The Pissarides Review into the Future of Work and Wellbeing

Final Report

The Pissarides Review into the Future of Work and Wellbeing

Institute for the Future of Work

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Our ground-breaking inquiry examines the impacts of automation on the labour market, who is benefiting and who is being hit hardest by the disruption caused.

Through a new social and economic paradigm of Good Work, it proposes a new model of human-centred automation, a comprehensive socio-technical approach that understands technological transformation as highly interconnected, and interdependent with socio-economic change.

Sir Christopher Pissarides
Nobel Laureate and Co-Chair of the Institute for the Future of Work

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Citation

Institute for the Future of Work (2025). *Final Report of the Pissarides Review into the Future of Work and Wellbeing.* London: Institute for the Future of Work. DOI: 10.5281/zenodo.14615712

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The Pissarides Review into the Future of Work and Wellbeing

About

Institute for the Future of Work

The Institute for the Future of Work is an independent research and development institute exploring how new technologies are transforming work and working lives. We develop practical solutions to promote people's future wellbeing and prosperity. Co-founded by Nobel prize winning economist Sir Christopher Pissarides, technologist Naomi Climer CBE and former employment barrister Anna Thomas MBE, we work at the intersection of government, industry and civil society to shape a fairer future through better work.

Find out more:
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The Nuffield Foundation is an independent charitable trust with a mission to advance social well-being. It funds research that informs social policy, primarily in Education, Welfare, and Justice.
The Nuffield Foundation is the founder and co-funder of the Nuffield Council on Bioethics, the Ada Lovelace Institute and the Nuffield Family Justice Observatory.
The Foundation has funded this project, but the views expressed are those of the authors and not necessarily the Foundation.

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About the Review

Professor Sir Christopher Pissarides

This report marks the culmination of the Pissarides Review into the Future of Work and Wellbeing, a collaboration between the Institute for the Future of Work, Imperial College London and Warwick Business School. The Pissarides Review has been a three-year programme of work, informed and supported by an expert Steering Group and funded by the Nuffield Foundation.

Our objectives in this multi-year research project have been to study transitions: how workers are coping with change, how work is transforming, and how individual and social wellbeing is being impacted through this period of technological transition.

The theoretical basis – expanded further on in the report – is the work I pioneered at the turn of the millennium have done on the 'frictions' in the labour market that mean that it fails to respond perfectly to changes. When conditions change, workers can be slow to adapt, either because they need to move to exploit new opportunities, or need information about where these opportunities are, or new skills. AI and automation technologies have changed these frictions in many ways, and the main aim of the Review has been to better understand how these frictions can be overcome in ways that enable better 'matches'.

We have been fortunate to gather an interdisciplinary group of experts to lead three major workstreams. The first has had a system or 'macro 'level focus, thinking about national and regional innovation systems, investment flows and changes in skills. The second has had a firm or 'meso' level focus, exploring how firms are responding to the transformations in play, and how governance regimes are interacting with them. Finally, and most centrally, the third workstream has focused on the individual experiences of workers – at the 'micro' level – and how their work and their wellbeing is being impacted.

The report is structured as follows. We begin with a summary of our **key findings**, and follow that with a **chapter focused on the new model of automation** that has come out of the review, with this work led by Anna Thomas MBE from IFOW. Then, across three chapters, we summarise the research of the workstreams, and why this work matters. We then finish with a **comprehensive chapter of recommendations** springing from the research.

Full details of working papers released through the course of the Review – on which these summaries are based – can be found on our dedicated site at pissaridesreview.ifow.org.

Full list of research publications from the Review

Framing the Review

Introducing the Pissarides Review into the Future of Work and Wellbeing

Reframing Automation - a new model for anticipating risks and impacts

Reframing Skills - Sen's Capability Approach in an age of automation

Workstream 1 - Systems

Literature Review - what do we know about automation at work and workers' wellbeing?

A Disruption Index - the geography of technological transformations across England

Disruption Index technical report

Disruption Index interactive report

Disruption Index dashboard

Old skills, new skills - what is changing in the UK labour market

Patterns of co-occurrent skills in UK job adverts: a novel clustering analysis to inform policy

Learning to grow: how to situate skills in an economic policy

Workstream 2 - Firms

Literature Review - organisational adoption of automation technologies

What drives UK firms to adopt AI and robotics, and what are the consequences for jobs?

Firm-level adoption of AI and robotics: case studies report

Workstream 3 - Individuals

Literature Review - addressing labour market challenges from a human-centred perspective: a review of the literature on work and the capability approach

Does technology use impact UK workers' quality of life?

From technology exposure to job quality - evidence from a comprehensive UK survey

Taking work or changing work? Understanding how technology adoption is reshaping work in the UK

Analysing the distribution of capabilities in the UK workforce amidst technological change

Key findings

A new model of automation is required

1. Automation is continuing at pace, but the key story is the huge variation across geography and sector

This is confirmed by each workstream. Almost 80% of firms surveyed had, in the last three years up to 2023, adopted AI, robotic, or automated equipment for physical tasks, while a very similar proportion had adopted it for cognitive tasks, including small and medium-sized businesses. Our Disruption Index and work on skills clusters, skills turnover and networks corroborate and add granularity to this finding, surfacing the speed and variation of transformation within jobs and across regions. The majority of workers report interacting with automated technologies including AI, even pre-Gen AI.

2. Workers are experiencing new types of automation, in new combinations, which are often obscured. These are having cumulative impacts on people's work and their wellbeing.

Exclusively task-based forecasts do not pick up the types and dimensions of automation to which workers are exposed and miss a wide range of new and significant impacts beyond job substitution. Automation can significantly impact job quality and worker wellbeing. We have also shown that good impacts, including upskilling and the substitution of routine tasks, cannot be assumed and must be consciously shaped. Our understanding of secondary, cumulative and relational impacts is increasing.

3. In response to new modes of automation, skills are also changing across the economy in new ways, revealing new dimensions of this technological transition.

Our clustering and skills network analyses emphasise the changing importance of communication skills and creativity, as well as tech/digital skills. Our work also identifies the skills that are most similar and therefore likely to be transferable to other roles, as well as their relationship to other skills and their centrality to roles and occupations. We have shown that skills diversity - i.e. combining social and technical skills - is increasing across the board, including within high-tech/digital roles. This reveals more about automation than traditional statistical approaches – but it also tells us that there is no single silver bullet solution.

Firms are the key driver of change

4. Firms are driving social and economic transformation within the system - but most UK SMEs are not ready for transformation, responsible innovation or governance of AI and automation.

High-involvement HR practices and the purposeful introduction of technology are shown to be important for securing better outcomes both for workers and firms. This requires foresight and good governance working hand-in-hand with innovation. We also find conditioning factors that shape firm-level decision-making. Firms are conditioned in their choices about 'good' or 'bad' automation by their local innovation ecosystem, which reflects system-level enablers.

5. The provision of good work is the foundation for individual wellbeing – a core driver of productivity. This means that good work should be recognised as a mediator of good outcomes and social value, and a cross-cutting policy goal to drive mission-led government.

By looking beyond uni-dimensional factors and decomposing impacts on good work and quality of life, we have laid out the route to a more innovative, inclusive and productive economy. A new focus on good work to build resilience through transition at systems, firm and job level is the best way to enhance the capabilities that improve productivity. Although more research is needed, enhanced participation, agency and learning are the most important dimensions of good work that support human capabilities and the wellbeing and productivity that follow.

New inequalities and wellbeing impacts are being exposed

6. National statistics mask dramatic, cumulative inequalities across the innovation ecosystem.

There are significant differences in innovation infrastructure and resource across the UK. These are compounding and deepening existing inequalities and creating new ones, across numerous dimensions. New research highlights differences in impact across socio-economic indicators, occupational grade and place, as well as the protected dimensions of inequality. This suggests that inequality should be conceived of as structural and is in need of systematic, positive action.

7. Left unchecked, technological transformation will further entrench regional inequalities.

All of our workstreams highlight the particular importance of place – and surfaced some unexpected findings about pace and local networks. In particular, we find significant regional concentration of technological transformation, with stark differences between regions, and between the towns and cities of the UK. The nature and extent of this variation is currently masked by national and aggregate statistics. Better regional data, combined with information on work, wellbeing and skills, is vital to shaping good transitions and should be accessible.

8. Investment in the infrastructure to support innovation – including skills and connectivity – is vital.

Innovation readiness significantly alters the relationship between technology adoption and positive outcomes. Where we see investment in supporting infrastructure, including people and connectivity, we see the best results of technological transformation. Further investment in this 'readiness' significantly above the current average levels is needed, without which job quality and job creation for the most vulnerable people and places is likely to diminish and therefore exacerbate regional, socio-economic and demographic inequalities. This insight should help inform devolution and infrastructure plans and regulation.

9. New workplace technologies have divergent impacts, and don't necessarily lead to less dull, dangerous and dirty work.

We are seeing new types of polarisation as a result of workplace technology adoption. Rather than eliminating dull, dirty or dangerous work, our evidence suggests routinisation, intensification and a lower level of discretion can often result from automation. This can negatively impact wellbeing and perceived safety and has broader social, health and political implications. We have shown new types of inequality in people's abilities to exercise agency and fulfil their potential by gender, race, age and socio-economic background.

A fairer future of better work is possible

10. AI and automation can lead to a fairer future of better work, but attitudes must change, and trust must be built.

Despite their potential to understand and redress national challenges, if they are carefully deployed and governed, new technologies – and AI in particular - are consistently associated with subjective feelings of anxiety and insecurity. This is concerning when our firm-level research shows that technology perceptions mediate positive outcomes. Trust is only possible with active and systematic worker engagement and support for worker transitions. This must start with higher levels of information and knowledge, and ways to apply it, through greater protections for workers in these innovation-critical areas.

In sum, if innovation and social good are to advance together, we need a new model of automation, one that actively manages risks as well as identifies opportunities in ways that secure benefit all people and places across the UK.

The work in our Pissarides Review shows how this can be done in practice, through integrated, future-oriented, socio-technical and outcomes-based approaches.

Jump to our full list of policy recommendations here.

Remodelling Automation

Policy priorities for a fairer future of better work

Anna Thomas MBE
Dr. Abigail Gilbert
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Kester Brewin

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Key Findings

Policy Recommendations

We are in the middle of a series of interconnected, structural transformations of the economy, of society and of work itself. These are fundamentally transforming how we experience work and life, and our research shows something of the scale, depth and potential of these transitions, from national skills and 'technological readiness' changes, through to firm-level adoption of new technologies and its impacts on individual workers up and down the whole of the United Kingdom.

Through these transformations, the dominant - but opposing - technology-centric narratives are that technology is upending work and society in ways that are predetermined; or that accelerating technology, especially AI, will solve the world's problems, including productivity and delivery of the 'pro-growth' mission in the UK. Standing on the research offered here as part of the Review, we are convinced that neither narrative is correct. Here, we offer new, evidence-driven approaches and a new narrative for transformation to help shape better transitions for people and places across the country.

It is well known the UK has a unique combination of structural factors and functions ('enabling conditions') alongside a rich civil society, world-leading universities and a proud history in leading governance and regulation, including labour and technology innovation and regulation. But – as we have highlighted in this work - these strengths that the UK has have not yet been harnessed to identify, unpick or reconstruct the drivers, enablers and barriers to shared prosperity and flourishing.

On the contrary, the UK is still better defined by stagnation, with staggering mismatches between potential and reality, huge disparities in productivity among firms, ongoing skills gaps and profound, cross-cutting inequalities.

Policy innovation has stagnated too, held back by the lack of independent, shared knowledge, practical frameworks and structured processes. This has prevented bold, evidence-driven, iterative and reflective cycles of design, development, application and rigorous evaluation, shared with those who are or may be affected. It has been hard for the new government to question and break away from deeply embedded assumptions regarding causation, value, what to measure, and why.

In short, the UK is at critical juncture. Technological transformation is continuing at pace, but it is doing so within an economy showing vast national, regional and local variation in terms of readiness to meet the challenges and opportunities of transition . Reaching for a more ambitious and transformational agenda, we need new ideas, insights and institutions help to establish new frameworks, alongside a new vision to enable systemic change.

Our work in the Pissarides Review has led us to the conclusion that an integral part of the solution to the challenges that our country faces is to remodel and reframe the primary drivers of the structural transformations we are experiencing. In doing so, we unpick, review and forefront human roles, experience and values: the human contribution and our human capabilities. We consider the nature of automation, the firm as the engine of transformation and the innovation system, in which jobs are created, shaped and changed.

Through four periods of industrial revolution, the potential of technology to transform our work, social and political life has been central to the work of economists, such as Joseph Schumpter, systems thinkers, such as Stafford Beer, dystopian novelists, such as Aldous Huxley, and politicians, like Prime Minister Stanley Perceval - who put down the Luddite riots.

This time, however, the ‘machines’ behind the new technological revolution are less tangible. We often do not control or ‘own’ the underlying systems, digital infrastructures or data that sustain them; automation processes are often obscured or misunderstood; and decision-making and accountability are becoming more diffuse and harder to pinpoint. More than this, human roles and interactions with new technology occur in varied contexts, for diverse purposes across the innovation ecosystem. Increasingly, we are engaging with technology not only as workers but also as citizens, consumers and members of a community. Meanwhile, the full and pervasive range of direct and indirect impacts is harder to grasp and crosses boundaries and domains - including work and life - as well as sectors, in ways that are often hidden.

Even in the course of the three-year Review, the computing power, training data sources, software architecture and related new technologies have been transformed. As we have carried out our research and policy analyses, we have ourselves learned about the nature and pace of change, including the opportunities and limitations of using AI in the Review itself, and of integrating different approaches, perspectives and disciplines.

Traditionally, we have relied on forecasts to try and understand or predict automation, based on statistical models that focus on technological capabilities and the substitution of human tasks. However, these do not tell us much about the impacts on work or wellbeing outside of a binary substitution risk. Nor do these approaches consider other types of transition or help us identify what drivers, actors or institutions are at play. Importantly, nor do they tell us about what should be done to respond to the new technological revolution.

The research in this report does just that, as we shift from thinking about surviving to thriving - from work as it is now, to transitions. In doing so, we learn about why and how human capabilities should be put before technological capabilities, why this aligns different interests, and how this generates better outcomes, capturing resilience through transformation. We show how 'good automation' can advance social wellbeing and is likely to unleash a wealth of new and unexpected opportunities for innovation.

In this report, we aim to show how this can be understood, measured and implemented in practice - as well as aspiration - through integrated, human-centred, anticipatory approaches. It is supported by simple frameworks and a strong narrative that highlights our overarching goal, while encouraging policymakers to consider complexity and relatedness. As part of our work, each workstream offers a different, socio-technical perspective on the central and mediating role of good work through transition, from the early stages of innovation - which can lead to the creation of good jobs - to improving choice, overcoming barriers and developing capabilities at all levels. In this way, we combine 'capabilities' and 'innovation' based approaches to policymaking, demonstrating that, if done well, these are not contradictory but can support each other. Our ultimate goal is to help build the conditions for human flourishing through the most significant transformation of our economy and society that we have experienced since the Industrial Revolution.

The Review shows that the future is not predetermined. If we act now, we can shape our future of work and our society by making sure that risks are managed, opportunities are seized and technology serves the flourishing of people, places and the public good.

What we have done

Work in the Review has unpacked the structural and functional drivers, mediators and multi-dimensional, interconnected impacts of automation on work and wellbeing - and then organised it in ways that not only offer new insight but will help people and policymakers understand and shape these transformations, now and into the future.

We have unearthed pervasive and related impacts driven by AI and automation technologies across systems, firm and individual levels and growing divisions – not just between groups 'winners' and 'losers' but of resource and capacity, infrastructure and institutions across the country. As we set out to test at the start of the Review, we now know that these are having profound impacts on the creation, nature, conditions and quality of jobs, employment relationships, models of work and society more broadly.

At an individual level, automation is increasingly used to substitute, create, transfer, match or intensify work tasks, enhancing or reducing discretion and the development of skills and capabilities. This can be explicit and obvious, but these changes are often hidden or unnoticed. Digging deeper, we show that automation is shaped by the relationships between (i) tasks (ii) human knowledge and the application of human capabilities and (iii) new technologies as these are shaped by a particular context and with the wider, structural and functional components of any workplace environment, as the process of automation unfolds. The very same technologies that have the potential to deliver good matches, augment or diminish human agency and improve work quality have also opened the door to unpredictable, unintended and systematic risks, impacts and cascading effects. We demonstrate that these are already having profound effects on work and wellbeing, both positive and negative.

This strongly suggests that we must consider the information and other frictions that limit choice and hamper decision-making, especially with regard to choices around automation, job quality and the architectures of value creation, and to how transitions are managed and governed. In particular, it takes us to thinking more sharply about gaps, more targeted and experimental policy mixes and interventions that can build the conditions in which people can overcome 'frictions' and make good transitions to different futures of work.

At a firm level, we show how management practices, choices, HR philosophy and relationships are enabling new approaches to capture and create value and models of automation which influence and may determine the outcomes of technology adoption - including job creation and quality, trust and optimism. With high involvement factors - such as higher levels of information, consultation and investment in training - purposeful technology adoption has the potential to create new jobs, open up new routes to innovation and improve productivity.

We also show how local, regional and national institutions, infrastructures and other functions provide an enabling or inhibiting environment which also condition outcomes on work, wellbeing and productivity. These findings invite an integrated, systematic approach to innovation and governance involving stakeholders, anticipating significant effects and setting up a system of monitoring and adaptation. As we explore in the Review, this is aimed at better and more widely shared understanding and continually improving outcomes. This points to revitalising socio-technical approaches, sovereignty and social partnerships, which take on strategic, new roles in the context of global competition and increasing divisions across the country.

At a systems level, business models and platforms which harness automation technologies are driving concentration in the economy, and rewiring labour markets, including the distribution of good jobs. Our research shows that while automation can improve wages for some, those already most vulnerable to the adverse effects of automation are also most likely to suffer the adverse effects of market concentration, including reductions in real wages. Although not captured by all workstreams in the Review, our evidence suggests that foundation models are increasing exposure to AI and related technologies, expediting some of these trends as access and experimentation increase, multiple stages in the automation process are transformed and accelerated, and entirely new markets, models of work and business emerge.

Our work also highlights structural problems and disconnects within the innovation system which compound across the technology life cycle and beyond it. This points to wider and more systematic policy interventions aimed at tackling systemic challenges and building a responsible, well-functioning innovation ecosystem in which actors and institutions cooperate and support each other, considering the highly interdependent and interconnected nature of technological transformation.

A new model of automation

Underpinning these conclusions and directions for policy is our new model of automation. This section summarises the rationale and frameworks that have guided development of the model, which is aimed at understanding and overcoming frictions in this period of transition.

The foundational frictions theory developed by Christopher Pissarides was aimed at modelling worker transitions as people move in and out of employment. Through the Review, we have integrated the ideas and framework from Nussbaum and Sen's (1993) theory of capabilities - including their seminal research on quality of life and work - into our interrogation of automation. Challenging traditional measures of success, as we do, Sen developed a framework for human wellbeing that focused on peoples' agency (Sen, 1999). By drawing these frameworks together, our aim is to help people (and other actors) overcome the frictions which may be holding them back from fulfilling their real potential.

Through the Review, we have learned that ‘capabilities’ capture the opportunity structure that is most relevant to resilience through transition: those people with higher capability scores have a supportive environment that enables them to exercise their agency, choose how best to convert their skills to new applications, develop and apply their talents and lead a fulfilling life - both at work and beyond it. This assessment reminds us that capabilities also comprise the opportunity structure that governments and firms can build, laying solid foundations for resilience, wellbeing and productivity. Reflecting this, our new model of automation has been developed across three levels.

Individuals - the ‘cells’ of automation

First, **at an individual level**, it extends task-based approaches which consider how these can be substituted by technologies with a new, central factor: capabilities. This demands consideration of the relationality between the more ‘objective’ abilities of the technology and the task, with the opportunities to develop the skills and capabilities of people performing the task.

In contrast to ‘skills’ which tend to be ascertained by the employer, an assessment of a person’s ‘capabilities’ must centre their perspective to capture a more comprehensive and aspirational picture, and operate as part of the co-development of more tailored, future-oriented innovation and career pathways. Further, our clustering analyses and qualitative research illustrate that there are no fixed boundaries to ‘tasks’, ‘skills and capabilities’, ‘technological abilities,’ or even jobs. Instead, each of these components transform - and are defined by - their relationships with each other, especially in cases of ‘cognitive’ automation, in which the human-machine interface is a more significant part. In this way, our model offers the opportunity to redesign the components of automation to offer people more agency, shape better futures and fulfil their potential.

These interactive, relational transformations within the ‘black box’ of the job act as the nuclear cell of technological transformation and must be unpicked using mixed methods, fore-fronting participatory approaches that surface hidden changes, shifting bounds and the relationships between the components of automation. This foundational step in our model, which illustrates the significance of socio-technical interaction at all levels, also invites new research questions, such as how are tasks perceived? To what extent are they interdependent? How central, or discretionary, are the tasks under consideration?

Firms - the ‘corpus’ of automation

Second, **at the firm-level stage** of our model, the relationships between technology, tasks and the capabilities needed to ensure the use of technology supports the ‘better’ conduct of a task, are understood as being shaped by firm-level decisions and strategies. These decisions and strategies are themselves shaped by those from whom they procure technologies and the wider economic environment, both of which shift firms' thinking about how to activate value.

Sitting above the individual level of changes between tasks, skills and technology within a single role and occupation, for this firm-level stage we deploy a framework of the automation technology archetypes which manifest the different approaches or combinations of automation (Gilbert, 2023). Each classification reflects distinct approaches to value capture or creation as work is transformed through cognitive automation. Each of the archetypes presented - displacement, creation, high discretion augmentation, low discretion augmentation, intensification, telepresence, and matching - represent a particular configuration of human and machine, of job design, organisational design and the process of production.

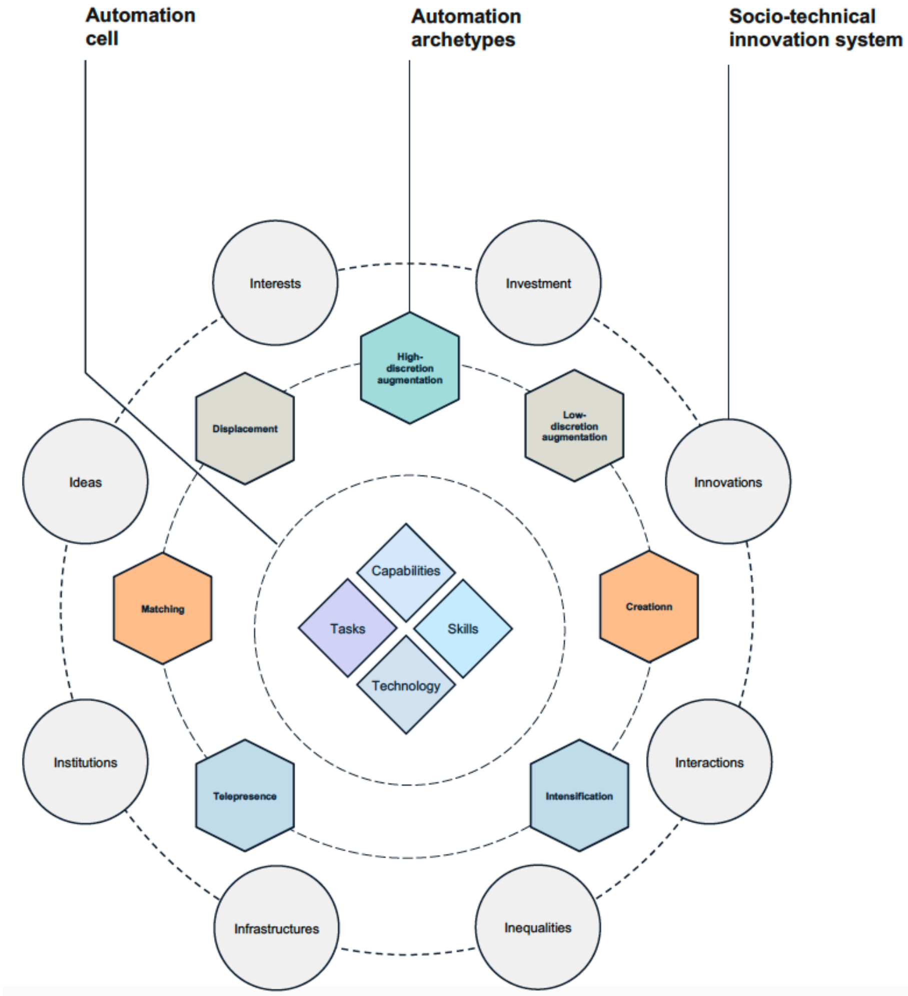
The innovation system - the 'ecosystem' of automation

Third, **at the systems-level stage**, a systems approach is deployed to situate our automation model in the context of the wider innovation system, inviting particular consideration of the wider structural and functional factors that determine what, when and how innovation happens. This stage requires wider consideration of the conditions and environment in which automation takes place - conceived of as structural components and functions - and doubles as a framework for policymaking (Nash, 2025). Together, the three stages of this model enable good matches to good jobs in which frictions are overcome and people's capabilities are recognised and developed.

At each of the three levels in our model - **individual, firm and system** – as well as across the set of mixed quantitative and qualitative methods used in each workstream, both active participation and relationality are key.

This builds on Christopher Pissarides' insight that optimal work transitions for individuals are responsive to the structural and macro-economic environment, the organisational and firm-level context, as well as the job. In this sense, this frictions theory is developed and extended to a 'systemic' level, and the model applies and reframes the concept of matches to a series of 'good matches' across all levels of the system, including those relevant to the environment of the job match. The idea of good matches derives from the two theoretical frameworks that we have drawn together, but has been demonstrated by the new insight produced by each workstream about the significance of human roles and choices and the imperative to look at the relationship between tasks, technology and human knowledge, skills and capabilities and - leading from this - design good automation aimed at goals that reflect conscious human choices and aim for human flourishing.

Figure 1 - A new model of automation



In essence, this means reorienting job 'matches' - and decisions about transitions more widely - through a more consistent focus on capabilities. Here, the goal of the matching is enriched and extended from labour market efficiency in the traditional sense to this new social and economic paradigm, shaped and delivered by an informed, inspired but responsible system of innovation and governance geared towards human flourishing. In short, matches become 'good matches'.

Trends

This section identifies and attempts to describe and summarise the trends within the technological transformations we have studied over the three years of the Review, wrapping up insights from three Social Policy Impact Accelerator (SPIA) days we conducted in September 2024 to surface key implications of the research: accelerating pace, increasing complexity, barriers and bottlenecks, compounding inequalities, hidden transitions. It groups insight by trend, combining trends in technology and its adoption; mechanisms by which these create impacts on work and wellbeing; broader trends which are interacting with technological transformation; and the impacts of these changes at different levels.

By describing these 'trends', we do not imply that economic forces are fixed and inexorable or the only ones that matter, or that the role of policy is merely to respond to those trends. On the contrary, the Review has shown that the future of work and wellbeing is not inexorable and can be shaped. The history of technological change and work, as well as the chapters in this report, illustrate that 'trends' that once seemed - or have been represented as - inexorable have been redirected or accelerated or slowed, harnessed or ignored, as a result of policy choices. How these existing trends play out in the future is, at least in part, a political choice. This requires that difficult political questions be asked about all areas of change - who is doing what to whom, who benefits and what do we value most as a society?

1. Rapid pace and complexity of transformation

The most cited predictions about the future of work - from Osborne and Frey's (2013) estimate that 35% of jobs in the UK were at high risk of automation, to McKinsey's recent prediction that 30% of tasks will be automated within 5 years – often reflect different thresholds, definitions and methods. No studies yet have combined individual, firm, system-level and multi-disciplinary perspectives. While recognising their utility to signify certain dimensions, through our approach, we have superseded numerical estimates of automation on the basis of assumed trajectories. Using this approach we find a rapid but highly variable pace and nature of technology adoption - and AI in particular - across multiple factors: industry, occupation, size of business, management approach and support infrastructure.

In our individual-level survey and interviews, we find that the majority of workers are now engaging with cognitive automation technologies at work, including AI and Gen AI, even where they may not/are rarely aware of all uses and interactions.

In our survey of 1,000 UK firms, we find that 79% of firms report adopting cognitive automation technologies (Hayton et al., 2023a).

Our analysis of tens of millions of job adverts reveals skills clusters, new and emerging skills, speed of turnover and skill networks, providing sharper, more responsive insights into role changes and surface the variation, skills diversity and internal shifts within jobs. This includes the emergence of 174 new skills and analysis of skills turnover that reveals a marked increase in combined or 'socio-technical' skills, including systems thinking, critical thinking and creativity, both in and outside IT and other high-tech jobs (Liu et al., 2024).

Although more research is needed, our qualitative work also supports the idea of a step change in, and likely acceleration of, automation notwithstanding a series of 'lags', obstacles and bottlenecks in the development and diffusion process. This is because our figures will be limited by the extent to which people can recognise the technology and their interactions with it.

People at work report feeling overwhelmed by the constant evolution of workplace technologies, and this rapid change has also intensified concerns about job security, social connections, and perceived worth. This is not surprising, given the dearth of information, firm-level capabilities and responsible governance to promote good automation. In light of significant changes to employment law, data governance, and accelerated adoption, UK businesses need new forms of support.

Complexity - in terms of new and different combinations of automation type, alongside the adoption of new forms of automation - is also increasing, alongside multi-dimensional, relational impacts. Our case studies highlight the extent of variation, uncertainty and experimentation, and illustrate that while some element of task substitution is commonplace, this is generally combined with different automation 'archetypes'. As we explore below, much of this change may be invisible, partly owing to the absence of reliable, shareable data. Notably, higher skills turnover correlates with higher skills diversity, and this is observed in towns and small-medium cities outside London more than in the capital, reinforcing our firm-level survey results on 'readiness' in the regions, and illustrating that non-technical skills are in increasing demand, alongside more complex combinations of the 'socio-technical' skills that go hand in hand with technological transitions. Our systems analysis surfaces a wide range of cross-cutting and related structural factors and functions.

A qualitative, participatory dimension is essential for this to surface new information, interrogate the full range of impacts and shape better outcomes, bringing 'governance' necessarily closer to innovation than has ever previously been recognised. New technical abilities to absorb, codify, use and represent human activity, behaviour and methods are relevant to questions of the pervasiveness and increasing breadth of social impact and complexity, as well as pace.

Technologists and economists disagree about whether the current wave of technological transformation is hype, or if it is driving the most profound changes to our work and ways of living ever faced. The answer is both – and the best we can do is identify and involve those affected as early as possible, combine different data sources and multi-disciplinary methods to anticipate impacts, and build systems for monitoring and intervention on an ongoing basis.

In sum, the picture of increasing complexity we have surfaced through the Review invites the continuation of our three-tiered approach, and demands systematic, anticipatory approaches to governance and innovation together, so that it is properly informed, responsive and context-sensitive.

2. Increasing barriers and bottlenecks to good automation

Frictions theory stresses that economic activity is uncoordinated, time-consuming, difficult and costly for both firms and workers (Pissarides, 2000). Job searching is a 'non-trivial' activity because of the existence of information gaps and other frictions which act as 'barriers' to matches between workers and jobs and so need to be overcome.

Our Review has been organised around three frictions which we have shown are becoming so pronounced and hard to unpick and overcome that a 'systems' approach is necessary, in which other frictions can surface, for example, institutional frictions within the innovation system. This must be combined with a high involvement or 'participatory' approach to engage those involved, introduce new perspectives and evidence types and contribute towards shaping alternative pathways.

In the light of our evidence – and our argued imperative to overcome them in ways that enable the fulfilment of human capabilities - we are therefore 'reframing' the frictions as 'information and knowledge', 'skills and capabilities' and 'geography and context' (i.e.in and outside of the firm).

We have found that 'information' frictions take new forms and dimensionalities with AI, and sit across a more diffuse and intangible ecosystem of accountable agents. Access to information is a prerequisite to good governance and organisational resilience, including data which is able to imitate behaviour, refine performance or infer insights about how a process or 'workflow' works.

We have also revealed a series of geographic frictions, taking the form of structural and 'bottlenecks' across the innovation system (Thomas, et al, 2024). Prominent innovation system bottlenecks identified through the Review include:

- **Capital barriers** - including access to venture capital
- **Institutional barriers**
- **Procurement barriers**
- **Adoption barriers**
- **Governance barriers**
- **Conceptual barriers**

Our analysis has allowed us to dig more deeply into some of the ideas and institutions hampering the UK's ability to open up policymaking in these areas. This also allows us to offer a new level of depth and granularity to skills analyses that emphasise the importance of skills such as communication and creativity, as well as technology skills: the skills that are most 'transferable' to other roles, their relationship to other skills and their centrality to roles and occupations. We have shown that skills diversity - i.e. employer requirements for new combinations of social and technical skills - is increasing (Liu, J. M. Clarke, et al., 2024). In the Review, we refer to this phenomenon as an increase in ‘co-occurrent’ skills (Liu, Clarke, et al., 2024).

The skills similarity or ‘transitional skills’ network analyses in our Disruption Index are a good indicator of current trajectories (i.e. predicting current transitions) and therefore ‘resilience’ in the sense of overcoming these frictions and barriers to cope with the status quo (Rohenkohl, Clarke and Pissarides, 2024). Our firm-level survey and case studies add to this by surfacing the high involvement ‘initiative and leadership skills’ that are in increasing demand, and interrogating the governance of information, or ‘information frictions’ as we see them (Hayton et al., 2023a). However, it is our qualitative work and capabilities survey that show the extent to which high involvement, capabilities-based approaches are needed to manage - or negotiate - improved transitions (Soffia, Leiva-Granados, et al., 2024; Yu Liu and Hayton, 2024).

3. Compounding inequalities and new divisions

History teaches us that there are ‘winners’ and ‘losers’ in terms of who technology benefits, and its consequences for demographic groups, communities, regions and nations, and this insight has been borne out in each workstream of the Review. Together, our findings strongly suggest that inequality should now be conceived and treated as a structural barrier to ‘good’ technological transitions, as well as a consequence of ‘laissez-faire’, poorly managed or ill-informed approaches. They also illustrate that, on current trajectories, the constellation of cumulative, relational and intersectional dimensions of inequality that we are seeing are compounding, leading to some worrying ‘secondary’ and ancillary consequences and new divisions. In the case of AI, our policy analyses show that these divisions are even more pronounced and illustrate the striking cumulative effects of institutional inequalities, in particular (Nash, 2025).

Our final capabilities paper also points to a new ‘capability divide’ between those involved in developing and building AI and automation technologies and those on the ‘receiving end’ of them - who feel as if technological transformation is something that it ‘done’ to them. These need further research, from the perspective of work, but extend as far as eroding trust and engagement with citizens, and precipitating political outcomes and polarisation (Pissarides, Thomas and De Lyon, 2018; Pissarides et al., 2019; Nash, 2025). Our findings about the relationship between perceived rights, the extent to which our institutions protect us, and quality of life further confirm the need for a socio-technical lens to understand intersectional inequalities and their drivers.

Across our work on the review - geographic, socio-economic and demographic inequalities stand out. Where they do not change headline statistics, for example in our final capabilities report, this masks the fact that ‘geographic’ factors caught by other demographic factors show that local geography represents clusters of socio-economic deprivation. This also tends to capture growing intersectional inequalities.

Our work also surfaces ‘innovation’ inequalities, serving as a reminder that there is a strong economic case - as well as a social and wellbeing one - to tackle inequalities from the start of the technology lifecycle.

Within these, new AI-related inequalities extend the scope and depth of the ‘digital divide’, which should be extended to cover the inequalities associated with benefits from or the dividend of good automation. To boost and achieve more shared prosperity, intentional approaches to innovation and governance (or ‘ethics’) which consider equality through design, development and deployment, are needed.

This will need to extend ‘up’ and ‘down’ the supply chain, and the innovation ecosystem. Currently, national capabilities - in terms of underlying functions, but also the capabilities of our people, policymakers and institutions to address these - are poor.

Our analysis points to the way in which these factors, combined with the way in which technology is adopted at work and people’s experiences of AI at work, shape perceptions and impact the social and economic benefits associated with technological change, including wellbeing benefits. The systemic barriers and enablers intersect at the individual, firm, and system levels.

4. Hidden transitions and the importance of participation

Our model of automation, qualitative interviews and skills network analyses suggest that beneath the headline statistics, ‘hidden’ transitions within jobs are happening faster and more commonly than job displacement. This takes place within the ‘black box’ of the job and firm, and invites a policy lens which goes beyond supply and demand, with elementary understandings of ‘the match’ on the basis of skill and location only, to more active and nuanced approaches. In turn, this means moving on from the assumption that more and better jobs, or productivity, are an inevitable consequence of AI and new technology adoption, and focusing instead on the conditions and choices which are required to realise these outcomes.

Our work suggests we need a renewed interest in the workplace as a socio-technical system which organises, manages, and shapes work and job design as a ‘productive unit’ (Keep, 2013). This demands higher levels of transparency and information about technology life cycles and the value chain, and firm-level choices and the design, development and deployment of technology. It also means that innovation should be directed towards understanding and enabling people’s unscripted capabilities, wisdom, hopes and aspirations, including how technology could complement and enhance these, rather than focus on traditional ‘skills matching’ between jobs, as it is determined by employers, according to immediate business needs, understood and perceived in ‘snapshot’ way.

The common fear of the impact of technology on the labour market is that it will bring job displacement. However, a number of other economic models exist. In analysing the impacts of early computerisation on labour markets, changes to jobs - with a focus on given industries and sectors - was used to derive more general lessons about the impacts of technological change. This led to the idea that technological change which was complementary - i.e. where people remained in roles, were not displaced, and worked with new technology - was ‘biased’ towards higher skills: ‘Skills Biased Technological Change’ (SBTC).

However, subsequent studies took a sharper lens, focussing on the specificities of tasks. Autor et al. (2003) distinguished between cognitive and manual, routine and non-routine tasks. They found evidence for computer substitution of both cognitive and manual routine tasks, leading to a new popular model for disruption: ‘Routine Biased Technological Change’ (RBTC) (Goos, Manning and Salomons, 2014). Other approaches have focussed more on business models. For instance, Capital Biased Technological Change (CBTC) emphasises the shifting balance of the rewards of innovation, from labour to capital. Others have focussed on the dynamics between employers and workers as facilitated by new technologies, with consequences for bargaining, described as ‘Power-Biased Technological Change’ (Guy and Skott, 2005). Where the redesign of roles, associated with new technologies drives an intensification of work, this has been framed as ‘Effort-Biased Technological Change’ (Green, 2001), where ‘effort’ is defined by ‘discretionary’ work.

As we outline in this report, each of these theories can be at play in the course of a single adoption – with different impacts for different workers and even overlapping impacts for the same workers. Taking this analysis down to the scale of job redesign, we have presented a series of archetypes which capture these potential macro-economic effects, as they arise from the everyday application of technology within a business.

To better track and understand these different patterns of innovation, we suggest building practical, policy and regulatory architectures for ongoing monitoring that will surface changing combinations and trajectories, and new information about the forms automation takes, following which intervention can take place. This does not imply that decision-makers should not be much clearer about their purpose and preferred type of automation – and should aim for good - or ‘high discretion’ - automation and improvements to job quality, where that is possible.

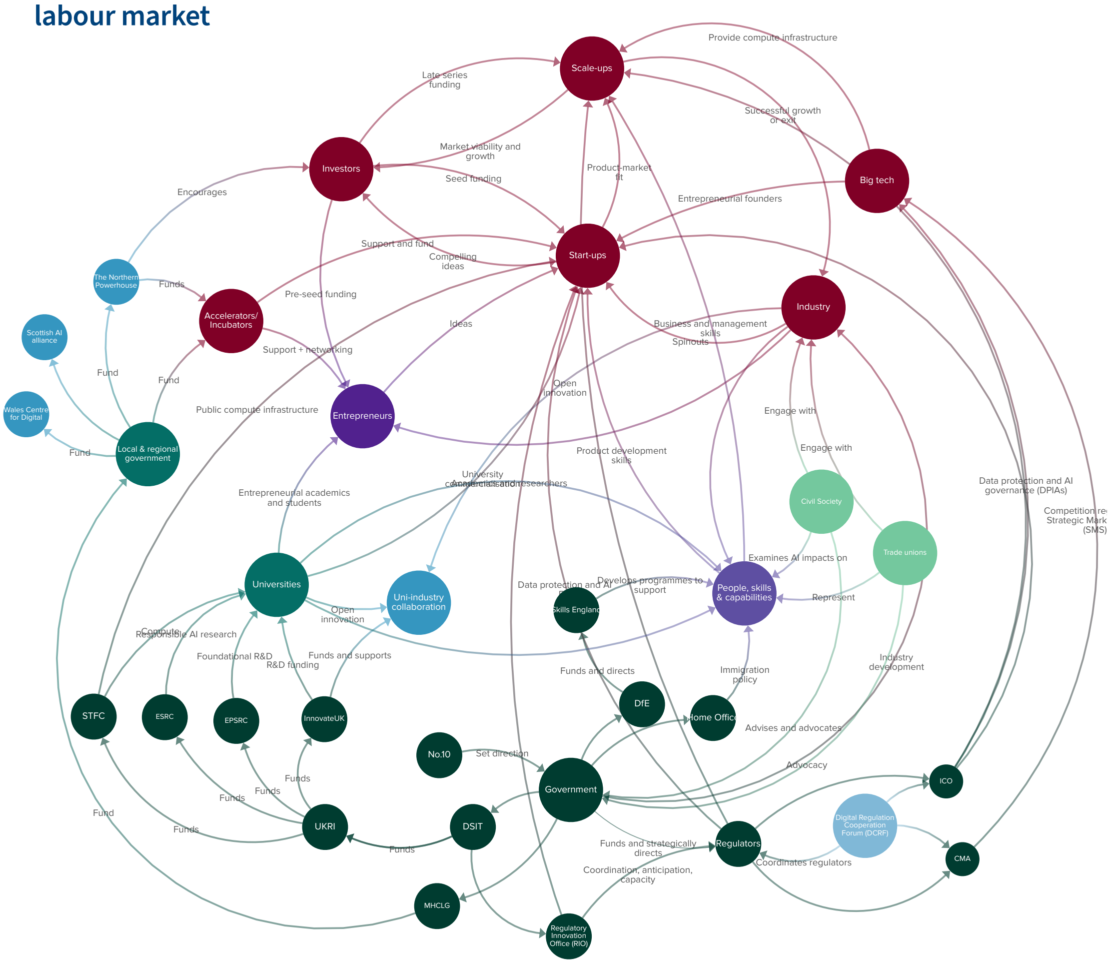
Towards intervention: unpacking the institutional landscape

To help us move towards intervention, we consider here how change begins with ideas, which are then delivered by institutions, which are gathered around sets of interests. Understanding the relationship between these three concepts is vital if we are to see effective policymaking. This section draws particularly from Reframing Automation, but also formed the basis for the structure of the Social Policy Impact Accelerator days we conducted to surface meaningful policy ideas from the findings of the Review, and is been further developed in a Working Paper (Nash, 2025).

Ideas

Ideas have a performative effect. They condition our actions, including our approach to technology research, development, adoption and policymaking. Ideas become material, manifest in the rules we make, and the resources we allocate. These rules and resources take form as institutions, which determine the success or failure of nation-states as they undergo great transitions (Acemoglu and Robinson, 2012).

Figure 2 - Causal loop diagram for the UK's socio-technical innovation system for AI and the labour market



Through the Review, we have seen enduring ideas about what automation is, and how it is shaped, considered, anticipated and measured. These ideas then shape what is researched and developed, how technology is designed (Bailey & Barley, 2020), how workers negotiate disruption (Carstensen, Ibsen and Schmidt, 2022) and firms adopt technology (Forsythe, 2001), and how governments look to manage risks and regulate it (Aloisi and De Stefano, 2023). So understanding ideas – as a system-level capability – is important.

Narrow or outmoded ideas about automation, AI, disruption and the future of work can lead to ineffective interventions to govern transition, as well as foreclosing the possibility of new choices and future avenues. Through new frameworks and heuristics, and with interventions which restructure the ideas we hold that organise our activity, reframing can help build new futures.

As set out above, in the review we have set out a new model of automation, to allow policymakers, workers, and firms to be more critical about the approaches they are taking to value capture and creation through the course of innovation substitution of human tasks. This idea has persisted for some time, with profound consequences observed at all levels, ultimately acting as a major blocker to the allocation of resources and types of innovation that are supported or even permitted.

However, ideas about what technology can and should do are shaped before the workplace. Analysis of both patent data and R&D funding data, including Innovate UK projects, reveals a prominent and growing emphasis on technologies designed to 'substitute' human work tasks, signified by terms such as 'automation' and 'matching' (see Figure 2).

Closer attention needs to be paid to the focus of innovation, and how it might be directed towards better outcomes, such as 'high discretion augmentation' (Gilbert, 2023) or 'good automation' (e.g. Acemoglu and Restrepo, 2020)., relative to projects more closely linked to human task substitution (Nash, 2025).

In addition to 'automation', our research illustrates that 'good work' needs particular consideration as an idea, driver and mediator of better outcomes. Simple frameworks, such as IFOW's Charter of Good Work serve to help focus a more ambitious conceptualisation, use and application of 'good work' principles in the context of policymaking for transitions.

We hope that the frameworks and heuristics, as well as the research, we have produced will help open up policymaking, innovation activity and firm-level decision-making to the types of automation that are designed to enable and promote human capabilities rather than substitute for them, leading to good automation and better transitions.

Institutions

Choices are shaped by ideas – but they are manifested and 'delivered' through institutions (Acemoglu and Robinson, 2008) (Schmidt, 2008). Our mapping analysis, combined with the research in this report, points to a disconnect between 'technical', 'people' and 'labour' focused institutions, which suggests that cross-cutting areas such as the future of work and automation are likely to be neglected and are certainly not considered in a systematic way. It also suggests silos between 'innovation' and 'governance' related institutions, which our research indicates is likely to act as a barrier to building firm-level capacity for responsible innovation and governance together. The nature and distribution of institutions lend weight to Professor McCann's view at our SPIA days we held to discuss implications of the work of the Review, that there is an "institutional vacuum", in the sense that of a lack of intermediary collaborative infrastructures between government and local businesses at the meso-level. As a whole, this analysis, like our skills' network analysis, illustrates the significance of relationality and 'networks' as part of well-functioning and integrated systems.

More specifically, building on the findings of our Disruption Index which highlight the extent of gaps and disparities across the technology life cycle, policy analysis for this chapter highlights the highly concentrated distribution of some of the most important institutions in the innovation ecosystem, including those able to apply for or undertake the different types of R&D, with a view to applying it well to ensure maximum, local benefit. This is likely to underpin and embed concentrations in public R&D funding which is, in turn, acts as a barrier to attracting business R&D funding, venture capital funding and start-up formation. Among other things, this points to the lack of innovation infrastructures across the UK, inviting an adverse comparison with Germany's network of 76 Fraunhofer Institutes which, for instance, increased local innovation (indicated by patent increase) by over 13%.

