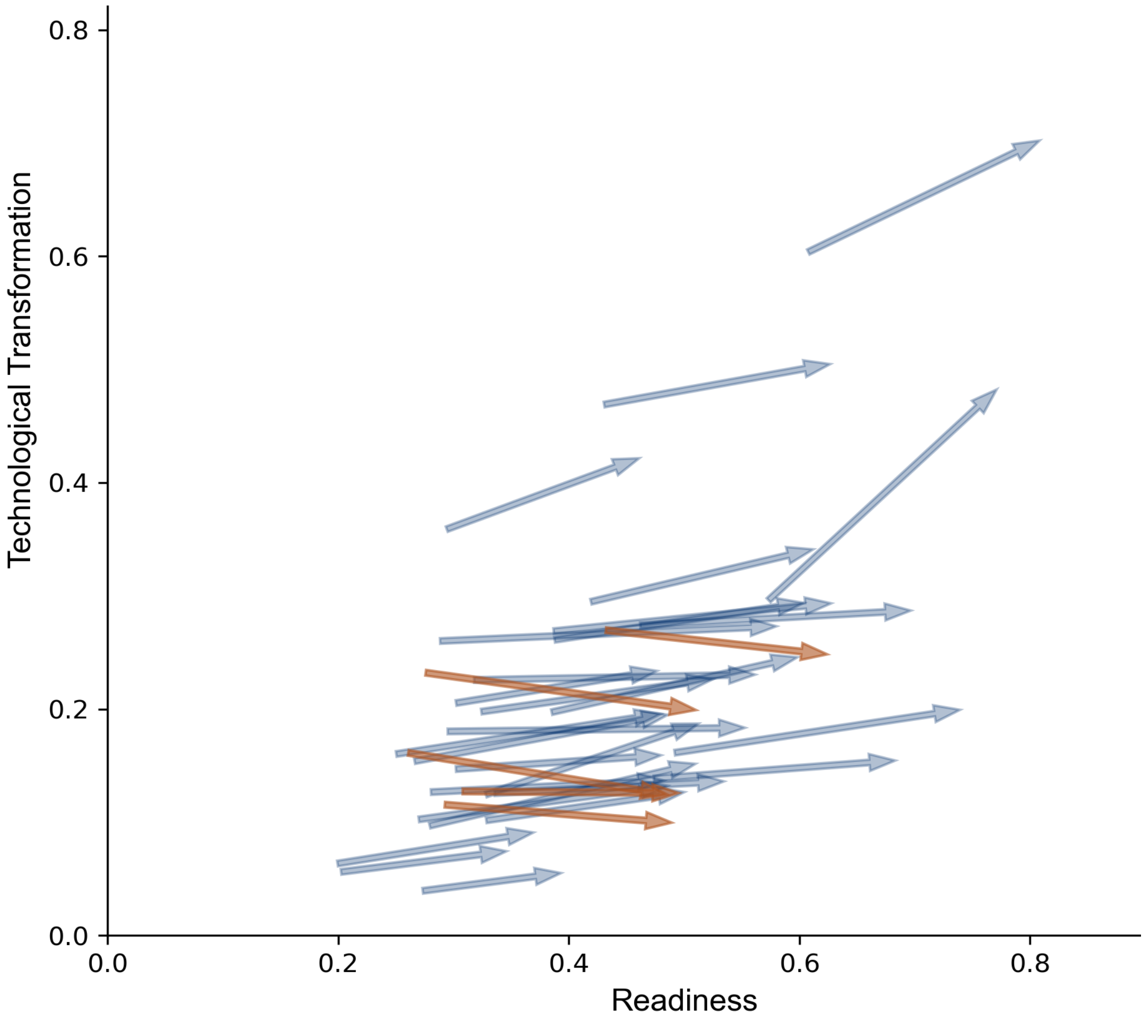


Figure 29 combines changes to Technological Transformation and Readiness scores between 2016 and 2020. While all areas increase their readiness score between 2016 and 2020, most areas have experienced smaller increases in their technological transformation over the same period. Five regions experience small decreases in their technological transformation scores (shown in red), while one area, Inner London – East, experiences significant growth in its score from 2016 to 2020, moving up to join other Technological Transformation outliers of Inner London – West, Berkshire, Buckinghamshire and Oxfordshire and overtaking East Anglia.

The Outer London regions escape the pack in terms of Readiness from 2016 to 2020, but did not see similar increases in their Technological Transformation scores. Notably, the two regions with the lowest Technological Transformation scores in 2016 (Cornwall and the Isles of Scilly and Lincolnshire) saw the smallest increases in Readiness scores from 2016 to 2020. These two regions have not seen the increases in their readiness to adopt new technologies to catch up with other regions.

