Skills, Organisations and Worker Engagement

Summary of People Research Programme

Authors:
Damian Grimshaw
King's College London
Mary O'Mahony
King's College London
Anthony Rafferty
University of Manchester

Date:
April 2026

The Productivity Institute
Productivity Insights Paper No. 083

RESEARCH PROGRAMME REPORT

Key words
Skill mismatch, skill demand and supply, green and digital transitions, AI, technology adoption, digital crowdsourcing, job complexity, self-employment, hybrid working, education policy, job design, employee voice.

Authors' contacts
damian.grimshaw@kcl.ac.uk
mary.omahony@kcl.ac.uk
Anthony.Rafferty@manchester.ac.uk

Suggested citation

D. Grimshaw, M. O'Mahony, A. Rafferty (2026) *Skills, Organisations and Worker Engagement Summary of People Research Programme*. Productivity Insights Paper No. 083, The Productivity Institute.

The Productivity Institute is an organisation that works across academia, business and policy to better understand, measure and enable productivity across the UK. It is funded by the Economic and Social Research Council (grant number ES/V002740/1).

The Productivity Institute is headquartered at Alliance Manchester Business School, The University of Manchester, Booth Street West, Manchester, M15 6PB. More information can be found on The Productivity Institute's website. Contact us at theproductivityinstitute@manchester.ac.uk

Abstract

This report is a synthesis of The Productivity Institute's People research workstream that covers skills needs, organisations capacity to fill these needs and worker engagement. It consists of three strands: skill demands and supplies, skill changes with digital technologies from an organisational perspective and job design and worker engagement. The overall objective was to determine how workers, managers and organisations develop the skills, job design and engagement necessary to ensure productivity gains in the digital era. The report summarises the main findings from each strand of the research and then puts forward recommendations for policy and business.

Table of Contents

Executive Summary **3**

Chapter 1. Introduction 5

Chapter 2. Research Questions and Research Design 7

Research questions 7

Research Design 9

Chapter 3. Skill Demands and Supplies: Findings and Analysis 13

Skill mismatch 13

Graduates and skill biased technical change. 14

Regional Skill Demand and Supply 17

Green and Digital Transitions 23

Soft Skills and Values 26

Firm provided Training 27

Chapter 4. How are skills changing with digital and AI technologies? A management and innovation perspective 29

Overview 29

The UK's independent games industry: Bottom-up innovation, AI, and the changing architecture of work 31

AI technologies at the BBC: A challenge for innovation management, learning and strategy making 33

Digital technology adoption in manufacturing SMEs: Boosting productivity growth through ecosystem relationships 36

Forging 'common ground' with AI technologies in the livestock sector 39

Digital crowdsourcing of knowledge: How does it shape organisations' skills, capabilities and innovation performance? 42

Sustaining employee productivity through better digital-work design 44

Chapter 5. Job design, people engagement and productivity 48

Introduction 48

The complex effects of job complexity on skill use and well-being 48

Effective worker voice and pathways to productivity 49

Self-employment, gender, part-time work and productivity 51

Hybrid working and productivity: Exploring flexibility stigma and ethnic inequalities 59

Employment and Technology Adoption Strategies in Food Manufacturing 61

Chapter 6. Conclusions and Implications for Policy and Business Practice 63

Improving education policy 63

Enhancing the role of employers 64

A focus on job design 67

Employee voice and productivity 67

Sector-specific challenges 69

Self-employment. Part-time work and productivity 70

Hybrid working and productivity 72

References 73

Executive Summary

This report summarises the research findings from three inter-related groups of people research projects. The first group examines **skill demands and supplies**, and how they vary by region and country. The second examines **how skills are changing with digital and AI technologies** from an organisational, innovation and industry perspective. The third group of projects interrogates **how characteristics of job design and people management practices, including how worker engagement and working from home**, shape productivity and inequalities.

The primary objective of this research was to determine **how do workers and organisations develop the skills, job design and engagement necessary to ensure productivity gains in the digital era?** The research employed an inter-disciplinary perspective with contributions from economics, social and work psychology, management and innovation studies, HRM and employment relations.