Interests

Our mapping analysis - using systems thinking methods such as causal loop diagrams - shows significant complexity arising from the emergence of new sector actors and highlights that the UK system is comprised of a highly centralised set of actors. It also points to a lack of clarity on departmental or cross-government ownership and overlapping remits, suggesting that automation and the future of work are not adequately recognised as areas that are growing in importance. This gives the impression that they are subject to silos, flux and a lack of 'grip' (Nash, 2025).

Structural inequalities, which are being compounded by new technologies on current trajectories, invite consideration of 'interests' in ways that consider power imbalances that affect decision-making relevant to transitions at job, firm, systems and sovereign levels. This has led us to consider the limitations of the role of unions, future roles and new alliances as the importance of developing existing architectures for social dialogue, partnership, learning and capacity building is reinforced. As the L7 OECD 2024 Statement put it, unions are essential for fostering 'social cohesion, solidarity and trust' in government, as well as tackling growing inequality through digitalisation, which tends to be overlooked in the wake of dominant narratives about the benefits of technology for working people through the public services of healthcare and education.

In the context of the latest wave of GenAI, national, sovereign interests also invite close attention, especially with regard to weaknesses identified in foundational research and compute, and bottlenecks spotted across the innovation ecosystem, which are barriers to innovation in different ways.

Rethinking policymaking

Public policy aspires to address society's most pressing challenges, yet its ability to challenge entrenched assumptions and reductive framing, adopt new approaches and keep pace with and respond to the complexity and interdependencies of technological and societal transformations, remains constrained.

Public capacity and capabilities, especially with regard to the integration and practice of newer socio-technical approaches, are low. There continues to be a lack of deliberate, systemic and future-oriented frameworks to help evaluate, monitor and respond to pressing challenges. Participatory methods to policy development remain very rare in government, in spite of increasing recognition of the value of involving stakeholders to shape policy directions.

The narrow focus and remit of many government forums means that dialogue about the societal and wellbeing impacts of technology tends to occur in silos. Our analyses suggest that this creates gaps in understanding and risks skewing policy priorities away from systemic work and wellbeing inequalities.

The evidence in the review points firmly to the need for a new focus on human capabilities, potential and choices - which itself demands a reinvigorated and systematic, socio-technical approach, paying close attention to context and dynamic interrelations.To enable this - and bolder and more integrated action - it follows that policymakers should aim to open up, intervene and then rebuild a set of 'black boxes' at each level. In turn, this invites policymakers to go 'downstream' and consider the entire technology, job and career life cycles and their inter-relations within the system – from design and development through to deployment, adaptation and eventual demise.

The capabilities approach we advocate for in this chapter supports pragmatic policy development. Here, capabilities comprise the opportunity structure that firms and governments can build.

A capabilities lens is effectively an architectural guide to the laying of solid foundations for resilience and productivity, as well as wellbeing. Policymakers cannot mandate growth or productivity, but can build an environment and the capabilities of key functions and systems in which it has the opportunity to flourish - and then provide the incentives for firms and workers to take up those opportunities.

Systems thinking and the workplace

People are at the heart of every complex human system, yet people's perceptions, aspirations and motivations are often overlooked in policymaking about these systems. Work is the primary determinant of living standards and the site of multiple, daily interactions with new technologies, but it is also a source of non-material benefits including development, relationships and purpose. In different ways, our Review highlights the particular importance of work and the workplace to understand and deliver meaningful 'human-centred' approaches, including systems thinking. In light of this, new forums, frameworks, methods and institutional capabilities are required to allow people not only to be involved in the automation process but also to envision and consciously 'design' their social futures, including work futures. This means (at least) a three-tier involvement, starting with the design of automation, and extending to the design of the systems that shape and sustain them.

As outlined above, the Institute for the Future of Work has developed the Social Policy Innovation Accelerator (SPIA) method to generate innovative responses to the challenges and social changes driven by technological change. Inherently socio-technical, SPIA is a human-centred design process for collaborative problem solving focused on complex policy challenges - including challenges that cut across the level of firms, places, and whole systems. SPIA creates a level playing field, unearths 'hidden information', and recognises lived experience and stakeholder involvement as a unique and essential form of expertise. By doing so, participants confront institutional and structural inequalities that often constrain or underpin policy options, including how policy issues are framed in the first place.

SPIA offers a mechanism for identifying common ground and developing solutions where there could be reasonable disagreement about how best to approach a given issue. The SPIA workshop days convened by IFOW and mediated by Professor Jolene Skordis reinforced the need to 'get under the bonnet', pay careful attention to systematic, structural and cross-cutting issues and the value of the frictions as both an organising framework and providing lenses to explore the different dimensions of change.

Towards this, we deploy a new analytical policy framework designed for complex, socio-technical innovation systems, which has been inspired by the Review: the Socio-Technical Innovation Systems (STIS) framework. STIS, which is an additional output of the Pissarides Review, represents a new, reframed and reconfigured approach to understanding complex innovation systems, which is designed to enable public problem-solvers to make sense of the larger dynamics of a system whilst staying grounded in the needs of people.

The STIS framework has been developed in light of frictions theory, the capabilities approach and socio-technical theory, building in mechanisms to help policymakers consider trade-offs, interdependencies and relatedness. This sets out core structural components and functions of the systems, enabling evidence of risks and benefits to be further organised, including the ways in which the functions and policies interact and within which risks and benefits co-exist and must be unpicked, anticipated, and traded off - mitigating risks and maximising opportunities. STIS includes an assessment approach based on indicators, which aligns with recent international guidance, such as the UN's AI societal readiness methodology (e.g. UNESCO, 2024) as well as technology, innovation and socio-economic indicators from the Disruption Index (Rohenkohl, Clarke and Pissarides, 2024) - ensuring a systematic and integrated approach.

STIS embeds the automation model designed in the Review, and encourages our capabilities and outcomes-based approach, doubling as a way to monitor, synthesise and translate information and knowledge as it surfaces on an ongoing basis. Details will be provided in a working paper (Nash, 2025). In this chapter, we have used STIS to refine, organise, prioritise and develop many of the recommendations emerging from the SPIA days. Our approach, which combines the SPIA and STIS methodologies, has also identified areas for further research, consultation and analysis which will be ongoing in 2025.

Recommendations

Reflecting this approach, the recommendations that spring from the research chapters now following will be grouped in 'buckets' that home in on a key theme to signify our systems, firm and individual level research streams and outlooks, although we have identified overlaps and several cross-cutting areas.

Following our STIS policy framework, they will focus on high-impact, complementary policies aimed at systemic change, responding directly to the findings from this Review. We also highlight where these are 'signifiers' that will need to be built on over time in order to measure progress towards these recommendations.

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Research Introduction

Professor Sir Christopher Pissarides

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Through human history, large numbers of people have spent most of their waking time at work. For many, this work might have been cultivating the fields or – later - working in factories. More recently it has been spending the day in an office, or – for many more, over a longer period of history – engaged in "home production": the unpaid work of millions of people providing free services to family and friends.

The things that we do at work have changed fundamentally since the early days of humanity. Indeed, much work today would be unrecognisable to someone living and working just a century ago. These changes to work – and how it is organised – happened very slowly at first, even after the first urban communities grew six to seven millennia ago. But change accelerated after the industrial revolutions of the late 18th and 19th centuries, and it has continued at a fast pace to this day. With this change came healthier living conditions and rising population numbers, but also changes to the length of the working day, and the intensity of labour.

What brought about these changes? The most fundamental cause is innovation and technology. New tools augment our abilities to act in the world – ploughing more efficiently, or working metals more accurately, or sharing information more quickly. The adoption of these new technologies aims to bring economic growth and with economic growth we can – in theory - work less and yet have a better quality of life, enjoying more and better material goods and services and having more time for leisure and intellectual pursuits. This kind of economic growth removes the need to work purely focused on survival and allows us to consider the quality of work we undertake, how much time we want to spend doing it. In the current era, most of us in advanced countries work because we want to improve our living standards, but we can often enjoy the privilege of being selective about what we do, and influence our own terms, directly or indirectly. Beyond our pay packet, we also care about the quality of our work and the satisfaction that we get from it.

Accompanying the rise in living standards that follow technological progress, there are other economic changes that take place. People begin to have more choice about the types of jobs they do, the accompanying rise in educational standards influences further innovation and the technologies that are then adopted. Even – as books by Douglas North and Daron Acemoglu and James Robinson have argued - countries' institutional structures and political systems – explored in this project as 'innovation ecosystems' (Nash, forthcoming) influence technology adoption. Thus, we see in countries at a similar stage of economic development, like Britain and Germany, there are stark differences. In Germany about 19 per cent of the labour force is engaged in manufacturing and in Britain it is only 9%. Three decades ago, the numbers were about twice as large as they are today in both countries. And, in different economies and in different regions within individual economies, we see the variations in work – and access to it – manifest in radically different living standards and huge differences in the choices people have about work and the quality of it, and thus their health and wellbeing.

Our objective in this multi-year research project – generously funded by the Nuffield Foundation – has been to study how workers in Britain are faring in this changing world of work – especially in the context of a period of particularly fast-paced technological transformation, which is bringing inequalities in job quality and wellbeing into more stark relief. How are workers in Britain coping with transition from one job to another, and how are their job satisfaction and other aspects of their wellbeing being impacted? We have then sought to understand how employers, government, and workers themselves can improve this situation.

Underlying our analysis is a narrative about how the economy responds in real time to the dynamic changes taking place, and how – experiencing this technological transformation as it happens – workers and firms transition from one aggregate state to another.

The key property of economic growth that drives the job transitions that we are describing is its uneven nature. New technology does not benefit all sectors of the economy uniformly. Some sectors benefit more, raising their output at the existing distribution of work, whereas others may not benefit at all. Accompanying the introduction of new technology there is a shift in the sectoral distribution of labour productivities across the economy. This manifests as varied conditions of work. If, before the introduction of the new technology, the economy was operating at a point where each sector's output matched demand at the existing price distribution, the initial impact of the introduction of the new technology would be to change prices, reducing those of the products that benefit from the introduction of the new technology. The fall in the price of digital products since 1980, whose sector is the one that benefited most from the new technologies at this time, is a good example of this realignment. The relative price of most capital goods also fell during this time, for the same reason.

What happens next depends on the response of demand and supply to the new price distribution. It is unlikely that the economy will remain in equilibrium at the existing employment allocations (see Ngai and Pissarides, 2007, for the conditions needed for this to hold). In general, technological progress requires the reallocation of labour across production activities, to bring the economy back into equilibrium. The shift in employment allocations during economic growth is known as the structural transformation and, although it has attracted less attention by economists than the growth effect of new technology, it is equally important when considering the impact of new technology on jobs (see Herrendorf, Rogerson and Valentinyi 2014 for a recent survey).

Other factors – such as the shifts between consumption of "necessities" like food and "luxuries" like holidays – contribute to the structural transformation too, but their contribution is either short-lived or less important in magnitude. But whatever the cause of the structural transformation, firms and workers need to respond quickly to take advantage of new technologies and shifts in consumer demands. The type of work that workers do (their "role" in the firm) changes, jobs become obsolete and other jobs are created, new firms are started, and existing ones change the way that they do business, or leave the market altogether. These processes require investments in the new technologies and the transition of workers from the roles that they were playing in the old economy to the ones they need to play in the new one. But how exactly do firms go about the process of deciding to adopt these new technologies, and how do workers navigate the transitions necessitated by it? These are the questions that we have attempted to address.

The impetus for our research has been the current automation technology revolution, which is precipitating very large-scale structural changes in the economy. Our aim has been to find what is going on in the labour market, how firms are responding to the new technologies and how workers are affected by it. Are firms introducing the new technologies collaboratively and responsibly? Are workers happy with what is happening to their jobs? If these things are not happening, can the situation be improved and, if so, under what conditions?

The underlying belief through this research is that with every work task that becomes obsolete because of the adoption of new technology, the opportunity to create another one will emerge, either in the same company, sector, or location, or in a new one. This has been the experience of every past industrial revolution, and there is evidence that it is happening again, with Britain and other major economies suffering from worker shortages as the new technologies penetrate the labour market.

Given how labour markets work, most initial transitions are likely to be taking place within companies, with workers learning new skills to take on new roles. But new jobs will also be created as new start-ups emerge, or as some companies adapt and grow quickly and others stagnate.

In the past, economists made the dubious assumption that, as these technological transitions happened, although capital was a "fixed" factor – changing only slowly over time – labour was a "variable" factor, adapting immediately and painlessly to the new world of work. In this world workers would be quickly taking on new positions in their companies and adapting to new sets of tasks, or changing jobs, and the only thing slowing down the adjustment to a new world of work would be the slow response of employers in the acquisition of the capital equipment needed to make automation operational.

But we know now that this is not how the labour market works in practice. Workers are slow to adapt, because of the need to find out what adjustments are taking place, learn new skills and possibly move location to take advantage of the opportunities that are opening. This failure of the labour market to respond perfectly is due to "frictions" (Pissarides, 2000, Mortensen and Pissarides, 1999).

The results of these frictions show up first as mismatch of *skills*: companies cannot make the best use of capital and new technologies because workers do not have the required skills. Alternatively, workers may have skills which are not being recognised or utilised within the economy. In extreme cases, workers remain unemployed, even though there are vacant job positions they could be taking if the conditions for a match were in place. This friction can be understood more widely as one of 'readiness' – the extent to which individuals or regions are prepared to take advantage of technological transformation, whether that be in terms of an individuals' skills, or – for example - a region's infrastructure and access to capital.

Second, these frictions show up as mismatch of *geography*: job vacancies are in areas of the country that are inaccessible to the workers who live elsewhere, because of mobility costs associated with housing, family ties or just unwillingness to move, and because companies cannot relocate.

Thirdly, frictions can also arise because of the lack of reliable *information*: how much do employers and workers know about the new technologies, their market, each other and their respective intentions, their motivations and the potential for conflict or collaboration?

Without frictions these mismatches and imperfections would disappear, and productivity, at least, would be maximised, but with frictions this is not possible, and labour market participants must settle for something less. What happens to workers' wellbeing in those situations is a totally uncharted area of research, and it is our objective to uncover facts and make suggestions how to improve the situation.

Throughout the research, we attach great importance to the wellbeing of workers, avoiding the frequent temptation of commentators to focus on productivity. We argue that this focus on human experience is particularly important during this period of AI and automation, where very significant changes to people's experience of work – and access to it – are in play. Higher productivity as a result of the adoption of new technologies is important, because it enables a rise in incomes and provides the government with more revenue to achieve its social objectives, such as good health and education systems and social support to vulnerable groups. But it cannot be the be-all and end-all, and having it as a sole focus would not be appropriate because it cannot be assumed that increasing productivity will lead inexorably to better wellbeing simply because median incomes rise. If new technologies bring higher productivity, but leave us with work that makes us unhappy and depressed, and raises the risk of mental illness, is that a price worth paying?

Our starting point is that labour markets do not deliver the best outcomes with respect to productivity and wellbeing if they are left alone, even when technology is not changing fast. When there is more technological change, as currently, the situation can get a lot worse. That's why our focus is the future of work. Work is changing; how can we make sure that it is changing for the better for both productivity and the wellbeing of workers?

The view we take up in this Report is that we should pursue the two objectives in parallel and look for pathways to improved wellbeing alongside better productivity.

Surveys of life and work satisfaction show that workers are generally not happy with their work, and they are worried about what the new technologies will do to it (Layard and de Neve, 2024). Although views amongst economists differ, the majority would agree that the conditions needed for good societal outcomes in this transition need fixing. The disagreements are mostly about the degree of fixing needed in which market, and who takes it on to do the fixing. Our view is that although employers' and workers' organisations have a role to play, the government has a potentially bigger role to play if the situation in the labour market is to improve. To do this, it needs an appropriately designed policy, and our objective in this project is to make recommendations about that policy.

But what is “wellbeing” and how can it be measured at work? In what ways are wellbeing at work and job quality related, and do individual workers’ circumstances change how they experience technological transformation? In one sense, wellbeing at work is simply the way that the worker feels about work - are they happy doing whatever activity they are doing? Stressed? Relaxed? This can be measured objectively through data on absenteeism, medically diagnosed stress or reported mental health issues. We have chosen to approach it through subjective measures, via responses to a survey and through focus groups. These can often be more encompassing, and are being used more widely in empirical studies.

An effective government policy is one that reduces one or more of the three frictions outlined above – skills, geography or information. To discover what form a good policy might take, we need a detailed understanding of how a friction is operating by not allowing firms and workers to take full advantage of the opportunities available to them. Filling in our understanding of frictions – and employers’ and workers’ responses to them – occupies the bulk of our research as we ask: what stops employers and workers from taking full advantage of new technologies and other opportunities available to them, and how do they respond to them?

This phase of the work is divided into three streams; a fourth then considers policy in light of our results and the institutional structure of the economy.

The first stream – at the widest zoom level - focuses on local labour markets. We assemble data on UK geographic areas to quantify how much disruption there has been from new technologies in each area and how prepared different parts of the country are to take on the new digital technologies. The result is summarised into the first “disruption index” for Great Britain, and it is done at the Institute for the Future of Work, under the general direction of Professor Sir Christopher Pissarides, working in collaboration with Dr Bertha Rohenkohl and a team based at Imperial College and supervised by Professor Mauricio Barahona and Dr Jonathan Clarke. The friction in this stream is market readiness and it covers market structure, skills, and innovation potential.

Focusing in slightly more, in the second stream we look at the firm level, and study employers and their reactions to new technologies. We collect detailed information from employers about their policies towards their workers and how they are responding to the new technologies that are becoming available to them. The data for this analysis are collected through a survey of employers that we conducted as part of our project. We also collected data through visits to eleven sites that have introduced new technologies and talking to them directly about their experiences with new technologies. This work is done under the direction of Professor James Hayton of the Warwick Business School and assisted by

Dr Hong Liu Yu. The friction here is mainly about employers' technological know-how, information about their market and workers' attitudes, and how employers are responding to them.

Finally, focusing in most tightly, in the third stream, we study workers and investigate how they are responding to new technologies and how they feel about their jobs in the current climate. The data for this study is also collected through our own survey of workers in different part of the country, and is directed by Professor Jolene Skordis of University College, London, working with Dr Magdalena Soffia at the IFOW. In this stream we identify frictions that directly influence workers – information and attitudes about the new technologies, attitudes to work generally and relations in the workplace.

Armed with the findings of this research, we then turn to policy. The objective here is to derive conclusions about the institutional structure of the labour market and whether it can be improved; and about the best policies that can improve the situation for both workers and employers, with emphasis on workers' wellbeing. This work is supervised by Anna Thomas MBE and Dr Abigail Gilbert at the IFOW, with the collaboration of the entire team engaged on the project. The key innovation presented here is a new framework to help develop policies that take account of the highly interconnected and interdependent mechanisms of technological transformation and socio-economic progress.

At the outset of the project, our stated hope was to shine a light on how rapid technological transformation has - and will - impact different communities and groups of workers from different backgrounds. We set out to build a strong evidence base that could help with the creation of a roadmap for the UK to promote worker-focused, human-centred automation.

In the time that we have been working we have seen dramatic changes with the launch of numerous generative AI tools, as well as huge turbulence in the global economy precipitated by conflict and climate change. But our hope remains the same: that a future of work and wellbeing is achievable, one where innovation and social good can advance together.

We hope that the work that follows delivers on the strong evidence base that we sought to build, and does off a firm foundation for policies to build a fairer future of better work.

Jump to our full list of recommendations.

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Section 1
Technological Disruption across the UK

1 Technological Disruption Across the UK

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We have argued in the Introduction that, if left alone, labour markets will not deliver the best outcomes for society. They contain too many frictions and non-competitive elements to achieve inclusive and sustainable growth, and a working environment that can improve workers' wellbeing.

Given these challenges, what can governments, companies and workers do to steer labour markets towards better outcomes? Whilst innovation and technological transformation have an important role to play in this steering, the consistent argument in this Report is that these cannot be understood in isolation, and must be combined at all levels – system, firm and individual - with an understanding of how social dimensions interact in a cross-cutting way. This requires a more socio-technical, systemic approach.

We know that the freedoms people have to lead fulfilling working lives – what we call in this Report 'capabilities' – are fundamentally intertwined with the ways in which innovation systems are functioning. These individual capabilities exist in relation to the capabilities that firms themselves have to function optimally, and these in turn to the capabilities that each place in the country has to be able to make the most of the opportunities that it has within that region.

In this section, our focus is technology adoption across geographies, and how this is distributing work with different characteristics, and opportunities – as reflected in the skills composition of new jobs across the country. The decision to adopt new technologies depends on many different factors. At a firm level – as we show in more detail in the next section - this includes how managers perceive technology, and where a particular firm is operating. As we explore in the section on workers, the adoption decision depends on how workers are supported, and the capabilities workers may feel that they have - or could have - in order to harness new opportunities.

But, at a system level, what we are seeing is the aggregate patterns of automation. This reflects choices. Choices by firms, and individuals, but also the government. This distribution reflects history. Historic institutional conditions – what has been invested in, and what has been prioritised. But also the raw conditions of different regions and their intrinsic nature. As we see, this institutional structure manifests as some more consistent variables, and other highly variegated outcomes. We explore this by reference to – among other things - local technology infrastructure (for example, broadband or 5G), access to capital, and the skill-levels of the local workforce.

The mechanics of how and where innovation and technology adoption happens, and the factors in play which shape this, are vital to understand. For this, we need a better understanding of the current picture of technological transformation, and of the changes in skills which are symptomatic of automation, be that both new skills which are required to utilise new technology, or old skills which highlight what it is displacing. Both ends of this spectrum require careful attention. Towards this, we construct the first technological "disruption index" – currently for England, but with a hope that the datasets that underpin it will be developed to allow it to expand to cover the whole of the UK. This is an index for each of the International Territorial Level 2 (formerly NUTS2) geographies that captures two interrelated dimensions: how much new technology is being introduced and how ready the region is to absorb new technology.

Given how inexpensive it is to transfer knowledge about new technologies in the world of digital communication, one might think that this transfer is frictionless, and that every corner of the country will know what others know about what a particular technology can do. But we don't live in a frictionless world, and the adoption of new technologies and which types are being taken up in different parts of the country depend on a host of factors beyond access to information. Important among these are the availability and quality of capital, labour, and entrepreneurship, the traditional "factors of production" of economic theory. Adoption depends on the available capital stock and its quality, the industrial structure of the region and the volume and quality of new investments that are directed to the region – all of which are seeing great flux as the pace of technological change intensifies. But the ability to exploit the potential of these new tools also depends on the available labour force, their skills, and their willingness to adopt them and develop them.

So in this period of intense transformation, one of the major challenges that labour markets are facing is that of worker transitions. Although many researchers and media commentators have focused on how many jobs the new technologies will destroy through obsolescence, and where the new jobs that are needed to employ the displaced workers will come from, we have argued that this emphasis is misplaced. Instead, the biggest challenges faced by the labour market are not associated with the replacement of old jobs by new ones, but with the adjustment of workers to new roles. Workers learn how to use new technologies, how to provide new types of services for which there is demand in our predominantly service economy, and how to keep a customer base happy, in light of new demands associated with health concerns, climate change and social preoccupations.

The adoption of new technologies is a key component of delivering sustainable growth and a fairer future of better work. What we hope to show in this section of the Report are the major areas of system-level focus if this aspiration is to be delivered on in practice in a way that supports innovation and social good. Issues of geography, capital flows, infrastructure and skills changes are understood at the systemic level, because labour markets working without the guiding effects of good policy may be able to deliver a future that is highly innovative and technology-focused, but not one that is socially responsible or good for us.

These are the issues that we address in this section of the Report.[1]

[1] Two longer and more formal papers explain in detail our underlying analysis of technological disruption. Links: Disruption Index and Technical Report

1.1 Unpacking Technological Disruption

Professor Sir Christopher Pissarides
Dr Bertha Rohenkohl

Key Working Papers from the Review:

A Disruption Index: the geography of technological transformations across England - *B. Rohenkohl, J. Clarke, C. Pissarides*

A Disruption Index: Technical Report - *B. Rohenkohl, J. Clarke*

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Key Findings

Policy Recommendations

The research team at the Pissarides Review developed the Disruption Index (DI), a tool designed to measure the capacity of regions to invest in new technologies, and the factors that enable firms to adopt and integrate them.

Introduction

As the UK economy undergoes major structural transformation, the hope is that the outcome will be a world-leading, responsible and thriving innovation ecosystem in which people flourish. Such a place would be marked by the agile adoption of new technologies, supported by smooth flows of knowledge and capital, and deployed among a highly skilled workforce reporting good wellbeing.

We are currently some way away from this. The transformation already in play is having profound societal impacts, not only on access to work, but also on the nature, conditions and quality of this work.

In order to understand the scale and form of this restructuring, we must first understand when and where the technological transformation is happening. However, the evidence on how technologies are being developed and adopted in and across the country is sparse.

To bridge this gap, the research team at the Pissarides Review developed the Disruption Index (DI), a tool designed to measure the capacity of regions to invest in new technologies, and the factors that enable firms to adopt and integrate them.

Aggregating data from a range of sources, the DI is an innovative analytical tool that offers a nuanced perspective on the nature of technological transformation across the regions of the country. Armed with this knowledge, our hope is that policymakers and regional leaders will be better equipped to formulate strategies that will deliver improved local capabilities that, in turn will allow firms to invest in both new technologies and people, and thus see a renewed innovation ecosystem.

What follows below is a summary of the full work that was done on the DI, which can be found here.

In the next section we explain how the DI measures technological disruption through the indicators used. Then we discuss the extent of the technological transformation revealed by the DI and then discuss the factors that facilitate technological disruption, which we term enabling factors. Finally, we summarise our findings and briefly discuss how the current unequal distribution of "technological prosperity" can be narrowed.

Measuring technological disruption

The Disruption Index is divided into two main sub-indices, the Technological Transformation Index (TTI) and the Readiness Index (RI). The first sub-index measures how much technological adoption is taking place across geographies, and the second measures the readiness of each region to take on the new technology and use it in production. To allow for proper comparisons between regions, uneven data availability forced us to restrict our analysis to the thirty-three International Territorial Level 2 (formerly NUTS2) regions of England, each of which represents either single counties or, more often, groups of counties.

The TTI includes eleven indicators that describe the extent of technological transformation across England. Table 1.1 outlines the structure of the Technological Transformation Index. Each of the two 'Dimensions' has equal weight of 0.5, and each sub-dimension is given equal weight across that dimension, with each indicator in each subdimension also carrying equal weight. We use a min-max normalisation to transform all indicators to a 0-1 scale. This approach assigns a number between 0 and 1 to every indicator in every region, which can be compared with each other. The way that the normalisation works is that for each indicator, say employment in R&D, the region with the smallest number is assigned 0, and the region with the biggest number is assigned 1. The regions in-between are assigned a number based on the difference between their number and 0, relative to the difference between the maximum and minimum numbers. So if, say, the region with the smallest number of people working on R&D employs 100, and the region with the biggest number employs 500, they are respectively assigned 0 and 1. A region that employs 200 people then gets a number 100/400, or 0.25. A full technical analysis can be found in the Disruption Index Technical Report.

The Readiness Index (RI) consists of sixteen indicators, shown in Table 1.2, aggregated into a single index using a similar method as the TTI. This RI is the average of human capital and infrastructure as enablers supporting the technological transformation. It assesses the availability of a skilled workforce, investments and participation in education and the presence of a modern digital infrastructure.

To build the dataset, we consolidated data from a variety of sources, both public and private, including the Office for National Statistics, Eurostat, OECD, UK government, Crunchbase and Adzuna. This is the first time these datasets have been combined and mapped together to understand the relationships between innovation, tech adoption and readiness in the UK. This allows for a deeper understanding of the innovation ecosystem beneath the headline national statistics and lays the foundations for future research on the impacts of this disruption on work and society at large.

In addition, we also developed a "Disruption Index Dashboard" – a data visualisation tool that allows users to explore the data in more detail. This can be found here. The dashboard enables the exploration of measures from the index across the country, over time, identifies factors and individual indicators that contribute to the differences observed and zooms in key indicators. The data on which the DI is based can also be downloaded and shared under a Creative Commons license.

Table 1.1 – **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

Table 1.2 – 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.

The Technological Transformation Index: How is the technological transformation happening across England?

The focus of the TTI is to understand and measure different types of investment in innovation and innovation activity, alongside measures of technology creation and adoption in the workplace. It emphasises the significance of two key dimensions:

- **investments,** including the funding possibilities for firms
- **technology creation and adoption,** looking at adoption and diffusion of technologies in practice.

The Index that we calculated from this exercise reveals a significant regional concentration of technological transformations, which seems to be increasing over time. These gaps in regional performance are particularly evident when looking at the data on venture capital investments in tech sectors, R&D expenditure, and the creation of patented technology.

The growing polarisation between “technology adopters” and “laggards,” often discussed in connection to firms, is now also apparent at a regional level. Given the UK’s already deep regional inequalities in many dimensions (McCann 2020; Overman and Xu 2022), the Disruption Index – alongside other Pissarides Review outputs – highlights how technology and innovation exacerbate inequalities, by measuring a large gap between the South-East and the rest of the country.

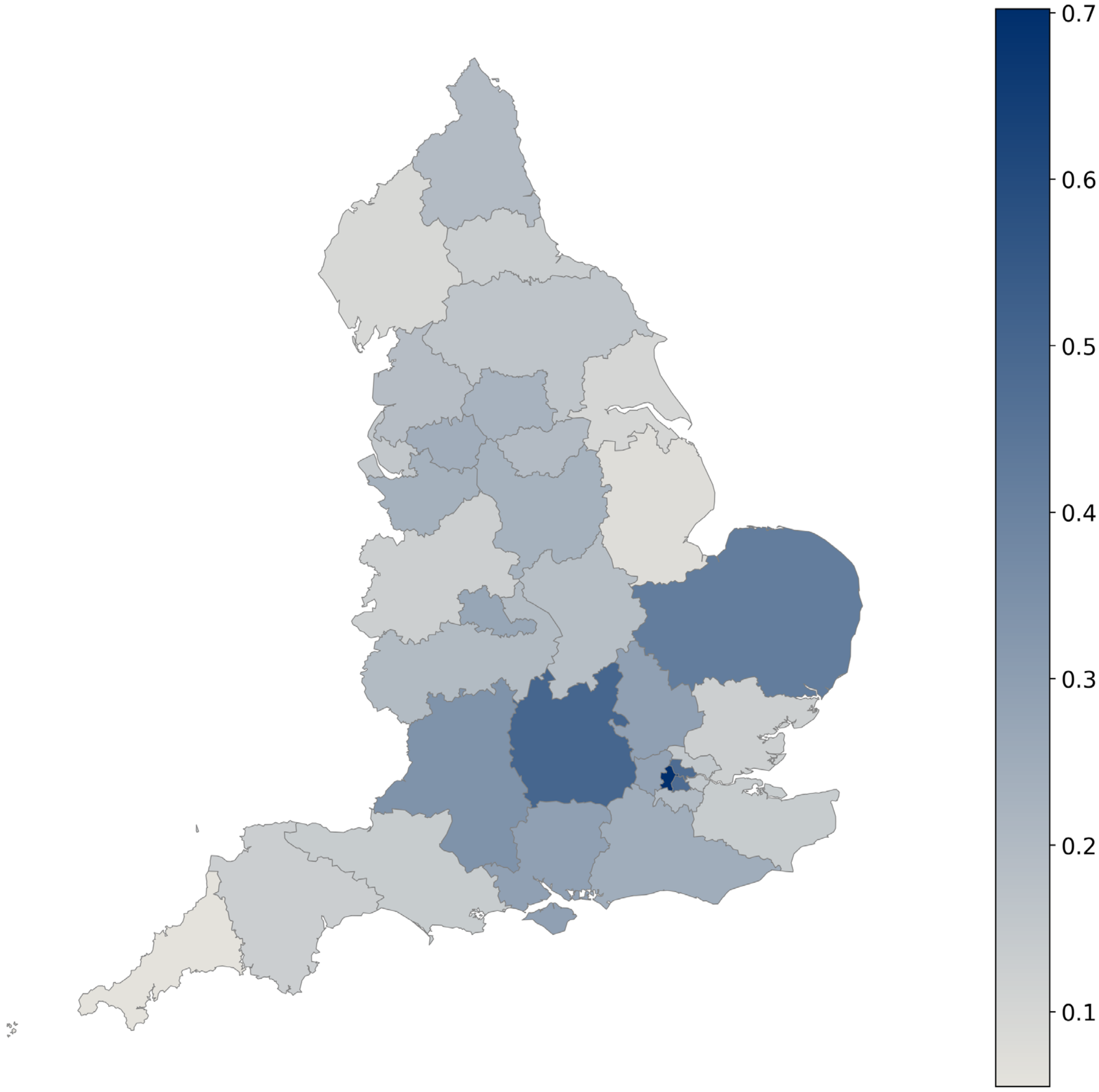
Our analysis of developments over the 2016-2020 period suggests that without significant policy intervention, there is a risk of further concentration of technological investment in a few regions which would deepen existing inequalities. To address this, we need new frameworks that can respond to how individual, firm and system dynamics interact and enable strategies tailored to the needs of each region.

Our key findings paint a picture of a great divide between four regions with strong innovation activity – London East and West; Berkshire, Buckinghamshire, Oxfordshire; and East Anglia – and the rest of the country. This is evident not just in the total scores of the TTI, shown Figures 1.1 and 1.2, but also in all its subdimensions, such as R&D expenditure, innovation activity and access to venture capital (shown in the fuller report available online).

Inner London West (centred around Westminster and the City of London) is the leading region, with a high score of 0.70, driven by high performance across all subdimensions of the index. Other leading regions are Berkshire, Buckinghamshire, Oxfordshire (0.50), Inner London East (0.48, Islington and Canary Wharf area), and East Anglia (0.42, including Cambridgeshire). There is then a clear break with all other regions scoring below 0.4, led by Gloucestershire, Wiltshire, and Bath/Bristol (0.34), which neighbours the other more active southern regions. A common feature among these top-performing regions is their high scores across all dimensions.

At the other end of the range, there are regions with much lower scores on the TTI. Cornwall and Isles of Scilly sit at the very bottom with a score of just 0.06. This low performance can largely be attributed to lack of venture capital funding to tech sectors and low R&D expenditure. This region’s economy is heavily focused on sectors like hospitality and food services, which traditionally do not attract high levels of tech investment. Other low-scoring regions include Lincolnshire (0.07), Cumbria (0.09), East Yorkshire/ Northern Lincolnshire (0.10), and Shropshire and Staffordshire (0.12). These regions share similar challenges in attracting investments for the tech development. More concerning is the fact that some urban

Figure 1.1 - 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](#).

centres feature low on the list (below score 0.2), such as Tyne and Wear (Newcastle) and Merseyside (Liverpool).

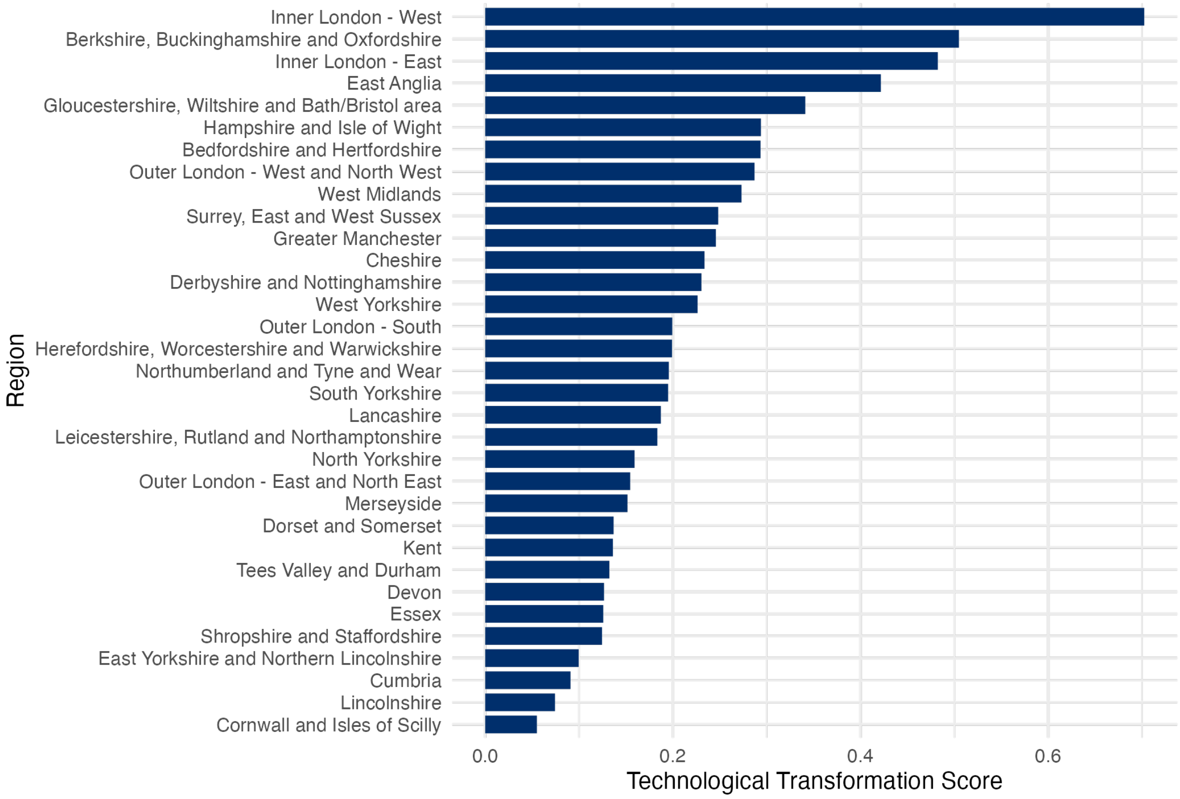
Our data goes back to 2016, and when we look at the changes in TTI scores between 2016 and 2020, we see that almost all regions have experienced positive changes, which suggests increased investments and adoption of technology. But progress has been unequally distributed, as shown in Figure 1.3.

The region with largest gains in total scores is Inner London East, which neighbours the most innovative region, London West, and went from 0.30 in 2016 to 0.48 in 2020. This growth was driven by an upsurge of venture capital flows and another surge in the number of jobs requiring technology-related skills. Other regions that saw improvements are East Anglia, Lancashire, Greater Manchester and Merseyside, all of which gained more than 0.04 points. The three regions in the North-West of England are the only ones that have seen significant improvements in technological transformation outside the wider South-East, although they remain below the South-East in overall performance. Nevertheless, the reasons that that part of the country outperformed others outside the South-East are not obvious from our data, and it warrants further study.

When looking at rankings, we observe that the top-performing regions in 2020 were also the leaders in 2016. Similarly, the three lowest-scoring regions also remain in the same position. Unfortunately, when looking at these trends over time, the impact of the COVID-19 pandemic in 2020 cannot be isolated, as a suitable counterfactual does not exist.

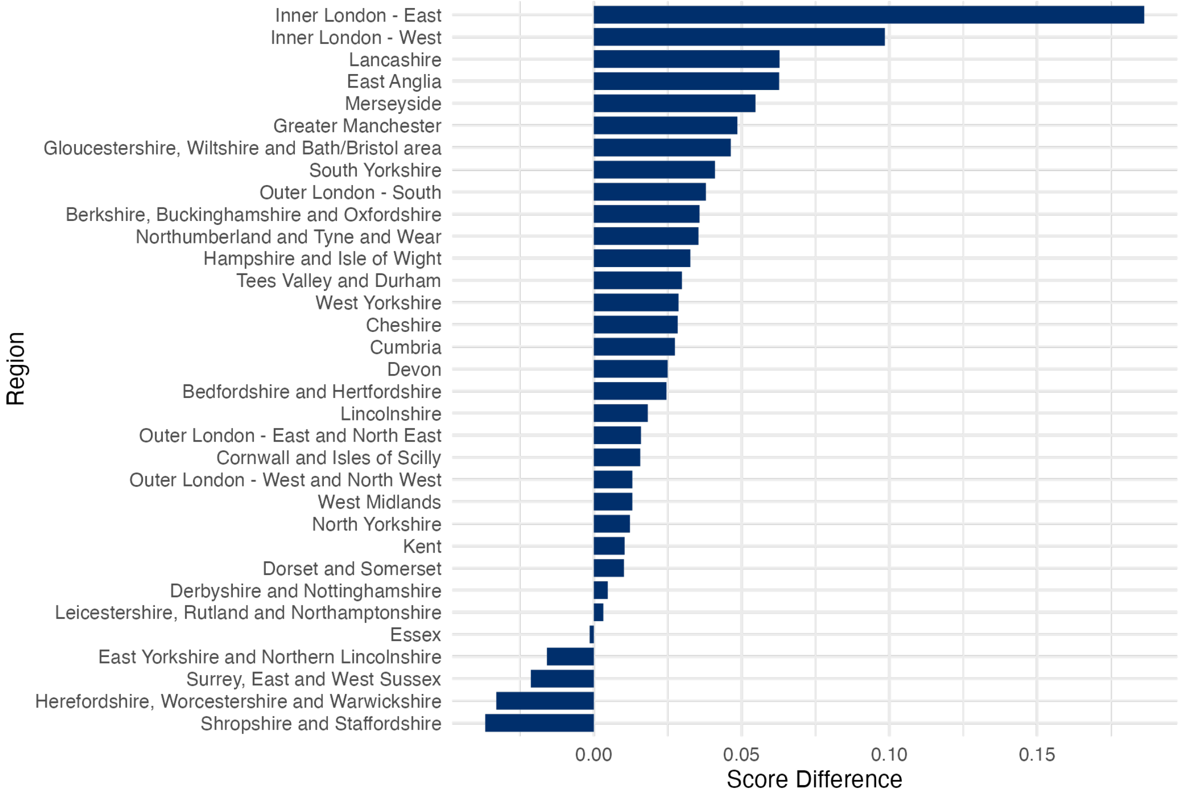
The very uneven distribution of investments across regions, which is one of the main drivers of the inequalities that our construction of the TTI has identified, is especially concerning when viewed in relation with aggregate investment performance. As other studies have noted, the UK suffers from weak investment performance, which is often cited as a key factor behind the country's sluggish productivity growth (Coyle, Van Ark, and Pendrill 2023; Carella, Chen, and Shao 2023).

Figure 1.2 – Technological Transformation scores in 2020



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

Figure 1.3 – Changes in Technological Transformation Scores, 2016 - 2020



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

We find that when the productivity-enhancing investments in tech development and innovation do happen, they are highly concentrated in a small number of regions.

Venture capital investments to technology firms, R&D expenditure and innovation activities are deeply interconnected and tend to reinforce one another. We find that all three are concentrated in the “golden triangle” of central London, East Anglia, Berkshire, Buckinghamshire and Oxfordshire. So, our analysis shows that the overall weak investment figure is not a good representation of performance across the country. The golden triangle might be internationally competitive at the level of investment that they get, but other parts of the country are worse-off than the aggregate figures indicate.

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 £2.5 billion, going up to £6.1 billion by 2020. But the increase across the regions was very uneven. 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. The inequalities highlighted in the preceding paragraph have gotten worse in the six years of our study.

The same is observed with R&D spending. In 2019/2020, the top five regions accounted for approximately 42% of total investments in R&D, a notable increase from 35% in 2016. Regions such as

Greater Manchester and Tees Valley and Durham saw large growth in business R&D expenditure, with the latter experiencing a remarkable 61% increase (from £110m to £177m). But other regions, such as Merseyside, saw business R&D expenditure decline by 21%, from £499m to £394m. Of course, even after these changes are considered, the overall investment figure going to these regions remains well below the one going to London and the South-East.

As shown in Table 1.1, the TTI also includes data on both business and non-business gross domestic R&D expenditure, highlighting how these are also regionally concentrated, and how private and public investments are related. We find that non-business R&D expenditure – performed by government, higher education and non-profit institutions – follows a similar pattern to business R&D. Business and non-business R&D expenditures are complements, rather than substitutes (Jones, 2023), and in the last six years the concentration has gotten worse. In 2019/20, the top five regions accounted for 24% of all non-business R&D expenditure, up from 16% in 2016.

The TTI also reveals differences in the number of tech start-ups across regions and their trajectories, indicating that regional disparities are present from the very start, through to later stages, when larger rounds of investment take place, technologies are adopted and start-ups look to scale.

Perhaps surprisingly, our data reveals a drop in the number of tech start-ups across all regions over 2016-2020, with the smallest fall in Inner London West (6%). In 2020, the top five regions in the country accounted for well over 20% of the recorded tech start-ups, a proportion that does not align with our other indicators of talent or readiness (see next section). Research suggests that higher education can increase the likelihood of securing investments for a technology venture (Ratzinger et al., 2018), so these findings suggests that there could be important innovation bottlenecks in regions with strong academic talent, in the form of insufficient support for university entrepreneurship and for scaling up.

In our construction of the TTI we also look at the demand for technology skills as a proxy for the adoption of new technologies by firms. This captures the extent to which firms are integrating new systems and tools, requiring a workforce that is equipped with the necessary skillsets to work with technology effectively.

The topic of skills will be covered in more depth in the next Chapter. As a summary of the skills indicators within the DI, our data reveals significant disparities in the demand for technology skills across the country. 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 new technologies, while other regions, such as East Yorkshire and Lincolnshire are less active with respect to both measures, the count of jobs requiring tech skills and their percentage of all vacancies.

The industrial composition of a region might be a factor behind the attractiveness of the region for R&D spending and other forms of investment. To gain some more information on this connection, we compared our TTI data to the Business Register and Employment Survey (BRES) – the most reliable source of data on employment by sector at a local level in the UK. Comparing the proportion of a region's workers employed in each industrial sector with TTI scores in 2020, our findings show that higher employment shares in sectors such as ICT, scientific research and financial services are strongly associated with higher TTI scores that we calculated. These sectors are likely to be more technology-intensive, driving higher scores in the regions where they dominate. Conversely, areas with higher shares of employment in manufacturing, retail and healthcare generally have lower TTI scores. These relationships have remained consistent over time. Although retail and healthcare might be easy to explain as low-tech industries, the fact that manufacturing doesn't seem to attract high-tech investments might be a reason behind the decline of British manufacturing, when compared with its main competitors, such as Germany and Japan.

Factors that enable the technological transformation

Technology design, development and adoption thrive in environments that support entrepreneurs, businesses, technologists and workers, empowering them to continuously learn new things, create new activities and grow. The Readiness Index (RI) focuses on these enabling factors, highlighting the key role of human capital and a firm's ability to absorb and develop new knowledge. It also emphasises the importance of connectivity infrastructure that supports technological transformations. These different elements can act as enablers or, where they are undeveloped, as reasons for bottlenecks for innovation and tech adoption.