5. Conclusions

Key findings

The Disruption Index (DI) was developed to provide a nuanced perspective on technological transformation across England at the ITL2 level (formerly known as NUTS2), focusing on measures of technological investments and the enablers of transformation, such as human capital and good digital connections.

Our findings reveal stark regional disparities in terms of Technological Transformation, with venture capital investments, R&D expenditure and creation of patented technology being concentrated in a few regions. Much has been written about the fact that the UK faces significant challenges with low levels of investment and productivity growth. We find that although, on average, there are substantial high-tech investments to counter this claim, they are so concentrated into a few small geographical areas that the national average is not informative for the remaining large parts of the country. These parts are seeing lower investment levels which are considerably worse than that which is indicated by the highly-skewed national average. This double effect of a small number of places taking a larger slice of a larger pie has nationwide impacts that must be researched further and addressed to prevent further entrenching of inequalities.

Inner London West had the highest scores in the Technological Transformation index in 2020, followed by Berkshire, Buckinghamshire and Oxfordshire, and Inner London East. These regions excelled in all subdimensions of the index, and particularly so in R&D, Innovation Activity and Venture Capital flows. On the other hand, regions like Cornwall and Lincolnshire had very low scores, with minimal levels of Venture Capital funding to technology and R&D expenditure.

Our analysis reveals that R&D expenditures performed by businesses and other organisations (government, non-profits and the higher education sector) are concentrated in broadly the same places, as are investments in venture capital to tech companies. Some of these differences are very likely due to differences in the particular structure of industry across certain regions, but the concentration is so strong that this is unlikely to be the whole story. The relationship between industry structure and investment concentration needs further research, which would be useful in designing innovative policies to support the regions and sectors with low investment.

Notable regional disparities are also observed with respect to the demand for technology skills. This demand is generally associated with the incidence of high-tech investments, showing that, rather than substitutability between labour and capital, there is a complementarity between high-tech skills and high-tech capital. Regions that have lower demand for both tech skills and investment, like Cornwall and East Yorkshire, risk falling further behind unless interventions prioritise at least one of these areas, with the other following independently. Which should take priority is a matter for further research.

Between 2016 and 2020, the highest and lowest-scoring regions in the Technological Transformation index remained largely unchanged. However, despite an improvement in the average score between the two dates, regional inequalities have also increased. The increase in both the average score and its variance was driven by several factors, most notably venture capital investments which increased in most regions - but by more in the regions that had attracted relatively more venture capital in the past.

The Readiness index asks how ready regions are to accept and implement new technologies. The main factors that influence Readiness are the quality of human capital and the infrastructure in the region, especially the digital components of that infrastructure.

There are again differences in the Readiness index across regions, but not as pronounced as the differences in the Technological Transformation index. Most of the differences in Readiness are driven by human capital indicators. In terms of infrastructure, there are no significant differences, because of the widespread 4G and high-speed internet availability across the whole of England. Unlike the dominance of Inner London in Technological Transformation, the readiness scores present a more mixed distribution of scores across the country. Inner London West and Inner London East are again leaders, but by a smaller margin.

Furthermore, we find a clear positive association between Technological Transformation scores and Readiness scores. This reflects the interconnectedness of technological capacity and the presence of enabling factors in regions that adopt and leverage technology.

The much greater disparity in the Technological Transformation Index than in the Readiness Index is mainly due to the profoundly skewed venture capital investment, R&D expenditure and patents, which are concentrated in the ‘golden triangle’ - of London, East Anglia and Berkshire, Buckinghamshire and Oxfordshire. This suggests that there are other regions that have untapped potential and that existing enabling factors to innovate, develop and implement new technologies are not yet being taken full advantage of. It also suggests that targeted public investments should focus on these regions, to unlock the potential in their enabling factors.

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The Pissarides Review into the Future of Work and Wellbeing

Automation technologies are transforming work, society and the economy in the UK in ways comparable to the Industrial Revolution. The adoption of these technologies has accelerated through the COVID-19 pandemic, and the impact of automation is unevenly distributed, with a disproportionate impact on demographic groups in lower pay jobs.

The Pissarides Review into the Future of Work and Wellbeing will research the impacts of automation on work and wellbeing, and analyse how these are differently distributed between socio-demographic groups and geographical communities in the UK.

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If you have a professional or research interest in the subject of the impact of automation technologies on work and wellbeing and have insights to share, please contact Abby Gilbert, Director of Praxis at the Institute for the Future of Work at abby@ifow.org

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