The main findings from the **skill demands and supplies** research were:

In the digital era, technologies continue to be biased in the direction of demanding high skilled labour, but the reliance on university graduates to measure high skills is less salient than in previous eras.

There are large regional variations in the extent to which firms demand advanced digital technical skills and to which formal education supplies the STEM skills required, with London and parts of the South, including Cambridge, dominating. These variations do not just reflect industry compositions.

Digital and Green skills are highly correlated across occupations. Most UK industries exhibit greater digital and green skill intensity than their European, mostly driven by its greater share of knowledge intensive services industries.

The quality rather than the quantity of firm provided training is crucial for generating productivity improvements and it is important that both managers and workers acquire this training.

The main findings from **skill changes with digital technologies** work strand were**:**

Skills are changing with AI and digital technologies in a variety of ways, far beyond a narrow focus on AI and digital skills, that reflect organisational, industry and institutional context and diverse skill outcomes.

In sectors with a high degree of collaborative work (e.g. creative sectors), AI technologies are reducing interdependencies between job roles and speeding up workflow with mixed outcomes for employment prospects.

In public service, purpose-driven organisations (like the BBC), an effective organisational innovation strategy (with sustained resources, deep cross-functional capabilities and clear end-to-end ownership) can support the bridging and scaling of required skills with implementation of generative AI technologies.

Skills required for digital transformation in core sectors of agriculture and manufacturing extend beyond technical proficiency to include: supply chain capabilities; strategic planning; and interrogative capabilities.

Patterns of skill change (and organisational performance) with AI implementation are closely related to features of job design, particularly whether humans or AI set task rules and/or execute the task actions.

The main findings from the **job design and worker engagement** work strand were:

Understanding job design and different forms of task complexity is important to learning and wellbeing within organisations.

Non-standard and broader 'low road' employment practices than conceive human capital as a cost rather than 'input' may hold immediate benefits to employers but present risks to longer term skills development, technological adoption and productivity growth.

The rise in self-employment and outsourcing within more Knowledge Intensive services raises questions regarding potential impacts on longer term human resource development sustainability where human capital needs are sourced externally rather than developed in-house.

A climate of psychological safety is essential to effective employee voice to fully harness the productive potential of the workforce, while there is a need to more fully articulate the management case for increasing employee voice.

A **common idea** that emerges from all three strands is the notion of 'alignment', whether it is matching digital skills to available supply, aligning training of workers and managers, organisations needing to align practices that engage workers with changes in innovation, strategy and human resource management practices.

The main **policy conclusions** are as follows:

To promote revisions to education curricula to better prepare students for changes in the labour market brought about by technological changes. This may require more joined up provision of education at all levels, school, FE colleges and Universities, increased funding and more coherent skills policies at national and regional levels.

The need to provide incentives for firms to invest in more high-quality training and provide information to small and medium sized enterprises on opportunities for training, especially online offerings.

Develop a clear sector-focused approach to skill change by aligning with industrial policy and employment strategies for different sectors.

Incentivise organisations to commit resources and design new activities for cultivating the required relational and organisational capabilities to enable them to implement, adapt and derive value from AI and digital technologies.

Support management efforts to bridge knowledge and technology gaps with specialist AI and digital suppliers - including joint team problem-design and problem-solving, inhouse training, and new inter-firm methods to diagnose problems and improve collaborative relationships.

Productivity strategies should explicitly recognise job design, learning opportunities and worker wellbeing as foundations of sustained performance.

TPI research calls for the introduction of policies such as a right to disconnect to protect workers, especially homeworkers and disadvantaged groups.

Expanding access to higher quality flexible and part time work is important to reducing gendered and life-course inequalities in productive participation.

Chapter 1. Introduction

People are central to productivity growth, in their roles as workers, managers, entrepreneurs, investors and inventors. The extent to which workers perform their jobs and tasks well affects the overall productivity of the organisations where they work. In crafting their organisation's strategy – in hiring, training, marketing and financing, among others – managers shape the nature and success of performance. People are also key to the development and diffusion of new, productivity-enhancing ideas and technologies.