Our approach draws on a socio-technical perspective to innovation and the governance of technology, where innovation hinges on the interplay of a range of technological and non-technological factors at the individual, firm, regional and national levels.

The Readiness Index covers two dimensions:

Human capital, including education, qualifications and workforce characteristics.

Connectivity infrastructure, including the digital infrastructure needed to enable digital technologies.

Overall, our findings show that while there are clear regional differences in Readiness scores, these gaps are not as pronounced as those observed for Technological Transformation. This finding suggests that there are regions that have the potential to innovate but that opportunities are being missed.

Figures 1.4 and 1.5 show the Readiness scores for 2020. Inner London West and Inner London East are again leaders, but their margin of advantage is much smaller, pointing to untapped regional and human potential in other parts of the country. The main disparities observed here are related to the human capital indicators, such as the number of postgraduates and presence of on-the-job training opportunities. Digital infrastructure is the most equal of all dimensions within the broader disruption index.

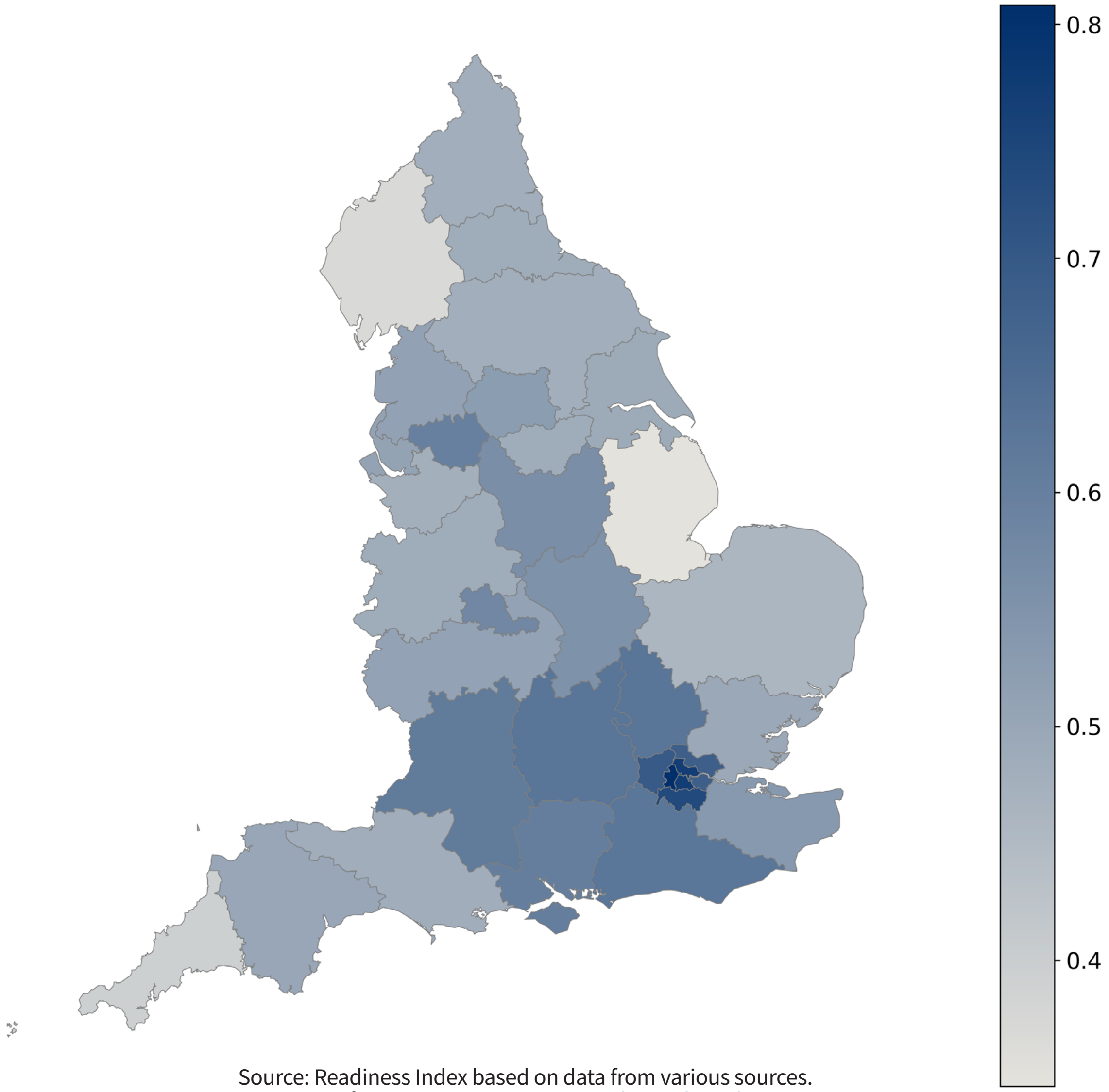
The Human Capital dimension of the Disruption Index examines the characteristics of a region's workforce with respect to its size, skills and qualifications, and the investment made in education to further advance those skills. Divided into five subdimensions of 'Basic Skills', 'Workforce', 'Investment 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.

Looking at the role of different subdimensions, we see that the total scores for London and the South-East are boosted by the Workforce subdimension, driven by their densely populated areas, which create a large pool of potential well-qualified workers. Inner London West also stands out in terms of post-secondary education, due to the presence of several large, leading universities.

We also see that the Basic Skills and Investment in Education subdimensions generally tend to favour urban areas, with regions like Greater Manchester and the West Midlands leading in terms of these indicators. Adult Education bucks this trend, with less urbanised areas such as Devon and Hampshire and the Isle of Wight scoring higher than urban areas, such as Merseyside and the West Midlands.

The Infrastructure dimension of readiness consists of four indicators examining the internet and mobile phone connectivity of regions. In an economy that increasingly relies on digital communications and high-speed connectivity, access to fast and reliable networks is essential for competitiveness. Overall, we find that ICT infrastructure is the most equal of all subdimensions in the Disruption Index, with mobile phone and high-speed internet now widespread across England. London has the highest overall ICT scores, followed by the urban centres of the West Midlands, Bedfordshire and Hertfordshire and Greater Manchester. Rural and coastal areas have lower scores. For example, mobile phone coverage in both Cumbria and Dorset and Somerset increased from around 25% to 60% over this period, but still lags well behind

Figure 1.4 - Geographical distribution of Readiness scores in 2020

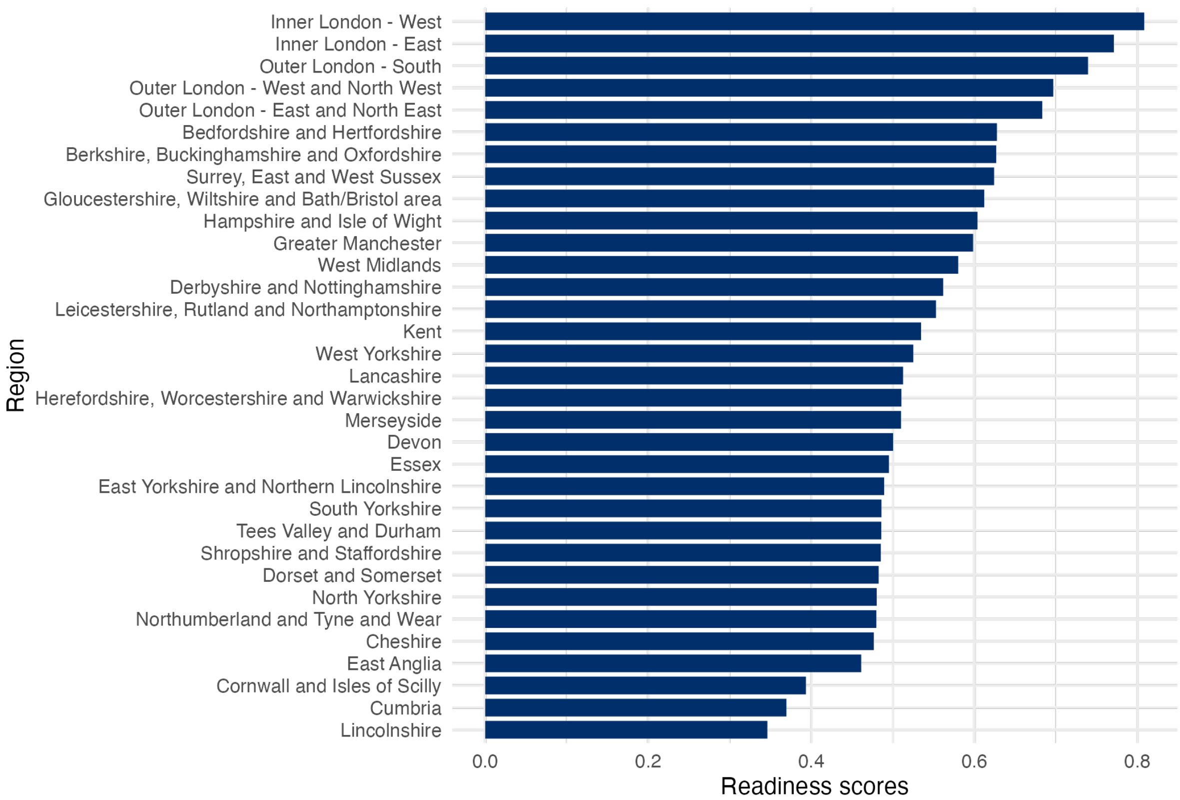


Source: Readiness Index based on data from various sources.
For more information, see Disruption Index Technical Report

central London with almost 100% coverage already achieved by 2016. However, we note that these differences are mostly small, especially when compared to other subdimensions related to human capital and are far smaller than those observed in all subdimensions of the TTI.

From this analysis it is evident that the readiness of a region to accept new technology is not the reason for the unequal distribution of high-tech investments. Although the quality of labour is an important factor in attracting high-tech investments, within the country labour is mobile. Our view is that the reason places like London and the South-East have more highly qualified personnel who could work in new high-tech companies is that young people with suitable degrees move there to get the jobs. And when looking for a university to qualify in high-tech subjects, they choose to go to the top universities located in the areas that also attract the high-tech investments, like those in the Golden Triangle of London, Oxford and Cambridge.

Figure 1.5 – Readiness scores in 2020

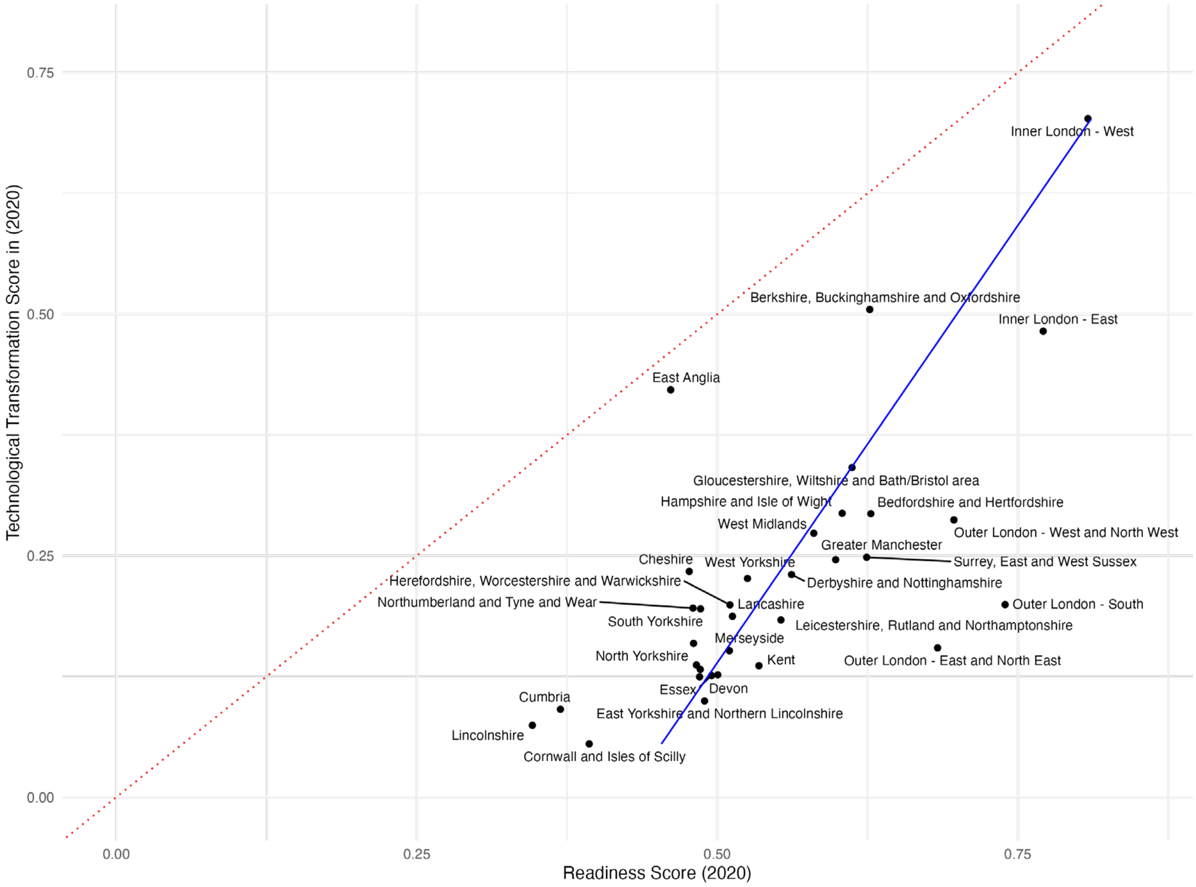


Source: Readiness Index based on data from various sources.
For more information, see [Disruption Index Technical Report]

There is an inherent difficulty in the quest to find the exact reasons that some parts of the country attract more investments and more qualified people to work with each other. This is because of what is known as the agglomeration externality: whatever the reason that triggered the advantage initially, once a region establishes itself as one that can provide the resources needed for a high-tech company to flourish, it then attracts more of them (see Miyauchi, 2024, for a recent test with Japanese industry data). Considering this, the way to make neglected regions attractive to more investors is to find a way of breaking the vicious circle of low investment and the out-migration of qualified labour. Moreover, it would be futile to try and break the vicious circle by putting obstacles on young people prepared to migrate because of the absence of good job opportunities. Efforts should be directed at improving the investment incentives and bringing local universities and industry closer together for fruitful collaborations.

Given what we said about labour mobility as the differentiator between regions on the readiness criteria, it is not surprising to find a good correlation between the regions that do well on technology adoption (high TTI) and those that have more attractive workforces (high RI). Figure 1.6 shows this relationship, where the positive correlation between the two measures is evident. The reason that the blue line that shows the correlation is steeper than the dotted red line, drawn at 45 degrees to show points of equality between the scores, is that there is more inequality in the TTI score than in the DI score. An interesting feature about the location of the individual regional points in relation to the blue line is that the points above it are ones that given their readiness index, they take on more new technology than the average (they punch above their weight), and those below experience the opposite. So, we see East Anglia and Berkshire, Buckinghamshire and Oxfordshire as the two regions that punch most strongly above their weight, whereas Outer London and London East are the regions that fail to match their high readiness score with new technology adoption. The reasons for this differentiation might well be related to the quality of their educational institutions, respectively Cambridge and Oxford, which is an unmeasurable in our index.

Figure 1.6 – Technological Transformation and Readiness scores in 2020



Conclusions

Our analysis of technological disruption across the counties of England has unearthed stark inequalities. Most marked of these are between the wider South-East, centred on the capital, and the rest of the country. Although some of these can be explained by industrial structure, this is not even the main story. The South-East attracts more investments and better qualified human capital, and the companies located there are engaged in more research and more development and application of new technologies.

Of course, unless we go back to City States, we cannot expect activities related to the development of new technologies to be evenly spread across the country. No country in the world exhibits such a feature. But the United Kingdom has urban centres outside the South-East, which are well endowed with digital infrastructures and good workforces, which could develop their own niche technologies. Although there are notable new developments in this direction in the North-West over the six-year period of our study, cantered around Greater Manchester, the gap between the South-East and the rest of the country widened further over this period.

Given Britain's economic structure, dominated by high-level services such as business management and finance, it is more important than ever that more focus is placed on the development of new technologies at the local level; unlike robotics, which find applications mainly in manufacturing, more recent AI technologies are service-oriented.

Even in robotics, however, defined as self-propelled individual units that can perform tasks independently, Britain is well behind its competitors. British manufacturing is not even in the top 20 countries in the world in terms of robots in use, employing about 111 robots per 10,000 workers, when countries like Germany employ more than 400, and Spain, the country that ranks 20th, employing 169 (International Federation of Robotics, 2024). This failure to match its competitors in manufacturing might be partly explained by poor R&D activities at the manufacturing hubs, which are needed to adapt the technology to Britain's needs, and to a less export-oriented manufacturing than its competitors. Britain's export performance in manufacturing matches that of Southern Europe, rather than that of the Northern countries that it considers its main competitors (Kapetaniou and Pissarides, 2025)

The development of more research hubs in urban centres outside the South-East, mainly in Greater Manchester and the North-West, in the West Midlands centred around Birmingham, and in the North-East cantered around Newcastle, will improve this situation. It will enhance the competitiveness of manufacturing by increasing the adoption of automation technologies in the form of high-tech robots, and – more importantly given the relative sector sizes – it will open the door to the development of AI technologies that can be employed across the whole economy. The key to this development is the one that can break the vicious circle of low investment and out-migration of highly qualified workers, both of which converge in the South-East. Policies that can contribute to this direction are discussed in later sections of this Report.

1.2 The Changing Landscape of Skills

Dr. Bertha Rohenkohl,
Milla Hamunen,
Professor Mauricio Barahona,
Dr. Jonathan Clarke

Key Working Papers from the Review:

Old skills, new skills - what is changing in the UK labour market - R. Costa, Z. Liu, C. Pissarides, B. Rohenkohl

Patterns of co-occurrent skills in UK job adverts: a novel clustering analysis to inform policy - L. Zhaolu, J. Clarke, B. Rohenkohl, M. Barahona

Learning to grow: how to situate skills in an economic policy - R. Costa, Z. Li, S. McNally, L. Murphy, C. Pissarides, B. Rohenkohl, A. Valero, G. Ventura

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Learning to Grow was produced in collaboration with the Centre for Economic Performance (CEP).

The authors thank the CEP at the London School of Economics for the facilities made available for this research and the very helpful comments received from several of its members. Many thanks are also due to colleagues at Adzuna Intelligence, particularly Scott Sweden and James Neave, for supplying the data used in this report.

As highlighted by the Disruption Index in the previous chapter, the UK labour market is undergoing profound changes, driven by rapid technological advances alongside other megatrends such as globalisation and demographic shifts. These forces are reshaping how work is organised, what tasks are performed, and which skills are essential for success in the workplace.

It is to this key question of skills – a fundamental dimension of 'readiness' to overcome frictions and enable technological transformation – that we turn in this chapter.

In recent years, the pace of change has continued to accelerate. Entire skills - and indeed, whole new jobs - are emerging, while others are disappearing. Consider, for example, the rise of jobs such as artificial intelligence (AI) specialists or cybersecurity analysts, which barely existed before the 2000s and are now rapidly growing roles in the modern economy. Technology is a major driver of new job creation, but some new jobs are also the result of new products and services being created to meet consumer demand, such as those for an ageing population.

As these changes unfold, it is becoming harder for employers across many sectors to find the right talent. In today's labour markets, skills gaps – the difference between the skills that employers need and the skills that workers have - represent an important source of labour market friction. This is a global challenge and is not unique to the UK. A recent Manpower Group survey (Manpower 2024) found that three out of four employers worldwide, spanning 41 countries, report difficulty in filling roles. In the UK, the most recent data from the Employer Skills Survey (ESS) (UK Government 2022) revealed a similar trend, highlighting that 'skill shortage vacancies' – positions that are hard to fill due to a lack of qualified candidates - are on the rise. Echoing the global findings in the Manpower survey, the ESS survey showed that more than a third (36%) of all vacancies in 2022 in the UK were skill shortage vacancies, compared to 22% in 2017.

These studies illustrate the highly dynamic, fast-changing nature of labour markets today, where the ability of workers to adapt and acquire new skills is becoming increasingly important. Recent estimates by the World Economic Forum indicate that 6 in 10 workers will require training to acquire new skills before 2027 (World Economic Forum 2023), an issue that becomes even more pressing in the context of the closely linked green and digital transitions. Without the right mix of skills, firms and economies will struggle to respond and adapt to take advantage of new advances in technology that will help to improve productivity.

Understanding the changes in skills demand is therefore not only a question of education and workforce development, but rather a cross-cutting issue encompassing questions around economic policy, industrial strategy, education and the changing role of universities, as well as the purpose of work for people. This is why, in the context of technological disruption, research into skills is a central thread running through the Pissarides Review into the Future of Work and Wellbeing.

One key element of our research involves characterising labour market trends through large-scale analyses of new extensive sources of data that can provide a system-wide picture of skill requirements in the UK labour market. Using data from a comprehensive platform of online job adverts, we explore which skills are currently being demanded by UK employers, highlighting skills that are both rapidly emerging and disappearing. We examine the speed at which different occupations are changing, and how skills trends are being shaped across cities of different sizes across the whole UK. We also study this extensive data with cutting-edge clustering and network analytics to capture the interlinkages and interdependences across skills in the UK labour market, and to extract data-driven skills clusters, i.e., skills that consistently appear together as requirements within job adverts. Additionally, we examine which skills are most central in this skills network, and which skills are more versatile across a range of jobs.

As the UK labour market continues to evolve rapidly, it is increasingly clear that a long-term strategy for skills development is needed. Such a strategy must be informed by up-to-date data and research into skills needs, and it must be adaptable and responsive to the rapid changes happening at the system, firm and individual levels. Only by doing so, will the UK workforce remain adaptable to these changes and well-prepared for the future.

Using online job adverts data to understand skills trends

Analysing online job adverts data has become a powerful approach to examining skills trends and anticipating labour market needs. This type of data offers a real-time snapshot of what skills are sought-after by employers across the whole economy, providing insights into skills that are valued and in demand today, as well as those likely to be relevant in the near future.

Key advantages of online job advert data are its richness of detail, timeliness and granularity (Cammeraat and Squicciarini 2021). Importantly, this data enables a more detailed view of skill changes beyond the broad conceptual categories used in traditional workers' surveys. Thanks to recent advancements in natural language processing techniques, data analytics and cloud computing, researchers can now analyse these large, and often unstructured, datasets with accuracy and speed.

It is now widely recognised that online job adverts can be used as a source of valuable insights that complement other types of survey-based analyses or skills forecasts (Cedefop, 2021). Unlike sources that rely on retrospective data, such as employment data, online job adverts allow us to see what is happening in the labour market in near real-time. This can be a useful complement to other methods, such as scenario-based forecasting of future skill needs, which typically rely on assumptions about the occupational composition of the economy and how the job market will evolve.

In recent years, the use of big datasets of job adverts has gained traction with policymakers, governments and international organisations and is quickly becoming an indispensable tool in modern labour market analyses. In the UK, the Office for National Statistics (ONS) and various local authorities are already using online job advert data to inform their analyses (Office for National Statistics 2024). Globally, institutions like the Organisation for Economic Co-operation and Development (OECD) and EU agencies like the European Centre for the Development of Vocational Training (Cedefop) have also incorporated this data. Cedefop has recently released the Skills-OVATE platform, which provides data on online job adverts for 32 European countries (Cedefop 2024). These datasets have been shown to be largely representative of the vacancies in different regions and occupations. As not all jobs are advertised online, these platforms are unfortunately unable to cover the whole economy, particularly omitting vacancies that are not advertised online - generally in the very highest and lowest paid roles. However, these data resources still provide an extensive snapshot of labour markets across sectors and geographies.

In the Pissarides Review, our research on skills draws on data from Adzuna Intelligence covering the near universe of UK online job postings from 2016-2022. Adzuna is a comprehensive online job search engine that aggregates information from a variety of sources, including employers' websites, recruitment software providers and traditional job boards, via weekly snapshots. By aggregating this data, Adzuna provides information on the stock of job postings and a detailed view of a wide spectrum of job adverts across the

UK, covering an estimated 90% of all online vacancies (Bassier, Manning, and Petrongolo 2023).

The Adzuna dataset contains rich textual information on the jobs advertised. Each job advert includes details, such as job titles, company names, posting dates and locations. Adzuna also categorises adverts according to their Standard Occupational Classification (SOC) codes and provides a derived list of skills required for each role, extracted from the text of the advert. We then match these skills to the Open Skills taxonomy developed by Lightcast (formerly known as Burning Glass Technologies), another organisation specialising in online job adverts data. The Open Skills taxonomy is an open-source library that offers a hierarchical classification of skills into 32 thematic groups and over 400 subcategories. We emphasise that we use the skills terminology in the Open Skills taxonomy for analytical convenience and comparability with other work, without necessarily endorsing it. For more detailed information on how this data was processed, please refer to our Old Skills, New Skills report.

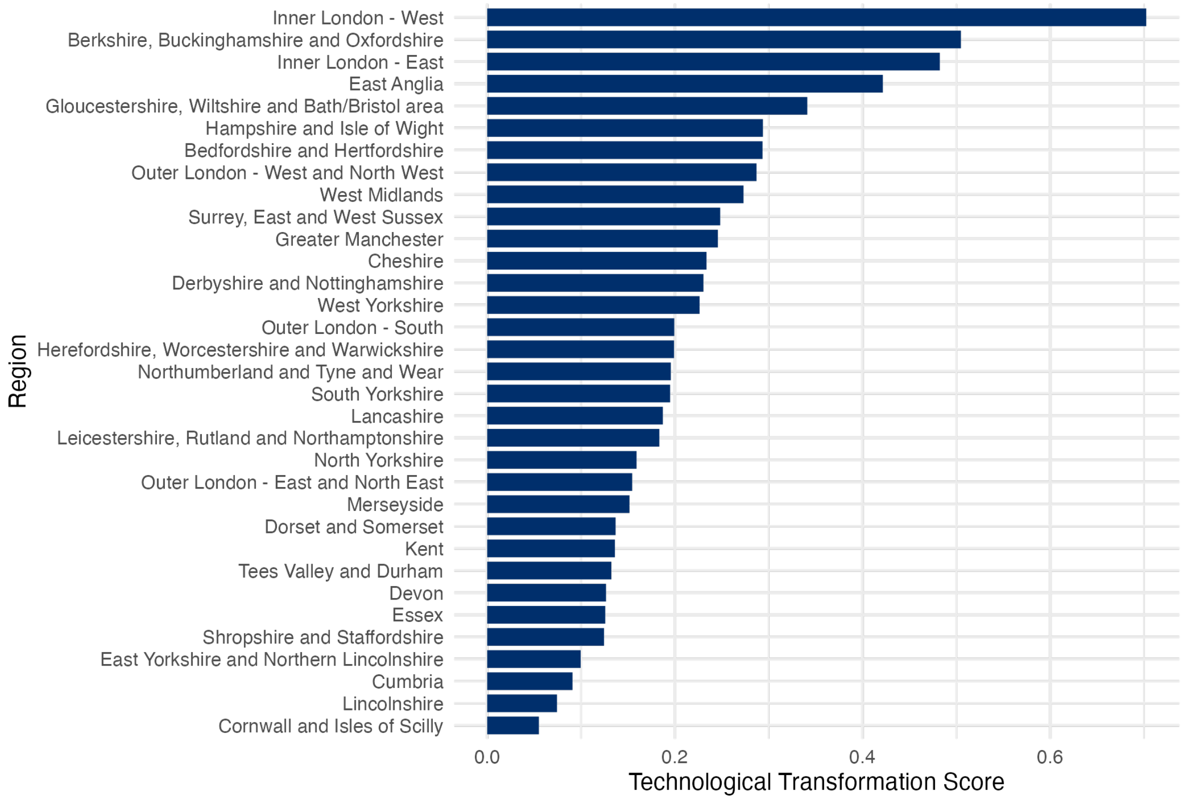
How is demand for skills changing in the UK?

In our Old Skills, New Skills report (Costa et al., 2023), we conduct an in-depth analysis of the skills required in UK online job adverts from 2016 to 2022. This period captures important changes in the UK labour market, from rapid technological innovation to the Covid-19 pandemic. Our study highlights both skills that have gained importance and those that have declined, also quantifying, for the first time, the speed at which different occupations are changing.

To begin with, we examine the current categories of skills that are in high demand in the UK labour market. On average, each advert in our sample lists around 10 distinct skills. When looking at the broad thematic categories of the skills mentioned, the most frequently mentioned ones reflect the nature of the British economy, which has become overwhelmingly a service-based economy, focussed on business and management service provision (see Figure 1.7).

As shown in Figure 1.7, Business skills were the most frequently cited in 2022, appearing in 79% of job adverts. This category includes skills related to Management, Operations, Strategy and Consulting, among others. Following behind are Social Skills, Leadership and Critical Thinking skills, which appeared in 59% of vacancies. This category encompasses skills related to critical thinking, problem solving, initiative and leadership and other interpersonal skills. In third place we have Media and Communications (54%), which includes communication, writing and presentation skills. Customer and Client Support (49%) is another highly sought-after skill category, covering client services, customer support and customer experience skills.

Figure 1.7 - Most in demand skill thematic categories in 2022 (% of job postings)



Source: Analysis of data provided by Adzuna Intelligence

A closer look at the technology-related skills, focusing on IT and advanced data analysis, reveals a large increase in their mentions over this period. By 2022, as many as 34% of vacancies mentioned at least one IT skill, and 23% required at least one analysis-related skill, showing that they are not exclusive to "high-tech" jobs. Among the most frequently cited IT skills we have Computer Literacy, Programming, SQL, and Databases, while popular analysis skills included Analytics, Data Analysis, Forecasting, and Business Intelligence. These technology skills were especially prevalent in adverts for jobs in Science, Research, Engineering, and Technology, where 85% of adverts required IT skills and 42% demanded analysis skills. Technology skills are also in high demand for Corporate Management, Business, Public Service, and Administrative roles.

To explore the most rapid changes in skills demand, we define emerging or new skills as those mentioned at least three times more frequently in 2022 than in 2016. Conversely, disappearing or old skills are defined as those whose mentions halved over the same period.

Our analysis identified 174 new skills and 437 old skills, accounting for approximately 16% of all individual skills recorded in our data. Given the rise of digital technologies in workplaces, it is not surprising that most new and old skills are related to Information Technology (IT) and Healthcare. Together, these two categories account for about a third of new skills and 60% of the disappearing skills.

In 2022, 8% of all job adverts featured new IT skills, while 26% of IT skills advertised in 2016 were much less in demand in 2022. Emerging IT skills include software development methodologies such as DevOps and CI/CD, along with technical competencies in Cybersecurity and Machine Learning. On the other hand, some IT skills that were once in high demand – such as Microsoft SQL servers, PHP (a scripting language) and HTML5 – are being mentioned less frequently (although some remain used), reflecting that the diversification of tools in the market and advanced technical skills now required.

Our report also examines the speed of change across different occupations, identifying which jobs have undergone the fastest and slowest transformations since 2016. We measure this by calculating the skill turnover of specific occupations (at 2 and 4-digit SOC level) – which captures the absolute difference in occupational skill shares between 2016 and 2022. This metric helps us determine how quickly the skills required for a specific occupation are evolving and allows us to rank occupations by speed of change. For more details on this method, please refer to the full Old Skills, New Skills report.

The fastest changes – those with highest rates of turnover - were observed for occupations within the major groups of Protective Service Professionals, followed by Science, Engineering, Technology professionals and associates. On the other hand, the slowest changes are observed among Teaching professionals, Textiles, Printing and other skilled trades and Transport operators, where the demand for existing skills has remained more stable.

Looking at detailed occupations within these groups (at the 4-digit SOC code level), the fastest-changing roles include computer system and equipment installers, electrical trades professionals, aerospace engineers and design occupations. These jobs are increasingly demanding specialised skills in areas like cybersecurity and network security, electrical and computer engineering, circuitry, data analysis and UI/UX design (see Figure 1.8).

In contrast, among the slowest-changing occupations we find teaching professionals, elementary construction workers, elementary trade occupations (e.g. stonemasons, carpenters) and machine operatives. However, it is important to note that while our data reveals that these roles are evolving more slowly, this doesn't mean that their skills are static – this could also reflect job adverts being more generic. For example, an advert for a teaching role might mention "teaching skills" but not go into more detail about the type of teaching, technology used, or techniques involved.

Throughout our analysis, some of the biggest changes we observe are related to the adoption of new technologies. While adverts for some occupations, such as for professionals in Science, Research, Engineering and Technology tend to demand a high percentage of both IT (85%) and analysis (42%) skills, we also observe that the demand for tech skills goes well beyond the traditionally tech-intensive occupations.

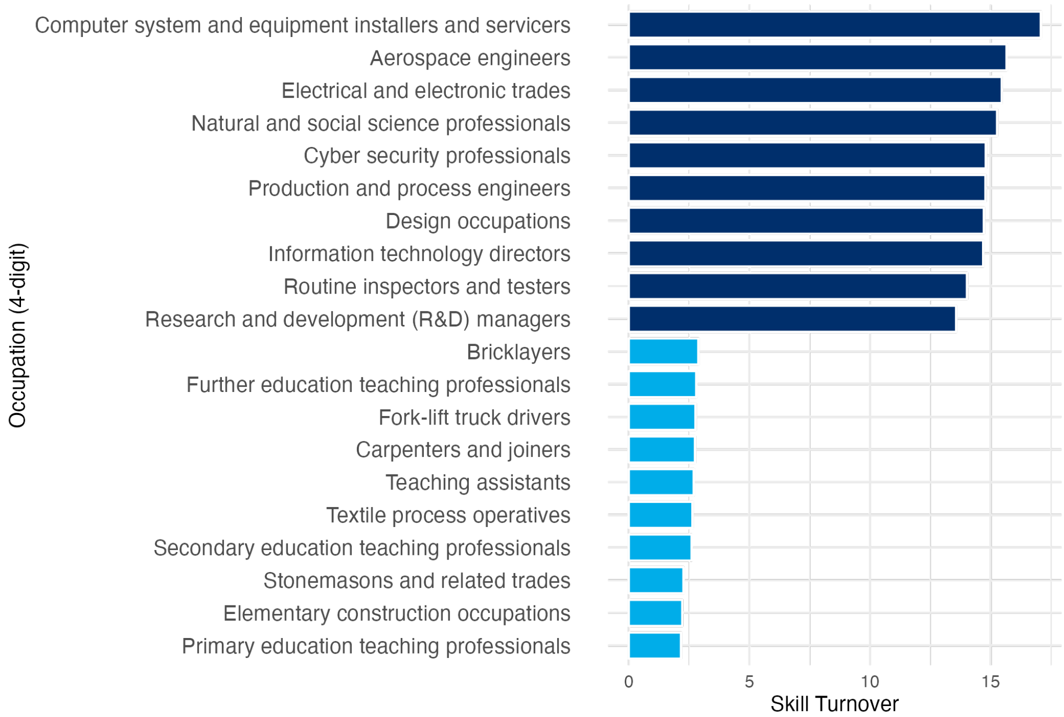
Despite the rapid rise in demand for these technology-related skills, our analysis also highlights the increasing importance of non-technical, foundational and leadership skills. Skills such as clear communication, high-quality client services, problem solving, and effective customer relations remain highly sought after, with some of these seeing a rapid increase in demand. In our data, we see that logical reasoning, systems thinking, critical thinking and creativity emerge as new skills, with mentions increasing more than three-fold over the six-year period. This aligns with broader findings in the literature that emphasise the growing importance of these "21st century" skills, recognising they are crucial for innovation and enhancing workers' ability to adapt (World Economic Forum 2023).

Variation in skills demand across the UK

While national analyses provide important insights into overarching trends in skills demand, focusing exclusively on national trends in skills demand may overlook important regional and city-level differences. This is particularly significant in a country like the UK, which is one of the most regionally unequal countries in the OECD.

Our work for the Pissarides Review has shown how technological transformation is disproportionately concentrated in London and some surrounding regions, while other parts of the country see less investment and innovation activity (chapter 1.1 of this Report). This

Figure 1.8 - **Occupations (4-digit SOC code level) with largest and smallest skill turnover**



Source: Analysis of data provided by Adzuna Intelligence geographic concentration of innovation is related to differences in employers' skills demands across various regions. Understanding these regional differences is crucial if technology adoption is to help close regional inequalities, rather than further entrench them, and expand access to broader opportunities for people.

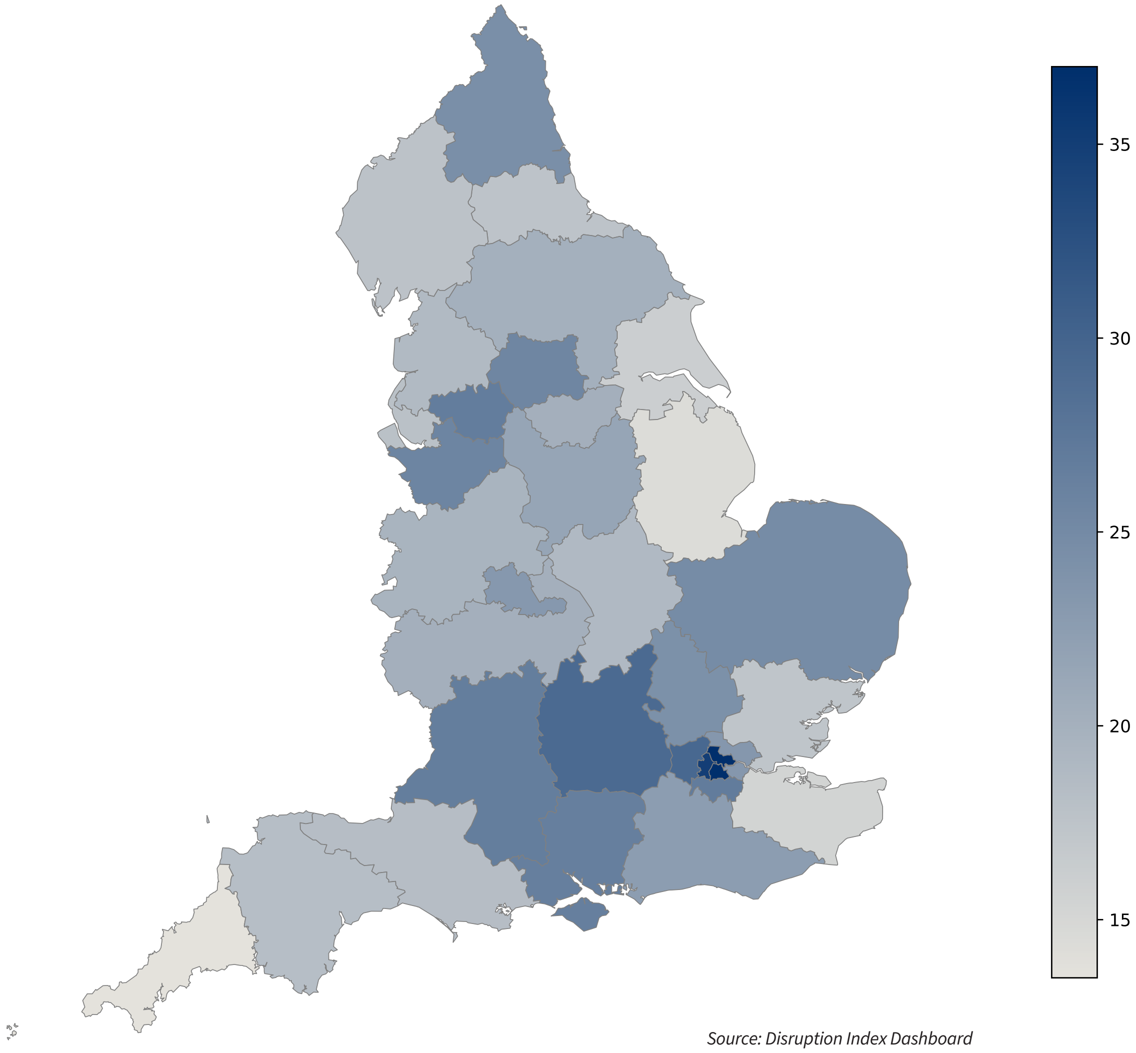
As part of our Disruption Index, we examined the demand for technology skills at the regional (ITL2) level across England (Figure 1.9). This indicator captured the extent to which firms are integrating new systems and tools, requiring a workforce that is equipped with the necessary skills to utilise them effectively. By 'technology skills' we mean those in the categories of Advanced Data Analysis and Information Technology, which include skills like data analysis, data science, data visualisation, image analysis, maths and mathematical modelling, statistical software, NLP, business intelligence (all within "Analysis") and API, AI and machine learning, programming languages, cloud computing, computer science, data collection and storage, databases, IoT, cybersecurity, network security (within "Information Technology").

Our data reveals significant disparities in the demand for technology skills across England, with a high concentration of 'tech jobs' in a few regions. West and East London lead significantly in tech job vacancies, reflecting their status as tech hubs. The growth in these types of postings in other regions since 2016 likely reflects the presence of large anchor tech employers. e.g. Berkshire/Bucks/Oxford (Microsoft) and Gloucester (GCHQ and the fast-growing cluster).

In a forthcoming paper exploring geographic analyses in the Adzuna dataset, we look in depth at how skills demand in job adverts varies across 63 cities in the UK, and how the pace of change in skills differs by geography. Our report considers all 63 cities as defined by the Centre for Cities, i.e., continuous areas of built-up land containing urban structures that are within 50m of each other and with an overall daytime population of more than 135,000 people. These areas were then mapped to the best fit local authority districts. The cities in our sample span a wide range of labour market sizes, from London, with over 10 million residents, to Worthing in East Sussex, with around 110,000 residents.

For this more granular analysis, we use the Adzuna dataset and focus on job adverts grouped according to their 3-digit SOC occupations (in contrast to the 4-digit SOC level used in the national analysis), and we group individual skills into broader skill subcategories of the Open Skills taxonomy. Our analysis focuses on the 30 most common occupations (at 3-digit SOC). We then use two metrics to understand changes in the composition and relevance of different types of skills across occupations and cities:

Figure 1.9 - Demand for Tech Skills (% of job ads)



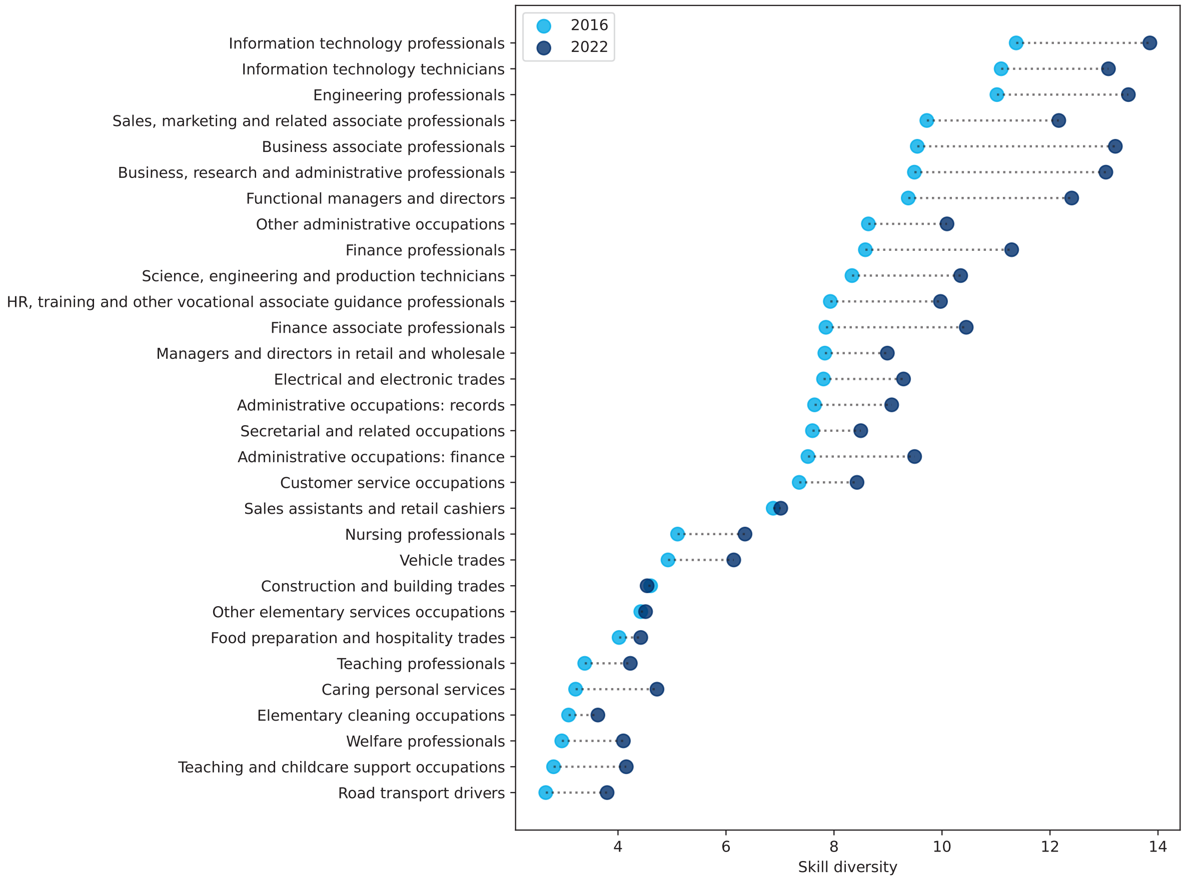
Source: Disruption Index Dashboard

- **Skill diversity** refers to the number of different skills thematic categories present in the descriptions of job adverts. Higher skill diversity indicates a broader range of skills required for a particular occupation.
- **Skill turnover** is used to examine the speed of change in the categories of skills mentioned in job adverts over time, in a similar way to the approach taken in our national Old Skills, New Skills study. Skill turnover reflects how quickly the demand for specific skills within a specific occupation is evolving.

First, our analysis shows that skill diversity varies markedly by occupation. High-tech occupations, such as those in IT and engineering, tend to require a more diverse set of skills (Figure 1.10). For instance, in 2022, IT job postings mentioned, on average, 13.9 skills categories, compared to occupations in cleaning, which mentioned, on average, 3.6 skill categories. From 2016 to 2022, growth in the number of skill categories being asked for was observed across occupations, particularly in business, sales and IT roles.

Skill turnover is highest in high-tech occupations. As is also seen in the national data, the pace of change in skills is much faster in technology-focused occupations, such as those in IT. However, we see that postings are highly concentrated in London, which accounts for around 41% of all job adverts, and this influences the overall national trends.

Figure 1.10 - National skill diversity in 2016 and 2022 for each occupation



Source: Analysis of data provided by Adzuna Intelligence

We found that the more skills mentioned in a job advert, the higher the turnover; that is, when a job requires a broad range of skills, those skills are more likely to change over time. Our data shows that high skill turnover is more often due to new skills being added to job adverts, rather than existing skills being removed.

In cities where skill turnover is highest for a particular occupation, we also observe an increase in skill diversity over the same period. This suggests that as employers in a city adapt to new market conditions or technologies, they are also broadening the set of skills they require from workers.

At first sight, the average level of skill diversity or skill turnover does not vary greatly between UK cities. Yet, upon closer inspection, differences across cities appear when focussing on specific occupations. Overall, larger cities tend to have lower turnover of skills, but this is largely driven by differences in skill turnover in 'high-tech' occupations between large and small cities. For example, IT professionals in many smaller and medium cities have higher skill turnover than in London. Yet, looking from 2016 to 2022, this seems to be a result of these cities 'catching up' with the skills London's employers were already demanding in 2016. In some cases, cities even outpace the capital in adopting new technologies, such as uptake of cloud computing in Wigan, leading to changing skill requirements of the local workforce as a result.

For other occupations, such as sales assistants, there is no clear relationship between skill turnover and city size.

Across the whole country, employers are increasingly demanding non-technical skills, even for more technical roles. For example, a large proportion of skill turnover in IT jobs comes from an increase in demand for Initiative and Leadership skills – these include skills like quick learning, motivational skills, time management and emotional skills.

Some of the observed idiosyncrasies in skill turnover and skill diversity could be driven by the presence of a major employer within a region (e.g. high skill turnover in engineering jobs in Luton, where Luton Airport is located), or the demographic characteristics of an area (e.g. high skill turnover in nursing in Worthing, where 11.2% of the population are aged 75 or above, compared to 8.5% in England overall). Other evidence suggests that large employers can demand a greater number of skills, with the impact being more profound for low-skilled professions (Hershbein and Macaluso, 2018).

While the Disruption Index shows that technological disruption is heavily concentrated in London, human capital and digital infrastructure, which are needed to take advantage of these technologies, are far more evenly spread across the UK. This mismatch, along with variation in the different facets of human capital, including educational attainment, labour market size and opportunities for on-the-job training highlights the need for more tailored solutions to ensure cities across the UK are able to thrive.

Overall, these findings demonstrate there is no 'one size fits all' approach to understanding the changing skills requirements of the cities of the UK. Instead, appreciation of the local characteristics of cities - their size, their current and historical industrial composition and local labour markets (as well as that of their close neighbours), to mention a few - is crucial to developing effective, targeted policies to assist workers in navigating the changing skills demands of their local labour markets..

Mapping the skills network based on employers' demand for combinations of skills in the UK

Jobs often require workers to apply a wide range of skills to do their work effectively. Understanding how these skills manifest within jobs and how they relate to one another can provide insights into the ability of workers to carry out their tasks, to adapt when their jobs are changing, or to find alternative jobs. With new technologies at work changing the nature and tasks of many jobs, studying the relationship between skills and tasks is crucial to understand how jobs are being affected by technological change.

Traditionally, the relationship between skills and tasks has been studied using a task model to explore and predict the impact of new technologies on workers and jobs (see Acemoglu and Autor, 2011; Acemoglu and Restrepo, 2019 for reviews). In this model, a task is defined as a unit of work activity that produces an output, such as goods and services, and skills are seen as the worker's know-how that allows them to perform these tasks.

Seeing skills and tasks as distinct concepts highlights the versatility of skills compared to tasks. For example, workers with a particular set of skills may perform various tasks and be employed across different occupations. Some jobs require skills that are specialised for that role, while others require a mix of specialised and more general skills that help workers switch between tasks (and even roles) more easily (Alabdulkareem et al., 2018). In the current rapidly changing labour market, being able to assemble and adapt a relevant bundle of skills is increasingly important to take advantage of this technological evolution.

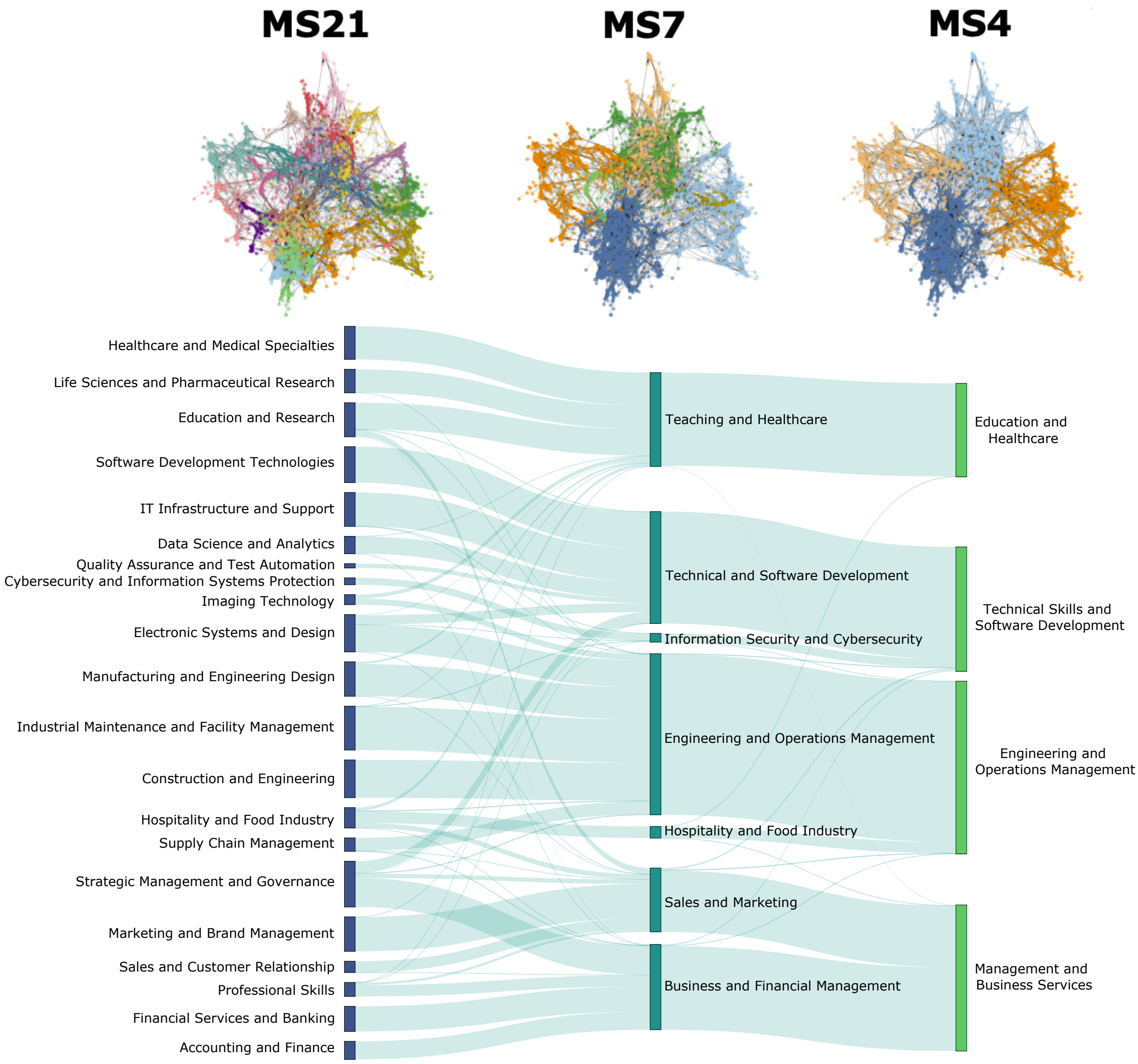
Unpacking the association between a job, its tasks, and the skills it requires is a complex challenge. Indeed, skills do not exist in isolation – they interact and complement each other in non-trivial ways when performing tasks in a job. A recent approach to study this association is to analyse large datasets of job adverts where skills are required conjointly by employers. As mentioned above, these datasets provide rich information not only about the skills employers are currently seeking, but also how employers see these skills being combined for different jobs. We therefore examine how often individual skills occur and co-occur with other skills, as a means to study their complementarity and synergy. In this sense, job postings represent a direct view from the employer's perspective of the skills that need to be matched to a job within an organisation. This is a more practical view of the skills-job interlinkage, in contrast to focusing on a worker's educational history, qualifications and other competencies, which may not map neatly to the skills that employers require (Autor and Dorn, 2013). Overall, this data-driven approach provides an alternative entry point to examine important combinations of skills in an agnostic manner, as derived directly from the extensive data available across the UK labour market.

Given that our focus is on the interlinkages and co-occurrence of skills required within a job, it is natural to apply network analysis methods to this problem. Network analysis allows us to map how different skills are related to each other based on how they appear together in job postings, and to analyse the overall system of complex interlinkages and interdependences between skills across the whole UK labour market. Similar network methods have been applied to characterise different economic problems, from international trade networks (Hidalgo and Hausmann, 2009) to the skills capabilities of cities; from skills basins in labour networks (O'Clery and Kinsella, 2022) to the economics of environmental sustainability (Hidalgo, 2021; Balland et al., 2022).

In related studies, skill networks have been shown to predict worker transitions between occupations and have revealed how skills frictions and geographic frictions affect job transitions (Frank et al., 2024; del Rio-Chanona et al., 2021). Other research has found that cities with highly connected skills networks (i.e., where skills are not required in isolation but rather appear conjointly with others) displayed greater economic resilience during the great recession of 2007-2009 (Moro et al., 2021). In recent and related work, clustering has been used to identify groups of similar skills from a smaller dataset of job postings on an online labour platform (Stephany and Teutloff 2024).

In our forthcoming research (Liu et al., 2025), we use the large dataset of online job adverts from Adzuna, consisting of tens of millions of job postings between 2016-2022, to create a skills network that captures the frequency of skill co-occurrence in job adverts. Considered as a whole, this network captures the system-wide interlinkage between skills beyond pairwise relationships. The skills network so derived from the data is then used to identify clusters of skills that co-occur consistently in the large body of job adverts. This clustering is achieved by applying a multiscale community detection algorithm to group over 3,900 individual skills into skill clusters at different levels of resolution (Figure 1.11). These data-driven clusters represent groups of skills that are commonly and consistently required conjointly by employers. In addition, the analysis provides a data-driven 'map' of how more detailed skills are integrated into larger 'skill categories' in a quasi-hierarchical manner directly derived from the requirements in job adverts.

Figure 1.11 - Skills clusters derived from the skills co-occurrence network that captures the frequency with which skills occur together in job adverts



Source: Analysis of data provided by Adzuna Intelligence

This network of skills is derived from the frequency with which skills co-occur in the Adzuna dataset of UK job adverts. Clusters of skills that co-occur consistently in job adverts were obtained at different levels of resolution using multiscale community detection. The top of the figure shows the skills network, where each of the 3,900 nodes is a skill and each node is coloured according to their assigned cluster at three levels of resolution consisting of 21, 7 and 4 clusters (MS21, MS7 and MS4, respectively). The skills clusters are assigned descriptive labels summarising their content and are also presented within a Sankey diagram that demonstrates how groups of more detailed skills are integrated quasi-hierarchically into larger skill categories.

One interesting finding from our research is that this data-driven process generates thematic groups that are different to the expert classification in the Open Skills taxonomy. Indeed, the relationships between skills in the UK labour market are highly complex, and groups of skills are commonly required alongside one another in ways that are not always expected according to the thematic categorisation of skills by experts. This is discussed at the end of the chapter in more detail.

Although our work identifies groupings at different levels of resolution (Figure 1.11) we focus on the grouping into 21 skill clusters (MS21), which is optimal based on data-driven criteria and of comparable granularity to the Lightcast expert-driven classification.

The skills network summarises how different skills are connected to each other across the whole system, and network analysis can thus capture how central a role each group of skills plays within the UK labour market; how central individual skills are; and the extent to which skills are required alongside other skills from the same cluster or spread across different clusters. To characterise the clusters and the relationships between skills in this network, we use two metrics:

Closeness centrality. Skills with high centrality can be found near the core of the skills network. Skills that are central in this network tend to be shared across a wide range of jobs, meaning that workers with these skills may find it easier to transition between roles.

Skill cluster containment. A high containment means that a skill is more likely to co-occur with skills that belong to the same cluster (e.g. technical skills tend to group together). However, even highly contained skill clusters are strongly linked to skills outside their own cluster and across the network, i.e., we find that there are no skill silos in the UK skills network we analysed.

The key metrics for each cluster are summarised in Table 1.3, together with the number of times that skills from each cluster are mentioned in adverts, the average mentions of skills in each group in an advert, and the total number of skills in each skills cluster.

Table 1.3- Summary of properties of the derived data-driven skills clusters (MS21) ordered in decreasing order of average mentions, per advert, of skills in the cluster

	Cluster	Number of Skills	Number of Mentions	Average Mentions	Skill Containment	Closeness Centrality
1	Strategic Management and Governance	329	116654801	1.79	0.316	0.154
2	Professional Skills	100	79035037	1.22	0.229	0.149
3	Sales and Customer Relationship	81	43746343	0.67	0.276	0.13
4	Hospitality and Food Industry	150	35552886	0.55	0.198	0.138
5	Software Development Technologies	265	34966624	0.54	0.41	0.127
6	Accounting and Finance	129	33423443	0.51	0.285	0.123
7	Construction and Engineering	277	32640316	0.5	0.205	0.147
8	Education and Research	249	31458940	0.48	0.154	0.15
9	Manufacturing and Engineering Design	253	29459698	0.45	0.25	0.145
10	Industrial Maintenance and Facility Management	319	27501198	0.42	0.205	0.142
11	Marketing and Brand Management	249	25570594	0.39	0.248	0.136
12	IT Infrastructure and Support	250	23828152	0.36	0.296	0.127
13	Data Science and Analytics	126	20184523	0.31	0.2	0.131
14	Healthcare and Medical Specialties	241	19464635	0.3	0.322	0.125
15	Supply Chain Management	99	17582566	0.27	0.128	0.148
16	Financial Services and Banking	180	15899362	0.24	0.145	0.137
17	Electronic Systems and Design	277	13615819	0.21	0.175	0.147
18	Life Sciences and Pharmaceutical Research	176	6718425	0.1	0.223	0.128
19	Quality Assurance and Test Automation	31	2920005	0.04	0.129	0.122
20	Cybersecurity and Information Systems Protection	52	2468472	0.04	0.166	0.116
21	Imaging Technology	73	1311933	0.02	0.078	0.133

Our analysis shows that different skill clusters play unique roles within the network. Some clusters are more self-contained and have connections with only a limited number of other clusters - this is collectively indicated by high skill containment and low closeness centrality. On the other hand, other clusters are more general and tend to co-occur frequently with a broader range of skills. These different characteristics within the network may reflect the significance to jobs of general or specialised skills, as we exemplify below.

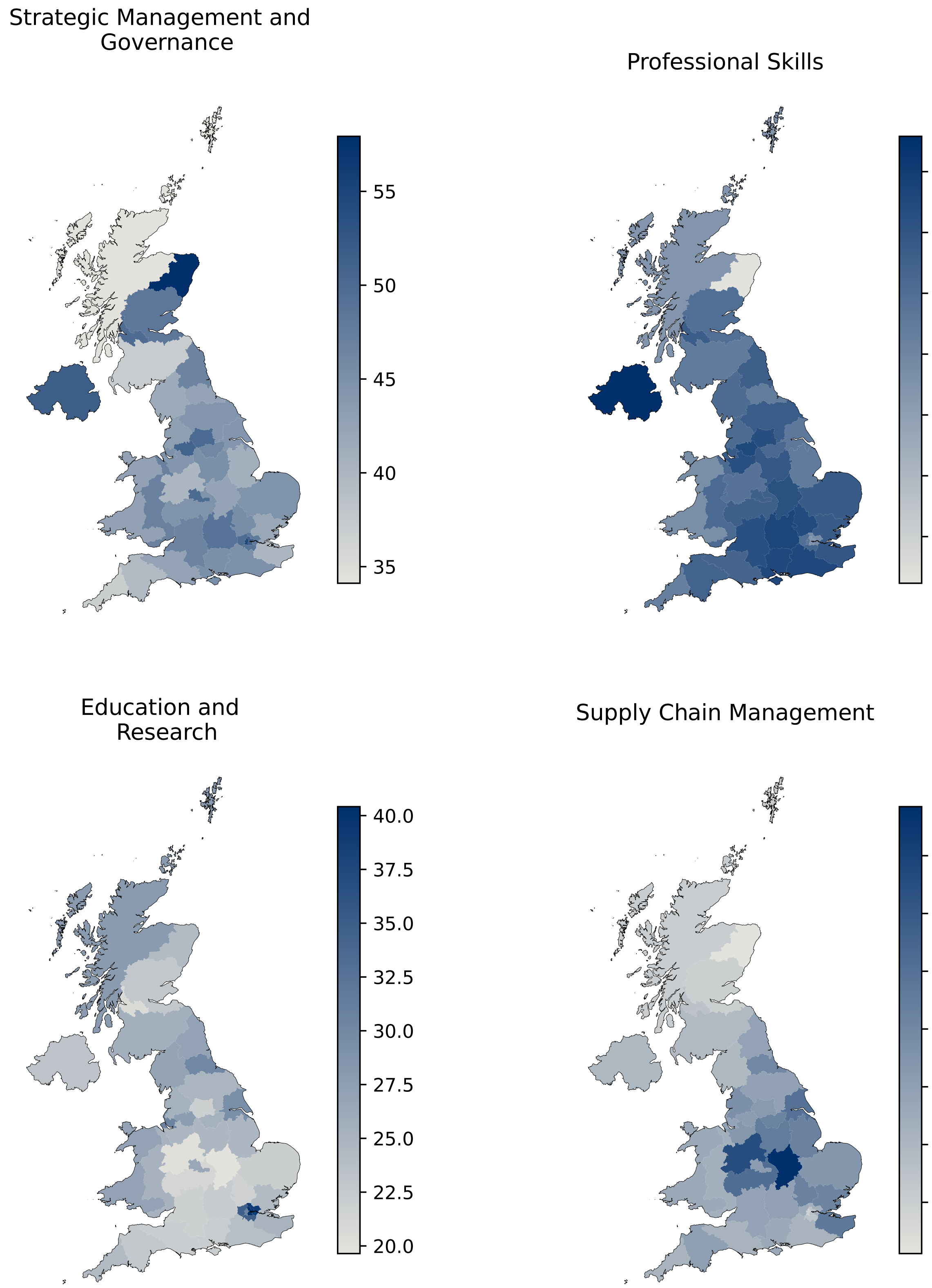
For instance, we see that ‘Cybersecurity and Information Systems Protection’ and ‘Accounting and Finance’ have low closeness centrality, meaning that the skills within these groups tend to have less reach across the skills network and suggesting they are more peripheral or function as supporting skills across sectors. On the other hand, ‘Strategic Management and Governance’ and ‘Professional Skills’ have very high closeness centrality, highlighting the fact that they have a wide reach across the entire network, potentially acting as more generalist skills that are applicable across a broad range of jobs and contexts.

High skill containment is observed for ‘Software Development’, ‘Healthcare and Medical Specialities’ and ‘Strategic Management and Governance’. These clusters have skills that tend to be frequently grouped together, yet even these most contained clusters do not act as skill silos and have strong connections outside the cluster. At the other extreme, ‘Imaging Technology’, ‘Supply Chain Management’ and ‘Financial Services and Banking’ have lower containment, indicating that skills in these clusters are more spread across different roles.

In addition, we see differences in the geographic distribution of the data-driven skill clusters across England (Figure 1.12). For instance, the two most common clusters ‘Strategic Management and Governance’ and ‘Professional Skills’ have quite different spatial distributions, while less common clusters are found in specific regions where their skills are particularly in demand, for example ‘Education and Research’ in London, and ‘Supply Chain Management’ in the Midlands. This largely reflects variation in the industrial and occupational composition of these regions.

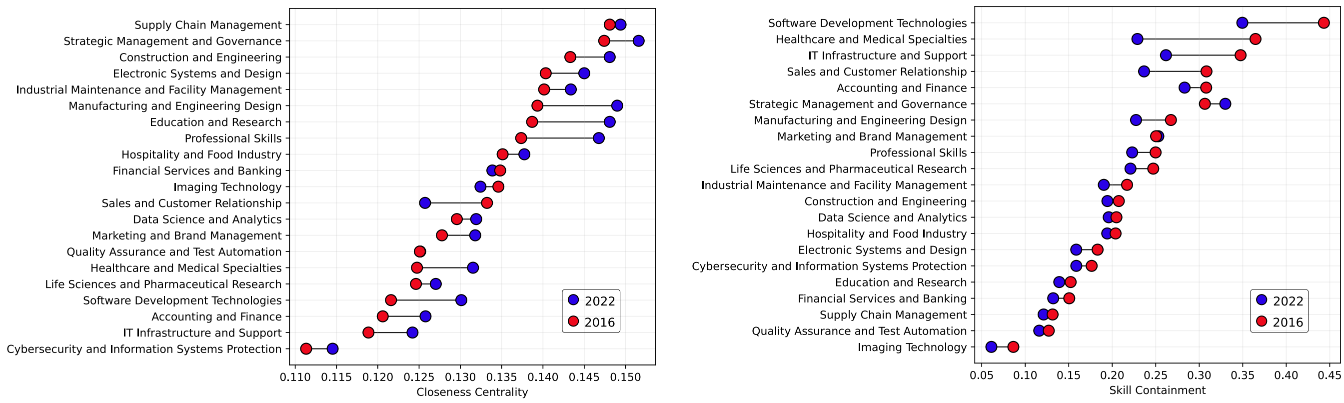
Looking at the skills network in 2016 compared to 2022, we find an increase in the closeness centrality of skill clusters and a decrease in skill containment across the board (with few exceptions), as shown in Figure 1.13. Overall, this indicates an increase in the connectedness of the skills network and a reduction in the isolation of skills groups - thus implying a broadening of the skills required of workers in the UK over this period, both in number and in variety.

Figure 1.12 - The percentage of job adverts in each ITL2 region featuring a skill from four selected clusters



Source: Liu et a. 2024l, based on analysis of data provided by [Adzuna Intelligence]

Figure 1.13 - Change in the closeness centrality and skill containment for the 21 data-driven skills clusters between 2016 and 2022.



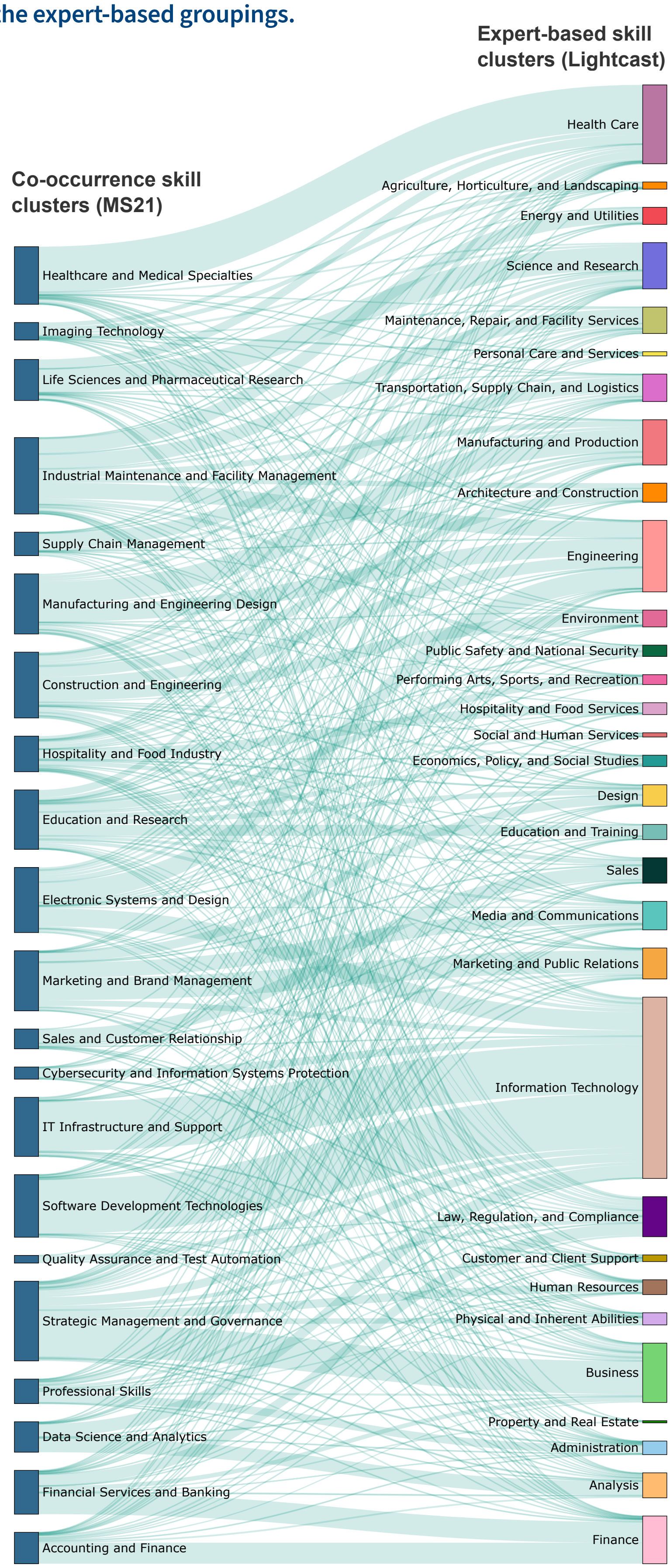
Source: Liu et al., based on analysis of data provided by Adzuna Intelligence

However, this phenomenon is not uniform across skill clusters; it is particularly evident that skills related to software, IT, healthcare and engineering design have become more commonly found alongside less related skills, i.e., these skills have become more central and less contained in the skills network. In contrast, only skills related to strategic management and marketing have become less commonly found with other skills from 2016 to 2022, perhaps signalling the increasing importance of technical skills across diverse occupations. Skills policies should therefore better reflect the widening of the skills demanded by employers, especially ensuring foundational skills and leadership skills are taught alongside technical skills across the education sector. Forthcoming work from the Pissarides Review, examining the relationship between local labour market concentration and wages, indicates that this trend towards diversification of skills by employers may strengthen workers' position in wage negotiations. Employer-driven demand for broader skills may therefore also convey benefits to workers in navigating the labour market within and outside of their present employment.

Finally, grouping skills based on how often they occur together in adverts, rather than how similar experts may consider skills to be, offers the opportunity to find new or unexpected relationships between skills empirically. Comparing the 32 expert-derived skill categories from the Open Skills Taxonomy (Lightcast) to the 21 data-driven skill clusters obtained in our analysis (MS21), we find several areas of commonality and some notable disagreements (Figure 1.14).

These differences are expected and indicate that the basket of skills required by employers often span diverse traditional expert-based categories. For example, a single 'Information Technology' category (in Lightcast) is too broad to capture the varied and distinct roles of IT-related skills.

Figure 1.14 - Sankey diagram capturing the relationship between the data-driven skill clusters (MS21) and expert-based skill categories (Lightcast) highlighting the agreement and differences between skill clusters derived from co-occurrence in job adverts and the expert-based groupings.



Instead, in MS21 this group of skills is spread across several skill clusters, most notably 'Software Development Technologies', 'IT Infrastructure and Support', 'Electronic Systems and Design', 'Cybersecurity and Information Systems Protection' and 'Data Science and Analytics'. Notably, these skill clusters correspond partly to a finer level of the Lightcast taxonomy(sub-categories), confirming the relevance of these finer skill relationships based on expert assessment but signalling that a finer level of granularity would be warranted to represent the observed job advert data.

In other instances, some of the MS21 clusters span several Lightcast categories, likely reflecting the co-occurrence in adverts of skills from different thematic areas, such as the MS21 'Data Science and Analytics' cluster spanning the Lightcast 'Information Technology' and 'Analysis' clusters. This finding highlights the importance of the co-occurrence in job adverts of skills that are different thematically, yet potentially complementary.

Conclusions

Skills in the UK labour market are changing rapidly. As highlighted throughout this chapter, keeping track of trends in skills demand is key to assess the current state of the market and anticipate (as much as possible) future skills needs. One of the first steps to ensuring that workers and employers can have the skills they need is the availability and access to up to date information on skills trends.

In the Pissarides Review, we used large online job adverts datasets that provide extensive coverage of the UK labour market to shine light on some of these skills dynamics. Some highlight findings from our research:

Skills demand is evolving quickly, with many new emerging skills gaining importance and others disappearing. We also see variation in the speed of change across different occupations and places.

More skills and a wider diversity of skills is being required in job adverts. On average, employers are seeking a broader range of skills, now spanning more skill clusters.

Tech skills are not just for tech jobs. Our findings show that occupations across all sectors are demanding more advanced technology-related skills. Tech is becoming a key part of many jobs, far beyond the traditional "high-tech jobs."

Non-technical skills are also rising in importance. Skills like analytical thinking, problem-solving, creativity and leadership are becoming more important as workers are expected to adapt quickly to changes in the market.

While online job postings data can provide valuable insights and are a key part of modern skills intelligence strategies, they also have limitations. These datasets may not capture the whole economy, as some jobs are not advertised online. In addition, they tend to represent primarily the employers' perspective. Therefore, to gain a more comprehensive understanding of skills needs (and how to achieve them), it would be important to also consider the worker's perspectives. Worker involvement in these discussions about skills can be very beneficial to reveal practical insights into skills needed day to day in their jobs.

Access to adequate training opportunities for reskilling and upskilling is equally important in responding to these challenges. Lifelong learning is essential for reducing skills gaps. While much focus in recent UK policy has been placed on education and training of young people, via discussions around higher education and further education, it is important to expand these discussions to other forms of adult education that can ensure the existing workforce also has opportunities for adapting their skills sets.

To address these complex skills challenges, a flexible and responsive system of education and training provision is needed; one that is capable of evolving alongside the labour market or anticipating its future trends. Developing such a system will require close collaboration between employers, workers, policymakers and education institutions. In this context, it is crucial to think about developing better skills strategies, which are informed by data and robust research, and involve all stakeholders.

1.3 Lessons from system-level research

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The Disruption Index (DI) provides the first panoramic overview of the scale and trajectories of technological transformation across the country, tracking indicators across the technology lifecycle - from investment, infrastructure and the innovation ecosystem to education. The DI enables exploration of the primary components of technological transformation, our readiness for it and the wide-ranging consequences of it, helping policymakers identify the most impactful access points for intervention.

Our analysis demonstrates that the demand-side and supply-side risks and opportunities associated with technological transformation differ markedly in regional contexts, playing out with striking asymmetries across multiple domains - from access to capital and ICT infrastructure to education. Highlighting the pronounced impacts on different regional inequalities, it provides an empirical foundation for an evaluation of social and economic risks, impacts and implications of AI and automation technologies across the country.

By breaking down these components – and showing that they are not inevitable – the DI opens the door to a more sustainable, responsible technology ecosystem and decentralised, equitable economy. Correspondingly, these same insights challenge policymakers and analysts to consider the place of technological change in driving new inequalities and polarisations if left unchecked, as well as opening up new opportunities.

As a country experiencing technological transformation, the most profound risks we face are around deepening social, economic and health polarisations arising from failures to anticipate and shape the changes in play in ways that benefit everyone, everywhere. By using technological transformation and readiness to cut across the regional inequality, Industrial Strategy and Artificial Intelligence policy agendas, the DI demonstrates how large-scale, asymmetric shocks – both current and anticipated – demand coherent regulation, institutions and infrastructures to support ‘good’ transitions at all levels.

In the DI, we use the novel approach of skill transformation to detect innovation. As we see in work presented in Chapter 1.2, there are significant merits in this approach relative to task-based models. We surface the variation in skills demand, and the nature and pace of change between the same occupations across geographies. We find that there are novel clusters of skills, which would allow transitions between roles in counterintuitive ways – ways which could be harnessed to support workers as they transition.

Next, we dig into what these insights mean for job quality by examining the way firms perceive innovation and respond to their environment when doing this. We find that the readiness of innovation ecosystems directly shapes employer choices about adoption. We unpack the qualitative experience of the skills transitions unpacked in this chapter, and highlight that productivity benefits are conditional on their own set of enabling factors and interdependencies between firm competency in human resource management, and worker skills.

Section 2
Technology Adoption in Firms

2 Technology Adoption in Firms

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In this section, we focus more on firms and what issues are in play as they look to adopt new technologies as a means of staying competitive, efficient and innovative. Which factors influence the technology adoption decision, and how might these be shaped by wider system dynamics, with what effects on work?

In the first section of the Report, our focus was on technology adoption across place, and the changes that this is bringing to the skills that workers require in the new world of work. This 'system' level focus is important, because we need to understand the geography and scale of the technological transformation in play, and the frictions that are preventing the smooth and equal adoption of new technologies across different parts of the country. It is also important for us to see the system-level picture of changing skills demands and readiness conditions, as this is vital to the way firms can undertake technological transformation. As we show across chapters in this section, firm level choices are shaped by wider, systemic conditions.

Now, we turn to firms, looking at the factors that influence the technology adoption decision and the impacts that these decisions have. Are more jobs created? Are the skills required of workers diminished or augmented? Is quality improved, or negatively impacted? And can we perceive differences in these outcomes depending on how the firm approaches the deployment of a new technology?

Firm-level deployment does not happen in a vacuum. Firms function in labour markets, which host workers with different levels of experience. Firms are structured, commonly, by corporate law, and have to function in regulatory environments, heeding new governance requirements and legal frameworks. These are being developed at different speeds in different parts of the world, with different priorities. Understanding this changing landscape is its own form of disruption for firms. In the UK – sitting, as it often is seen, between the EU and the USA – new legislation has not been a priority, however experiments in governance abound. Because these regulatory environments influence how companies act, in this section exploring firm-level impacts we look at the interaction between AI governance and the quality of people's jobs. This, we think, reflects new dimensions of information friction.

Further, the technology adoption decisions that firms take when designing, developing or deploying new technology also take place within organisational cultures. So, the final part of this section looks to understand what we know from focus groups and in-depth case studies talking to workers about how they experienced the ways in which organisations handled the roll-out of new technologies, and how these issues interact with skills and productivity.

The traditional view of technological innovation is that productivity is inevitable. This persists, despite decades of evidence to the contrary.

The consistent message from the work in the Review is that to harness the potential of this new moment, the conditions for success, and avenues to new value capture, must receive greater attention. These are related, and must be considered in an integrated way which centres around good work.

As raised in the previous section, what must be added is the social dimension to innovation. In the context of firms in this section, this means acting on what the research presented here highlights: that productivity gains are more likely when workers are engaged in the whole process of technology adoption.

As we look to the much-needed renewal of our economy and for labour markets to be steered towards better outcomes, a secure research footing on how these gains can be achieved in practice is vital. We have seen in the previous section the system-level changes that are required to create the environment in which innovation and social good can advance together – with a high-skill workforce employed in 'good' jobs. What this following section does is outline the evidence we have generated as to what factors are, and could, determine and contribute to this economic renewal – and the kinds of management practices that help technology adoption processes to support job quality.

The section begins with a summary of a survey of 1,000 UK firms, and how technology adoption practices impact jobs and skills. This is followed by an overview of the AI governance question and how this interacts with job quality. We then end with a discussion of twelve in-depth case studies exploring how workers experienced the adoption of new automation technologies in a variety of UK organisations, and lessons for skills development and productivity.

2.1 The adoption of AI and automation in UK firms

Professor James Hayton

Key Working Papers from the Review:

What drives UK firms to adopt AI and robotics, and what are the consequences for jobs? - *J. Hayton, B. Rohenkohl, C. Pissarides, H. Y. Liu*

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In the era of rapidly advancing artificial intelligence (AI), media headlines speculate on AI's dramatic influence on labour markets and broader society. The dominant narrative anticipates significant job losses due to automation, and while these discussions draw attention to large-scale economic shifts, they often miss a crucial perspective: the nuanced impact of AI adoption at the firm level.

It is here - within firms - where actual changes in job creation, skill demands, and work quality are determined. This chapter delves into this underexplored terrain, highlighting both the disruptive and transformative potential of AI on employment and on the organisational factors that influence these outcomes.

The impacts of AI and robotic technologies on jobs and work are not always only positive or only negative. On one end, these technologies may automate routine tasks and displace workers, while on the other, they have the potential to augment human abilities, enabling employees to concentrate on meaningful, complex tasks. The nature of impact of automation on work is influenced by organisational decision makers and their objectives, ambitions and perceived constraints—whether companies prioritize replacing employees with machines for efficiency or aim to enhance the productivity and job satisfaction of their workforce. This dual possibility calls for research that goes beyond simple predictions of potential for job automation by examining how organisations, and in particular organisational leaders, decide technology's role in the workplace.

Beyond Technical Feasibility: The Social Context of Technology Adoption

Many of the studies which argue for the negative impacts of AI on jobs and work only analyse the potential for disruption. That is, they examine the nature of work and look at the potential of new technologies for automating tasks. However, this potential impact may or may not be realised in practice because of the challenges and costs of technology adoption in practice. In practice, the influence of AI is far from uniform across nations, industries, and organisations, each being shaped by unique cultural, regulatory, and operational contexts. This underscores the importance of examining actual technology adoption within companies, where organisational decisions reflect the real context in which technologies must be deployed.

Decision-makers' perceptions of technology can be expected to vary widely based on their organisational context, culture, and goals, reinforcing the idea that technology adoption is less about inherent characteristics of the technology itself, and more about how stakeholders envision it functioning in their organisations. A deeper understanding of these dynamics reveals that outcomes are shaped not just by technology but by the intentions and choices of those who adopt it.

This research contributes to the conversation on AI's impacts by emphasizing the significant role of context, specifically how a company's internal and external environment shapes perceptions of AI and its applications. For instance, regional variations—such as disparities in educational investment, workforce skills, and technological infrastructure—create different landscapes for technology adoption, even within the same country. In areas with high levels of innovation readiness, technology adoption is more likely to yield positive outcomes, including job creation and skill enhancement. This regional variance supports the longstanding notion that an educated, prepared workforce facilitates technology's constructive integration into the economy.

Human Resource Management (HRM) practices emerge as critical antecedents and moderators in the adoption of AI and robotic technology, and their impacts on employees. This chapter explores how an investment-focused HRM philosophy can shape technology adoption by promoting practices that involve workers in decision-making, ultimately influencing whether technology is used to augment rather than replace labour. Companies that adopt a high-involvement HRM approach, where employees' skills are developed and valued, tend to see more positive impacts, as technology is used to support employees' work and enhance job quality rather than simply drive efficiency gains through automation.

Although prior research has tended to focus on the impacts of automation on job quantity, job quality also demands attention. Beyond simply counting jobs, it's essential to consider whether these jobs offer fair pay, reasonable working hours, and opportunities for personal growth and development. AI and robotic technology integration into the workplace could significantly affect these dimensions of job quality, either by enhancing jobs to be more engaging and rewarding or by creating a workforce dominated by low-quality, monotonous roles. This focus on quality of work is essential, as research suggests that poor-quality jobs are detrimental not only to employees but also to societal well-being.

The study reported here rejects a deterministic view of automation. Instead, it emphasises that the impacts on jobs, skills, and work quality are mediated by both organisational context and managerial choice. This nuanced perspective suggests that technology's influence is malleable and shaped by how firms strategically choose to integrate it, to realise value. To this end, understanding the contingencies that influence managers' decisions on technology adoption is key to fostering policies and practices that maximize positive outcomes and minimise risks.

The stages of technology adoption

At the heart of the discussion on technology adoption lies the understanding that it rarely occurs in a linear fashion and is not a one-shot problem. Rogers (2010) identifies five key stages through which organisations typically progress: awareness of a new technology is the critical first stage. This is followed by evaluation of the technology's potential and anticipated value to the adopter. A positive evaluation of potential may be followed by trials to test the utility and the organisation's own capacity to successfully deploy the technology. If the trials are successful, this leads to an eventual decision to adopt, along with the implementation process itself. Finally, post-adoption outcomes may include either successful adoption and implementation, or not. These stages encompass not only the decision to adopt a technology but also the subsequent evaluation of its effectiveness and the integration into ongoing operations.

While much emphasis has historically been placed on this decision point, less attention has been directed toward the implementation phase and the long-term impacts of adoption (Bailey and Barley, 2020). Scholars have pointed out a significant gap in understanding the full life cycle of technology within organisations, particularly concerning how adoption influences ongoing operations and performance (Tornatzky and Klein, 1982).

Rogers proposes that five main characteristics - relative advantage, compatibility, complexity, observability, and trialability - significantly impact the rate at which an innovation diffuses within an organisation.

Relative Advantage refers to the perceived benefits that a technology offers compared to existing methods. Organisations are more likely to adopt technologies they believe will enhance their operational effectiveness.

Compatibility reflects how well the new technology aligns with the organisation's current practices, values, and user needs.

Complexity examines the perceived difficulty associated with understanding and using the technology. Technologies that are deemed too complex may face resistance during the adoption process.

Observability relates to how visible the technology's benefits are to others within the organisation. The more observable the advantages, the greater the likelihood of adoption.

Trialability reflects the extent to which potential adopters can experiment with the technology before committing to full-scale implementation.

These characteristics have demonstrated relevance across diverse organisational contexts, providing a broad perspective on the elements that facilitate or hinder the adoption of innovations. However, research (Tornatzky and Klein, 1982) suggests that not all five factors consistently influence adoption. Across a large number of studies, they found that relative advantage, compatibility, and complexity are more consistently impactful, indicating that these variables may have the strongest predictive power.

Despite its foundational role in the study of technology diffusion, the subjective nature of innovation characteristics presents a challenge, as perceptions can vary widely based on individual and situational contexts. This underscores the need for frameworks that integrate subjective interpretation into the adoption process. To address some of the limitations of this model, researchers have developed alternative frameworks, including the Technology Acceptance Model (TAM) and the Technology-Organisation-Environment (TOE) framework.

Grounded in the theory of reasoned action, TAM emphasizes individual perceptions of usefulness (akin to relative advantage) and ease of use (similar to complexity). This model links attitudes directly to individual cognition and behaviour, making it particularly adaptable for analysing personal motivations regarding technology adoption. TAM has been widely applied across various technological contexts, including hardware, software, and communication tools, confirming that individual perceptions significantly influence the likelihood of adoption. Its enduring relevance lies in its ability to assess not only initial adoption but also sustained engagement with new technologies.

In contrast, the TOE framework shifts the focus from individual users to the organisational level, embedding technology perceptions within broader environmental and structural contexts. This model highlights organisational capabilities—such as financial resources and technical sophistication—as critical determinants of adoption readiness. Financial resources are necessary to cover installation, ongoing maintenance, and scaling costs, while effective human resource practices, including training and employee empowerment, are essential for successful technology integration.

The role of Human Resource Management (HRM) is particularly vital in building the competencies necessary for technology adoption. HRM practices that prioritize skill development create an environment that is more receptive to new technologies. As automation often leads to the elimination of low-skill tasks, there is an increasing demand for higher-skill roles, necessitating robust training and adaptability (Thomas, 1994). This interplay between skill demands and technology underscores the importance of HRM strategies that emphasize flexible training programs and employee involvement in decision-making processes.

While internal organisational factors are crucial, external environmental pressures also significantly shape adoption decisions. Market demands, customer expectations, and support from institutions such as trade associations and universities exert considerable influence on organisations' technology adoption choices. Previous studies have shown that external pressures for increased productivity and competitiveness can encourage the adoption of new technologies (Chwelos et. al., 2001; Waldman-Brown, 2020). Specifically, customer requirements and competitive pressures enhance the perceived necessity of adopting technologies like AI, while institutional support can facilitate knowledge sharing and training resources.

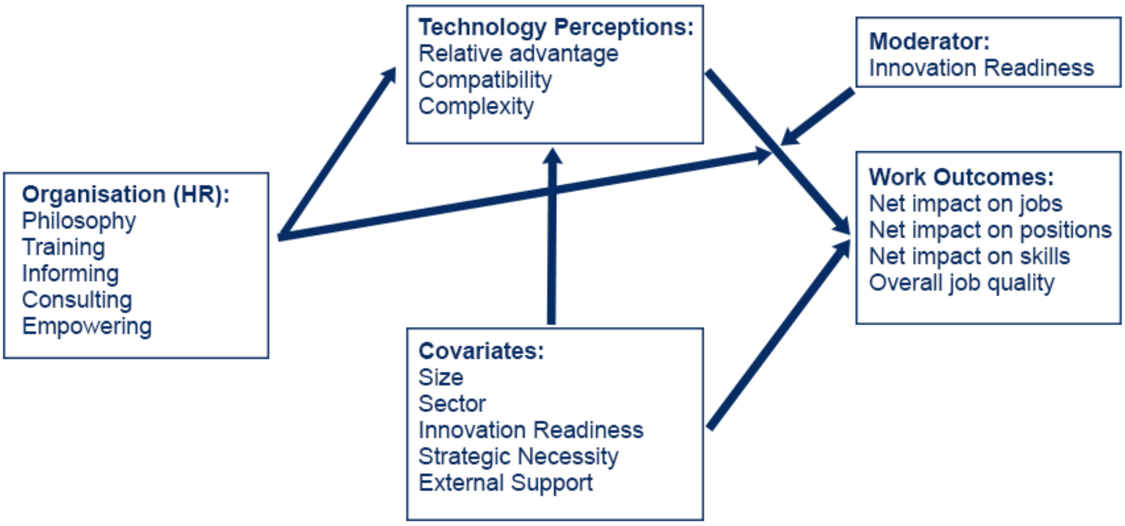
In summary, technology adoption is a complex, multi-stage process influenced by a myriad of organisational, individual, and environmental factors. We propose that perceptions of relative advantage, compatibility, and complexity are pivotal in determining adoption, with HRM practices and organisational size serving as significant moderators of these influences. By considering external pressures and institutional support, we enrich our understanding of technology adoption, positioning it as an evolving journey shaped by interdependent factors and culminating in diverse implementation experiences.

Impact of Technology Adoption on Jobs, Skills, and Job Quality

The effects of adopting AI technologies within organisations hinge on various factors, including the technology's capabilities and the availability of resources such as knowledge, expertise, and employee relations (Barley, 1986; Thomas, 1994). This section explores three significant impacts of AI adoption: its effects on jobs, skills, and job quality. We also address the influencing factors within organisations that implement AI and robotic technologies for cognitive and physical task automation.

As illustrated in Figure 2.1, the outcomes of technology adoption are shaped by both internal organisational factors and external contextual elements. Decision-makers are influenced by institutional arrangements and resources, which create different contexts for implementing new technologies (Graetz and Michaels, 2017; Kapetaniou and Pissarides, 2023; OECD, 2023). The success of technology implementation relies heavily on access to a skilled, motivated, and adaptable workforce (Autor et. al., 2003; Goldin and Katz, 2008; Machin and Van Reenen, 1998).