Workers and managers differ in their abilities and characteristics with one of the most important being the skills they bring to the workplace. Skilled workers are behind the invention, development and adoption of new technologies, products and services. At the same time skilled workers are likely to earn higher wages, enjoy job security and experience greater job satisfaction, so enhancing skills of all workers is important for inclusive productivity growth. Ensuring jobs are carefully designed and workers have the opportunity to engage in relevant workplace decisions are also important factors within organisational settings that shape productivity in relation to effective people management.

In the 1980s and 1990s in many advanced economies there is evidence that the first wave of information and communication technologies (ICT) raised the demand for highly educated labour faster than its supply, a phenomenon labelled 'skill biased technical change[1]. As digital technologies changed, from cloud computing and machine learning to generative artificial intelligence (AI), the impact on skills, organisations, employment relations and ultimately productivity, has become more complex. The purpose of The Productivity Institute's "People research programme" is to dig deeper into this complexity. It designed an interdisciplinary suite of research projects, drawing on theoretical insights from labour economics, management, work psychology and innovation disciplines, among others. The research aimed to investigate how organisations and workers are developing and adapting the skills required for productivity improvements in this uncertain time of rapid digital transformation and change in labour markets, management practices and workers' experiences.

This report summarises the research findings from three inter-related groups of people research projects, presented in chapters 3, 4 and 5. The first group examines skill demands and supplies from a number of perspectives. The second examines how skills are changing with digital and AI technologies from an organisational, innovation and industry perspective. The third group of projects interrogates how characteristics of job design and people management practices, including how worker engagement and working from home, shape productivity and inequalities. A common idea that emerges from all three strands is the notion of 'alignment', whether in the macro sense of the need for regions to match demands by organisations for digital skills to available supply, or in the micro sense of organisations needing to align management and workers in designing or implementing digital technologies, or aligning management and employment practices that engage workers.

The measurement of skills is central to the first group of projects, labelled "Skill demands and supplies" (chapter 3). The earlier economics literature on skill biased technical change based its evidence by comparing highly qualified (university educated) with less qualified people, implying that qualifications are a good proxy for skills. Recent research in economics increasingly

[1] See, for example, Katz and Murphy 1992; Krueger 1993; Goldin and Katz 1998; Acemoglu 2002; Acemoglu and Autor, 2011; O'Mahony et al. 2008; Violante 2018; and Autor et al. 2020.

conceptualises skills as bundles of task-specific capabilities rather than fixed attributes tied to occupations or formal qualifications. “Skill demands and supplies” research advances our understanding of measuring digital skills, and how these relate to AI and soft skills, as well as international comparative work on the links between digital and green skills. This research also broadens the definition of human capital to take account of health aspects, focusing on the mental health of young people. Moreover, the research identifies what type of workers benefit the most from firm provided training.

The second group of projects, labelled “Skill changes with digital technologies” build on three inter-related insights from the management and innovation disciplines (chapter 4). First, it seeks to identify the key sources of agency - associated with the decisions and actions of management, entrepreneurs and workers – responsible for shaping long-term patterns of skill change with digital technologies. Second, it adopts a broad ‘organisational conceptualisation’ of skill in order to capture the objective attributes of skill related to the job (e.g., task complexity) and individual (e.g., years of schooling), as well as the relational attributes of skill (e.g., the social interdependence of job tasks and job roles). The third insight concerns the need to explore the fast pace and turbulence of digital technologies. This characteristic opens up opportunities for managers and workers to exercise agency in reshaping skills for improved performance, but may be constrained by the likely slower pace of deliberative human-led change.