Figure 2.1 - **Framework for factors influencing technology perceptions and work outcomes**



Regional Factors in Technology Adoption

As we demonstrate in Section 1, the UK is characterised by varied innovation ecosystems. The impact of technology on work outcomes is not only shaped by national innovation readiness but also by regional resource availability, which can lead to differential impacts on job outcomes within countries. Two critical regional resources include:

1. **Human Capital Investments:** Regions with higher investments in education foster environments conducive to technology adoption that enhances jobs rather than displaces them. A well-educated workforce incentivizes firms to leverage technologies that complement labour rather than replace it (Blundell et. al., 2022; Carneiro et. al., 2023; Kapetaniou and Pissarides, 2023).
2. **Digital Infrastructure:** The availability of high-speed internet and mobile network coverage plays a vital role in facilitating technology adoption, contributing to better job outcomes. Access to robust communications networks and infrastructure further supports the adoption of new technologies, enhancing productivity (Andrews et. al., 2018; OECD, 2019c).

We propose that these two factors create a concept we term “Regional Innovation Readiness,” which is expected to moderate the relationship between technology adoption and positive work outcomes.

Management Orientation and Workforce Investment

A fundamental distinction in management philosophy regarding the workforce lies between viewing human resources as an investment versus treating them as a cost (Lepak et al., 2017). A high-involvement management philosophy values workforce development and is associated with increased investments in training and skills development, which facilitate adaptation to new technologies. This approach can influence technology adoption outcomes through three primary mechanisms (Mirvis et al., 1991):

1. Understanding and Acceptance: A skilled workforce is better equipped to understand and accept new technologies, which facilitates integration rather than replacement of labour.
2. Incentives for High-Discretion Augmentation: Organisations adopting a high-involvement approach are less likely to eliminate jobs, choosing instead to augment labour with technology which enhances demand for skills and job quality.
3. Supportive Organisational Culture: A culture that emphasizes information sharing, employee involvement, and empowerment nurtures a conducive environment for technology adoption, leading to increased productivity and job satisfaction.

As a result of these influences, we predict that a high involvement approach to HRM will strengthen the impact of technology adoption on net job creation, skills demand, and job quality.

In summary, the adoption of AI technologies presents both challenges and opportunities for jobs, skills, and job quality. By emphasizing regional innovation readiness and high-involvement HRM practices, organisations can adopt technologies in ways that foster positive work outcomes, enhance job quality, and stimulate economic growth. The framework outlined in this section offers insights into how organisations can strategically implement AI to benefit their workforce and overall productivity.

Our Research

Our study aims to investigate the effects of technology adoption on jobs, skills, and job quality using data derived from a nationwide employer survey and various secondary sources. The survey was designed to capture insights from senior executives - including CEOs, COOs, CTOs, and CHROs - who are knowledgeable about their organisations' technology adoption and management practices for human resources.

We want our results to be representative of the population of all businesses in the UK. We used a database of all registered businesses to sample from a total of 74,420 UK firms. We limited our study to organisations with a minimum of 20 employees to ensure some level of formalized management practices existed.

To enhance the study's focus on technology adoption, a stratified sampling strategy was employed. In other words, rather than randomly sampling, which would lead to many more small firms being selected (they are most common in the population of all firms), we deliberately oversampled medium and large firms to achieve a better balance across size categories. Ultimately, the final sample consisted of 1,012 firms, distributed as follows:

- 20-249 employees: 435 firms (42.9%)
- 250-499 employees: 208 firms (20.6%)
- 500+ employees: 369 firms (36.5%)

The sample represented diverse industry sectors, with Financial Services (19.3%), Information and Communication Services (15.4%), Manufacturing (12%), and Professional, Scientific, and Technical Activities (10.4%) being the most prominent. On average, respondents had 9.3 years of experience in their respective organisations.

The study measures two primary sets of outcomes: technology adoption and its subsequent impacts on jobs (what roles exist, e.g., Machinist; Receptionist), positions (the aggregate number of jobs, i.e., how many people are employed in total), skills, and job quality. Technology adoption is assessed through questions (Hunt et al., 2020):

1. **Physical Task Automation:** "In the last three years, we have introduced AI, robotic, or automated equipment to undertake a physical task."
2. **Cognitive Task Automation:** "In the last three years, we have introduced AI, robotic, or automated software to undertake a cognitive/non-physical task."

The impacts of technology adoption are gauged through questions focused on new job creation, skill requirements, and the overall quality of work. Respondents who affirmed that they were adopting AI or robotic technologies were then asked:

1. Whether new jobs or positions had been created (Yes/No).
2. If new technology had led to job eliminations or a reduction in established skills (Yes/No).
3. Overall net impact on jobs and positions, measured using a five-point scale ranging from "a lot more" (5) to "a lot less" (1).

For assessing job quality, interviewers posed questions regarding the anticipated impact of new technology on aspects such as pay, hours, meaningful work, opportunities for personal development, and employee participation in workplace issues.

The study examines several predictors of technology adoption, focusing on perceptions of technology as outlined by Moore and Benbasat (1991):

1. **Relative Advantage (perceived usefulness):** Measured with five questions that assess how AI/Robotic Automation can enhance efficiency and quality.
2. **Perceived Compatibility:** Evaluated using three questions that determine how well the technology aligns with existing operations and work styles.
3. **Perceived Complexity:** Also measured with three questions, focusing on the ease of implementation and usage of AI/Robotic Automation.

Regional Innovation Readiness is assessed through the Disruption Index (see Chapter 1) which incorporates human capital and infrastructure dimensions vital for supporting innovative technology adoption.

Human Resource Management (HRM) practices were measured using a number of survey scales (multiple questions) to capture the firms' HRM philosophy and practices. Key areas measured include:

1. **HR Philosophy:** Reflecting the organisation's investment in employee development, assessed with four questions from Lepak et al. (2007).
2. **Informing Employees about New Technologies:** Assessed using three questions from the UK Workplace Employment Relations Survey.
3. **Consulting Employees about New Technologies:** Evaluated with three questions from the WERS that gauge employee involvement in decision-making processes.
4. **Employer Attitude Towards Training:** Measured using five questions that assess investment in employee training compared to peers.
5. **Employer Attitudes Towards Empowerment:** Assessed with five questions focusing on employee engagement in problem-solving and decision-making.

Additional Measures

Organisational Size: We expect organisational size to be associated with technology adoption because it reflects the availability of skills and knowledge within the organisation. Historically, smaller firms have been less likely to adopt technology of all kinds. Smaller organisations tend to employ more generalists and fewer technical specialists and tend to lack the financial resources needed for investigating, experimenting, and developing new technologies. As with all kinds of innovation it is helpful to take a long-term orientation, and yet smaller firms often face financial constraints, forcing them to prioritise short-term objectives. There are systematic differences between large and small firms that are relevant to the adoption of AI based technologies. We measured size through self-reported employee numbers, logged for analysis due to skewed distribution.

Strategic Necessity: Measured with three items that assess the competitive pressures driving technology adoption.

Institutional Support for Technology Adoption: Assessed using two items that evaluate access to resources needed for adopting new technologies.

Industry Sector: Included as a control variable, with categorization following the UK Standard Industrial Classification (SIC) hierarchy, recognizing sector-specific tendencies towards technology adoption.

By utilizing a comprehensive methodology, this study aims to illuminate the interplay between technology adoption, management practices, and workforce outcomes in the context of AI and automation.

Descriptive Results

Of the n=1,012 respondents, 79.2% reported that their organisation had adopted AI, robotic, or automated equipment to undertake a physical task. Similarly, 78.8% reported that their organisation had adopted AI, robotic, or automated equipment to undertake a cognitive or non-physical task. A total of 864 organisations reported having adopted one or both forms of technology in the last three-year period prior to the survey. Of these, 684 (78%) report that the introduction of new technology has created new jobs; while 483 (55.3%) report that the introduction of new technology has eliminated or replaced jobs.

Of the 864 firms reporting technology adoption, 717 (83%) report an increased demand for new skills in the organisation. At the same time, 466 (53.9%) organisations report that these new technologies have reduced the need for some skills. These results indicate that the same technology enhances skills demands for some jobs, while reducing these demands for others.

Turning to job quality, 69.3% of respondents report that they believe that job quality is improved a little (48%) or a lot (21.3%), while just 4.9% believe that job quality is reduced by a little (4.4%) or a lot (.5%). We later contextualise these findings from worker perspectives. Furthermore, 219 respondents (21.3%) report no changes in job quality in the terms defined in the survey.

In summary, the overall picture is one which leans towards net positive effects on job quality.

Automating for Physical Tasks: Predictors of Adoption

We found that Manufacturing, Construction, Transportation and Storage, Information and Communication, Financial and Insurance, Real Estate, Professional, Scientific and Technical Activities, are all positive and more likely to have positive Technology Perceptions in contrast to Other Services. Accommodation and Food Services, Administrative and Support Service Activities, Public Administration and Defence, and Art, Entertainment and Recreation are significantly less likely to adopt technology for physical tasks. These sectoral differences influence Technology Perceptions which in turn impact technology adoption.

Size does not appear to directly influence technology perceptions. However, despite this, we do find that larger organisations are more likely to adopt AI and robotic technology for physical tasks than smaller organisations. This distinction may reflect the fact that despite having similar perceptions, larger organisations have greater resources which facilitate technology adoption regardless of perceptions.

We also found that perceived strategic necessity and perceived availability of external support are both positively associated with favourable Technology Perceptions. In turn, these perceptions have a significant and strong positive association with Technology Adoption. We found that a unit change in Technology Perceptions increases the probability of Technology Adoption by more than 4x, all else equal.

Our results indicate that HRM is significantly associated with Technology Perceptions. However, there is not a main effect of HRM on Technology Adoption. This means that HRM influences technology adoption by exerting a positive influence upon Technology Perceptions of decision makers. In other words, by creating an informed and committed workforce, engaged in decision making about technology, the result is to enhance the perceptions of decision makers regarding the potential and fit of new technologies and the expected utility of adopting those technologies.

Automating for Cognitive Tasks: Predictors of Adoption

For cognitive tasks we found that organisation size was not related to perceptions or technology adoption. We found strategic necessity and perceptions of external support are significant predictors of positive technology perceptions, which in turn are positively and significantly associated with technology adoption. We can estimate that for a unit increase in positive technology perceptions, there would be close to 3x the probability of adopting technologies to perform cognitive tasks.

We also found that HRM positively influences technology adoption for cognitive tasks, through its influence on positive perceptions of technology.

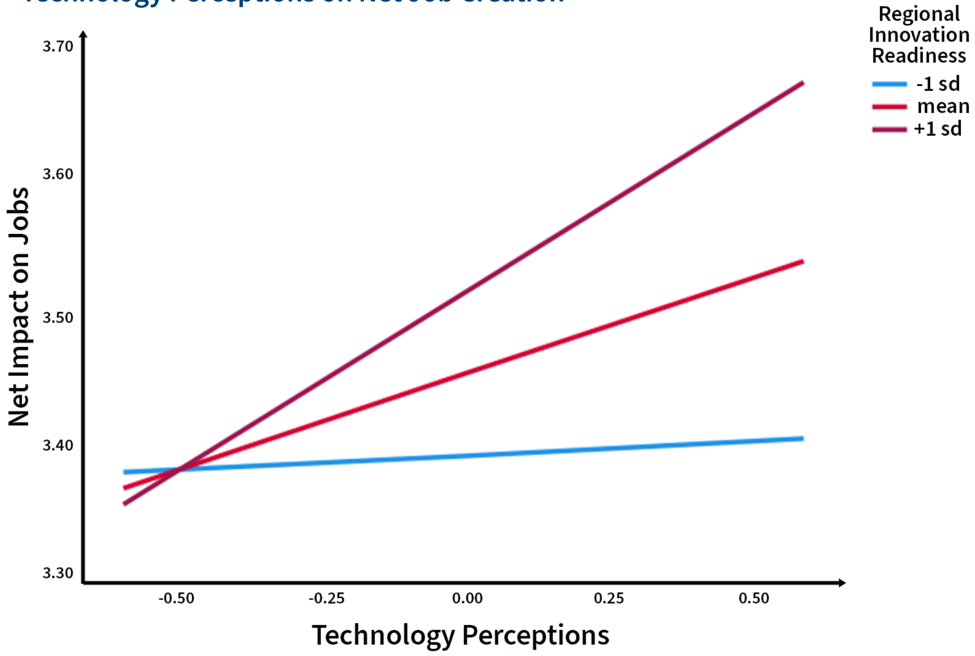
The Impacts of Technology Adoption on Work Outcomes

We then analyse the impacts of technology adoption on jobs, skills and job quality, as well as the factors influencing these outcomes.

We found that Perceptions of Technology play a central role in the relationship between High-involvement HRM and the Net Impact on Jobs. That is, through the positive influence on Perceptions of Technology, high involvement HRM is associated with a positive Net Impact on Jobs. We also find that Regional Innovation Readiness serves to enhance the effects of a positive attitude towards technology. What this means is that in environments with more investment in human capital and digital networks, positive technology perceptions exert a stronger positive force, tending to mean technology adoption has a net impact on jobs.

We illustrate this interaction between Regional Innovation Readiness and Perceptions of technology graphically in Figure 2.2. In this analysis, we compare the association between the variable, Perceptions of Technology, and the outcome, Net Impact on Jobs, for three levels of the Regional Innovation Readiness, High, Average and Low. There is a positive impact on the association. This indicates that Perceptions of Technology are positively associated with Net Job Creation, but only when Regional Innovation Readiness is high.

Figure 2.2 - The interaction between Regional Innovation Readiness and Technology Perceptions on Net Job Creation



We also found find that high involvement HRM positively influences the Net Impact on Jobs, as well as serving to increase the influence of positive perceptions of technology on net job creation. Thus, HRM not only serves as an antecedent to Perceptions of Technology but also moderates the relationship between these perceptions and net job creation.

When we examine the Net Impact on Skills, we find that Regional Innovation Readiness, again interacts with technology perceptions. We depict this relationship graphically in Figure 2.3. This means that in environments with more human and technological capital available, the effect of positive technology perceptions is more positive. Meaning that decision makers appear to be influenced positively towards forms of adoption which create more skills, when environments have more available human and technological capital.

We also found that HRM enhances the influence of technology perceptions on skills creation. This means that for organisations with an investment orientation towards their employees, a positive perception of technology is more likely to lead to skills creation.

When it comes to analysis of the impacts on job quality we observe more sectoral differences than in any of the other outcomes. The results suggest greater sectoral variation with respect to the impact of AI on job quality outcomes. We found a strong positive effect of high involvement HRM and job quality. There is also a significant interaction between technology and HRM on job quality meaning that high involvement HRM strengthens the influence of technology on enhanced job quality. Most interesting, we found that technology perceptions and Regional Innovation Readiness interact in their impact on job quality in a striking way, depicted graphically in Figure 2.4. Here the results are striking in that when Regional Innovation Readiness is below the mean, the association between Perceptions of Technology and the outcome of Job Quality is negative, while when readiness is high, this relationship is positive.

Figure 2.3 - The interaction between Regional Innovation Readiness and Technology Perceptions on Skills

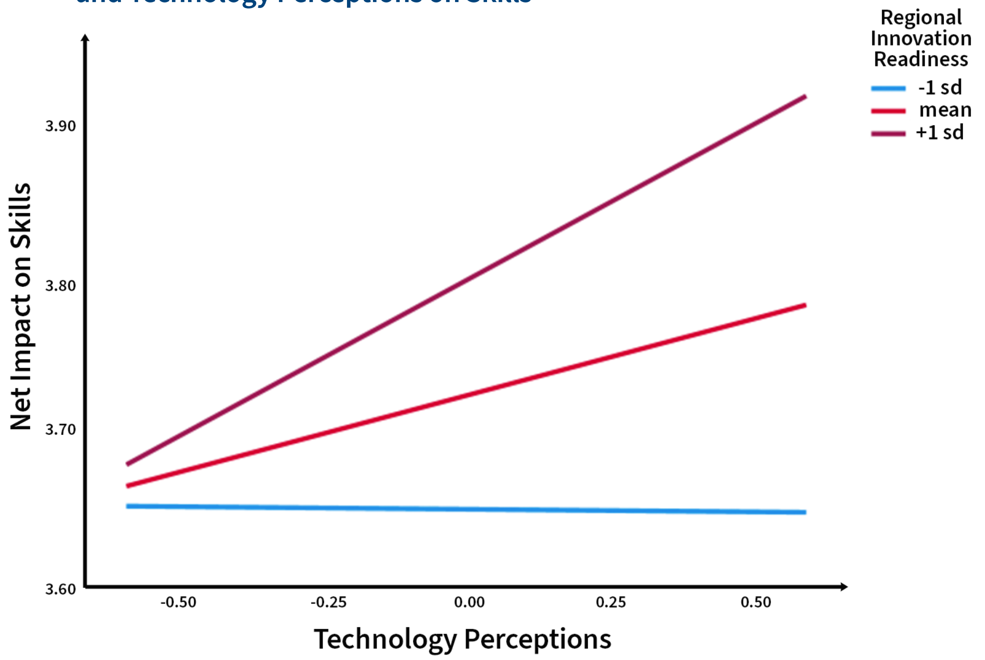
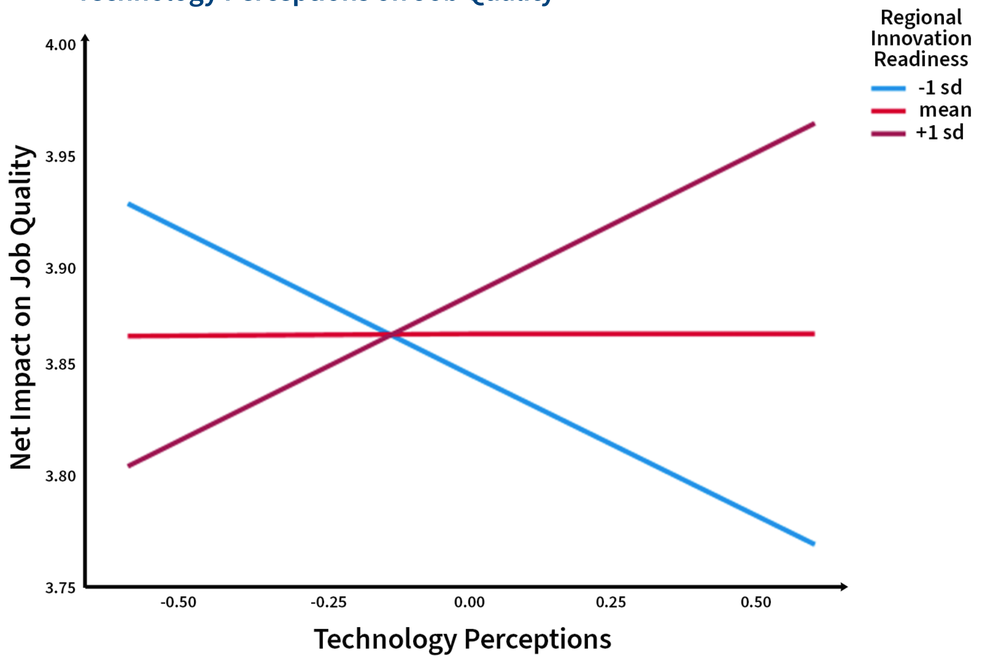


Figure 2.4 - The interaction between Regional Innovation Readiness and Technology Perceptions on Job Quality



Discussion

Research on the adoption and diffusion of new technologies highlights several potential drawbacks associated with technology automation, such as diminished control over work pace impacting physical and mental well-being (Ettlie, 1986; Friedland and Barton, 1975); increased routinisation of tasks (Brod, 1988); stricter supervision of employees (Mankin, 1983); and disturbances to social dynamics (Nussbaum, 1980). However, understanding whether and when AI positively or negatively influences key work outcomes is still evolving. This study contributes to this ongoing discussion in several ways. Firstly, we consider multiple outcomes, including job quality, alongside effects on job numbers and skills. We also explore both positive and negative outcomes. Secondly, we provide evidence for conditions that moderate the relationship between technology adoption and these outcomes, offering insights that are of significance for practice and policy development.

In an earlier era, amid widespread computerization, Mirvis et al. (1991) suggested that workers had valid reasons to approach computerized technology positively. More recently, Davenport and Miller (2022) observed through case studies that AI generally augments rather than replaces jobs, with minimal evidence of job loss. Similarly, the 2023 OECD Employment Outlook report noted limited evidence of substantial negative employment effects due to AI (OECD, 2023, Chapter 3). Despite the ongoing debate about AI's labour market impacts, historical insights reveal that technology alone does not predetermine outcomes for work or workers (e.g., Barley, 1986; Thomas, 1994). A shift from viewing technology as fixed to seeing it as socially constructed (Orlikowski, 2009) shows that technology's implementation and its job impacts are shaped by managerial and social choices (Barley, 1986, 2020; Trist, 1980). Our findings align with this view and underscore the role of HRM in shaping perceptions that drive technology adoption.

Our study emphasises how technology perceptions connect organisational and environmental factors with AI adoption decisions. Previous research has not deeply analysed the precursors to technology perceptions influencing adoption. We provide a theoretical framework linking High Involvement HRM practices to these perceptions, showing that such HRM approaches positively affect an organisation's investment in human resources and perceptions of AI attractiveness. Additionally, we demonstrate that these perceptions mediate the relationship between HRM and technology adoption, even when considering other organisational and environmental factors. This broadens our understanding of HRM's strategic role in organisational performance (Huselid, 1995), particularly in technology adoption, a topic with limited prior attention (Hayton, 2005).

Holm and Lorenz (2022) observed that AI's skill impact varies with its application: positively when augmenting work by providing information, and negatively when significant automation leads to directive-based work. Our results indicate that the choice to enhance or disrupt human labour depends on external environmental conditions. The concept of Regional Innovation Readiness shows that enabling resources encourage AI use that creates jobs and enhances skills. Conversely, when such resources are lacking, new jobs and skill requirements are less likely. Notably, when regional readiness is low, AI adoption tends to adversely affect job quality.

These findings have major policy implications. In the UK, for example, regional disparities in wealth and inclusion are significant concerns (McCann, 2020). Technological advances risk worsening these inequalities unless addressed by governmental intervention. Our results suggest that investments in regional education and infrastructure are essential for mitigating negative AI impacts and fostering job quality improvements. Higher-than-average readiness levels are necessary to boost job creation and workforce skills.

We also explore the influence of HR philosophy and practices on AI adoption and implementation. High Involvement HRM can shape the successful adoption and integration of new technologies and modulate their impact on work outcomes. Socio-technical systems theory (Trist, 1980) argues that involving employees as stakeholders through development and participation positively influences technology adoption results. Our study supports this theory and builds on previous qualitative research (Guest et al., 2022) with new quantitative evidence.

Research shows that new technologies can improve job quality by enhancing access to data and simplifying workplace interactions, contributing to job satisfaction (Castellacci and Viñas-Bardolet, 2019; Martin & Omrani, 2015). Positive impacts often stem from increased productivity and meaningful work as routine tasks are reduced. For instance, the introduction of word processing expanded secretarial roles (Buchanan and Boddy, 1982). However, there are also downsides, such as time management challenges and stress (Castellacci & Tveito, 2018; Johnson et al., 2020). Our findings extend these observations, showing that positive outcomes depend on HRM practices and environmental support.

Unexpectedly, organisational size did not significantly affect AI adoption for cognitive tasks, indicating that both large and small firms can integrate these technologies effectively. This may be due to the simpler integration of cognitive, as opposed to physical, processes. Such findings may imply swift AI diffusion across sectors and underscore the importance of addressing regional readiness for job quality.

Conclusion

While we acknowledge AI's disruptive potential to reshape and displace jobs and occupations, we also believe that an essential aspect of fostering a more humane future of work lies in examining how AI is influencing the decisions of organisational leaders today, and how these adoption decisions are affecting current work practices. By understanding the mechanisms that drive the adoption of new technologies and the choices surrounding their implementation, we can better position ourselves to shape a positive future.

This study supports the notion that AI adoption leads to both positive and negative outcomes. The impact on jobs, skills, and job quality is not solely determined by the technology itself. Instead, management philosophies regarding human resources, coupled with available environmental resources, play a crucial role in shaping technology adoption in ways that promote beneficial outcomes.

2.2 Technology adoption and implications for skills and productivity:

what do employers and employees tell us?

Dr. Magdalena Soffia,
Dr Shuting Xia and
Dr. Hong Yu Liu

Increased productivity is universally desired and seen as the cornerstone of prosperity, but what exactly does it mean and how can be achieved?

Key Working Papers from the Review:

Firm-level adoption of AI and automation technologies: Case Studies Report - *H. Y. Liu, J. Hayton*

Taking work, or changing work? Understanding how technology adoption is reshaping work in the UK - *S. Xia, M. Soffia, J. Skordis*

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Key Findings

Policy Recommendations

The productivity dilemma

The UK has grappled with low productivity levels for a long time, leaving businesses and employers frustrated as anticipated solutions have not materialised. This has led to widespread concern within public policy circles, particularly around stagnating Gross Domestic Product (GDP) and the ripple effects on employment, human capital formation, health and welfare.

In industry, productivity is traditionally understood as the ratio of output to input, meaning higher productivity involves producing more goods or services per unit of labour, capital or resources. It can also be seen as creating more value with the same or less effort, tying productivity not only to quantity but also to efficiency and quality of output.

An economy at the level of maturity of the United Kingdom needs new technology adoption to achieve persistent productivity growth. But does the mere adoption of technology and upskilling workers automatically lead to higher productivity?

In this chapter, we dispel two myths which regrettably underpin a widespread business mindset. The first is that technology will be inevitably labour saving. This view is rooted in most analyses of automation, which view technology through the lens of the tasks it can substitute. The second is that where technology exists alongside workers, or ‘augments’ them, this will lead to upskilling, and job quality improvements. As we demonstrate, reliance on these false assumptions is leading to a lack of attention to the true conditions which are required for productivity benefits to be realised. Technology holds promise but – as increasingly suggested in the literature– its impact depends on how it is implemented and deployed. Our research shows that better productivity outcomes are more likely when individual workers are engaged in the technology adoption process, and their agency is enhanced.

The technology push – adoption and its promise

According to the findings of the Disruption Index and firm-level survey research in the context of the Pissarides Review, as well as other contemporary studies, there is an increasing, albeit geographically uneven, drive among UK businesses to adopt new technology, accelerated by the Covid-19 pandemic (Costa and Yu, 2022; Hayton et al., 2023; Oliveira-Cunha, Serra-Lorenzo and Valero, 2024; Rohenkohl, Clarke and Pissarides, 2024). Local firms are rushing to implement new tools and platforms to boost efficiency as their main motivation (Stuart et al., 2023). As described by Hayton in the preceding chapter, employers are generally positive about innovation, and report adopting new systems in their work processes to achieve higher productivity. Specifically, 79% of the over 1,000 organisations consulted reported that they had adopted AI, robotic or automated equipment to undertake a physical task, and the same proportion reported they had adopted these tools to undertake cognitive tasks.

Many employers assume that greater automation will lead to increased productivity, along with potential benefits like higher wages for workers. Indeed, in all the 11 case studies conducted for the Pissarides Review, the initial expectation was that adopting new technology would lead to productivity and efficiency gains. Whether it was reducing manual labour, streamlining processes, or increasing capacity, the anticipation of improvement was a common theme. This reflects common models of automation, which build from the logic that technology replaces or substitutes for labour in tasks.

For instance, an NHS Trust adopted the da Vinci surgical robot, expecting to increase capacity to deliver procedures and reduce patient wait times. Similarly, a market research firm introduced MS Power Automate, aiming to streamline project management and eliminate human errors, thus improving efficiency. A charity network implemented the SmartLogistic system (our pseudonym) to optimise delivery routes and improve logistics efficiency. In each case, the expectation was that technology would deliver productivity gains. However, while this was a consistent expectation, it was not a consistent outcome. In fact we find it is highly contingent on a number of factors during adoption.

The efficiency gains of technology adoption are often enhanced as employees take pride in being part of innovative companies, consequently improving their engagement. As a sales representative for a plastic packaging manufacturer stated during the group discussions:

> *"I like our company moving with technology. It keeps us at the forefront of the market... I like that I work for a company that invests in new technology, and again we're a global company.... It's as if your colleague is sat across the desk from you. I can speak to one of my colleagues in China or America or Germany. We're all just one big team through technology".*

Moreover, several case studies demonstrated how well-designed systems can secure efficiencies and allow workers to refocus on key tasks. For example, the NHS Trust found that robotic surgery allowed surgeons to avoid the long-term occupational injuries common in laparoscopic surgery, improving their occupational health while increasing surgical capacity and allowing for more efficient procedures and quicker patient recoveries.

However, there is more to the productivity equation than technology alone. This includes, critically, skills. However, it is also shaped by information frictions, cultural norms and expectations, and human resource management approach.

What are skills? Skills refer to the knowledge or ability that enables an employee to perform tasks at work. Some skills are quantifiable and measurable, such as how fast an employee can type; others are not quantifiable and measurable, such as creativity or critical thinking.

According to the literature on high-performance work systems (HPWS), if an organisation invests in its employees' skill development, it can help stimulate their commitment at work and achieve a higher level of performance (Boxall, 2012). Some scholars also believe that increasing employees' responsibility and discretion in the workplace can motivate them to perform better, as a result contributing to the overall competitiveness of an organisation (De Menezes, Wood and Gelade, 2010). In this sense, then, specific skills sit within a broader, organising approach to job design which affords workers the chance to demonstrate their capabilities, or diminishes this.

The imperative to upskill the workforce

The pro-innovation attitude among UK employers is accompanied by an increased demand for skills, with firms shaping skill trends to meet their innovation requirements. The prevailing approach involves a constant push for upskilling, with workers seen as malleable recipients of skills, under continuous pressure to adapt to technological advancements.

The "skills imperative" narrative (Wilson et al., 2022) is driven by the assumption that technological innovation only yields productivity benefits if the workforce is equipped with the skills needed to operate new systems. In other words, it's not enough to have the bicycle to move faster; employees also need to know how to ride it effectively. This has led to policy discourses focusing on upskilling and reskilling the UK workforce, to avoid mass technological unemployment and obsolescence.

Our research makes evident that workers are increasingly feeling the pressure to upskill and many perceive an imminent threat of being replaced by automated tools if they do not do as demanded by employers. However, the pressure to upskill can take a toll on workers' mental health, as one focus group participant, from the construction insurance sector, noted:

> *"Some of these people that have worked for many years doing those jobs you either have to reskill or upskill or there's nothing left for you".*

Another, jewellery artist, reflected on how frustrating the reskilling journey can be when the demand for the requested skills does not match your interests:

> *"I don't want to be sitting in front of a computer uploading the photographs, writing words and paragraphs and explaining things. That's not my skillset. It's not something I'm particularly interested in, but I need to do it."*

Adding to that pressure, the skills that companies are seeking are constantly evolving. Based on 2022 job advert data, in Chapter 1.2 of this report we found that the British economy is increasingly dominated by service-related "business" skills, followed by socio-emotional and leadership skills, which appeared in 59% of vacancies. Skills in AI and machine learning are also rapidly growing in demand, with 35% of vacancies mentioning at least one IT-related skill and 23% requiring analytical skills. These skills are increasingly considered vital for employees to manage tasks efficiently in the new digital environment.

As companies adopt new technologies, they recognise the need to upskill workers to bridge the gaps that arise. For example, at the market research firm using MS Power Automate, the automated system created new opportunities for on-the-job training, as employees needed to adapt to the evolving demands of their roles.

The skills race reality check

Juxtaposing workers' experiences of innovation and upskilling with employers' productivity aspirations is a necessary reality check. Our case studies reveal that despite assumed and desired upskilling, only some workers benefit from upskilling, while others may find that their skills become less relevant.

In some cases, upskilling can directly improve workers' career prospects, wage levels, and job satisfaction. For instance, at Hope Technical (a vehicle safety equipment manufacturer), the adoption of a collaborative welding robot (a "cobot") enhanced welders' job safety, allowed them to apply their specialised knowledge and focus on more engaging non-routine production tasks. Workers gained greater control over their shifts while providing flexibility in labour management. Overall, this reflects the choices of the firm to integrate the technology and redesign roles in a way which afforded the worker's better work. This reflected a series of choices not only in technology design, but also in its deployment within the business.

In one of our Police Force case studies, adopting robotic systems, further demonstrates how upskilling can support innovation, and role redesign associated with new technologies can increase workers' autonomy and engagement by shifting them from low-discretion and routine workload to more valuable and fulfilling roles. As described by the Police Head of Digital Technology on Robotic Process Automation of the Police Force:

> *"[…] the robot is removing laborious, repetitive tasks that they [police officers] once had to do to give them more time to get to more incidents or spend more time with the victim… Talking to them, reassuring them, gathering further evidence which is the value add as to what a police officer should be doing rather than processing paperwork. […] So, I can honestly say this has had nothing but positive impacts, not only for the officers, because that is important, because they're my colleagues, but moreover, a positive impact on the members of the public of [Police Force name] because of the time that I'm saving for officers."*

However, the reality of other cases is more nuanced. At an NHS hospital, the da Vinci surgical robot improved surgeons' occupational health, morale and upskilling opportunities, but other team members, such as scrub nurses, felt their roles were diminished as the technology took away the more interesting aspects of their roles. The nurses were still required, nominally, to participate yet their contribution was minimal and not befitting of their skill level, or harnessing their capability. While there was encouragement for nurses to retrain, many struggled to access the necessary opportunities owing to cost and time barriers, and the perception of clear pathways and opportunities which ensured that this investment was going to translate to real and improved opportunities.

As further example of workers experiencing technological changes as reduced agency and discretion, we can remember the case of a chain of charity shops that adopted a logistics management software system. The new system successfully lowered logistics costs and increased transparency. However, some van drivers felt frustrated and disengaged as the system reduced their autonomy by prescribing their routes and increasing surveillance. Drivers felt the process of adoption reduced their ability to take initiative and disregarded their knowledge of local traffic and route efficiency. Furthermore, the automation of payment upon task completion stripped many managers of their previous tasks and their associated financial reward.

As illustrated by the excerpts below, it can be the case that technology frees time for workers allowing them to develop and pursue their own skills. However, this is not reliably the case and of course depends on managerial choices about how time saved can then be used. In organisations which seek to translate new efficiencies into reduced headcount, such opportunities would not exist. Some enjoyed the upskilling and learning opportunities that innovation brought, others simply reflected on the need to learn different skills, while others expressed frustration at the changes when their creative or discretionary roles were truncated: Others highlighted the subtle changes to core skills such as communication and engagement, which may not be recognised with formal training, that come from mediating interaction online. Others expressed frustration about reduced creativity:

> *"[Artificial Intelligence] It's really helped expedite the repetitive tasks, freeing up my time for more strategic thinking." – Cybersecurity worker, in their 30s.*

> *"I think actually, just generally, that technology has had a huge impact on that and it's meant that most of the skills that we all needed - just chatting to someone across the office or meeting someone for the first time and making a good impression - it's a completely different set of skills now on Microsoft Teams, on Zoom." – Music producer, in their 30s.*

> *"When you're hindered by tick-box exercises, all of that creativity goes out of the window because… there doesn't seem an opportunity to express in your own way what you're doing because it's become so much of a tick-box exercise. It's very difficult, it just seems to be a platform for recording statistics, as opposed to expressing and showing on paper that creatively... you might have cared for that person, perhaps, or how that person presented." – Health and Social Workers, in their 50s.*

Part of the problem in cases like this lies in the assumption that upskilling is always inherently beneficial or sufficient on its own. In reality, several other enabling conditions must be in place to ensure that technological resources lead to actual productivity gains. Upskilling workers is important, but it is not a one-size-fits-all solution. The broader context – such as how technology is integrated into workflows, how much agency workers have in shaping its use, and whether there is meaningful consultation during implementation – plays a crucial role in determining whether productivity improvements are achieved.

What's missing? The role of worker involvement and HR Management

If in many cases technology adoption and upskilling alone do not guarantee the substantial productivity gains that the investments promised, what is missing? Here we argue, using our findings, that institutional factors – especially worker involvement, employer-provided training, and supportive HR practices which promote worker wellbeing – are crucial to the successful implementation of new technology.

'Technological determinism' accounts claim that technological innovation naturally leads to better jobs, with those workers who remain in their jobs and are not displaced or relocated, inevitably receiving the benefits. This mindset is also frequently encountered in the context of upskilling policies, which view training as something imposed on workers to meet predetermined organisational needs. This perspective reflects the conventional notion of "employability," where workers are expected to offer a pool of skills to employers to suit business needs, often with little consideration for workers' personal goals or fulfilment (McQuaid and Lindsay, 2005; Jabeen et al., 2022). While remaining employable is essential, this approach overlooks a critical factor which can be beneficial both to the worker and their employer: their workers' desires to shape their own working futures and use their skills with autonomy and discretion.

A challenge with this approach, which requires workers to conform to industrial demands as they arise, with little flexibility in how they apply their skills, is that it may not engender the kind of adaptive capabilities which are needed to respond to the transition we face, as set out in Chapter 1.2.

Just as workers are likely to have a more granular insight into the task composition of work, so too are they likely to have more granular insight into the skills required to achieve different objectives. In high performance systems, they would also feed into what those objectives are or should be – which is known to increase the likelihood that these are achieved.

While workers will require specific, new skills through transition the conditions for their adaptive capacity are equally important. A rigid approach to skills training often relies on imperfect proxies (Wilson, 2019) and fails to account for the unpredictability of how technology, economic conditions, and societal factors will evolve, making skills forecasting inherently flawed. Even accurate forecasts can lead to mismatches between the skills workers acquire and what employers value, as predictions often prioritise employer needs without considering workers' own perspectives. This is the case, for instance, of predictive studies based on online job adverts metadata. The current 'skills imperative' has largely been shaped by the company side, with limited input from workers.

In that sense, too often technological changes are imposed on workers without their input, leading to frustration and disengagement. We encountered several of these testimonies in both our focus groups and our case studies. One discussion group participant in the social work sector shared their experience of how communication gaps and lack of feedback channels negatively impacted their morale, putting at risk the potential positive impacts from new technologies:

> *"I've told management that things aren't working from a shop floor level. Then I've just had a sarcastic response, 'I'll do your job on the shop floor. You come and do a managerial position.' I'm just telling you the problems that I'm experiencing. You're asking me to do my job and I'm telling you for whatever reason X Y and Z that I cannot do my job, but you're not helping to resolve that problem."*

Differently, in the case study of the Collaborative Welding Robot at a vehicle safety firm, welders were actively involved in programming and managing the robot. Management sought their input throughout the process, which improved the robot's efficiency, gave workers greater control over their tasks, and enhanced their job satisfaction and motivation. This involvement empowered workers and boosted both job quality and productivity, implying that when higher levels of worker representation, engagement, and consultation are present during the adoption of new technologies, outcomes significantly improve at both individual and organisational levels.

Worker level survey data collected as part of the Review supports these findings, showing that workers' access to representational structures and involvement in decision-making significantly shapes the association between technology and learning outcomes. In environments where workers have a say, the link between technology exposure and learning opportunities, and so too with overall quality of life tends to be stronger. This may be because firms which take high-involvement practices also invest in better training; because workers are more invested in their own reskilling when they feel ownership over a transition, or because representative structures make the case for employer support in reskilling, highlighting the importance of unions in mediating transition.

The importance of worker involvement extends beyond just technological adoption – it also applies to associated training strategies. Learning programmes co-determined by workers and management tend to be more successful, partly because it gives workers the ability to articulate their own role and contribution. One focus group participant working in the social care sector emphasised the value of having feedback loops in training strategies and the importance of ongoing learning to keep pace with technological change:

> *"In our work we have champions of different areas, so we've got a Liquidlogic champion who goes to specific designated training and feeds that back to the team. We've got a Microsoft 365 champion who again goes to the training and comes back (…). It can work two ways, so we can give him feedback and he will go to - I don't know if it's Microsoft - but wherever he goes, he feeds it back and then comes back with feedback for us. (…) It's like word of mouth, like, 'Oh, have you come into this?' Helping each other out. We did get a basic induction training. I think that was the beauty of us being a new initiative. Everyone was kind of starting off fresh, so we got a two-week induction package which included a whole day of Liquidlogic training, a whole day of Microsoft 365. I'm still learning [laughter] three years, four years on."*

Co-designed training ensures that workers can continuously improve their skills while being directly involved in shaping how those skills are applied. Worker engagement and supportive training can both be encouraged by management. Strong HR management practices play an essential role in motivating workers, thus ensuring efficacy. By way of example, we can refer to the case of the Market Research Firm that implemented an Algorithmic Automation system for task requests, reducing personal errors and standardising processes. As described by a key informant, this firm saw significant improvements in efficiency not just because of changes in skills but also due to improvements in job quality and worker agency. Workers were provided with extensive training, leading to better job satisfaction and engagement as they felt more competent and in control of their tasks. As a result, both the individual worker experience and overall company productivity improved due to these high-involvement work practices.

Results from our survey of workers as part of the Review (Soffia, Leiva-Granados, et al., 2024; Soffia, Skordis, et al., 2024) indicate that employee-centred HR policies, those that emphasise employee care and wellbeing over productivity, are associated with higher job quality and overall quality of life (as measured by EQ-5D-3L scores).

Moreover, our engagement with workers via survey data indicates that supportive HR policies, particularly those fostering employee retention, investing in the workforce and committing to their growth and wellbeing, are significantly associated with higher levels of workers' capabilities as measured by the ICECAP-A framework (see Chapter 3.2). This positive link is notably amplified among employees frequently exposed to advanced technologies such as wearables, AI, and robotics (Xia et al., 2024). These results strongly suggest that institutional structures that promote employee capabilities, provide the right conditions for technology-driven productivity gains. The corresponding regression coefficients are available in the Appendix for reference.

Focus group evidence further underscores the importance of supportive management styles. When management actively communicates and involves workers in decisions about new systems, employees feel more empowered to embrace technological changes. As one participant noted:

> *"Our manager always checks in with us when new systems are implemented. We get training, and there's a follow-up to see how we're coping. It makes a huge difference."*

This kind of engagement fosters a sense of security and control, easing the transition into new workflows and helping workers view technology as a tool for improvement, not as a burden.

In contrast, when management adopts a top-down approach, workers are often left to adapt without sufficient guidance or support. One healthcare assistant expressed frustration, saying,

> *"…you certainly feel unsupported, not listened to. Everything that you say and do is incorrect. In the eyes of management there's always a different way of doing things."*

Such environments breed anxiety and alienation, which can severely undermine the benefits that new technologies are supposed to bring.

Similarly, in one of our case studies, an NHS trust adopted a new AI-powered digital dictation system to replace an old software system, without an open consultation process to its staff. These physicians struggled with the new system and eventually it cost them more time and effort to perform their tasks.

The role of HR practices is equally crucial in determining how workers perceive and adapt to technological change. Organisations that prioritise long-term employee learning and wellbeing create a more positive environment for navigating technological transitions. A participant in one focus group said,

> *"We get good training when new systems come in. It's not just a quick session—they make sure we really know what we're doing, and that gives you peace of mind."*

High-quality training builds trust and loyalty, making workers feel that their organisations are genuinely invested in their success.

Conversely, reactive HR practices that focus solely on efficiency without considering workers' experiences can leave employees feeling unsupported. One participant described their experience with insufficient training, saying,

> *"You feel pretty useless because you don't really know what's going on with new technology."*

Without proper support, workers may see technology as a threat to their job security and a source of anxiety, rather than an opportunity for growth.

The culture of the workplace also plays a significant role in shaping how workers experience technological change. Open, collaborative environments that encourage feedback help workers feel more comfortable navigating new technologies. As one project engineer shared,

> *"You've got the rest of your peer group to help you learn how to use those things."*

This sense of collective problem-solving reduces the stress of adapting to technological change.

On the other hand, in more rigid, hierarchical workplaces, workers may feel that technology is imposed upon them without their input. One worker remarked,

> *"Management doesn't listen... they just think, 'it suits its purpose,' even though it could be a lot better." In such environments, technology can become a source of surveillance and control, further straining worker-management relationships.*

The integration of new technologies is not inherently positive or negative. The outcomes depend on how well organisations align their management, HR policies, and workplace culture to support workers through these changes. When done right, technology can enhance productivity, flexibility, and skill development. But when these institutional factors are lacking, technology can exacerbate feelings of stress, insecurity, and disengagement.

The case for High-Performance Systems

Strong HR management practices, particularly those that involve workers in decision-making and encourage them to use their skills, are not new. These are known as high-performance work systems (HPWS). HPWS have been closely linked to improvements in productivity and efficiency because they focus on enhancing worker capabilities, not just through skill acquisition but also by increasing agency and discretion.

Research shows that organisations implementing HPWS experience higher levels of employee engagement, job satisfaction, and overall performance. This is especially true when adopting new technologies, where HPWS ensure that workers are equipped to manage complex systems, leading to better productivity outcomes (Hayton, 2023). This is particularly important in the context of technological adoption, where HPWS practices provide workers with the necessary tools and discretion to manage the complexity of new technologies and optimise their use.

The various case studies provide evidence to this, showing that better efficiency outcomes were observed not just because of adoption, or enhanced or changed skills, but because of enhanced job quality and worker agency.

These cases suggest that the path from technology adoption to higher productivity is not as straightforward as often assumed. Simply adding more skills to the labour market is not the missing link. The connection between increased automation and productivity is more complex. Achieving higher performance likely begins with technology adoption, followed by targeted training and skill development, and then creating better job experiences for workers—focusing on autonomy, opportunities for skill use, representation, and voice. These elements are crucial for unlocking productivity.

Moreover, the link between job quality and worker wellbeing has been shown to be vital, even more so than education (Green et al., 2024). If improving worker wellbeing isn't reason enough for employers to prioritise it, recent evidence shows a causal relationship between enhanced wellbeing and better firm performance (Bellet, De Neve and Ward, 2019; Krekel, Ward and De Neve, 2019; Isham, Mair and Jackson, 2021). Happy, healthy, and motivated workers are more productive.

Rethinking the automation, skills and productivity nexus

We invite readers to a fresh perspective on the technology, skill and productivity dynamic. Instead of focusing on automation and assuming upskilling will follow, businesses should emphasise workers' potential to shape their work, and participate in role redesign in ways which engage their understanding of the tasks involved and the skills required to achieve meaningfully shared objectives. But, beyond this socio-technical approach to role redesign, employers should seek to harness automation in ways which advance worker capabilities. Commonly this relies on better worker representation, participation, and discretion – ultimately, empowerment.

Refocusing on people's potential, and their choices and values is one way of opening new conversations about what we value and reward. This requires a shift in how we value human skills, abilities and experience. As seen earlier, critical thinking, leadership, creativity, and communication tend to be less automatable and are growing in importance, but these skills are often undervalued, both by society and by the labour market.

When viewed at an aggregate level, productivity problems and inefficient labour markets are often seen as a simple issue of mismatched skills relative to new technological requirements. However, there is much more to unlocking productivity than merely aligning the skills needed with those provided. It is crucial to consider how these changes affect workers at an individual level, and engage them in shaping their own future of work. If we want a workforce and businesses that are resilient to technological disruption, we must not only develop the necessary skills to meet employer demands, but also ensure that workers have the opportunity to use those skills in meaningful ways. Workers' agency in shaping these trends and preferences is essential to making these "matches" successful.

Businesses must rethink their approach to productivity by creating environments where workers feel listened to and valued. A human-centred approach to technology and skills will not only boost productivity but also improve the wellbeing of the workforce.

2.3 Information Frictions and Cognitive Technologies: Why AI Governance is a Job Quality Issue

Dr. Abigail Gilbert and Dr. Hong Yu Liu

Key Working Papers from the Review:

Firm-level adoption of AI and automation technologies: Case Studies Report - *H. Y. Liu, J. Hayton*

Reframing Automation: a new model for anticipating risks and impacts - *A. Gilbert*

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The frictions framework guiding this study was first developed to explain mismatch between workers and jobs and the phenomena of unemployment. In this context, information friction represents a lack of worker knowledge about possible opportunities, and a lack of employer knowledge about where to find the right workers.

Unemployment is the most commonly feared outcome of automation. Yet, the findings of our firm level survey, case studies, and individual-level survey all reinforce the fact that displacement is not the primary form of disruption. Far more often, workers remain in roles but see their work transformed. Thus, workers are as commonly navigating frictions within the job they are in as between jobs in the labour market.

If we want to explore the role of technology as a lever, an opportunity or a shock which can navigate towards better futures of advanced wellbeing and productivity, we must also consider in more detail what frictions look like in this context, within rather than between roles. To do this we need to more deeply consider how information technology can be designed, developed and deployed to change work.

If animal muscle drove the agrarian revolution, and steam engines propelled the industrial revolution that followed, the fuel that has driven this revolution is information. The period of technological change we are currently living through, defined by digitalisation, computing, AI and the application of these new capabilities to drive contemporary robotics means most developments are transformations in information technology ('IT').

In this chapter, we explore the specific implications of information technology for information frictions.

Cognitive automation and new dimensions of information friction

To understand how information frictions change in an era of cognitive technologies, it is helpful to first understand the nature of these technologies and their constituent components. Below we provide an overview of cognitive technologies in order that the more dynamic nature of information frictions in an era of cognitive automation can be understood.

Data

Data is the raw material of information technologies. Data can encode information about workers, or about the processes, logics and nature of the work they do. The use and processing of both types of data can impact workers. This can be through either primary impacts (informing automated decisions about workers pay, or promotion at work) or secondary effects (by learning from patterns in data how workers achieve tasks, and subsequently automating these tasks). Data can be used to generate significant value for an organisation. Unlike physical resources, data is non-rivalrous and can be shared with others without excluding the originating party from its use. In AI Governance, it is common to expect that certain information about data is recorded – such as what data is used to train a system, what data are being collected, the purpose(s) of their collection, their storage, use and processing.

Machine Learning

Algorithms use variables to make decisions using data. Those criteria can be predefined by people, such as in the case of Robotic Process Automation (RPA) which can follow an if-then model (i.e. if applicant says no to degree, then reject). In 'Machine Learning' systems, mass datasets can be used to create classifications (groups of data representing common phenomena) and to generate inferences (assumptions about the relationships between these phenomena). In this case the system may devise the most suitable (or statistically 'accurate') variables to inform decisions, within the parameters of what it is designed to optimise for. For instance, a hiring AI could process both the data from applicant CVs to identify words which signified a candidate should be recommended for interview. These systems can be designed in ways which ensure the logic behind these recommendations is interpretable – so the datasets, variables, criteria and weightings ('models') guiding decisions are known. Or they can be designed with little to no explainability. Choosing to use unexplainable systems, or systems with poor transparency to their users in the context of management decisions, reduces the scope for a system to be scrutinised. In turn, it reduces the capacity of an employer to know that decisions they are accountable for are robust.

Generative AI

Generative AI is distinct from Machine Learning, in that rather than using data to derive inferences which inform decisions, make classifications, or make recommendations, predictive analytics are used to replicate data, devise novel associations and generate outputs that imitate different types of human tasks or patterns of behaviour and activity, including 'creative' tasks on the basis of what is 'probable'. This comes from the use and application of deep neural networks, relying on extremely vast training datasets and higher orders of compute. Both of these conditions mean there is a more concentrated market and handful of providers of the 'foundation models' that commonly comprise GenerativeAI. The data sources used to train GenerativeAI are commonly scraped from the internet, however use of GenerativeAI tools within workplaces can also be a source of data. Generative AI is also composed of datasets, variables, weightings, and training methodologies, but the complexity of the ecosystems from which data is sourced are far more complicated, reflecting the scale, pace, computing power and accessibility of these tools. GenAI is a platform ('platform as a service') upon which other services are now being built. This increases the reach of these 'general purpose' technologies, making understanding their role within the economy ever more significant. OpenAI, the world's leading generative AI company so far, was founded with a public benefit mission and has a name chosen to reflect the principles of 'openness' associated with the formation of the internet. Yet the significant risks these systems can present if misused by malicious actors has also been used to justify reduced or partial transparency.

Compute

Compute is the hardware which allows data to be processed. Cloud computing is a model of compute that offers conventional firms the flexibility to scale and access data from anywhere. SaaS firms commonly rent the right to use AI chips – the hardware's which allow for advanced data processing – from a cloud provider. While data and algorithms are intangible, and non-rivalrous, compute is detectable, excludable, and quantifiable. This renders its use potentially more visible.

What does this mean for 'information frictions'?

When considering unemployment, information frictions relate to worker knowledge about new opportunities and firm knowledge about where to find the right workers. But how does information friction take on new characteristics when we look at the use of cognitive technologies within work - those changing jobs but with workers still employed?

Before going into this, it is important to highlight that most UK firms do not build their own ML or AI, but procure machine learning as a component of Software as a Service, ('SaaS'), which can integrate GenerativeAI capabilities from Platforms as a Service ('PaaS') with all data processed and stored using infrastructure as a service (IaaS), such as compute (Rani and Ranjan, 2014). Most commonly UK businesses are not developing their own cognitive technologies but procuring them. 78% of businesses report accessing, buying, listening or using third party AI tools, and more than half (53%) rely exclusively on third party AI tools (Brown, 2023). Cloud computing underpins a significant and growing share of UK business activity, with 89% of firms using at least one provider. A growing market of 'little tech' (Negron, 2021) SaaS providers offer workplace solutions which gather and process data about workers, workplaces, and organisational practices but rely on 'big tech' for their operating systems, compute and storage. This ecosystem of information exchange impacts worker-employer relationships, but also the extent to which firms are the sole proprietors of knowledge about what is happening in their businesses.

Therefore information sits across an ecosystem of digital actors. This is significant when thinking through information frictions in the case of employment. Let us look at two examples.

Worker Performance

Historically, any information frictions about performance assessment and requirements of a role would have been communicated between workers and employers, qualitatively. For instance, managers set criteria, formally or informally, to determine promotions. However, many firms now procure systems which manage performance of the workforce. They may not have access to information about the variables used to inform recommendations about promotion or the ability to evaluate for themselves whether a system demonstrates bias. In this sense information friction begins to extend beyond employer-employee, to the third party.

Work Methods

Codifying work methods in order that machines can substitute for labour is foundational to automation. Historically, management conducted observation and time in motion studies, following and documenting how tasks were completed or long it took to complete them, in order to a) share this knowledge with others, expanding the workforce; b) automate processes or c) schedule work in ways which minimise non-productive time. Contemporary information technology can automate these processes. The capacity of Machine Learning to derive patterns from large datasets can elicit tacit knowledge – that which is beyond explanation by workers themselves. While tacit knowledge elicitation has long been an unrealised ideal, advances in GenerativeAI and their integration into workplace applications increase the feasibility, pace and likelihood of success. This raises questions about where this data is held and who captures value from it.

Information frictions under contemporary automation are not only between worker and employer.

How does this play out across different automation archetypes?

As noted above, automation can take varied forms in an era of cognitive technologies. As we set out in earlier work within the review (Gilbert, 2024), these different forms reflect different approaches to reorganising work, or job design, to harness the capabilities of technology in ways which deliver value to the business. These are all underpinned by the substitution of some tasks, as is common in models of automation. However each also represents a different method of value capture (see Table 2.1 below).

Each of these approaches to role redesign, harnessing technology, changes the nature of frictions. Geographic frictions may be reconceived when thinking about the impacts of matching, or telepresence. Matching collapses geographic frictions in matching workers and tasks, telepresence can also achieve this. Yet, both may result in other kinds of adjustment cost for workers. Low or high discretion augmentation could both generate different kinds of skill friction, by driving overqualification or underqualification through

Table 2.1 - **Automation archetypes and approaches to value capture**

Automation Archetype	Task change	Firm route to value capture
Displacement Technology is designed or deployed to conduct tasks previously conducted by people, in a way which reduces the demand for labour at the level of an entire job.	Sufficient tasks within a job are substituted so that a role can be deleted.	Deletion of positions
Creation New jobs are created as a result of technologies that would not have previously existed.	New tasks are created associated with the use of a novel technology.	Creation of jobs with value creating potential.
High Discretion Augmentation Technology helps workers to conduct work in ways which improve processes, their experience and, potentially, their productivity.	Tasks which are peripheral, low value, or meaningless from the perspective of the worker are substituted.	Efficiency of skilled labour/increased scope for 'discretionary effort' by worker.
Low Discretion Augmentation Technology is designed and deployed to reduce the required discretion and skills composition of work.	Tasks which are core, high value or meaningful from the perspective of the worker are substituted.	Reduced discretion leading to reduced errors, reduced skill equating to reduced human capital contribution, allowing reduced salary and or bargaining power.
Intensification Technology is designed, developed or deployed to support increased density of tasks. This generates value by increasing the output and activity of humans.	Task composition may not change, but tasks may be monitored (telepresence) and performance measured against this with a view to managerial decisions, (see matching).	Increased yield from same human capital input.
Telepresence Technology is designed and deployed to project perceptual, cognitive or psychomotor capabilities into a distant environment..	Substitutes supervision; mediates cognitive/manual tasks across distance.	Efficiency, Performance, Relocation/ Re-distribution/ Fissurisation of workforce, allowing firms to exploit wage differentials .
Matching Information processing capabilities of technology are harnessed to reduce frictions in processes of pairing (worker to job, or task).	Tasks are mediated differently across space, possibly involving some substitution and or creation depending on position.	Deletion of supervisory roles, possibility of exploiting wage differentials through dynamic pricing; removal of standardised employment protections

the course of any automation process. Yet the most significantly transformed frictions are information frictions (see Table 2.2. below).

Our case studies in the review demonstrate these types of conventional but also novel information frictions.

For instance, in a case study of a Digital Dictation System in healthcare - which sought to substitute tasks previously conducted by secretaries (drafting letters and taking notes, to help physicians) - failed to realise these benefits owing to poor involvement of these workers in the process of planning how the system would be integrated. The system did not perform as well as expected,

Table 2.2 - **Automation archetypes and information frictions**

Automation archetype	Within-firm information frictions	Third-party information frictions
Displacement	Communication with workforce about design, development and deployment approach; organizational strategy for managing anticipated impacts	Growing use of AI in hiring and recruitment, raising questions of bias, robustness, accuracy and transparency.
Creation	Communication with workforce about design, development and deployment approach and organisational strategy for managing anticipated impacts; new opportunities, associated required skills, probability of opportunities.	Growing use of AI in hiring and recruitment, raising questions of bias, robustness, accuracy and transparency. How systems decisions are delegated to work can be important to understand from the perspective of trust, professionalism and accountability.
High Discretion Augmentation	Communication with workforce about design, development and deployment approach and organizational strategy for managing anticipated impacts; new opportunities, skills required; how to access support, the implementation process, including key decision-making points, evaluation and adjustment; negotiation about compensation.	How systems decisions are delegated to work can be important to understand from the perspective of trust, professionalism and accountability. Transparency about the purposes for which data collected will be used, including for the future automation of work processes.
Low Discretion Augmentation	Communication with workforce about design, development and deployment approach and organizational strategy for managing anticipated impacts; negotiation about the purpose and anticipated effects of the technology.	Transparency about the purposes for which data collected will be used, including for the future automation of work processes. Decision criteria and thresholds which determine worker choices (such as when, where and how to work) may be hidden.
Intensification	Communication with workforce about design, development and deployment approach and organizational strategy for managing anticipated impacts; negotiations around tasks and pace, the fairness of work allocation, the process of anticipating and monitoring impacts.	Transparency about the purposes for which data collected will be used, including the future automation of work processes. Decision criteria and thresholds which determine worker choices (such as when, where and how to complete tasks, how task performance and quality is measured; proxies for performance).
Telepresence	Management functions can be carried out remotely. Monitoring or 'surveillance' can be enabled principally through technology.	Transparency about the purposes for which data collected will be used, including the future automation of work processes

requiring extensive editing and review due to poor robustness of outputs. The software was designed specifically for medical professionals, therefore it is very good at recognising complicated medical terminology. However, the software is not good at recognising simple, everyday language. For example, in one case, 'you must have been a lot' was recognised as 'you masturbate a lot', or in another case, 'you're in pain' was recognised as 'urine pain' - both 'masturbate' and 'urine' are very common medical terms in urology, but can cause serious misunderstanding when they are being used under the wrong circumstances. Therefore, physicians have to pay additional attention to their letters to avoid miscommunication.

The physicians did not want to burden their secretaries with this, owing to the fact the process was meant to relieve them from this work. So the physicians saw their workload intensified as they were now spending days editing the letters before they were sent to patients. Nervousness about accuracy had negative impacts on wellbeing and perceived professionalism. Physicians who are not satisfied with the software mentioned that they have reported these issues to the hospital's IT department, but since the digital dictation system is a third party software, there is little they can do to help with improving the functionality. This led the physicians to feel unvalued.

Further, previously, secretaries when drafting patient letters had tended to schedule associated tests and follow up actions. As there had been no overview of the current nature of work as a system of interdependent and related activities and tasks, reflecting different team capabilities and responsibilities, removing secretaries from the process of letter writing led to reduced timeliness of referrals.

This case reflects both contemporary and new information frictions. In essence the plan was for receptionists to be substituted by the system, and for physicians to be augmented, without any negative impacts and potentially with greater discretion about how letters were written by directly producing the content. However, the process of implementation (conventional information frictions) and the nature of the technology (novel information frictions) both shaped this in practice.

Workers were not consulted on introduction or able to effectively pilot the technology to understand and forecast changes to their work quality and system performance. This has contributed to an intensification of work by physicians because time saving estimations were too high. This is a common challenge in the implementation of new technology and can lead to negative impacts on wellbeing, reducing potential productivity savings.

Equally, the software was not adaptable by those using it, which lead to frustration, with impacts for job satisfaction and performance. The ability of the system to perform under different conditions is also described by those who audit these systems as 'robustness'. This is commonly tested for products by there are not mandatory requirements for robustness testing, or communication of this, for UK products. This case may also highlight the need for firms to be able to subject systems to their robustness assessments before purchase. As many SaaS technologies are deployed on a rent-based model this would be feasible.

Another case we explored was that of Generative AI in a Technology Solutions Firm. This software development company create digital solutions for businesses, charities, and social enterprises across the UK. The firm adopted Generative AI (ChatGPT) to support many aspects of its operation. This allowed them to 'displace' work of copywriters who had previously been contractors, delivering an immediate efficiency. It also augmented their comms team in developing social media posts. Further, ChatGPT is now used to support software development. ChatGPT can correct mistakes in the code and even suggest the next five or six lines of code in programming. It has also been used to create persona's for design processes which was previously a time-intensive task. Further it supported the team to draft tricky customer emails.

Generally, those within the firm experienced this as high-discretion augmentation, affording more time for the work they enjoyed and considered creative. However, there were concerns about data processing, and performance relating to hallucinations. Our interviewees were aware of the fact that ChatGPT is capable of making some very convincing but incorrect arguments. While time saving, the risk of automation bias – assuming that it will be accurate because it's convincing – required staff training, to ensure content is checked, reviewed, and fits the requirements.

Staff were also concerned about data 'leakage'. This was not just in relation to the ways in which using the system treated personal data, including that of customers and clients, but also proprietary information. The team acknowledged using the tool for source code generation, allowing it to learn from their work for any given project. As they submit code to repositories which they know are scraped by these tools anyway, this did not concern them. But they were conscious that anything that involves client information, 'we'll have to think about how we sandbox that and how we make sure that it does not form part of a wider knowledge bank, and we're not training AI based on that information.'

Concerns about the use of proprietorial data (either of the firm or clients) reflect information frictions between the provider, firm and employees about how information is processed within the system. Many businesses lack knowledge of the legal frameworks governing data access, ownership and rights (Bond, 2022) or identified 'gaps' in its coverage and application, including application to the supply and value 'chain' of the technology. Control of data access and use - or data 'ownership' - is also hard to substantiate in English law, it is not a homogeneous legal object and rights that apply will vary depending on the nature of the data and the circumstances in which it was created and shared. Further, regimes that do exist (such as rights of confidence; copyright; database rights; IP and contractual rights) may be inadequate in the context of this new wave of information technologies in terms of their remit, scope, application (including core definitions) or focus. More critically, sacrificing data about business operations could diminish firm capabilities, hollowing out firm capabilities and increasing risks of market concentration.

We also looked at the use of a Smart Logistics Algorithmic Management Tool in one of the largest charity retail networks in the UK, which supported with accepting bulky item donations, collecting them, transportation and storage and eventually retailing. For many years, this operation was paper-based. Drivers previously worked out how many collections they could do, what would fit in the van, devised their own route plans and were paid based on the number of collections they completed. Under the new system, donation details are submitted to a centralised management system, which can calculate and suggest the most efficient route for a van driver to pick up and deliver donations during the day. Rather than precise sizing of goods, or intuition about size and shape the system works according to a points-based logic: for example, the maximum capacity of a van is 20 points, a piece of large-size furniture is 5 points, a medium is 3 points. From a management perspective, this system can provide the most efficient solution when scheduling drivers' daily tasks and managing their vans' space. Another feature of the system is that it will track the driver's location. When a driver accepts a task on his/her tablet and heads to the following pick-up location, a text message will be sent to notify the customer that the driver is on the way. This could help facilitate communication between store staff, drivers, and customers.

While the system is designed in a way that is easy to use, drawbacks were identified during the implementation process which had not been foreseen. While in principle, the charity would not reject donations, in reality shop managers would turn down a donation if there are many similar items in storage; or schedule the pick-up later to free more space. This is not possible with the new digital system because it will schedule a pick-up by default. In addition, sometimes van drivers did not agree with the route suggested because they have better knowledge of local traffic. As the van drivers are well aware of their tablets tracking their locations, they tend to comply with the instructions nonetheless. They also found their tacit knowledge from years of experience looking at items and sizing them that their ability to pack the van to capacity was superior to the points based logic. Lastly, in the past, when van drivers' payments were made manually by store managers, this allowed discretionary recognition of particularly difficult tasks (e.g., collection or delivering of heavy furniture from higher floor apartments) reflecting their efforts. However, this is not accounted for within the digital system and the drivers have no avenues to contest this.

In sum, while managers reported feeling more supported by the system due to greater 'transparency' afforded by the extension of their supervision at distance (telepresence) and the system was seen to improve efficiency, workers experienced increased information frictions, reduced discretion and therefore ability to use their skills and capabilities within their role design, with social and material consequences.

Discussion

Each adoption of new technology is an opportunity to improve work, and improve the match between workers and their jobs. Our case studies suggest that managers cannot foresee the impacts of automation clear sightedly, and that greater workforce in design development and planned approach to deployment would improve both system performance and job quality. However, beyond these classic information frictions relating to communication, information frictions take on new dimensions as relating to the nature of cognitive technologies, their business models and governance. Better consideration of how this interacts with the workplace system is increasingly urgent; as are frameworks for anticipating and managing downstream and unexpected impacts.

In many of the 11 case studies conducted for the Review, a lack of workforce consultation and involvement in the planning and integration of new systems undermined delivery with negative impacts on ultimate performance of the system, prediction of risks, and job quality. Modelling how a new cognitive technology will interact with people seems core to effective performance; and also understanding how social relationships and dynamics will change. Worker involvement can support better anticipation of job quality impacts, and improvements to organisational performance and productivity. Rather than being restrictive, good governance of this kind would mirror that of 'high performance' work systems (Boxall and Macky, 2009). Planning in this context goes beyond matching of technology and task, instead reflecting the conscious and careful integration of human and technical components as more mirrored in socio-technical system design (Mumford, 2006).

However it is notable that firms may not always have the answers and information asymmetries now sit across a wider ecosystem of actors. The experience of delivery drivers in the Charity case study reflects a common set of experiences as algorithmic management to allocate and schedule work is rising across the economy (Prassl, 2018). This began in segments of the economy – 'gig work' – but is now increasingly commonplace across sectors, including knowledge and service work, allowing for the same gradual transformation of conditions and contract types (‘gigification’). While loss of control is one facet of the poor implementation of these tools so too are issues of contestability and redress around management decisions, which may have significant impacts on work and its quality. As decision making becomes both more diffuse and more ‘centralised’, extracting more information from the worker while giving less away, bargaining power of workers is negatively impacted.

The concerns about how data which may be proprietorial is treated by ChatGPT also signify the secondary risks to workers, associated with the capacity of new technologies to rewire and restructure markets. Firms are not procuring tools with regard to their use and processing of data. This more-than-personal, industrial data could be used in ways which transform their own sectors and competitive ability. The business model of cloud based services is commonly that of a rentier: they collect data, enclose access, and then monetise access (Sadawski, 2020). The key technology of this enclosure is the software license (Perzanowski and Schultz, 2016). Many businesses lack knowledge of the legal frameworks governing data access, ownership and rights (Bond, 2022) and, confounded by a lack of technical expertise in procurement, lack the capabilities to be critical procurers of these systems – specifying the forms of disclosure they may require to be effective in their operations. Further, regimes that do exist (such as rights of confidence; copyright; database rights; IP and contractual rights) may be inadequate in the context of this new systemic challenge. While there is a growing interest in AI ethics among businesses, with executives ranking AI ethics as important jumping from less than 50% in 2018 to nearly 75% in 2021; fewer than 20% of executives strongly agree that their organisations’ practices and actions on AI ethics match (or exceed) their principles and values (IBM 2021). This raises the question as to why firms aren’t achieving this, and what they might need to consider where this relates to new information frictions at work.

Conclusion

Past technological revolutions have demanded that governments moderate their impact. In a time of great flux, this has meant balancing asymmetries that arise as technologies are adopted at different rates, or impact different people in different places at different times.

In an era of information technologies, information asymmetries are growing. New processes which support involvement of workers in design, development and deployment are needed, to better anticipate impacts and plan effective implementation. However, the extent to which firms can do this when relying on third party tools and services, depends on wider aspects of digital ecosystem regulation and governance.

This invites a closer focus on the relationship between automation, AI governance, and job quality, fore fronting good work and wellbeing but also intelligent procurement and contracting of service providers by UK businesses.

2.4 Lessons from firm-level research

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Here, we have seen that the outcomes of technology adoption are conditional on choices made by employers. They are the nucleus of this broader transformation, holding the power and capacity to determine its effects. However, their choices are shaped. They are shaped by their values with respect to employees and their management. They are shaped by place. Another, is the embedded ideas and false assumptions about the inevitability of productivity. The last is AI Governance.

Regarding place. In Chapter 1 we learned that there is a better distribution of innovation readiness across the country, than there is innovation in practice. This highlights the need for more distributed investment, and architectures which support the translation of innovation into useful applications within industries across the country. However, by cross-referencing these findings with our survey data asking firms about their practices of adoption, we find that where innovation readiness is lower, organisations tend to adopt technology in ways which erode the quality of work, the number of positions, and aggregate skill demand. In this sense, innovation readiness is a key factor in shaping the quality of innovation within a region where this is measured by good work. Failing to address this could have a combined, detrimental effect, to consolidate regional inequalities and confound those of earlier industrial transitions. Intervention, then is required both at the system, place and firm levels. A more than technology focussed, more than technological skills focussed, and necessarily deeply place-based strategy which focusses on transition is required, with the appropriate architectures to encourage and support good innovation (matches between firm and innovation) and good transitions (matches between workers and jobs).

Regarding ideas of productivity. Common models of automation view the route to productivity to be the substitution of tasks previously conducted by workers. This can scale up, to the entire deletion of a role, or be partial, changing human capital contribution within a job in ways which impact the skills required. From analysis of our qualitative cases, we see that simply adding skills and technology will not be an effective route to securing the benefits we so need for any economic renewal. New technologies afford possible approaches to role redesign which can have positive or negative impacts for work quality and skills demand, depending on the chosen route to value creation. Understanding whether these will be realised, in practice requires far more socially-intelligent approaches to design, development and deployment.

While we find in our survey that senior leaders generally anticipate improvements to job quality, we see in the case studies how poorly equipped leaders are to anticipate the ways disruption will play out in practice. This may reflect their ability to understand the true task composition of work, or relationships within a workplace. This is a risk which is confounded by low-involvement practices, directly contributing to innovation failures. Regarding skills, while there may always be some form of 'upskilling' associated with learning to use new technologies, and associated new skills may arise as the production process changes, sitting above the granularity of those skills is the fundamental management choice to either increase the discretion afforded to workers, or decrease it through innovation. As we have seen technology can be an instrument in this objective. Augmentation, then is not simply a matter of upskilling. Augmentation is an approach to job redesign, supported by technology which can take different directions. It can be aligned to high performance system approaches, giving greater discretion to the workforce about how to achieve tasks and utilising their knowledge and skills to do so, or it can be associated with low-road approaches; not limited to role deletion but also to reduced skill use and discretion. The consequences of this for workers are explored further in the next chapter.

Regarding AI governance we find that information technologies change the nature of information frictions relative to earlier stages of innovation. High involvement practices through adoption remain significant. Our case studies clearly demonstrate frequent unintended consequences which hamper good work, and performance, where there are not strong ex-ante processes of review. However, information frictions can sit beyond the firm. Businesses are not always able to access the information they need about the technologies they feel they must procure to innovate. Policymakers should consider the intersection between good work and the wider AI governance conversation. The need for this is further unpacked in the following section which unpacks individual level experience.

Section 3
Work and Wellbeing

3 Work and Wellbeing

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Understanding the experience of individuals in the midst of technological transformation has been central to all of the research we have been doing in the review, so in this final section of the Report, our focus turns to the experiences of individual workers.

We have examined the geography of disruption, and evolving nature of skills frictions at the national, systems level. We then focused down to the firm level to understand how this transformation is playing out in affecting workplaces across the country. We explored the contexts – ideas, resources, rules – which that shape decisions about automation at the firm level. We also discussed the challenges and opportunities that companies are experiencing as they look to consider adopting new technologies – and management processes and regulatory and governance environments that influence how technology adoption interacts with job quality and productivity.

Understanding the experience of individuals in the midst of technological transformation has been central to our work on the Review. This work seeks to understand how the fast-arriving future of work is affecting the daily lives of our workforce, including their health and wellbeing. Without this evidence, we cannot build the institutional conditions needed to promote and protect human flourishing.

As AI systems present ever more human-like outputs, and robotics and automation systems are heralded as the key to our productivity puzzle, it is valid to ask: what does this mean for the nature of our society? If our economy undergoes a radical technological transformation, but research suggests that this will result in work for the majority becoming less rewarding, less inspiring and having more deleterious impacts on health and wellbeing, is it a path that we should nonetheless still follow because of other economic forces? Similarly, if we can identify paths through technology adoption and innovation that sustain job quality and skills, to make us happier and healthier, but this requires stronger regulatory and legislative interventions, to what extent should we look to steer towards these better outcomes for people in a highly globalised economy?

Through a survey of over 5,000 UK employees and focus groups with employees from different regions and industries across the UK, we explore how workers experience new workplace technologies, and how those technologies impact their work and lives.

This section opens with an exploration of how exposure to different types of workplace technologies is impacting people's quality of work and life. It finds that these impacts are highly divergent depending on the technology in play and the worker – with positives for many people like flexibility and improved decision-making, and many negative impacts for others, like routinisation and feelings of surveillance. It also points to an idea that has been underpinning the Review over these three years: that the future of work is not a settled space, but rather is one still under negotiation, one that can be actively shaped towards good, if people are given the appropriate agency.

We then explore this area of agency in more detail through the lens of capabilities. This approach takes us beyond the standard policy conversations about human capital investment, job satisfaction and productivity, and aims to understand whether people have the necessary freedoms to make the choices that would lead to a better and more fulfilling future of work. Since the start of the Review we have argued that capabilities are a promising avenue to help build a more resilient workforce that can navigate growing labour market frictions. Thus, we provide a novel description of how such capabilities are currently distributed across the UK workforce, shedding light on which groups are at risk of falling behind.

This is a vital dimension to our work in the Review. Policies that focus on skills shortages and what firms need to become more productive can leave workers painted as passive, subject to skills being put into them in order to make them employable and keep the market functioning. By focusing on capabilities, this picture changes and employees are seen as active agents in developing their own futures of work. In the same way, we see the role of policy as not to instruct people on how to live a good life, but to create or protect the conditions that ensure people have all the opportunities to do so.

Our firm-level research in Section 2 found that when people are invested and engaged in the process of new technology design, development and deployment we see positive interactions with job numbers, skills and job quality. This is supported by the findings in this Section of the report. This is a critical finding as the work presented at our mid-Review conference by economists Daron Acemoglu and Erik Brynjolfsson, connected these outcomes to improvements in productivity far beyond those seen when new technologies are deployed without engaging workers.

If a capabilities approach is central to delivering a future of work in which innovation and social benefit advance together, how do we develop this approach? We see that capabilities can be constructed, provided and supported. It is possible to identify and build the enabling institutional and environmental conditions for these capabilities to grow.

This section concludes by highlighting how capabilities are consistently higher when there is an employee-centred HR philosophy, formal and employer-provided training, and access to independent representative structures such as trades unions and employee forums. Our analyses suggest these enabling conditions become ever more relevant in contexts where employees are exposed to newer workplace technologies. The technological transition is already underway. We can choose how best to respond and this Section suggests pragmatic strategies to ensure that the technological transformation of our work, supports a positive transformation in our lives and communities.

3.1 How is Exposure to Workplace Technology Impacting Quality of Work and Life?

Dr. Magdalena Soffia, Dr. Shuting Xia, Dr Rolando Leiva-Granados, Xingzuo Zhou, and Professor Jolene Skordis

Key Working Papers from the Review:

Does technology use impact UK workers' quality of life? A report on worker wellbeing - *M. Soffia, R. Leiva-Granados, X. Zhou, J. Skordis*

From technology exposure to job quality: evidence from a comprehensive UK survey - *M. Soffia, R. Leiva-Granados, X. Zhou, J. Skordis*

Taking work, or changing work? Understanding how technology adoption is reshaping work in the UK - *S. Xia, M. Soffia, J. Skordis*

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The varied impacts of different technologies on job quality are mirrored in the equally diverse effects on workers' health-based quality of life. The impact on quality of life might be positive, through enhanced flexibility and reduced physical strain. Yet, these changes may also elevate stress through increased workloads, the perceived risk of job loss, or a sense of mistrust due to monitoring.

Tools such as digital information and communication technologies, AI and Machine Learning software, wearables and robotics are fundamentally reshaping work processes and transforming the nature of jobs. As noted in other analyses from the Review, these changes can affect workers in very different ways. For some, they offer opportunities for greater flexibility, skill development and a revised balance between work and home life. For others, they introduce new pressures through intensified workloads, heightened surveillance, and increased job insecurity.

As we will discuss in the following paragraphs, workers' experiences with new technologies suggest that there is nothing inherent in the technology itself that dictates whether the outcome is positive or negative. Rather, as explored in Chapter 2.2 regarding the role of managerial and human resources philosophies, we propose that there can be different avenues through which workplace realities can be shaped to make these experiences of technology more positive than negative.

Given the growing exposure to technology in the workplace, and the centrality of work to most of our lives, it is important to fully understand how workplace technology exposure affects employees' overall quality of life. Understanding how individuals experience the benefits and drawbacks of new technologies should be instrumental in shaping the policies and practices that can amplify the benefits of new technologies or mitigate the risks.

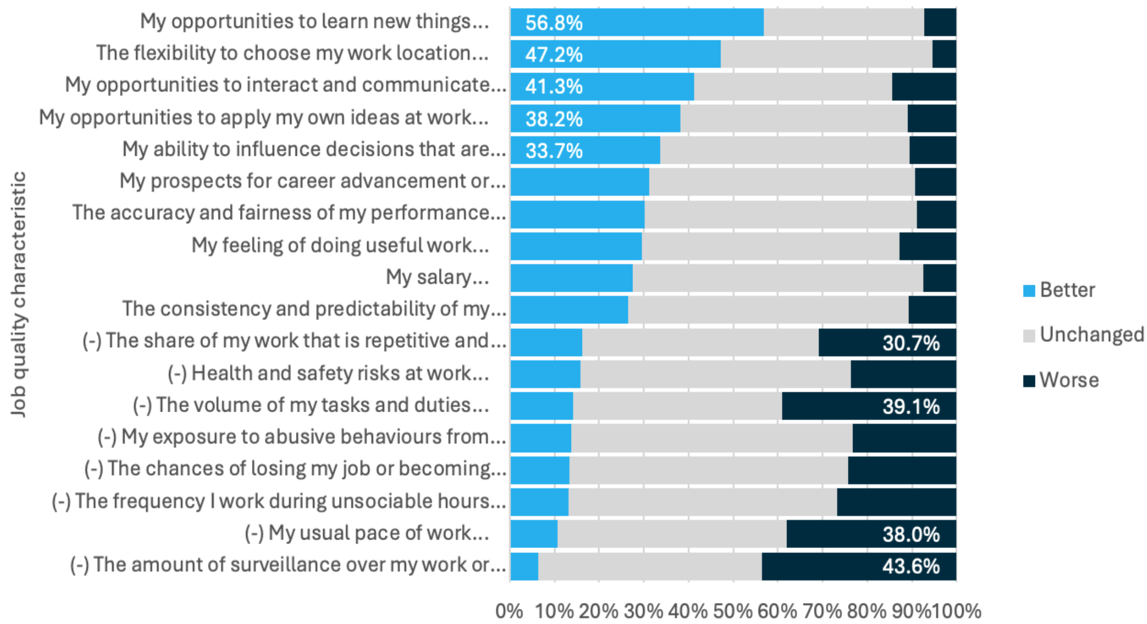
Drawing on survey data from over 5,000 UK employees and insights from 12 focus group discussions (see Annex for a description of methods used), this chapter examines the ways in which exposure to workplace technologies is affecting workers' quality of work and life. The findings reveal that the future of work is a dynamic landscape that we can actively shape, where the decisions we make today about how technology is introduced and managed - will define whether technology elevates or undermines the quality of work and life for millions.

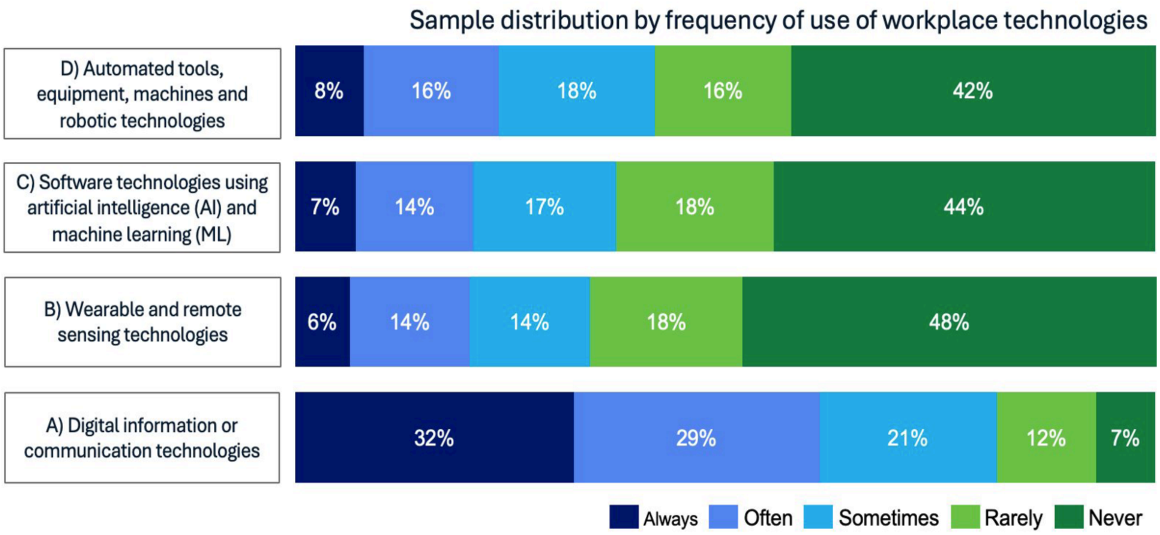
Shifting realities: How different technologies reshape the quality of work

Job quality is about the various characteristics of a job that contribute to a person's objective and subjective wellbeing (Felstead et al., 2019). In our research, we focus on 18 key areas of job quality, including pay, work intensity, the working environment, and the ability to develop skills. We explore how, from the viewpoint of employees, these aspects of job quality have changed in recent years, particularly as new technologies have been introduced. We asked participants to reflect on how technology had impacted their work, using a scale to track whether these changes had improved or worsened their job experience. This allowed us to capture a nuanced view and first-hand account of how new technologies are reshaping the modern workplace, offering insights into both the opportunities and challenges these systems present.

Our results show thatinteracting with technological innovations in the job doesn't always translate into universal benefits for workers. The reality is more complex. When we asked employees whether technology – broadly speaking – had changed their everyday work experiences, the responses were varied. Many participants reported no significant change in certain aspects of their job, but among those who did notice changes, the effects went in different directions (Figure 3.1). For example, while a notable proportion of respondents (41.3%) reported a positive increase in their opportunities to communicate and interact with the people they work, a similar proportion (43.6%) mentioned that technologies have increased the amount of surveillance over their work or that of their colleagues. Even from these mixed findings however, it's clear that the impacts of technology are not unanimously positive, as some businesses and organisations might hope.

The divergent changes in job quality suggest a critical point: technological disruption does not affect everyone equally, and the range of outcomes for workers can be broad. These variations also likely reflect the diverse and potential ways in which different types of technologies – such as Digital ICTs, Wearables, AI, and Robotics – shape these experiences. While some workers primarily interact with more familiar tools like digital ICTs, others are exposed to newer, more specialised technologies such as AI-driven systems, robotics and wearable devices.





Indeed, our data reveals that individuals' exposure to these technologies varies significantly. As shown in Figure 3.2, Digital ICTs are far more prevalent than newer technologies, with 61% of workers reporting frequent interactions with this form of technology.

This widespread use highlights the central role that ICTs now play in communication, task management and collaboration across multiple sectors. However, exposure to newer technologies like AI, robotics, and wearables during a typical working week remains less common - with less than 25% of respondents reporting frequent use. This limited exposure suggests there is an opportunity to shape the impacts of these technologies on the majority of workers as adoption expands. Nevertheless, the effects of these newer technologies are already being felt by a sizeable portion of the workforce. As we shall see next, the degree to which workers interact with different types of newer technology, can influence specific dimensions of job quality such as autonomy, skill use, and job security.

Our findings further suggest that exposure to Digital ICTs is likely to explain a big part of the most notable positive changes in jobs that individuals attribute to technology in recent years, such as improved learning opportunities and more flexibility, broadening the horizons of the workplace.

Looking back at Figure 3.1, we observe that over half of the surveyed workforce reported gaining opportunities to learn new things. Results from ordered logistic regressions further indicate that employees who frequently interact with Digital ICTs are significantly more likely to report such positive changes, with an odds ratio (OR) greater than 1.6 ($p < 0.05$). This sentiment was mirrored in the focus groups, where participants noted the ease of accessing learning resources, with online tutorials and courses readily available. For example, a digital product manager in telecommunications mentioned how the pandemic had normalised online learning, allowing them to continuously upskill and engage in internal training sessions about new technologies. This respondent highlighted how easily they could now acquire new skills and apply them in their day-to-day tasks, reflecting a broader trend observed among participants.

While this suggests that digital ICTs play a critical role in fostering workplace learning and development, it couples with a contrasting finding: workers who engage with this type of technology are also more likely to report worsening career prospects. Notably, this was the only significantly negative change associated with ICT use among the 18 job quality aspects surveyed. This contradiction suggests that as proficiency in digital ICTs becomes more widespread, this skill no longer constitutes a competitive edge in the labour market. This might sound even more paradoxical if we consider that use of Digital ICTs may also be associated with accelerated automation, as workers generate data which trains the newer systems they interact with, although this was difficult to evidence from workers direct accounts.

Digital ICTs have also introduced a new era of flexibility, allowing workers to manage their work from virtually anywhere. As shown in Figure 3.1, nearly half of the surveyed individuals reported increased flexibility to choose where they work and further analyses suggest that frequent exposure to Digital ICTs is significantly contributing to that perception. Many participants in the focus groups emphasised that their use of ICTs supporting remote and hybrid working, which began during the pandemic, have now become a standard practice. One insurance broker shared that their routine now involves two or three days in the office, with the rest of the week spent working from home or any location that suits their needs. Participants often highlighted the benefits of digital tools by making remote work more efficient, facilitating seamless communication and collaboration across distances, keeping teams connected and productive regardless of location.

Another notable benefit of frequently interacting with digital ICTs, according to survey respondents, was an increase in their opportunities to apply their own ideas at work. While further evidence is needed to confirm this, it could be theorised that enjoying greater flexibility to work remotely also allows employees to have more “headspace” and time for creative and strategic work that can be applied in practice, as well as more control of their workday overall.

In contrast, while newer technologies like wearables, AI software, and robotics are not as prevalent as ICTs, their growing presence is reshaping job quality in ways that are not always beneficial. Wearable technologies, for instance, pose benefits and risks to job quality. On the positive side, the survey data shows that these devices are associated with salary growth, more predictable and consistent working hours, an enhanced feeling of fairness when it comes to performance evaluations, and – contrary to frequent users of Digital ICTs – better career prospects. On the negative side, the same survey evidence suggests that wearable technologies generate a sense of unease about job loss, repetitive tasks, intensified workload, safety risks, antisocial working hours and even a feeling of being constantly monitored. It’s a curious paradox: the very tools meant to enhance efficiency and fairness, can also erode the sense of autonomy that so many workers value. Of note, despite still being an emergent workplace technology, wearables are associated with a larger number of negative job quality changes than other types of technologies.

Over 40% of employees in our survey reported increased workplace surveillance, although attributed to ‘technology’ in general. Surveillance was also a recurring topic in the focus groups, where participants more often associated it with the growing use of technologies that track their movements and activities. Tools such as digital log-ins, swipe cards, and electronic work documentation now record everything from the time employees enter and exit the building, to the completion of specific tasks - with every action logged and time-stamped. Although these systems are primarily designed to enhance operational efficiency and maintain accurate records, as workers would assume, they are also perceived to function as surveillance tools. One family support worker noted that even basic systems, like code tags, track when employees are present or absent. This highlights how general-purpose technologies are potentially being used to monitor workers across various aspects of their daily routines, which can also include work methods and practices, allowing for future automation.

A significant number of survey respondents also reported that their workload had intensified, with more tasks to complete and an increase in repetitive work (see Figure 3.1). Further analysis of this data showed that exposure to wearable technologies is significantly contributing to these negative perceptions, although discussions form the focus groups did not point out to a specific type of system propelling this feeling. For instance, several participants observed that time saved by the use of new technologies often led to heightened expectations and additional responsibilities.

One fabric technician shared their experience:

> *"You just get quicker and quicker, more and more workload, faster and faster - you just have to try and keep up with everything... You need to be on top of your game."*

Even common digital equipment was cited as the culprit of work intensification inasmuch as it allowed continuous multitasking and increased documentation. In that note, one healthcare professional commented:

> *"Even in face-to-face meetings, people are on their laptops, multitasking – responding to emails while attending meetings. It feels like technology is constantly pushing us to do more and more."*

Moreover, the perception of intensified workloads was evident across various roles and sectors. For example, one manager described how AI-generated content, while cost-effective, added to her workload through the need for proofreading and corrections. She explained:

> *"We realised that we don't necessarily need someone to sit and do content writing ...but not everything the system generates is 100% accurate. So, I end up having to sit and read through everything, proofreading it all. It's taking time away from my day-to-day tasks."*

AI and machine learning are arguably the most transformative technologies in the workplace today, in spite of the fact that the proportion of the UK workforce frequently interacting with these systems is barely over one fifth (see Figure 3.2). Our survey findings suggest that workers who frequently engage with AI report significant improvements in the use of own ideas, decision-making power, career prospects, schedule consistency, communication, flexibility to choose where to work from, and even salary growth. These technologies also appear to enhance employees' ability to focus on more meaningful aspects of their work. For only some of these positive outcomes, we find their equals in focus groups accounts. For instance, enhanced communication with colleagues and clients was a recurrent issue in the group discussions. One participant mentioned their use of the tool Mural, which, in their experience, had made remote collaboration with colleagues easier.

The tool allowed the team to brainstorm and share ideas on a virtual whiteboard, which they found especially useful for projects requiring teamwork and shared responsibilities.

However, the rapid pace of AI adoption is also raising concerns about job security, with the perception that the same tools that empower employees could eventually replace them. This concern was echoed in the focus groups where, as an example, one sales representative recounted seeing their company replace a human social media marketer with AI-driven tools, and how that spread fear among colleagues of different occupational grades.

Robotics, though less widely adopted, is steadily making its mark, particularly in sectors like manufacturing and logistics. As with AI, our survey findings suggest that the perceived improvements in job quality linked to robotics were largely positive, reflecting emergent benefits in areas such as salaries, career prospects, evaluation fairness, and schedule consistency. Despite common claims that robots reduce repetitive tasks and enhance health and safety, our survey findings offer little evidence to support these specific impacts. Also, in keeping with the findings for AI, the potential for increased productivity through automation is tempered by the persistent concern of job displacement.

The effects of various technology exposure discussed above present complex challenges, such as navigating the flexibility-intensification trade-off and the learning-routinisation duality. Opportunities for skill development and learning are often accompanied by an increase in repetitive, routine tasks. Benefits – such as improved career prospects, flexibility, and schedule consistency – are frequently offset by challenges like increased workloads, job insecurity and heightened surveillance.