The third group of projects, labelled “Job design and worker engagement” (chapter 5), focuses on the role of people management practices and draws on perspectives from work psychology, human resource management and employment relations. In particular, it examines key issues surrounding job design and people management that hold the potential to impact productivity. First, it examines job complexity, defined as jobs characterised by the extent to which job tasks are varied, unstructured and dynamic, which can be an important factor that enhances the links between skills, technology and productivity. Second, it explores how alternative arrangements for employee voice shape productivity and how they can encourage inclusive and sustainable productivity. Third, it focuses on the effects of broader employment and human resource practices, including hybrid and work from home (WFH) arrangements, but also more long-standing practices such as part-time employment, self-employment and temporary or other non-permanent precarious work, considering the extent to which low skill, low wage and insecure employment are a drag on the UK’s productivity performance.

This report is structured as follows. Chapter 2 sets out the headline research questions and gives a brief outline of the methodological approaches adopted in the three groups of research projects undertaken for the TPI People research programme. Chapters 3, 4 and 5 provide summaries of the key findings for each group of research projects. Chapter 6 considers the policy implications while Chapter 7 concludes and suggests ways forward.

Chapter 2. Research Questions and Research Design

Research questions

The overarching research question in the TPI People research programme is, *how do workers and organisations develop the skills, job design and engagement necessary to ensure productivity gains in the digital era and how has this changed and adapted in recent times?*

TPI approached this question by designing a suite of inter-disciplinary research projects. Three groups of projects set out with a distinctive set of theoretical premises and investigated inter-related components of the overarching question. Table 2.1 describes the summary features of each group of projects, which are labelled as: i) Skill demands and supplies; ii) Skill changes with digital technologies; and iii) Job design and worker engagement.

Table 2.1. Summary features of three groups of People research projects

Research group	Aim	Discipline/ theory	Key research questions
i) Skill demands and supplies	To provide new measures of skill prevalence by country, region and industry	Labour economics. Social psychology	• How have new technologies affected the graduate wage premium over time? • How do UK regions and industries vary in their demands for and supply of digital skills? • How do digital and green skills in the UK compare with other countries? • Is there evidence that younger cohorts have particular issues that impact negatively on their skill sets and reduce their productivity? • Is firm training provided effectively in the UK?
ii) Skill changes with digital technologies	To understand how organisations and workers are adapting skills with new AI and DTs for innovation and performance	Management and innovation research	• How do AI tools impact the division of labour within and between firms? • How do relations between organisations affect DT adoption and innovation outcomes? • How do different DTs affect work design? • What organisational capabilities support skill formation? • How do DTs reconfigure analogue and digital skills? • Is crowdsourcing for knowledge conducive to innovation performance?
iii) Job design and worker engagement	To explore how job design and people management practices have the potential to impact productivity	Work psychology, HRM and employment relations research	• How does job design and work organisation shape skill use, learning, wellbeing and performance? • How does job complexity relate to task performance, learning, well-being, and job strain? • How do different forms of employee voice and participation contribute to productivity? • What factors shape worker voice strategies and outcomes? • How do HR practices (e.g., part-time work, self-employment, hybrid/homeworking practices) interact with productivity, technological adoption and inequalities? • How can digital presenteeism overcome biases against marginalised workers?

Note: DTs = digital technologies.

i) Skill demands and supplies. Drawing on theoretical insights from the labour economics discipline, this research began by establishing new measures of skill prevalence by country, region and industry. These measures gave a picture of the skills firms are looking for and the extent to which they are being provided through the education and training systems. The research then explored how advances in technology have affected the graduate wage premium over time. The novel findings revisited the notion of skill-biased technological change, and derived new results on the determinants of the graduate wage premium, a measure of equilibrium in the labour market for skills.

This research then went beneath a measure of skills based on qualifications to one based on particular digital skills to explore how UK regions and industries vary in their demands for and supply of these skills. In addition, the research was concerned with identifying those areas of the UK where employers are seeking to hire people with digital skills but supply is weak. It also investigated how the supply of digital and green skills in the UK compares with other countries.

Drawing on insights from social psychology the research examined types of individual behaviours related to skills, focusing on mental health, especially among young people. The main research question addressed is whether or not there is evidence that younger cohorts have particular issues that are likely to impact negatively on their skill sets and reduce their productivity?