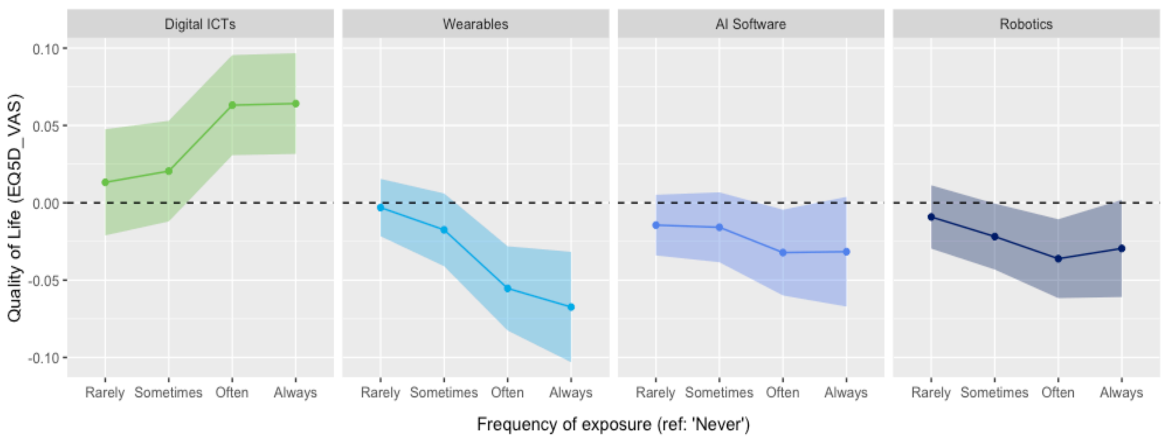
What’s clear is that technology is not just changing the tasks we perform –it is redefining how we work, how we interact with our jobs, and how we view our careers. As these technologies become more integrated into our daily working lives, the challenge will be navigating this delicate balance to ensure that innovation enhances, rather than diminishes, the quality of work for everyone.

A balancing act: How technology shapes the quality of life

Given the significant and varied perceptions of participants around the impacts of different types of technology on their jobs and ways of working, we further explored whether exposure to such workplace technologies also relates to employees’ overall quality of life beyond work. While technology is only one of many factors affecting wellbeing, and we do not expect technology alone to affect substantial changes in workers’ quality of life, the workplace –where most people spend a large part of their day– becomes a key environment where the effects of technology, both positive and negative, are keenly felt. After all, good-quality jobs provide workers with a wide range of opportunities to build a life that they value. This is essential, as higher-quality jobs directly contribute to a healthier, happier and more satisfied workforce (Green et al., 2024).

To measure the relationship between technology exposure and workers' quality of life, we used the EQ-5D-3L measure, a widely recognised tool for assessing health-related quality of life (EuroQol Group, 1990; EuroQol Research Foundation, 2018). The EQ-5D-3L evaluates quality of life across five dimensions: mobility, self-care, usual activities, pain or discomfort, and anxiety or depression. Based on the value preferences of the UK adult population, different combinations of health states across domains are assigned a score that ranges from -0.073 to 1 (anchored at 0 = death and 1 = full health, and negative values representing health states valued as worse than death). This allowed us to calculate a quality-of-life score for each survey respondent, and then explore the correlations between different types of technology exposure and overall quality of life. Insights from our focus group discussions also describe how workers' interactions with technology might shape – and be shaped by – their quality of life.

Figure 3.3 - Changes in QoL score across levels of exposure to different technologies



Digital ICTs

Our findings show that digital ICTs are positively correlated with improved quality of life. As shown in Figure 3.3, workers who engage more frequently with these technologies report higher quality of life scores. This positive association is particularly evident among professionals and managers who extensively use digital tools in their roles. However, this correlation between digital ICTs and quality of life is not uniform across all groups. For instance, and exceptionally, moderate exposure to ICTs among women aged 35 to 49, is correlated with a decline in quality of life (Soffia et al., 2024a).

The focus groups offered some insight into this relationship between ICT exposure and quality of life, reinforcing the benefits of location flexibility discussed earlier and highlighting additional advantages such as improved work-life balance, communication and productivity. Overall, these technologies appear to give workers more autonomy and control over their tasks, leading to greater satisfaction in both their personal and professional lives. For instance, one study participant highlighted the benefits of remote work technologies, which allowed them to balance personal and professional responsibilities more effectively. With tools such as video conferencing platforms and cloud-based systems, they were able to manage their workload seamlessly from various locations, fostering a stronger sense of control and integration between work and personal priorities.

Another participant, balancing work and childcare, explained that remote and hybrid arrangements, supported by digital tools such as shared calendars and mobile connectivity, were essential to managing both roles. These technologies provided the flexibility needed to handle childcare routines, such as dropping children at nursery, while maintaining professional commitments. This adaptability, particularly prominent in post-pandemic work environments, has enhanced their daily experience and reduced stress.

Digital ICTs also deliver tangible financial and time-saving benefits, frequently highlighted during the discussions. One participant noted that reducing the number of days commuting, especially to high-cost urban areas like London, resulted in significant savings in both time and money. This couples with the evidence that spending time commuting to work significantly lowers wellbeing (Clark et al. 2020), but also highlights freed up resources for personal activities and leisure, contributing directly to a better balance between work and personal life.

The focus groups further emphasised the transformative impact of Digital ICTs on communication and collaboration, which survey data initially suggested to be more closely associated with AI-based software. A senior executive explained how platforms such as Microsoft Teams streamlined meetings and facilitated staff training, with integrated tools like screen-sharing enabling more effective workflows. Building on this, an operator highlighted the role of smartphones and digital platforms in enabling speedy responses to urgent production issues. Reflecting on the pressures of resolving such problems, the operator explained,

> *"It's great because if things go wrong, there's a lot of pressure to catch up with the production plan. It affects everyone. It's just nicer if things are running smoothly."*

These tools enable swift global communication, reducing stress and ensuring a more stable work environment.

However, while many participants highlighted the positive outcomes of digital ICTs for their lives beyond work, the focus group discussions also revealed notable challenges that may not have surfaced in the survey data. Many workers spoke about the blurring of work and personal life, with the ease of accessing work via mobile devices extending working hours and creating an "always-on" culture. This constant connectivity left some workers struggling to "switch off" and feeling emotionally drained, often accompanied by guilt for ignoring work outside of hours. While remote work offers flexibility, participants emphasised the importance of setting boundaries to protect personal time and reduce risks to mental health.

Alongside these concerns about boundaries, digital ICTs have also reshaped workplace dynamics. Digital communication, though convenient, has increasingly replaced face-to-face interactions – a change that some workers perceive as a loss. A customer service representative reflected on this shift, explaining that while colleagues used to engage organically in the office, now interactions revolve only around roles, tasks, and processes, all happening online. This shift, they noted, feels "more clinical and a bit sad," pointing to a broader cultural change where efficiency and task management have overshadowed the informal social interactions that once thrived in office environments.

Moreover, the shift to remote work introduced a different set of physical health challenges. Workers who had transitioned to working from home found that their previously active routines had become far more sedentary. A financial analyst noted how the lack of movement in her daily routine had negatively affected her physical health. Instead of commuting to an office, she now simply walked downstairs to her dining room to start her day, which resulted in less exercise and contributed to an overall feeling of an unhealthy lifestyle. The physical strain of spending long hours behind a screen, combined with limited movement, led to issues such as eye strain, headaches, and back pain, which were common complaints among many participants. This is an interesting perception to consider as the survey data showed, on the contrary, that Digital ICTs were the only type of technology positively associated with an improvement in health and safety risks.

AI, robotics, and wearables

In contrast to the – on average – positive association between Digital ICTs and workers' quality of life, as revealed in the survey findings (Figure 3.3), newer technologies like AI, robotics, and wearables showed a more complex and varied link with quality of life. Frequent exposure to these technologies was correlated with lower life quality scores for most respondents. This negative correlation was particularly evident among women aged 35-49.

The focus groups expanded on these findings by illustrating the effects of specific modern technologies in workplace settings. Participants shared experiences with systems like keystroke trackers and movement-monitoring software, describing how these tools, while intended to improve efficiency or security, often left them feeling under constant scrutiny. This pervasive sense of being monitored added stress and discomfort, further underscoring the nuanced ways in which technology can impact workers' overall quality of life.

One participant referred to a device linked to the machinery they operated, noting that it tracked every action and made workers acutely aware of their activity. This constant monitoring influenced their mental health, as it created a sense of pressure to remain productive at all times. While the data collected by these devices was valuable to the organisation, the impact on individual wellbeing demonstrated the double-edged nature of such technologies.

Wearable devices were frequently cited as a source of anxiety due to their use in monitoring employee activities, further influencing mental and emotional wellbeing. A sales representative using a tracking device installed in his van shared his experience of its impact. He initially felt stressed about being watched and joked about it, saying,

> *"I felt like I was being watched, like they could see me going to McDonald's."*

Over time, he adapted to the system but admitted that it imposed additional pressure by requiring meticulous accountability for his time. The tracking technology also limited his sense of freedom to manage his day independently. While implemented to improve efficiency and ensure transparency, the device highlighted the unintended consequences such tools can have on mental wellbeing and sense of autonomy.

In addition, subjective feelings of job insecurity loomed large in the discussions around newer types of technological systems. As discussed in the previous section, the survey data demonstrated that wearables, AI, and robotics are consistently linked to the perception of growing "chances of job loss". This perceived threat, as we observed in the discussions, left many participants feeling stressed and anxious about being replaced, exacerbating concerns about their future roles in the workplace. The evident association between exposure to these newer systems and perceived job insecurity provides a plausible explanation for their average correlation with lower quality of life, as shown in Figure 3.

The effect of rising job insecurity appears to overshadow some of the benefits of modern technologies when it comes to an overall assessment of employees' quality of life. Indeed, research has shown how damaging the fear of job loss can be to individuals' mental health, pointing that job insecurity can have a deeper impact on mental wellbeing than actual periods of unemployment (Lozza, Libreri and Bosio, 2013; Chandola and Zhang, 2018). This underscores the psychological strain that perceived job insecurity can place on individuals, particularly as automation continues to influence the structure and expectations of work.

Workers in sectors such as manufacturing and finance expressed significant concerns during the focus groups about how rapidly automation, AI, and other advanced technologies could render their roles obsolete. These fears directly impacted their quality of life, fostering feelings of uncertainty and anxiety about the future. One operative noted that many practical skills people rely on today could soon become redundant due to automation, a prospect he found deeply unsettling. His concerns were shared by workers in administrative and bookkeeping roles, who observed that their fields were already contracting under the weight of automation. A bookkeeping participant remarked that opportunities in the profession were vanishing, describing it as "a dying industry."

This pervasive fear of obsolescence was a source of mental strain for many participants. For instance, a project analyst voiced concerns that AI advancements might soon eliminate higher-paid roles, prompting companies to downsize and favour lower-cost labour. She speculated that organisations could replace experienced professionals earning £70,000 to £80,000 a year with junior employees paid a fraction of that, whose primary responsibility would be feeding data into AI systems. Such scenarios amplified feelings of insecurity and underscored the broader impact of newer technologies on workers' mental wellbeing and sense of stability across multiple industries.

Building on the discussion of mental health impacts, newer technologies also influenced workers' physical safety, marking another critical aspect of their quality of life. For many participants in physically demanding jobs, such as manufacturing, advancements in workplace machinery were transformative. These innovations were particularly valued for reducing the risk of injuries, offering workers greater peace of mind. A cabinet maker, for instance, praised a new electric saw with a built-in safety mechanism that immediately stopped when it sensed human contact. He highlighted how this feature not only made his job safer but also enhanced efficiency, noting that it addressed health and safety concerns that previously went unaddressed.

For workers in high-risk roles, such technologies significantly improved their day-to-day experiences, reducing both the physical hazards and the anxiety associated with potential accidents. These tools provided a tangible sense of security, directly contributing to a better quality of life in the workplace.

However, the rapid adoption of advanced equipment also introduced challenges. Some participants expressed unease about the speed at which these tools were being rolled out, often leaving workers feeling unprepared to use them safely and effectively. A technician shared his concerns about the evolving nature of workplace health and safety, pointing out that the lack of thorough training or understanding of new machinery increased uncertainty and stress. He explained that while these advancements aimed to reduce risks, the pressure to adapt quickly without fully grasping the potential dangers added a new layer of tension to his work environment.

The sense of fast pace workplace transformation was not unique to the exposure to robotic equipment but to all newer technologies. Our research highlights that the rapid pace of technological change is one of the most deeply felt experiences for employees, with significant implications for their mental and emotional health. In the focus groups, participants frequently described the overwhelming nature of this constant evolution. One engineer, for instance, reflected on the relentless pace, explaining that it created a sense of inevitability—change felt unavoidable and beyond their control. He described the experience as “quite overwhelming,” intensifying concerns about job security, particularly in roles perceived to be vulnerable to automation. For many workers, this pace of technological change has fostered feelings of uncertainty and powerlessness, as they are forced to rapidly adapt to new tools and systems while grappling with a fear of being replaced.

The experiences outlined above reveal that while some workers benefit from increased autonomy and reduced physical strain, many others face the emotional strain of intensified monitoring, job insecurity, and the relentless pressure to adapt to new systems. The same technologies that enhance job efficiency can also heighten stress, blur the boundaries between work and personal life, and create a sense of distrust and constant surveillance.

Forging ahead: Shaping the future of work

As technology continues to reshape the modern workplace, its impact on job quality and workers’ overall quality of life is becoming increasingly apparent. The present scenario suggests that more established and widespread digital ICTs have generally benefited jobs and lives, while newer systems often bring risks that outweigh their advantages. However, these outcomes are not inevitable, nor are they inherent to the technologies themselves. Instead, the effects depend heavily on how these tools are designed, implemented, and integrated into the workplace.

A key question emerges: will the negative effects of newer technologies on job quality and mental health diminish over time as workers become more familiar and confident in interacting with them, similar to what occurred with earlier digital ICTs? Answering this is challenging without robust longitudinal data or counterfactuals. On one hand, it is reasonable to hope that the anxiety and job insecurity currently associated with new systems will subside as workers adapt and master these technologies. On the other hand, structural changes to work, such as job routinisation, intensification and increased monitoring, are unlikely to resolve themselves without intentional efforts to address their root causes. These issues demand careful attention to the design and implementation of technologies to ensure they support workers rather than exacerbate stress or inequalities.

That said, it is important to acknowledge the more positive experiences associated with technological advancements as they remind us that different outcomes are possible. Indeed, some participants in the study expressed optimism about how technology could enhance their working life. For instance, employees appreciated how innovation helped their companies stay competitive, motivating employees and instilling pride in their roles. One customer service operator shared that working for a company that embraced technology made her feel her workplace was “at the forefront of the market.” This sense of staying ahead fostered a more optimistic outlook, as some workers saw opportunities for growth and skill development, even in the face of the challenges of adaptation. Another participant described how learning new systems rekindled their enthusiasm for their job, making them feel more competent, engaged, and satisfied. These examples demonstrate that technology, when thoughtfully implemented, not only opens possibilities for productivity but can also enrich the work experience, deepen engagement, and bring renewed meaning to everyday tasks.

While technology undoubtedly transforms work processes, its impact on workers’ quality of life depends as much on how it is integrated into the workplace as on its functionality. As discussed in Section 2 of this report, it’s not just what technology can do, but how it is introduced, supported, and woven into the workplace culture. Positive outcomes are more likely when management, HR policies, and institutional frameworks align to ensure technology benefits employees. With appropriate support, technology can enhance productivity, flexibility, and skill development. Without it, however, technology can increase stress, surveillance, and insecurity, turning potential innovation into a source of anxiety and dissatisfaction.

The future of work is not a fixed path; it can be shaped by the decisions that policymakers, organisations and workers make together. By ensuring that workers have a voice in how technologies are implemented and supported, we can create a future where innovation enhances both the quality of work and the quality of life of workers. Technological progress should not come at the expense of worker satisfaction and mental health. Instead, it should foster an environment where workers feel empowered, valued, and able to make the most of their capabilities. This topic is explored further in the next chapter.

3.2 In Search of a Working Life We Value: a Capabilities Approach to Technology Exposure

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Key Working Papers from the Review:

Analysing the distribution of capabilities in the UK workforce amidst technological change - S. Xia, X. Zhou, R. Leiva-Granados, M. Soffia, J. Skordis

Reframing Skills - Sen's Capability Approach in an age of automation - *A. Thomas, M. Soffia, J. Skordis, K. Brewin*

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In this chapter, we continue placing our focus on the individual worker and ask whether they have the freedoms to choose the (working) lives they value. This is the key question behind Sen and Nussbaum's Capability Approach (Sen, 1999; Nussbaum, 2011) – placing less emphasis on job satisfaction and happiness as a result of people's choices, and more on whether people have the necessary freedoms to make those choices.

The work that we do can shape how we see our lives. Our jobs determine our living standards and play a key role in our wellbeing and social relationships. Our working environments are therefore critical to individual and collective flourishing. In Section 2 of this report, we considered the role of the firm in managing a positive technological transition for workers. We also explored ways in which improving job quality through positive technology adoption practices that enhance worker discretion, might also improve productivity. In the previous Chapter, we explained how exposure to different technologies is correlated with different aspects of job quality. We also described some of the ways in which job quality in turn, is correlated with the wellbeing of workers.

A capability framework emphasises the conditions for long-term human flourishing beyond short-term material satisfaction or subjective wellbeing. At the core of Sen's original capability theory is the distinction between capabilities (what people are able to do and be in their lives) and functionings (what people actually do and are in their lives). Understanding individual capabilities, in conjunction with functionings (outcomes) supports pragmatic policy development that "create[s] the opportunities for functionings to be realised" (Al-Janabi, 2018). Outcomes cannot be mandated by policy – people cannot be instructed to be happy or well. However, the freedoms (opportunities) to choose activities that support happiness or good life quality such as the provision of green spaces in urban centres or accessible health systems - can be created or protected by changes in policy.

In the context of work then, while measuring outcomes like job satisfaction or earnings can be useful to measure changes over time or inequalities in a population, it doesn't tell us whether workers are free to pursue these outcomes. For example, adopting smart technology to manage customer invoicing might create a temporary decrease in an employee's wellbeing or job quality if they feel anxious about the prospect of learning to use the technology. They may need to work longer hours to learn how to operate that technology or to address early mistakes operating the system. However, these metrics would not reveal whether the employee values the change, whether they felt free to choose the change and whether they believe they need only to tolerate some temporary discomfort in order to dispense with a least favoured job function they previously found routine, dull and time consuming.

This framing suggests also that employees who feel free to choose a course of action (or not) will be more resilient to the consequences of that choice than if it were forced upon them. This aligns to the focus on high performance systems which afford workers greater discretion, to achieve better results, as outlined in Chapter 2.2. Given the pace of the current technological transition, and the global market for skills in which we operate, a resilient workforce with the ability to choose a valued working life – is likely to be a more stable and productive workforce without the transaction costs of high staff turnover.

It is important to note that the notion of resilience and adaptive capacity that we use throughout the Review denotes much more than simply "coping" with technological changes or avoiding adverse outcomes in the future of work (Luthar and Cicchetti, 2000; Masten and Powell, 2003). The way we speak about resilience in this study is closer to the idea of thriving and flourishing through transition as a period of adversity, in the same way we promote a focus on not just matches but good matches.

The capability to choose valuable work, and a consequent resilience to disruptive change or adversity, is particularly important when individuals experience the labour market frictions described by Mortensen-Pissarides. As workplaces rapidly adopt new technologies, some workers may feel stuck; stuck in jobs over which they no longer have a sense of mastery, stuck with an expertise that feels redundant, or even stuck in the wrong physical place to apply their skills. In this context of change, the Mortensen-Pissarides (M-P) theory of labour market frictions posits that short-term mismatches in the labour market are often the result of obstacles – 'frictions' – that prevent economic agents from swiftly adjusting to new roles or tasks (Mortensen and Pissarides, 1999; Pissarides, 2000). Frictions can manifest, for example, as information asymmetries, delays in skillset adjustments, and inadequate conditions for workforce mobility among other forms. Each 'friction' slows the market's ability to reach equilibrium.

In Zappa et al. (2025, forthcoming) we apply the Mortensen-Pissarides framework to develop survey instruments and capture these frictions in a novel way, providing a new perspective on how they are distributed across different segments of the workforce. We asked our sample of workers whether they would experience certain frictions in the hypothetical scenario of transitioning between roles or employers, that is, when looking for the kind of jobs they like and wish to do. In our forthcoming analysis we report that the main friction they reported related to geographic obstacles. Specifically, less than 50% would agree with the statement that it is easy to access jobs locally (for 26% this was a direct obstacle, for the other 28% who were unsure, it really means not having full freedom and availability of opportunities in their horizon). Similarly, less than 60% of respondents did not agree with statements such as “I have enough time to search and apply for new interesting jobs”, or “good training opportunities are available to help me acquire or further develop the skills required for the jobs I want”.

In the context of our 3-year programme of research, we argue that frictions are associated with significant economic inefficiencies and personal costs. Frictions are hypothesised not only hinder labour market efficiency but also to negatively impact individual wellbeing in a broad sense.

Moreover, by providing insight into the causes of short-term disequilibria between labour supply and demand, the M-P theory of frictions emerges as a possible explanation to the fact that the UK labour market continues to grapple with persistent issues such as unemployment, underemployment, low productivity, and low levels of employee engagement. These challenges have persisted and potentially exacerbated in conditions of rapid investment on new technologies, thus elevating the urgency to focus on understanding how resilient the UK workforce is and how well-equipped employees are with a range of capabilities and opportunities to shape their future of work as they value.

In this chapter we propose that without the appropriate capabilities or freedoms, people will lack the adaptive capacity and resilience to navigate these rapid changes positively. Work across different countries – including studies in the UK, Hungary, China and Iran – has suggested that education, employment, income, relationships and marital status are associated with individual capability. However, there has been a lack of research about how capabilities are distributed in the UK workplace.

Here we use quantitative survey data to describe the distribution of capabilities in the UK workforce, that is their ability to achieve “outcomes that they have reason to value” (Sen, 1999). We also explore how frequent exposure to four types of technology might disrupt the known determinants of higher capabilities. We use the ICECAP-A questionnaire (Al-Janabi, Flynn and Coast, 2012) to measure capabilities across five domains, including the freedom to feel stable, attached, autonomous, and to have a sense of achievement and enjoyment.

We find significant disparities in capability levels based on age, ethnicity, occupational grade and industry, with institutional support playing a crucial role in enhancing capabilities – underscoring the importance of fostering supportive and inclusive workplace cultures that prioritise employee wellbeing and empowerment amid technological change. Importantly, technology exposure is found to moderate these effects in varying ways. Specifically, the associations between employees' capabilities and various socioeconomic and institutional factors can change in conditions where employees interact more often with newer technologies. This suggests that those facing the technological transition are not uniformly equipped with the right capabilities and freedom of opportunities to navigate current changes, creating new risks to social inequalities that society must actively address.

Measuring capabilities distribution with survey data

Table 3.1 - The ICECAP-A capability questionnaire

Domain label	Heading	*Thinking about your life in general, please indicate which of the following statements best apply to you.*
Stability	A – Feeling settled and secure	1 I am able to feel settled and secure in **all** areas of my life 2 I am able to feel settled and secure in **many** areas of my life 3 I am able to feel settled and secure in **a few** areas of my life 4 I am **unable** to feel settled and secure in **any** areas of my life
Attachment	B – Love, friendship, and support	1 I can have **a lot** of love, friendship and support 2 I can have **quite a lot** of love, friendship and support 3 I can have **a little** love, friendship and support 4 I **cannot have any** love, friendship and support
Autonomy	C – Being independent	1 I am able to be **completely** independent 2 I am able to be independent in **many** things 3 I am able to be independent in **a few** things 4 I am **unable** to be at all independent
Achievement	D – Achievement and progress	1 I can achieve and progress in **all** aspects of my life 2 I can achieve and progress in **many** aspects of my life 3 I can achieve and progress in **a few** aspects of my life 4 I **cannot** achieve and progress in **any** aspects of my life
Enjoyment	E – Enjoyment and pleasure	1 I can have **a lot** of enjoyment and pleasure 2 I can have **quite a lot** of enjoyment and pleasure 3 I can have **a little** enjoyment and pleasure 4 I **cannot have any** enjoyment and pleasure

Source: Al-Janabi, Flynn, and Coast (2012)

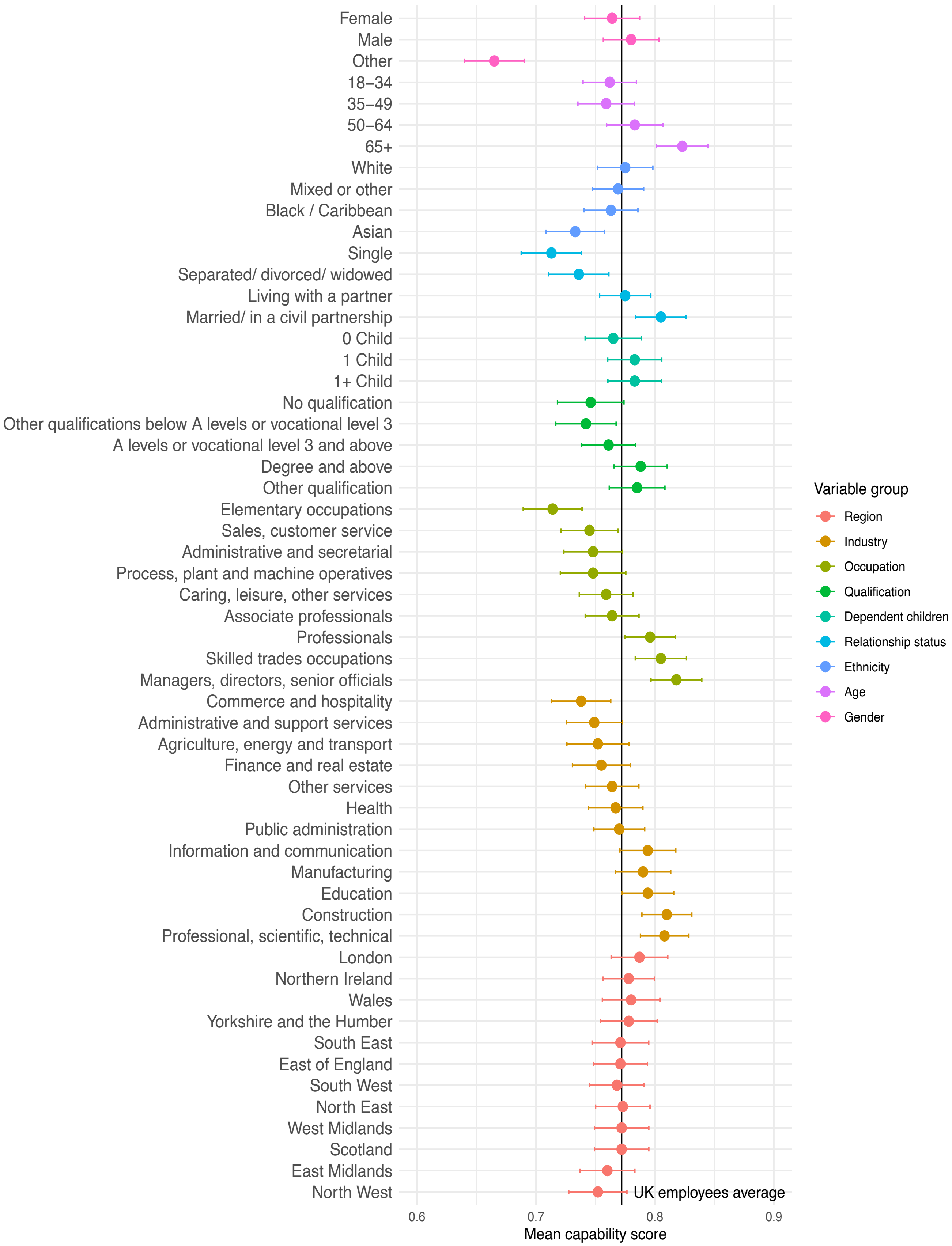
In Soffia, Skordis and Hall (2023) we offer a simplified overview of the fundamental principles of the Capability Approach and its most common empirical applications in the field of work and employment. Here we measured capability distribution in the national workforce using the 'Investigating Choice Experiments Capability Measure for Adults' (ICECAP-A) developed by Al-Janabi, Flynn and Coast (2012). As depicted in Table 1, ICECAP-A gauges five ‘freedoms’ that adults in the UK are understood to value: stability, attachment, achievement, autonomy and enjoyment. Each domain is measured on a 4-point scale from no capability to full capability.

Although not specifically designed for a work environment, the instrument has been widely used in the UK for economic evaluation policies and strategies and is one of the very few validated measures designed to capture capabilities as defined in Sen’s Capability Approach. The 5-domain measure was conceived using a deliberative method which involved, firstly, interviewing members of the public about what was important to individuals in their lives capturing meaningful lay terminology (Al-Janabi, Flynn and Coast, 2012), and subsequently, surveying a random sample of adults about the relative preference and weight they assign to each possible combination of the five “freedoms” identified (Flynn et al., 2015).

Measuring capabilities is not without complexity however, which partly explains why most survey research has focussed on the measure of subjective wellbeing indicators as an outcome or achieved state. Many lists and measures of capabilities are faced with the challenge of a blurred line between capability information and functioning information (Brandolini and D’Alessio, 1998). Our decision to use the ICECAP-A measure does not naively dismiss these challenges and we use it with the caveat that the capability domains captured are indeed very close to a notion of valued ‘functionings’. Al-Janabi (2018) addressed this issue and found that ICECAP-A performs well enough in capturing capability information that is reportedly different from functioning.

To assess how capabilities (ICECAP-A) were distributed in the UK workforce, we used the worker level survey data collected for the Review and followed an exploratory data analysis (EDA) approach (Marsh and Elliot, 2008). Details of the analysis steps are described in our working papers (see Xia et al., 2025). This started with the calculation of descriptive statistics (means and standard deviations) across various employee characteristics that are correlated with capability levels in other literature and were collected in our survey. These included demographic characteristics (employees’ gender, age and ethnicity), life-stage characteristics (relationship status, and number of dependent children), in addition to socioeconomic and occupational characteristics (education, occupation, industry sector, and geographic region of residence). The obtained means (and error bars) are visualised in Figure 3.4. The overall sample of UK employees exhibited a mean capability score of M=0.772 (SD=0.174). Analyses of variance (ANOVA) were also performed to inform the magnitude of difference in capability means between groups.

Figure 3.4 - **Capability (ICECAP) mean scores and error bars across socioeconomic groups**



Note: means scores are depicted by dots, and standard errors are depicted by horizontal whiskers. Error bars indicate variability or precision of the estimate, and are typically narrower than 95% confidence intervals

We then used regression analysis to more formally examine which characteristics were significantly correlated with increased capability, controlling also for the potential role of institutional characteristics, reflecting the well established institutionalist perspective in Sen's work (Sen, 1999; Farvaque, 2005; Nambiar, 2013). To control for institutional factors, we added five employee-reported institutional variables: Human Resources (HR) management philosophy (in a spectrum between efficiency-centrality and employee-centrality as reported by workers); employees' access to Formally Recognised and Independent Structures (FRIS) such as trade unions, staff associations, or employee forums; access to Internal Consultative and Participative Structures (ICPS), such as work councils or joint consultative committees; employees' uptake of formal or passive training provided by the employer; and uptake of informal or actively self-pursued training.

To understand whether the distribution of capabilities differed in contexts of high exposure to workplace automation, the sample of respondents was stratified into four cohorts, representing those exposed to Digital ICTs (relative to employees who'd not interact with ICTs), Wearables (versus those not exposed to Wearables), AI Software (versus no exposure to AI), and Robotics (compared to workers not exposed to Robotics). Measures of technology exposure used in our analysis are the same as those described in the preceding chapter and represent a novel attempt to capture diverse automation functions.

In what follows, we describe and discuss the results of the exploratory data analysis on the distribution of capabilities across a sample of 5,368 employees.

Capabilities and demographic factors

Our analysis revealed notable initial differences in capability scores between men and women. Men in our sample reported higher average capability scores (M=0.780, SD=0.175) than women (M=0.764, SD=0.173). However, these differences dissipated when multivariate analysis accounted for additional factors, rendering the gender disparity statistically insignificant. This aligns with findings by Shahtaheri et al. (2020) for Iran, who reported no significant differences in capability scores between adult men and women.

Interestingly, this pattern shifted in contexts of exposure to different technologies. While overall gender distribution of capabilities remained consistent, exposure to AI software presented a notable exception. In these scenarios, male employees enjoyed significantly higher capabilities than their female counterparts, which aligns with the findings by Al-Janabi (2018) and Tang et al. (2018). Tang et al. (2018) found that Chinese women are more likely to report feeling less stable, autonomous, and fulfilled than males. The broader literature on capabilities and gender points out to women generally reporting less self-confidence, courage, pride, and high aspirations than male, as well as less material and non-material resources for work, including lower income (Banerjee, 2015).

Further sensitivity analysis revealed that AI software is the only type of technology interacting with gender, with significant and positive interaction terms for male and non-binary employees (the latter being too small a sample to render it a robust finding). This suggests that, in the presence of AI technologies, male employees enjoy a clear capability advantage over female employees. These findings highlight a persistent gendered dynamic within specific technological contexts.

A clear age gradient in capability scores emerged from our data, with older workers (aged 50 and above) reporting higher scores than their younger counterparts. The eldest group (65+) recorded the highest mean capability scores (M=0.823, SD=0.162). This positive association between age and capability was consistent in the multivariate analysis and persisted after controlling for technological exposure, suggesting a robust relationship. Notably, these findings represent a novel contribution, as such associations have not been widely documented elsewhere. Further qualitative research would contribute to confirm whether older age is, on the whole, associated with more work experience and stability, thus enhancing perceived capabilities.

However, the advantage associated with age varied depending on exposure to newer technologies. For instance, while older employees retained their capability premium when interacting with Digital ICTs, this advantage weakened considerably with exposure to AI, wearables, and robotics. The disparity was particularly pronounced for the eldest group (65+), where exposure to wearables and robotics eliminated the capability premium, rendering differences statistically insignificant. Sensitivity analysis supported these observations, revealing significant negative interaction terms between older age groups and exposure to these newer technologies, indicating that the capabilities premium often presented by older workers is conditional to their level of exposure to these systems. This trend could be due to lower technological literacy and points to a potential risk factor in the adaptation of older groups to new technologies, in the context of the frictions they face.

Ethnic disparities in capability scores were also evident in our sample, adding novel findings that we have not observed before and require further attention. White employees consistently reported higher scores (M=0.775, SD=0.174) compared to Asian employees (M=0.733, SD=0.183) and other minority groups such as Black and Caribbean employees (M=0.763, SD=0.170).

While these disparities persisted across different conditions of technological exposure, their magnitude varied. For example, the ethnic gap between Black and White employees weakened among users of wearables and robotic technologies, becoming statistically significant only at the 90% confidence level. By contrast, the disadvantage for Asian employees relative to White employees appeared to worsen in contexts of exposure to newer technologies, particularly AI software. This exacerbation highlights systemic inequalities that may intersect with technological advancements, potentially compounding challenges faced by certain ethnic groups.

Capabilities and employees' life-stage

Our analysis reveals that employees' life-stage, as reflected in their relationship status and parental responsibilities, plays a significant role in shaping capability scores. Initially, descriptive analysis indicated that married employees or those in civil partnerships reported higher capability scores (M=0.805, SD=0.159) compared to their single counterparts (M=0.713, SD=0.190). This positive association between being partnered and higher capability scores persisted even after controlling for other factors in the multivariate analysis, aligning with findings from other population studies (e.g. Tang et al., 2018).

Interestingly, this advantage associated with being partnered or married slightly weakens in contexts involving exposure to newer technologies, such as wearables and AI software. Although initially there were no clear capability disadvantages for the separated, divorced, or widowed employees compared to single employees, the difference becomes more pronounced in contexts of exposure to newer technologies, with significantly lower capability scores compared to those who are single but equally exposed to these technologies. This dynamic suggests that the stability or attachment associated with being in a relationship might mitigate some of the challenges posed by rapid technological workplace changes. While the relevance of these factors from a public policy perspective is not evident at first sight, the role they play in shaping the distribution of capabilities reminds us of the range of forms that enabling conditions can take, that is, personal, social, and environmental elements that shape individuals' ability to transform resources into real and valued opportunities (Sen, 1992, 2000).

Having one or more dependent children also showed a modest positive correlation with capability scores in the descriptive analysis. However, this relationship lost significance in the multivariate analysis, indicating that the number of dependent children is not a strong independent predictor of capabilities. Despite this, some nuanced effects were observed. Employees with one dependent child displayed a slight capability advantage in contexts of AI software exposure, although this difference was statistically significant only at the 90% confidence level. While this finding warrants further investigation to determine its robustness, one plausible explanation is that employees interacting with AI software may benefit indirectly from their children's familiarity with newer technologies. Younger children, often more accustomed to engaging with new systems, might provide informal support, enhancing their parents' AI literacy. These findings, while preliminary, suggest a virtuous intergenerational cycle worth exploring in future research.

Capabilities and occupational characteristics

Descriptive analysis revealed that employees with higher educational qualifications reported the highest capability scores. Specifically, employees with a university degree or equivalent recorded the highest average scores (M=0.788, SD=0.167), compared to those with qualifications below A levels (M=0.742, SD=0.190) or no qualifications (M=0.746, SD=0.209). These findings align with prior studies (Al-Janabi et al., 2013; Al-Janabi, 2018; Tang et al., 2018; Shahtaheri et al., 2020). However, the multivariate analysis showed that the association between higher qualifications and capabilities weakened when controlling for other factors, with the difference for employees with degree-level qualifications remaining statistically significant only at the 90% confidence level.

In conditions of technology exposure, we continued to observe no significant variability of capabilities by education, with a single exception. Among those exposed to wearables, having a degree slightly acts as a protective factor (at 90% confidence level) and employees with "other qualifications" exhibited a notable capability advantage over those with no qualifications. This could reflect the higher adaptability of employees with specialised skills or well the higher benefits of using wearable technologies associated to high-paid and high-grade roles, what Moore calls the "quantified self" (Moore, 2017).

Occupational grade emerged as a strong predictor of capability scores. Managers, Directors, and Senior Officials reported the highest scores (M=0.818, SD=0.160), closely followed by Skilled Trades roles (M=0.805, SD=0.161). Conversely, employees in Elementary occupations recorded the lowest scores (M=0.714, SD=0.185). While the initial capability advantage associated with higher occupational grades was evident, this disparity attenuated in contexts of exposure to newer technologies. For example, employees interacting with Digital ICTs displayed a slightly exacerbated gap between high and low occupational grades. However, when exposed to advanced technologies such as wearables, AI software, and robotics, the disparities between higher-grade and elementary occupations diminished. This suggests that new technology may act as a levelling force, potentially reducing occupational inequalities in capabilities under certain conditions.

Industry-specific trends revealed that employees in the Construction sector (M=0.810, SD=0.157), and the Professional, Scientific, and Technical sector (M=0.808, SD=0.151) reported the highest capability scores. Other sectors, including Information and Communication, Education, and Manufacturing, also exceeded the average capability levels, while Commerce and Hospitality reported the lowest scores (M=0.738, SD=0.186). These sectoral differences remained consistent even after adjusting for other factors in the multivariate analysis. This analysis also highlighted similarly low capability scores among employees in Agriculture, Energy, Transport, and Finance and Real Estate, comparable to those in Commerce and Hospitality.

A plausible explanation for the high capability scores in Construction could be the nature of the work, which often involves perceivable meaning and attachment. Employees in this sector may enjoy a sense of camaraderie, and a balance of creativity and productivity. The tangible outcomes of their work, coupled with immediate feedback and a sense of achievement, may offset the physical risks associated with the industry. Such factors likely contribute to a heightened sense of capability among workers in this sector.

Interestingly, the capability premium observed in sectors like Construction, Manufacturing, and Education diminished with exposure to technologies, particularly newer ones such as wearables, AI software, and robotics. Only Manufacturing workers retained a slight capability advantage over the Commerce and Hospitality baseline when exposed to wearable technologies. Conversely, exposure to advanced technologies intensified disparities between other sectors: employees in the Professional, Scientific, and Technical sector maintained or even increased their capability advantage, while those in Agriculture, Energy, Transport, and, in some cases, Finance and Real Estate, lagged further behind.

This polarisation aligns with earlier studies predicting that technological adoption could widen gaps between those who design or create new tools and those who use or are displaced by them (e.g., Taylor et al., 2007). Our findings extend this evidence, suggesting that such polarisation impacts not only wages and skills but also capabilities.

The role of geography in capabilities distribution

The initial descriptive analysis shows relatively low variation in capabilities across regions, with London reporting the highest scores and the East Midlands and North West scoring below average. These lower capabilities in the East Midlands and North West remained consistent in the multivariate analysis. Compared to the baseline of London, the differences were statistically significant, with the East Midlands significant at the 90% confidence level and the North West at the 95% confidence level. Similar associations between capabilities and geographic location have been observed in other studies, such as Baji et al. (2020) for Hungary.

Geographic disparities in capabilities became even less pronounced among employees exposed to Digital ICTs. However, employees in the North West continued to score significantly lower than their London counterparts. In contexts of exposure to AI software, a notable shift occurred, with employees in the North East moving to the bottom of the capability distribution, significantly below those in London at the 90% confidence level.

These findings should be interpreted with caution as the geographic units used in the analysis may be too coarse to capture inequalities within regions. It is likely that at a more granular geographic level, such as comparing capitals to smaller towns or villages, sharper disparities might emerge. This aligns with Baji et al.'s findings, which highlighted capability differences between adults living in urban centres and those in rural areas. Further research using finer geographic distinctions could provide deeper insights into these regional differences.

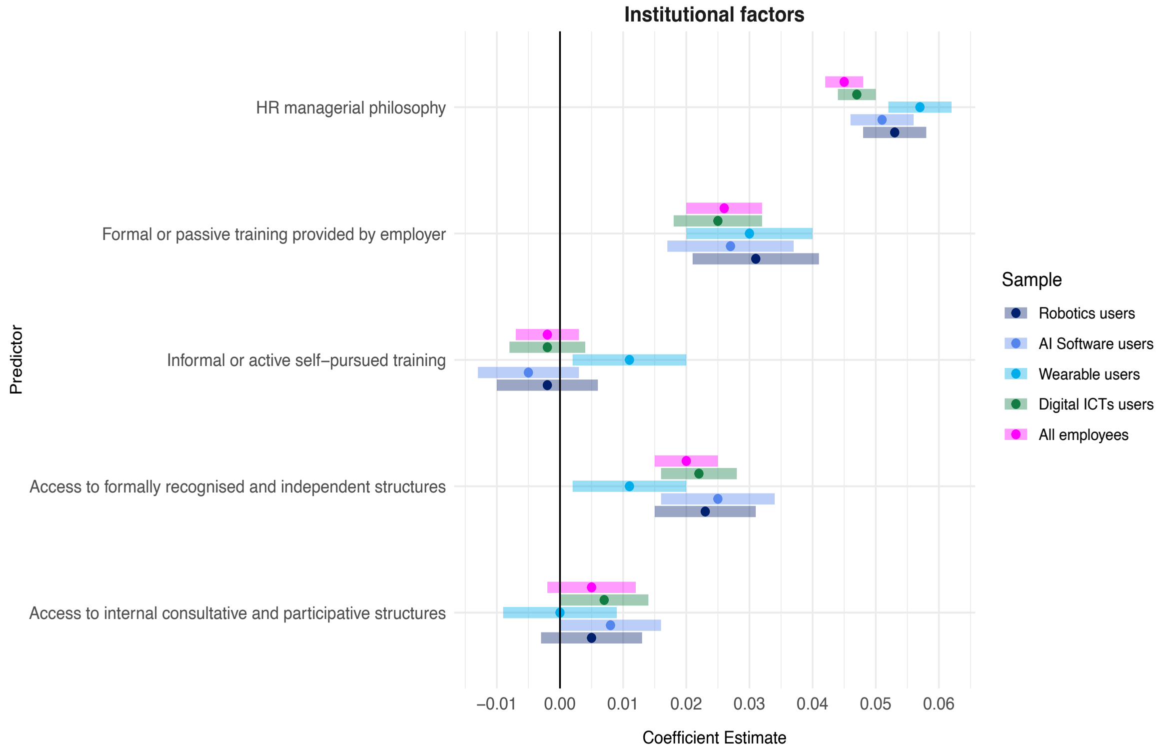
Capabilities and institutions

Various contextual factors indicative of more supportive working environments showed positive associations with employees' capability scores in our multivariate analysis. Respondents who reported stronger, employee-centred human resource (HR) philosophies consistently demonstrated higher capability scores. Similarly, undergoing formal employer-provided training and accessing formally recognised representative structures such as trade unions or employee forums correlated positively with employees' capabilities when other variables were held constant. While novel evidence, these findings align with the emphasis on institutional enabling factors in the Capability Approach literature.

Importantly, the positive relationship between capabilities and human resource policies persisted across contexts and became more pronounced with exposure to workplace technologies, as illustrated in Figure 3.5. This effect was particularly significant for newer technologies such as wearables. Formal employer-provided training also maintained its positive association with capability levels, with its contribution being even larger among employees interacting with wearables and robotics. Access to trade unions and other representative structures also showed a positive correlation with capability levels in most contexts, though the effect was not significant for employees interacting with wearables. Among workers exposed to AI software, the positive impact of access to these institutional resources was even larger than for the general population. It is worth noting that the capability contribution of trade unions or employee forums was more modest than the contribution of employee-centred HR policies.

The sensitivity analysis further confirmed that HR philosophy significantly amplified employees' capabilities in contexts of exposure to newer technologies, including wearables, AI software, and robotics. These findings highlight the superior role of strong HR management in fostering employee capabilities, especially in technology-driven workplaces. While trade unions and employee forums provide valuable support in the absence of strong institutional backing, our evidence suggests that well-designed HR policies are more effective at enhancing employee capabilities in modern work environments, possibly meeting expectations that go beyond simple compliance with law.

Figure 3.5 - OLS regression coefficients (with robust standard errors) for ICECAP on institutional factors, across sub-samples of technology exposure.



How the future of work is shaping the distribution of capabilities

The Review has put at the forefront the question about whether capabilities can help making workers more resilient to technological disruption. This chapter summarised an investigation into the distribution of capabilities within the UK workforce, using the ICECAP-A questionnaire to assess stability, attachment, autonomy, achievement, and enjoyment. These general capabilities are argued to equip workers with resilience to navigate technological transitions, with them guiding the way and choosing the future they want to have.

We analysed capability scores across a large sample of UK employees and examined how this distribution varied when employees were exposed to digital ICTs, wearables, AI software, and robotics. This represents a novel attempt to link workforce resilience with the equitable distribution of capabilities in the face of technological change.

Key findings revealed significant variability in capabilities across age, ethnicity, occupational grade, and industry. For example, older employees reported higher capabilities, potentially linked to experience and stability. Conversely, workers from Asian and Black backgrounds faced notable capability disadvantages, highlighting a need for strategies to prevent exacerbating inequalities.

Some patterns shifted in contexts of technological exposure, underscoring the moderating effect of automation on capability distribution. Our findings indicate that employees are not uniformly equipped with the right capabilities and freedoms to navigate technological transitions, posing risks of systemic inequality. For instance, the capability advantage associated with higher occupational grades diminished with exposure to newer technologies, potentially signalling a rebalancing of power that warrants further investigation. However, employees in Agriculture, Transport, and Energy sectors experienced sharper declines in perceived capabilities when exposed to newer technologies, underlining the need for targeted resources to support these groups to navigate change. Ever before such variability in capabilities across occupational and industrial groups has been measured, and we expect these initial findings unleash more granular research into occupational and sectoral differences.

A particularly novel finding was the consistently positive association between institutional support mechanisms and capabilities. Employees with access to independent representation, employer-provided training, or employee-centred HR policies consistently reported higher capabilities. The contribution of supportive HR philosophies was even more pronounced in contexts of newer technology exposure, reinforcing the critical role of inclusive workplace cultures that prioritise employee wellbeing, workforce development and empowerment amid technological change.

The relevant contribution of institutional conditions observed in our analysis is a reminder that capabilities and resilience are not solely determined by individual effort or personal traits, but are deeply influenced by structural and institutional factors that go beyond an individual's control. As Schoon and Bartley (2008) argue, framing resilience as a personal attribute or a dispositional attitude risks overlooking the systemic barriers and enablers that shape individual outcomes. Instead, inequalities must be reconceptualised as systemic, and tackling socioeconomic and intersectional inequalities must become mainstream priorities.

In conclusion, our study highlights the sensitivity and effectiveness of using multidimensional measures like ICECAP-A to assess workforce capabilities, capturing socioeconomic and institutional variability. However, as the UK workforce faces rapid technological change, there is a pressing need to develop and make use of available workplace-specific capability measures that capture freedoms employees value when exposed to new technologies, but that may not be reflected in existing tools. While several approaches have made progress in this direction (see, for instance, Van Der Klink's and Green's sustainable employment and job quality operationalisations in Soffia, Skordis and Hall, 2023), these frameworks are still predominantly focused on outcomes and functionings. Future work should focus on refining the list and measurement of the kind of workplace freedoms that employees have reason to value in contexts of rapid technological change.

3.3 Lessons from individual-level research

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In this third section of the Report, we used individual level survey data and focus group discussions conducted in the UK, to explore the impact that technology adoption is having on work and society. We find that the majority of employees are already interacting with advanced technologies at work.

This is consistent with the finding in Section 1 of the report that the pace of technology adoption is accelerating and demand for skills is changing. It also supports our findings in Section 2, which details the high rates of employer adoption of cognitive technologies to automate both manual and cognitive tasks.

Firms choose which sources of value to pursue, which technologies will best support that aim, and when and how to adopt new technologies (see Section 2). These choices affect workers directly and indirectly – and unequally. Quality of work and life for individual workers are both affected by the choices that firms make. In response, individual workers have different levels of resilience to the transitions they experience. This resilience is the product of capabilities or freedoms to determine their role in a transition that is taking place for the good of a firm or collective.

Established technologies such as ICTs, are associated with job design that can offer the benefits of flexible working locations and patterns, and increased connectivity. These benefits do not appear to be outweighed by the perceptions of blurred work/life boundaries and the risks of an 'always on' working culture. By comparison, newer technologies such as wearables, AI and Robotics can be associated with increased salary, better career prospects, more consistent schedules and fairer performance evaluations. However, this appears to be outweighed by negative perceptions of surveillance, work intensification and job insecurity among other risks. In short, different technologies afford different kinds of role redesign, shaping content, location, monitoring and intensification differently – with a range of impacts on job quality. Job quality in turn is correlated with wellbeing, emphasising the important centrality of work in most of our lives.

In the context of rapid technological transition, we used the measurement of capabilities across the UK workforce to understand how vulnerable – or resilient – the workforce might be to the changes they are experiencing. We find that several socioeconomic and demographic groups have higher levels of capabilities and that the capability advantage conferred by higher occupational grades is attenuated by exposure to newer technologies. In effect, this means that some segments of the workforce face a potential double disadvantage from technological disruption i.e. subject to more frictions but with fewer strategies or capabilities to overcome them. This indicates a risk of widening inequalities in wellbeing in the future if active steps are not taken to mitigate the negative consequences of rapid technological adoption. Such interventions must recognise the nature of these inequalities, which are not matters of discrimination but systemic differences in, or consolidation of, the distribution of capabilities.

Importantly, our research also pointed to strategies that might support positive and equitable technology adoption in the UK. We find that consistently higher capabilities scores were reported by employees who perceived their organisation to have an employee-centred HR philosophy, who have undergone formal training, provided by their employer, and with access to independent representative structures such as trades unions or employee forums.

Moreover, we find that wellbeing-centred HR policies increase capabilities and that this becomes more marked in contexts of the newest technology adoption. In sectors or jobs where new technologies are being introduced, it appears critical to adopt HR policies that emphasise employee engagement. With supportive employee engagement and adequate feedback loops, employees understand the benefits of technology transition and have some agency in the adoption and deployment process. This reduces the frictions associated with adoption and is likely also to increase the productivity gains of adoption sooner – although the latter was not formally studied in our data.

Our forthcoming research will provide additional insights into individual experiences of frictions and their connection to workforce capabilities. Are there sufficient good jobs in local areas, and what steps are regional authorities taking to support wider access to better work? Do people have the necessary information to find better work, or access support as they navigate technological disruption? Are systems designed to 'match' people with good jobs and training, functioning effectively? And do people have the skills needed to access jobs they value, or the in-work support to help them augment their roles while adapting to new technologies their workplaces may be adopting? This is where the 'frictions' that have framed the Review interface with people's everyday lives, and where a policy focus on capabilities may emerge as a critical solution.

4 Policy Recommendations

Anna Thomas MBE and Oliver Nash

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Our Review has interrogated technological transformation and used research insights to develop a new approach to policymaking – one which is better suited to complex, dynamic transitions, and considers a wide range of possible impacts, trade-offs and interdependencies.

This requires a major reorientation of policy aims, levers and resource allocation towards transitions in which frictions are overcome and technological capabilities are directed towards enhancing human capabilities and freedoms. In this way, we integrate 'capabilities' and 'pro-innovation' policymaking so that these approaches support one another.

To implement this approach, new governance architectures are needed to embed stakeholder participation, monitor the latest insight on risks and impacts, and enable reflective response and evaluation on an ongoing basis. Throughout the Review, the importance of the core principles and dimensions of 'good work' have been borne out: participation, support, learning, autonomy, dignity, equality, and wellbeing. In different ways, each workstream has illustrated how such good work can act as a mediator to improve the outcomes of technological transition, in particular through improving capabilities and building resilience, as well as improving social wellbeing. The multi-purpose concept of good work therefore acts as an overarching policy objective and focus across the domains under consideration, simplifying the insight we have gained and bridging our aims and analyses with practical policymaking.

Our approach also means challenging entrenched assumptions about what is valuable, and rethinking the processes and dynamics that contribute to meaningful change. It has led us to question conventional assumptions about 'growth' and call for a rethink of the value placed on the human contribution to it, proposing a shift away from taxing labour towards taxing physical and digital capital and infrastructure, or rents derived from it as our understanding increases. This will require new ways to measure and evaluate the positive impacts of investment in labour, and recognition of the additional benefits of technology being directed towards enhancing human capabilities.

All this points to a multi-dimensional, more dynamic approach to measuring GDP through transitions, which recognises that 'growth' is dynamic, that social conditions and functions are integral, and that the relational and multi-dimensional impacts of technological transformation must be taken into account. This points to the incorporation of new measures of good work, wellbeing and capabilities across policy areas - from innovation and skills through to investment - and consideration of the development of national measures and indicators for technological transformation.

In this context, businesses - and particularly SMEs - have a central role, and their active participation in shaping good transitions will be critical. Targeted support should be provided to help SMEs manage these transitions responsibly, and in a way that contributes to good work outcomes, including life-long learning measures, training covering core and transitional skills, access to knowledge resources related to technology adoption, and tools for leveraging technology effectively. In turn, this means building institutional capacity and expanding access to timely, accessible and relevant information to both businesses and workers related to transitions, enabling them to make more informed choices through this transition.

Our Review has empirically demonstrated that tasks and skills and jobs are not fixed or predetermined. Embedding a more consistent, deeper and socio-technical focus on participation could open up new avenues for technological transitions, from job design to new models of business - shaping futures of work that people have reason to value. This should double up to increase worker, citizen and stakeholder involvement in policymaking and practice at a national, regional and local level, thereby improving the depth of understanding and the effectiveness of our collective responses to old and new challenges. Beyond unions, startups and SMEs in the UK must have far greater access to meaningful channels for engagement on substantive policy issues. This would help to balance the powerful presence of the digital giants and the 'big four', whose research, political presence and narratives about technology automation continue to disproportionately shape this domain.

Thinking about innovation in a systematic, human-centred way also demands a new focus on building national, firm and individual level capabilities, including those for the design, development and deployment of the latest AI technologies. In the context of global strategic competition, this should focus on ensuring that we make the most of national strengths, while recognising weaknesses that have more recently come to light - for example, in the UK's relative share of High-Performance Computing (HPC) capacity. It is also important to ensure that, as well as social skills, new 'AI' skills to help understand, govern and innovate - with particular regard to good work and wellbeing – are fostered. These capabilities should now extend to an increasing need to access, use and 'control' as much information and data and innovation infrastructures as possible, since these underpin good automation and new approaches to innovation and value creation.

In short, we have seen that the extent of disparity and our current trajectories invites bold, coordinated action that meets structural challenges and is capable of redirecting current trajectories, breaking entrenched patterns of resource allocation and recognising marked deficits and bottlenecks. Underpinned by new approaches, targets and measures, this should enable new policy mixes and approaches to support responsible innovation, and the management and governance of new technologies which can be seen as policy 'dashboards', to encourage evidence-driven pilots, ongoing monitoring, evaluation and adjustment and the building of knowledge pipelines, observatories and data libraries.

Much of this can be drawn together and developed as part of a new strategy and approach to AI, automation and the future of work.

This would:

- **Recognise human values, roles, agency and autonomy**
- **Recognise the future of work and automation as high-priority, cross-cutting policy domains**. This should immediately become central to DSITs cross-cutting remit, DWP's extended role in good work, and DfE's new skills agenda, including as part of the Industrial Strategy, the AI Opportunities Action Plan, the Treasury's Pension Investment Review, and the revision of relevant policy appraisal frameworks, such as the Treasury 'Green Book'.
- **Bake in a socio-technical, systematic and coordinated approach,** and
- **Recentre human before technological capabilities across all levels of decision-making, departments and the functions of new institutions being established in 2025**. This would include Skills England, the AI Innovation Office, and the UK Sovereignty Unit.

Achieving this will involve significant capacity-building and a new approach to policymaking, grounded in better, combined and organised sources of data and knowledge related to the future of work within government. The strategy could also develop and showcase more involved and socio-technical forms of partnership working - as Denmark's Disruption Council started - but could be extended and taken further by the UK to cover new technologies and the design, development and deployment of technology life-cycles.

Place and Innovation

The importance of ‘place’ has been a powerful and enduring theme throughout the Review. This is evident not only in the challenges related to geographic inequalities in the UK - and their role in shaping automation practices and worker experiences at a firm level - but also in the critical role that place-based approaches could play in addressing them.

The Review has surfaced entrenched and deepening geographic inequalities related to technological transformation, with stark differences across regions. Our Disruption Index (DI) has proven invaluable in this regard – firstly by identifying the extent and drivers of these disparities and, secondly, by enabling the development of precise, data-informed approaches to policy analysis at a local level.

Our DI highlights that local disparities in Technological Transformation - driven by venture capital and R&D investment in particular - are significantly more pronounced than those related to Readiness, such as skills and human capital (Rohenkohl, Clarke and Pissarides, 2024). This means that many areas across the UK are ‘ready’ for this technological transition, but unable to realise its opportunities due to a lack of functional systems, networks, and capacity.

Through the Review, we have introduced the concept of ‘local innovation system bottlenecks’, which will be key to addressing local growth and good work challenges. This is both novel conceptually and useful practically as a policy ‘heuristic’.

A bottleneck, by definition, is a phenomenon whereby the functioning of an overall system is constrained by the capacity or the pace of a specific component. In the context of regional economies, through the Review, we have found bottlenecks to include institutional, resource, or capacity constraints - each of which may vary by region and over time. These constraints prevent regions from fully converting innovation readiness into the sustained improvements that might otherwise be expected. This includes improvements related to innovation activity, R&D intensity, good job creation, and real household disposable income. This reinforces the need for place-based and systemic approaches tailored to a local area’s unique challenges and opportunities.

A core contribution of the Review has been the use of data to understand these inequalities, the impact of technological change on them, and what to do in response. The DI exemplifies this, combining data from multiple sources - including economic, social, innovation, R&D, skills, and labour market indicators - and leveraging state-of-the-art machine learning methods to provide new insights into technological transitions. The Cornwall and Isles of Scilly Spotlight Report, developed in partnership with regional stakeholders, shows how these data-driven approaches, when combined with local insight, can help identify area-specific opportunities with significant potential to improve work and wellbeing outcomes. Institutionalising and scaling this type of activity will likely require the development of interconnected 'Local Disruption Indexes' or 'Future of Work Observatories'.

While many areas in the UK exhibit significant strengths in key areas - as well as improving innovation readiness - at a macro level, institutional gaps and coordination challenges mean this local potential is not being converted into outcomes that best support good work and prosperity. As well as bottlenecks, this mismatch reflects systemic challenges that need to be addressed at a national level. This includes the approach taken to devolution settlements, R&D funding allocations across regions, and the regional footprint of public institutions - which often overlook the 'work-related' and broader socially beneficial outcomes that materialise geographically, and which are downstream of these decisions.

National, regional and local disparities are shaped not only by local industrial structure, culture, and historical factors, but also by ongoing gaps in institutional capacity and resource allocation. These gaps can often be attributed to a failure to adequately or systemically account for geographic and socio-economic inequalities, including their intersections, or the compounding effects of policy decisions. These findings underpin our reconceptualisation of equality as a structural challenge that must be tackled through a package of systemic as well as unblocking policies that are developed and implemented in stages.

Overall, this suggests that integrated, placed-based growth and capabilities strategies should be prioritised and built into the government's growth mission in a more systematic way. For instance, whilst the recent AI Opportunities Action Plan published by the government includes interventions focused on regional growth - such as AI Growth Zones focused on increasing compute infrastructure - it does not consider the potential of technological transformation to exacerbate national and regional inequalities across the UK. Nor does it address the way in which a package of complementary policy interventions within each region will be needed as part of a coordinated plan. In this context, there is a pressing need to build the capacity of key institutions, functions and networks in which these elements become more than the sum of their parts. Place should be recognised as the primary 'unit' to manage good transitions, starting with Combined and Strategic Authorities.

All policy recommendations presented here are subject to ongoing consultation and review. The next phase of policy work will involve detailed mapping, information-gathering and participatory exercises for deeper engagement with stakeholders. Initial pilots could be carried out in one Combined Authority at city level, for example Birmingham, Manchester, Liverpool, or Newcastle.

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Place and Innovation Systems: policy recommendations

1. **Our approach to measuring 'growth' and 'progress' through transitions should aim to capture 'Growth and Capabilities' to measure social and technological transformation and progress.**
   Building on the Review, GDP should be developed to incorporate new measures for readiness, technological transformation, good work, wellbeing and capabilities. A new typology and measurements for national, local, firm and individual level capabilities should be monitored at the same time, together with relational and multi-dimensional impacts of technological transformation. This dashboard approach to GDP and other measures of progress should be covered as part of the Treasury and Green Book reviews and can be developed over time; it should also be adapted as conditions and knowledge about measurement of these new concepts change.

2. **The Devolution Framework and integrated 'devolution settlements' should be extended to include the critical infrastructures, regulatory powers, and resources needed to develop and implement effective 'Growth and Capabilities Strategies'.**
   A coherent and effective devolution framework is necessary for the development of well-functioning innovation ecosystems and to improve outcomes from technological transformation, as well as to tackle the growing regional inequalities. We have shown the significance of regional infrastructure - including digital, information; and skills infrastructures - to overcome frictions and ensure the best results from automation. The next step to develop the Devolution Framework, which should follow detailed mapping exercises, is to properly integrate the domains we have covered in this Review, from investment to job search. The creation and access to good, local jobs is the foundation for success and Good Work should be hard-wired through these plans, for example by building from regional Good and Fair Work Charters and modelling social partnership in the development and implementation of plans. Combined Authorities broadly equate with our Disruption Index analyses as initial, primary units and gateways for devolution but invite the formation of other units as the Devolution Framework is developed to deliver an entrepreneurial, capabilities-based approach to policymaking through local authorities and communities.

3. **Local Growth and Capabilities Strategies should develop growth plans by focusing on building local capabilities ready to meet the risks and opportunities of technological transformation.**
   Our analyses have identified that many areas are more innovation 'ready' than they are 'transforming,' partly because of the bottlenecks and infrastructure gaps identified in our Disruption Index and Interactive Report. A longer-term, systems approach to developing the Government's Plan for English Devolution over 10 years will be needed to overcome these barriers, understand local sectoral mixes and identify areas of particular strength and weakness. For example, Cornwall and Lincolnshire have low innovation readiness but there is a mix of sustainability sectors, including solar and offshore wind, rare minerals for batteries and semiconductors. Growth zones should become 'Growth and Capabilities' zones – to ensure socio-technical and systems approach, with regard to local skills and sector mix, institutions and strategies. Reflecting this, they should have wider, 'socio-technical' remits and capabilities-driven goals.

4. **Growth and Capabilities Zones should be established across the UK, which straddle the opportunity structures and functional components we have identified, and extend new institutions and networks where gaps are identified, civil society actors and the whole 'socio-technical' innovation ecosystem.**
   This should build on 'Investment Zones' introduced by the previous government and located in areas with existing local strengths and significant untapped potential. The new Growth and Capabilities Zones should be locally led by a multi-stakeholder local council, and would focus on the development and implementation of a 10-year plan, which would include targeted and cross-cutting responsible innovation and capabilities plan for the region. This should take into account local history, culture, and growth and future of work plans. These new zones should be aimed at developing well-functioning local innovation ecosystems, taking into account technology, job and career 'life-cycles'.

5. **Building on the Disruption Index and supported by the Treasury, local and regional Data Observatories should be developed, combining geographic, work, skills and health data - and help plug data gaps to inform, monitor and evaluate Growth and Capabilities plans.**
   Insight from local observatories can be 'pipelined' to a National Future of Work Unit. Armed with better information, Combined Authorities and entrepreneurial local authorities could be encouraged to apply for additional, costed resources for planned projects. For instance, building research and innovation institutes to support place-based social innovation. Data from these observatories could be developed further by these institutes, for example by establishing a secure 'airlock data' programme, which would facilitate access to and use of sensitive or confidential data sets that cannot be made fully public.

6. **The direction of technology innovation activity and public investment and activity should be changed to a new focus on high-discretion augmentation. This could start with Research and Development ('R&D') allocations, impact assessments and a new innovation challenge to promote 'good automation'.**
   Our analysis has surfaced the extent to which investment and R&D allocation are skewed by place and theme. In particular, R&D is not only highly variable by geography but has been directed towards the substitution or surveillance of human activities and capabilities, rather than focusing on augmenting them. R&D should refocus allocation on augmenting human capabilities and discretion. Using insight from new reporting obligations, this could be extended to excluding certain activities and the eligibility criteria of other innovation support, for example, the Enterprise Investment Scheme, which currently claims £2.5Bn per year. It could launch an independent review to examine how tax credits for technology R&D could be combined with skills credits to improve complementarity.

7. **This strategic shift should be signalled and reinforced with the launch of an innovation challenge to promote high-discretion augmentation or 'good automation', signifying the recognition of AI and automation as a significant, societal challenge.**
   This should be open to all sectors, with dedicated strands focused on increasing High Involvement Human Resource Management ('HR') Practices and High-Discretion Augmentation (HDA) - in sector-agnostic ways, to maximise its impact.

8. **The creation of good work can be further promoted directly through requirements, impact assessments and the monitoring of government investment across the UK, initially through tax credits for R&D and Innovate UK funding.**
   Our Disruption Index analysis has shown that 5 regions with the highest R&D account for 42% of total R&D investment, an increase from 35% four years prior. Our policy analysis shows this pattern of concentration is even more pronounced for AI investment, which needs wider recognition and targeted attention as part of the AI Opportunities. We recommend that R&D tax credits and Innovate UK funding should require consideration of impacts on the creation and quality of good jobs in the UK and report back on this so UKRI can refine its approach and have closer regard to how investments can support each other across the country. For instance, there should be better understanding of the complex, nationwide trade-offs from the high proportion of national R&D investment allocated to large multinationals largely based in London.

9. **Marked disparities in public investment could be reduced by focusing on different types and mixes of R&D funding, to rebalance the emphasis on foundational research in the Golden Triangle and ensure foundational research can be applied across the UK.**
   Marked disparities in public investment could be reduced by focusing on different types and mixes of R&D funding, to rebalance the emphasis on foundational research in the Golden Triangle and ensure foundational research can be applied across the UK. Different models sand combinations should be piloted and results evaluated

   Disparities in venture capital investment and R&D investment across the country have stood out in our analysis, but not in the rehearsed 'lack of access to capital' sense. The 'funding gaps' discourse in the UK often overlooks the structural and institutional barriers—such as inadequate infrastructure, ineffective capital markets, and outdated public procurement systems—that impede the effective deployment of existing venture capital, despite record levels of 'dry powder' in the market

   Similarly, with public R&D funding, public investment reflects a focus on primary or foundational innovation, and the location of expertise surrounding centres of excellence related to this primary innovation. Our research has also shown that 50% of patent applications, which tend to signify applied R&D, are in just 5 regions in England, suggesting that place-based disparities are even more pronounced here. The Review has also shown that regions such as Oxford, Cambridge and London receive disproportionately more funding due to their existing concentration of research institutions related to these innovations, while areas with strong potential for applied or translational innovation, such as parts of the North East or East Midlands, remain underfunded.

   For smarter, more distributed investment in innovation, new approaches to innovation funding should be piloted that could support a gradual 're-balancing' over time. This could be done by 'matching' different mixes of translational and applied R&D to suit local strengths, as part of developing Growth and Capabilities Strategies and Zones. This policy would enable context-sensitive, place-based approaches, with regard to local industrial and skills mixes and new opportunities for translational and applied R&D. The rapid pace and access to the latest wave of new technologies suggest this approach may become more important within the next 5 years.

   These efforts, combined with intentional initiatives to build institutional

R&D capacity in regions receiving substantially less innovation funding, should more effectively takes into account the full range of R&D stages — including translational, applied and adaptive innovation — ensuring that foundational research is not only conducted but that the enabling conditions in place for this to be effectively translated into regional economic, workforce, and societal benefits.

10. **Consult on measures focused on increasing the supply of social impact investment in the UK, working with industry, with an objective to allocate 5% across UK-based institutional investors.**
    Extending the former government's 'Mansion House Reforms' to insurance funds, family trusts and foundations and the larger university endowments could have a catalysing impact on social innovation and new 'good job' creation across the UK, with the potential to unlock up to £50bn of capital. The current Mansion House Reforms are focused on increasing the supply of capital from UK pension fund schemes to the UK's most promising high-growth companies - i.e. the innovation economy. However, as the Review has shown, the recipients of this investment are likely to be concentrated geographically without an intentional approach. Social impact investing is a type of investment that seeks to tackle social issues and generate a positive social impact alongside financial returns.

    The UK has a world-leading social investment ecosystem, and research from Big Society Capital shows that 82% of organisations receiving social investment recipients are based outside of London, and 62% are focused on the UK's most deprived communities. As such, a new set of reforms, building on the Mansion House Reforms, would look to establish a comparable set of reforms that would cover social investment.

    Social impact in this context should be defined here to include the creation of good work, and could be extended by theme or through match-funding initiatives, for instance, universities and endowments might agree to match-fund, invest, or offer other support for the establishment of the new research and innovation institutes, recommended below. We also recommend that the government consider deregulating restrictions on further social innovation above the initial 5% allocation.

11. **Establish national socio-technical research and innovation-leading research institutes, with laboratory and capacity-building functions, across the country where gaps are identified.**
    Our analyses have shown the extent of divergence in research, development and diffusion infrastructure across the country. A full research infrastructure review, leveraging our Disruption Index, could support the identification of locations with untapped potential for flagship, cross-sector research and innovation institutes. These could become focal points for a range of related policies and new knowledge infrastructures, building local institutional and SME capacity, and enabling the development and delivery of new training and business support packages, with an emphasis on combining technical and social learning. The institutes could have innovation, governance, piloting and sandbox functions, and be designed with regional partners. This 'network' joined by knowledge pipelines, secondments and project partnerships, should be seen as developing regional capabilities ready for transformation and making a success of the devolution agenda, including a longer-term and more strategic approach to creating future, good, local jobs across the country. This initiative could be developed as an updated, national, 'socio-technical' version of the Fraunhofer Institute network in

Germany, with integrated governance functions.

Further detailed mapping exercises and development with local stakeholders and institutions are essential, including the Catapult Centres, together with additional support for existing or planned initiatives such as The Brunel Centre, to be launched in April 2024 for the West of England.

12. **Revitalise a dedicated ministerial role for the Future of Work with a wider remit, and establish a dedicated Future of Work Unit based at the Cabinet Office. This would guide the remit and targets of cross-cutting policy strategies aimed at creating and transitioning to good future jobs, developing, integrating and aligning policy interventions across areas including skills, innovation, work, wellbeing, health, pensions and the labour market.**

    Establishing a dedicated unit, team and leads would recognise and signify the future of work and automation as central, policy areas that currently fall between departmental leads. The remit of the Unit would range from guiding the work of Innovate UK and the British Business Bank to identifying data gaps and sources, typologies and measurements of capabilities and good work, readiness and technological transformation.

    The Unit would be responsible for the establishment of a Future of Work data unit or observatory, and ensure that the future of work, automation and transitions policy relating to the future of work was forefronted in the Industrial Strategy Council. It would establish a dedicated Transitions Council, like the Disruption Council in Denmark, with a focus on good future jobs, which could support the Industrial Strategy. We recommend mirroring Future of Work units and councils at a Combined Authority level.

    The Future of Work Unit would recognise and help deliver Good Work as a cross-cutting objective that can drive and align mission-driven government; establish the national-level Future of Work observatory with knowledge pipelines to the regional observatories and Data Library; establish a Good Work Task Force; and establish a dedicated What Works Centre and Job Quality Institute.

Power and Prosperity

Firm-level automation does not happen in a vacuum. Firms have varying capacities for good automation, with varying support from surrounding infrastructures and institutions. They also have varying information and knowledge about their options, and the likely risks and impacts of them. Additionally, firms function in regulatory environments, heeding new governance requirements and legal frameworks. These are being developed at different speeds in different parts of the world, with different priorities. Understanding and anticipating this changing landscape adds new dimensions to our understanding of information frictions. Our research has covered the factors that influence technology adoption and development, how these are shaped by system dynamics, what mediates better outcomes on work and wellbeing, including the creation of new, better jobs, and how this is experienced and perceived on the ground.

Beyond the striking headline results of our firm-level survey - which highlights the investments that are needed in human capital and digital infrastructure and the range of better outcomes that tend to result from High-Involvement HR practices - our in-depth case studies merit particular attention in both policy development and best practice.

Here, we dig deeper into the critical and multi-purpose role of involving stakeholders, critically including workers, and the way that technology perceptions connect organisational and environmental factors with AI adoption decisions. The imperative must be for boosted capacity, faster, better access to information relevant to responsible innovation and good automation, and for clear, principles-based overarching regulation that reflects the new 'common sense' about automation and offers reassurance and direction without prescription about form or methods. This means firms boldly revisiting existing architectures for value creation and ownership in response to the opportunities, as well as challenges, we have identified in the Review. Combined with increased support for scaling up and SMEs, we think this approach would draw from the best of our research to challenge the traditional business mindset, bring together effective, responsible innovation and governance – and help support the small and medium British businesses that employ the largest share of workers, so that they can support and empower their employees to innovate, deploying and building on new technologies well, as well as allaying fears about the inevitable downsides of automation.

We have explored the value of frameworks and heuristics to convey the complex choices and new options made in the course of an automation process (or, more likely, a series of processes). We have found that creating, sustaining and protecting good work, creating new space and methods for meaningful participation and partnership working, and access to enough information to overcome the frictions we have explored through this report at a firm level too, are paramount. At a firm level, focusing on good work acts as a way to reorient practice, philosophy and decision-making in ways that enable new forms of innovation, higher levels of engagement, and internal alignment of automation planning.

New initiatives to improve national and regional infrastructure and institutions capable of supporting good transitions should be extended to knowledge, research and development, clearly signalling local strengths, culture and aspiration, so that they are capable of addressing the barriers we have set out – they can clearly inform and support the building of firm-level capabilities to 'raise the bar' and deploy new technologies to open up innovation. Critical procurement should be used much more to 'raise the bar' and develop regional capabilities. This should also be centred so that 'readiness' can be developed and applied and bottlenecks, including training gaps and skills mismatches, can be unplugged.

The overriding message is clear: the best results are not predetermined and can be positive or negative, for firms as well as people. These are mediated by organisational context and choice – and they must be actively shaped by national and regional government, as well as by firms, to reflect our new 'common sense' of automation. Supply chain 'sovereignty' – which includes but extends beyond AI - is also a growing concern and needs swift attention as part of a national automation/future of work strategy.

Our skills recommendations follow below, but our firm-level research strongly corroborates our finding from the Review that our approach to skills development and lifelong learning must be a key component, which needs to be integrated into innovation, automation and industrial strategies, as well as change management at a firm level. This should also entail much higher levels of involvement and the co-development of training packages and career pathways, for which leaders must be trained and prepared, as well as employees, through new core and transitional skills modular courses. This reflects our findings that the relative significance of leadership, management and initiative skills is growing – and our recommended capabilities-based and capacity-building approach to managing transitions. We think that the skills and lifelong learning packages discussed in our final section will only work if firm-level support and governance are implemented too.

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1. **We need a new focus on building firm-level capacity for responsible innovation and the governance of AI and automation technologies, including development, use and adaption of the latest new technologies.**
   Local innovation architectures should provide support for responsible adoption and development of AI, with careful regard to new risks, opportunities and impacts explored in the Review.

   This work should be supported by the new research and innovation institutes, regulators and professional advisory bodies, and Sandboxes, and should produce new guidance, tools and practical resources, such as the Good Work Algorithmic Impact Assessment (GWAIA). With capacity building in mind, the scope of the planned review of surveillance technologies should be extended to cover wider impacts and types of automation. Formal and informal social partnership working is important in this context.

2. **Develop and promote the concept of shared knowledge about technological transformation as a public good.**
   Our research has highlighted the importance of growing information frictions which has revealed new dimensions and identified knowledge gaps. Taken together, our analyses suggest that we need new sources, ways to obtain and use information relevant to decision-making at all levels, including system-level decision-making. Recognising this is the first step to the development of new, public knowledge pipelines and infrastructure, starting with the National Data Library and Data Observatories. We need to generate, share and combine new sources of information to enable informed decisions and support social innovation and partnerships, considered in the context of developing 'AI sovereignty,' and the UK's innovation system to reflect our dual pro-innovation and capabilities-based aims and approach. Understanding, monitoring and the ability to take informed steps in response to the immediate and wider impacts of technological transformation follow from this, including impacts on capabilities, good work and wellbeing.

   Testing and reviewing new ways to seek information at all levels will be important, for example: requiring firms benefiting from government-funded research and innovation projects to contribute anonymised data to public shared intelligence efforts; modelling air-locked resources with tiered levels of access, developing forms of data custodianship by representative bodies, seeking anonymised technology adoption data via HMRC - as Italy has started - or Banks, as Lloyds Bank volunteered to support SME skills-building. This may also inform novel ways and models to recognise, create and capture value, increase social innovation and help build new alliances. It should also help ensure that the UK is not locked out of some types of AI-related innovation.

3. **Increase the capacity of UK regulators to work together with each other, civil society and the academic community to consider significant, multi-dimensional impacts of technological transformation and develop statutory codes and advisory guidance.**
   Collaboration and information sharing between the regulators is paramount, including the regulators abilities to access relevant information, extending to cascading and multidimensional impacts on good work, capabilities and wellbeing which may be relevant to others' domains. Our priorities include:

- an integrated Fair Work Agency with information-gathering and enforcement powers, ideally on a statutory footing;
- a clarified remit for the Health and Safety Executive to ensure that cumulative wellbeing and psychosocial impacts are monitored and addressed;
- a government-commissioned review of legal categories and protection of data, including automation and industrial data as well as personal data which underpins automation processes and decision-making;
- dedicated funding for EHRC to monitor and respond to automation risks and impacts on equality and human rights, extending to social impacts and good work;
- trialling use of anonymised HMRC data, initially by CMA and ONS;
- consideration of regulator capacity for more future-oriented, anticipatory advisory roles.

4. **Develop a flagship, overarching AI Act which we refer to as 'the Responsible Innovation and AI Act', to capture and deliver the UK's principles-based approach, introducing proportionate and anticipatory regulatory direction across legal domains.**
The Review supports the case for an overarching, market-shaping, regulatory approach that steers actors towards responsible innovation and governance together, applying insight from the Review. This would involve implementing the UK's principles-based approach to AI at a high level through statute, and in particular encouraging pre-emptive assessment of significant risks, impacts, opportunities and trade-offs, including those in the workplace by responsible actors starting with large firms, who should take reasonable and appropriate action in the circumstances. This should sit above and overcome risks associated with regulatory fragmentation as independent bills are created on data, employment and other domains. An entirely domain-specific approach is struggling to keep pace, seen, for example, by the gaps between the Data (Access) Bill and the Employment Rights Bill, which largely overlook automation impacts. This high-level, reflective approach, which should be introduced in tiers and stages with the support packages outlined above, would reduce the risk of inconsistency steer actors towards the better outcomes, as outlined in the Review. It should also help shape the market for responsible AI in which the UK is well placed to lead, but our Review has shown this will not happen automatically.

5. **The Responsible Innovation and AI Act would be complemented by smarter use of public procurement, conditions and guidance, immediately demonstrating the benefits of compliance to British SMEs.**
We recommend that procurement should be used more proactively and critically to raise the bar, in parallel with new regulation. Our analysis has revealed that 80% of the £2.4 billion revenue from public AI contracts committed since 2018 - which is an increase of over 500% - 80% of this revenue has gone to large multinational companies, most of which are headquartered in the US. In addition, £1.18 Billion of public AI contracts have gone to companies based in the South East of England, versus just £1.3 million to the North East. There should be a fast-track procedure for British SMEs operating in priority areas, tiered to give extra credit for implementing good work principles, beyond legal requirements. This approach should be embedded in new national procurement codes, guidance and support programmes. In particular, we recommend

building in 'good work 'requirements and targets, to help make sure that any large procurement is in the overall national interest, considering economic, innovation, public value and regional growth perspectives.

6. **Boosting requirements on supply chain due diligence for large companies and subsidiaries would support smarter regulation and procurement in the UK, encouraging monitoring and disclosure of social risks and impacts, including work conditions and quality, which are already under increasing scrutiny.**
   This would have positive secondary effects, including higher levels of disclosure and encouraging early anticipation, monitoring, and mitigation of significant social and wellbeing impacts across the technology life cycle, in line with our proposed regulatory and governance direction. Consultation on this proposed regulation should consider a simpler version of the EU's Corporate Sustainability and Reporting Regulation with a focus on technology and technological transformation. This should support boosted rights for SMEs to access information relevant to automation decision-making through the supply chain.

7. **Building on the work of the AI Standards Hub, the UK should establish a dedicated, National Innovation and Measurement Agency (NIMA) - a UK 'NIST'.**
   NIMA would develop world-leading expertise in socio-technical measurements, benchmarks, typologies, standards, the methods for the evaluation of technological transformation and impacts. NIMA would work closely with the ONS, British Standards Institute (BSI) institutions, the AI Safety Institute (AISI) and the new Regulatory Innovation Office, focusing on emerging challenges related to automation and the future of work. NIMA would lead in developing a democratic architecture for identifying priority areas for attention and measurement, for example by convening representatives from research institutions and laboratories, and civil society. It would also work with Skills England to support the development of training programmes in this area.

People and Capabilities

The findings from the Review point to the way in which current approaches to national AI policy and the future of work have not yet adequately considered impacts on work, workers or wellbeing adequately, nor implemented a human-centred approach to technology adoption in which people's capabilities, perspectives and values are recognised.

In recognition of this, a major policy direction emerging from the Review has been the introduction and proposed implementation of the capabilities approach to policymaking as a way of meeting pressing challenges, tackling inequalities, and maximising opportunities for everyone. Building the conditions in which people have more agency and can develop their capabilities would also help a reorientation towards supporting opportunities and choice for transitions within jobs and active labour market policies to support transitions between jobs and sectors, which the rapid pace of change we have revealed suggest will become increasingly commonplace.

The Review has surfaced significant impacts on people's wellbeing, quality of work and life and their capabilities, both positive and negative, which can be cumulative and hidden. The uses of some newer technologies, especially AI, have huge impacts on job quality but are no longer associated with overall positive outcomes, as ICT and traditional technologies have been. New wellbeing and psychosocial impacts should be recognised, monitored and addressed.

Meanwhile, Learning and Development in the workplace in the UK is low compared to OECD peers, and declining, especially in vocational training, with SME apprenticeships declining 49% since 2017. We have shown through the Review that both at-work learning and formal vocational training, vary substantially by region. New insight from the Review into 'hidden transitions', workplace capabilities and High-Involvement Human Resources Practice (HIPRP) highlights the pressing need to increase the availability, quality and matching of training to support better transitions from a firm level, managerial and leadership perspective, as much as a worker one.

By deploying the latest qualitative research, the Review has highlighted the significance of peoples' experiences and values, and of participation in AI adoption in the development of human-centred practices and meaningful human control. Capabilities such as autonomy, wellbeing, and decision-making have been shown to decline without proactive measures to integrate AI in ways that enhance human potential (Soffia, Leiva-Granados, et al., 2024). The role of a baseline in the protection of labour rights has also been highlighted, together with its less well-known role in promoting optimism, trust and innovation (Deakin, 2025). Our research has also pointed to the need for new AI skills including best use of AI, ethics and governance.

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Narrow skills development initiatives have not adequately integrated the technical and social skills which our research has found are increasing in importance, especially with regard to AI. These should be properly developed and integrated with innovation, wellbeing, education or industrial strategy initiatives. Narrow conceptions and approaches to skills have limited the ambition, uptake and 'stickiness' of courses, as well as the adaptability and resilience of workers. Recent developments in AI and related training have highlighted the need for more dynamic, participatory approaches which pay far greater attention to transitions within and between jobs and the need to combine social and technical skills.

In short, we need a new and more unified and 'socio-technical' system of education, skills, professional development and vocational training that is fit for 'Work 5.0'. Driven by new technologies - but recognising that these are cross-cutting drivers - this should cover all sectors. The overhaul of career progression, reward and work quality should be part of our proposed capabilities-based approach to policymaking.

People and Capabilities: policy recommendations

1. **Drive a national skills transformation by developing an integrated Skills and Capabilities Strategy that reorients the focus towards equipping people with the skills, capabilities and resilience needed for lifelong learning and adaptability across sectors.**
   This could be signified by renaming the body Skills and Capabilities' England. This should be integrated with investment, industrial strategy, work and technology plans. It should have a greater and more consistent emphasis on improving skills development in the workplace, social-technical learning (i.e. integrated social and technical skills and courses, combining technical and social skills) and flexible, co-developed pathways for vocational training. Skills and Capabilities England would lead on the creation of standards and accreditation and take an active role in determining eligibility for tax deductions. Partnership working could be embedded by Skills England, for example by designating accredited providers of courses with permission for new courses co-developed through formal social partnerships. This major shift requires a new focus on 'skills and capabilities' matching during periods of unemployment and throughout career life cycles, including within roles built in.

   Insight from the DI on the importance of situating the programme in the context of local and national labour market trajectories and future options should be used. The latest analyses on new and changing skills mixes should be monitored and widely available. A socio-technical approach to a national skills strategy would involve co-developing and delivering an integrated and adaptive package for skills and capabilities development, including building in the newer core, 'central' and transitional skills that we have identified in this Review. Existing skills programmes, initiatives and hubs should be redesignated and developed as 'Skills and Capabilities'.

   Key measures to be piloted include:

   - The recognition and typology for new 21st-century skills.

- A Skills and Capabilities Enterprise Credit- a targeted, enhanced tax credit scheme to incentivise businesses to invest in workforce development. In practice, for SMEs, this would include a 'super-deduction' scheme, allowing SMEs and startups to deduct up to 130% of eligible workforce training costs from taxable income.
- Using the Skills and Capabilities Credit towards apprenticeships and other types of workforce training, which should be reoriented from 'growth' per se to capability development.
- A High-Involvement Human Resources Partner Programme - a government-led initiative working with businesses and unions to co-design training programmes.
- A revised and expanded Lifelong Learning Entitlement to reflect the social right to learn – wider and more flexible access to learning opportunities, including co-designed courses, secondments, learning and 'innovation' time. This could be extended to accredited or agreed types of community work as part of Growth and Capabilities plans.
- A new 'Enable UK' Programme to reflect the social right to a good job- a dedicated support initiative for unemployed individuals or people transitioning into or within work, offering training, career pathways, and job-matching services to improve transitions.

2. **Introduce new governance mechanisms and funding sources to increase partnership working at different levels.**
   Resourcing and capacity building for meaningful socio-technical partnership working, including increased civil society involvement in policy and governance, and new, funded roles in transitions for unions, including learning, development and governance. New forums, requirements and participatory methods will be needed to help ensure engagement, deliberation and cooperation to interrogate and shape socio-technical dynamics across the technology life-cycle - i.e. to deepen and embed social partnership and partnership working to deliver the proposed 'socio-technical' approach.

   his should happen at all levels from membership of the advisory councils, to the development of local Growth and Capabilities Strategies, development of plans for the new institutions, and extending trade unions 'access' to workplaces and potential members and involvement in technological transformation.

3. **DSIT's cross-cutting remit should be reconfigured to reflect the need to build cross-departmental capacity for 'socio-technical' capabilities-based policymaking to support good transitions.**
   This should include embedding approaches developed by the government's Policy Lab unit, including training in reflective, participatory, capabilities-based policymaking and evaluation. This be extended to key institutions as they are being set up, such as Skills England. New participatory mechanisms, methods and forums for policymaking should be introduced - focused on the future of work and transitions - including deliberative engagement programmes designed for the workplace.

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4. **Jobcentres should be redesigned and transformed into 'Job, Skills and Capabilities Centres' to better support individuals in navigating transitions into and within work.**
These centres would focus on improving pathways by integrating skills development, capabilities-building, and job-matching services. This redesign should emphasise good work principles and lifelong learning, and it should adopt a 'pilot-based' approach to test and improve different types of interventions related to jobs and skills pathways, including in-person person and integrated 'work and health' interventions, and piloting the latest technologies across these areas. The new Jobs, Skills and Capabilities Centres would have a broader mandate than current Jobcentres, including:

    - increased resources and tools to help people develop their capabilities, employability and choice options, which should be informed by local labour market tracking.
    - support options for people within work as well as people who are unemployed,
    - skills programmes that are community-based and in-person, as well as remote learning and flexible options,
    - de-stigmatising of unemployment and work transitions.

5. **Beyond access to members, unions should be given new rights of access, including digital access, and new e-learning roles, backed by the Treasury. New roles for unions with regard to data access and custodianship should be explored.**
The value and potential of trade unions in the governance of AI and automation technologies should be recognised to surface and redress difficult issues, counter information imbalances and help deliver improved outcomes through meaningful partnership working. This is especially the case with regard to cumulative, relational impacts that can be mitigated, if they are identified in advance. The use of co-designed and developed approaches to skills and capabilities development and e-learning programmes is also and may open up a new and important role for unions in transitions, as unions and members are 'upskilled' to manage better transitions.

6. **The Equality Act should be updated to permit intersectional discrimination and protect from socio-economic and place-based discrimination.**
Treating equality as a structural challenge also points to the development and extension of equality impact assessments, starting with the Public Sector Equalities Duty (PSED). In light of the new dimensions of inequality explored in this Review, and the critical role that good work plays in mediating better outcomes, the PSED could be broadened to incorporate 'good governance' and 'good work' principles into responsible innovation and AI. This framework could be simplified and aligned with procurement and supply chain policies, supported by new tools and capacity-building initiatives so that the private sector can also benefit from this approach and prepare for regulation. The Regulators should consider and build in 'good work' impacts to codes and guidance, supporting development of reflexive regulation. New ways to actively promote equality should be piloted in both regulator and civil society sandboxes, building on new insight regarding the risks and impacts on work and workers.

7. **Introduce additional signifying amendments, clauses and measures related to prior impact assessments on work and wellbeing impacts, individual and collective access to information into the Data, AI and Employment Bills.**
   These small but significant amendments would set up the new Bills - as well as people and firms - for transitions and signify the importance of these areas. Amendments ensuring access to information, consultation and ongoing monitoring relevant to automation risks, opportunities and impacts would further signify national and international regulatory direction. Such signifying amendments, including workplace / Good Work Algorithmic Impact Assessments and boosted transparency requirements, should be integrated into the Employment Rights Bill (ERB) and Data Use Access (DUA) Bills. These areas should also be considered as part of the anticipated review of surveillance technologies.

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Section 1

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Acknowledgements

We are grateful to the Nuffield Foundation for funding this project, and for all at Warwick Business School, Imperial College, University College London and the London School of Economics for their expertise and support that has built this research. In particular, we would like to thank:

Esta Adams
Nathalie Baker
Yesha Bhagat
Kester Brewin
Professor Brendan Burchell
Dr Rui Costa
Dr Flavio Comim
Professor Alan Felstead
Mark Franks
Caroline Fry
Hummd Ghouri
Professor Francis Green
Dr Matthew Hall
Nancy Hey
Hannah Kitcher
Angad Khurana
Dora Meredith
Patrick Moran
Professor Phoebe Moore
Claddagh NicLochlainn
Chioma Nwankwo
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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.

For more information on the Review, visit pissaridesreview.ifow.org

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, Co-Director at the Institute for the Future of Work at abby@ifow.org

If you are a member of the press and have an enquiry or would like to receive new press releases by email, please email Kester Brewin, Associate Director: Communications and Training Development at the Institute for the Future of Work, at kester@ifow.org