Finally, this research described the pattern of training provided by organisations and explored the extent to which this is provided effectively in the UK.

ii) Skill changes with digital technologies. Drawing on management and innovation research, this research investigated how organisations and workers are adapting skills with new AI and digital technologies (DTs) for enhanced innovation and performance.

A key feature of this group of projects is the attention to sector and organisation context as a means to understanding the relationship between skill changes and implementation of DTs. The specific context was instrumental in defining the nature of the research questions addressed (table 2.1). For example, investigation of AI and the shifting division of labour within and between firms emerged from case studies of independent games studios where job roles and job mobility are changing rapidly with AI technologies. By contrast, qualitative research with the BBC highlighted the need to understand strategic purpose and new organisational capabilities for AI implementation and skill development. Similarly, with the aim of understanding effective DT knowledge transfer among SME manufacturing firms, research underscored the important role of knowledge dissimilarities and relationships between SMEs and specialist DT provider firms).

Other research focused on particular types of DTs, which again helped to shape the question explored. One study explored the organisational factors (especially management practices) associated with productive sourcing of knowledge from digital crowdsourcing platforms. A further study investigated how different characteristics of digitalisation affected how employees changed their work practices and productivity.

iii) Job design and worker engagement. Drawing on work psychology, HRM and employment relations research, this research sought to identify factors within the organisational (and institutional) setting that shape productivity in relation to job design and people management practices.

The research on job complexity investigated how different types of job complexity relate to employee outcomes, such as learning, well-being, and job strain linked to performance. It also identified the various contextual factors that moderate the effects of job complexity.

Further work focuses on understanding the role of effective worker voice to explore how different forms of employee voice and participation contribute to alternative "pathways to productivity". The findings highlight the factors that influence worker voice strategies, and how employers perceive the relationship between voice and pro-productivity worker and/or organisational outcomes. The research also explores the extent to which management responsiveness to worker voice can mediate worker and/or organisational outcomes.

Finally, the Job design and worker engagement research asks specific questions about the role of people management practices. This incorporated a study of how task complexity affects employee learning and wellbeing and a detailed enquiry into how employment practices such as self-employment, part-time work and hybrid/homeworking practices interact with productivity, technological adoption and inequality outcomes. The analysis of hybrid work reveals insights into workers' experiences of working from home (WFH), how these relate to digital presenteeism and cultural norms and how digital presenteeism might be able to overcome biases against marginalised workers. Case studies of food manufacturing reveal the factors driving current and planned use of precarious work and migrant labour and the inter-relationship with decisions relating to the choice of and investment in DTs and the organisation of work.

Research Design

The People research programme sought to use evidence at a number of levels, from aggregate statistics on regions and industries to data relating to individuals and organisations. Much of the research in this programme is quantitative, using both standard secondary data sources but also new sources such as original organisation surveys, administrative and big data. The "Skill changes with DTs" and "Job design and worker engagement" research deploy a mix of quantitative and qualitative evidence. The latter consists of organisation case studies, as well as sector and ecosystem investigations, collecting original interview and archival data.

i) Skill demands and supplies.. Secondary databases form the backbone of much of the quantitative analysis reported in Chapter 3. The main data source for the work on graduate wage premiums is the EUKLEMS & INTANProd database[2] covering the period 1995-2019. This research used a range of econometric methods including the most commonly used fixed effects estimator and a dynamic specification using an Autoregressive Distributed Lag model that also includes corrections for cross-sectional dependence, using the cross-sectional averages of all variables in the model.

Two main data sources underlie the descriptive analysis on regional estimates of digital skills demand and supply. Job platform data, sourced from the Lightcast company,[3] is the main source on the demand side. Lightcast web scrapes job advertisements from a range of sources and currently provides information on virtually all job advertisements in the UK. The sample period considered in this work is 2014 to 2025, and consists of approximately 9 million job adverts on average per year. The primary source for the supply of skills developed through formal education

[2] https://euklems-intanprod-llee.luiss.it/
[3] https://lightcast.io/products/data/

is the Longitudinal Education Outcomes (LEO) database, accessed through the ONS Secure Research Service[4]. LEO contains administrative data that links together school records from the National Pupil Database (NPD), university records from the Higher Education Statistics Agency (HESA), records from the Individualised Learner Record (ILR) and tax records from His Majesty's Revenue and Customs (HMRC) and the Department for Work and Pensions (DWP).

The research on digital and green skills developed two standardised indicators. The green task intensity is measured using a task-based approach from the United States O*NET database, representing the share of green-specific tasks per occupation. Digital skill intensity is estimated using a skill-based index from the ESCO database, defined as the ratio of essential digital skills to total occupational skills. These occupational indicators are then aggregated to industry and country levels by weighting them with employment shares from national labour force surveys, with all classifications systematically aligned to ensure cross-country comparability.

The research on firm provided training uses linked firm level data from the UK Employer Skills Survey and the Investment in Training Survey[5], linked to the Business Structure Database, also accessed from the Secure Research Service. The research on attitudes to work across generations is based on the UK Household Longitudinal Survey, more commonly known as Understanding Society.[6]

ii) Skill changes with DTs. The focus of this research on organisational and sectoral context necessitated a research design equipped to explore and identify the variety of ways skills are changing with DTs. As such, three of the six projects deployed a rich qualitative design, three developed original survey questionnaires and two of the latter combined survey results with qualitative data. In each case, the method served to investigate mechanisms and outcomes of skill change and their inter-relationship with innovation in processes and products accompanying the adoption of AI and DTs.

Three of the six projects collected quantitative data by designing original survey questionnaires: Hsing-fen Lee and colleagues explored the factors associated with productive sourcing of knowledge from digital crowdsourcing platforms; Bindl investigated how different aspects of digitalisation affected how employees changed their work practices and productivity; and Vecciolini and colleagues (ongoing) is investigating how differences in knowledge dissimilarities and relationships between manufacturing SMEs and digital technology provider firms shapes knowledge transfer and innovation outcomes. The latter two projects combine statistical survey analysis with qualitative data. As table 2.2 shows, the other three projects collected and analysed original qualitative data, mostly consisting of interviews and archival materials.

[4] Secure Research Service - Office for National Statistics
[5] https://www.skillssurvey.co.uk/

[6] https://www.understandingsociety.ac.uk/

Table 2.2 Summary of research design for six projects on skill changes with digital technologies

Sector/ organisation	Authors	Research questions	Research method	Data analysis
Games industry/ SMEs & AI firms	Grimshaw, Miozzo & Sosa	How do AI tools impact the architecture of work within and between firms across an industry ecosystem?	Qualitative: interviews (CEOs, designers, artists, programmers) in independent games companies and AI specialist firms; archival materials	Thematic coding
Media/BBC	D'Ippolito, Miozzo & Zhang	What are the organisational processes and capability-building routines that support skill formation and translate DT-led productivity gains into sustained innovation performance without eroding public value?	Qualitative: interviews (BBC senior management, GenAI experts, R&D staff); on-site fieldwork observations; archival materials	Thematic coding
Manufacturing/ SMEs & digital services firms	Vecciolini, He, Grimshaw & Miozzo	What are the characteristics of interorganisational relationships affecting DT adoption, and how do patterns of knowledge dissimilarity shape learning and innovation outcomes?	Qualitative: interviews (CEOs, general managers, operations & shopfloor managers, engineers); archival materials Quantitative: original survey of manufacturing SMEs (ongoing)	Thematic coding & regression analysis
Agriculture/ livestock farms & agritech firms	Grimshaw, Miozzo & Kyriakopoulos	How are new data-led DTs reconfiguring analogue and digital knowledge, job roles and tasks?	Qualitative: interviews (farmers, agritech entrepreneurs and programmers, scientists); archival materials	Thematic coding
All sectors/ SMEs & digital crowdsourcing platforms	Lee, Grimshaw, Miozzo & Rani	Is crowdsourcing for knowledge conducive to exploratory innovation performance and do organisational practices condition its effect?	Quantitative: original survey of UK SMEs (N=183)	Regression analysis
All sectors/ all firm sizes/ employees	Bindl	How do different DTs affect work design, how do employees adapt and make changes beneficial for productivity, and what support do managers provide?	Qualitative: interviews (DT leads) Quantitative: original four-wave panel survey of employees	Thematic coding & regression analysis

iii) Job design, people engagement and productivity. This research used a variety of methodological approaches and data sources. This includes the quantitative analysis of comparative international, national and firm level survey data, in-depth qualitative analysis, rapid literature reviews and meta-analysis. The study of job complexity learning and well-being incorporated a meta-analysis and internationally comparative secondary data analysis. The second study was an analysis of nationally representative data sets including the European Working Conditions Survey (EWCS 2015 and EWCS 2021). From these surveys we developed measures of job complexity, employee outcomes (employee performance, learning, well-being and job strain), and various moderators at the individual (i.e., employee skills), relational (i.e., manager support), organisational (i.e., training, wages), and institutional level (i.e., national institutional regimes: Nordic, Coordinated, Liberal, Southern European and Eastern European (Gallie, 2007)).

For the study of employee voice and productivity, an inclusive definition of voice was adopted spanning "the ways and means through which employees attempt to have a say, formally and/or informally, collectively and/or individually, potentially to influence organisational affairs relating to issues that affect their work, their personal interests, and the interests of managers and

owners" (Wilkinson et al, 2020: 5). The research design comprised a rapid evidence review, survey research, the development of a holistic voice-performance model and four organisational case studies. Case studies were selected to reflect different voice configurations, with cases categorised as full-service unionised voice; full service non-union voice; simple non-union voice and non-union light voice. In each case study, mixed methods were deployed comprising documentary analysis, depth multiple stakeholder interviews (of strategic, HR, operations and line management, union representatives where present and workers – 26 in total) and a short pulse survey, delivering 302 useable responses across the four cases. Interviews and survey questions focussed on the organisation's approach to voice, voice channels, voice behaviours, perceptions of voice effectiveness, role of management and barriers, facilitators and outcomes of voice. Interviews also generated data on organisational strategies and culture and how these shaped and were shaped by worker voice.

The analysis of long-term trends uses nationally representative repeated cross-sectional data from the 2001-24 UK Labour Force Surveys. Using the jobs-based approach, defined as 4-digit SOC codes within 9 industry sectors, the median hourly wage rates for each job were calculated from a pooled independent dataset in the starting year of each observation period (2001 and 2011). This was used to examine changes in wage deciles. To examine the effects of self-employment (where income data is more problematic) measures were further constructed based on the mean level of people holding a degree level qualification or above within occupations. The gender part-time work and productivity project involved the systematic review of research evidence and the use of the 2022 Annual Population Survey (APS) to explore the characteristics of part-time employment in the UK.

The research project on digital presenteeism and cultural norms utilised data from the UK Survey of Working Arrangements and Attitudes (SWAA-UK) (Aksoy et al., 2022). The SWAA-UK surveys working-age adults in the UK who earned at least £10,000 in 2019, with data collected monthly from January 2021-to August 2024 and quarterly from Sept 2024 onwards. Each wave includes around 2,000 respondents. Focusing on full-time employees, representative samples were drawn from the September 2024, December 2024, and June 2025 datasets, together with a pooled sample of respondents, combining those who answered workplace-culture items in December 2024 and all respondents from June 2025.

The study of ethnic and gender intersectional inequalities in access to work from home (WFH) arrangements analysed a repeated cross-sectional dataset of employees derived from the 2017-2023 spring quarters of the UK Labour Force Survey, providing about 220,000 observations. The final study examined flexibility stigma, gender and racial biases, and how digital presenteeism may potentially help overcome biases by employing an experimental vignette study.

Taking a qualitative approach, a comparative case study was designed to examine flexible labour practices and technology adoption within the food manufacturing sector. Eight food manufacturing organisations were purposively sampled to capture variation in product specifications to reflect the complex ways in which production processes and market position influence practices of flexible labour and technology adoption, thereby enabling cross-case comparison and the identification of sectoral patterns. Data were collected through a combination of semi-structured qualitative interviews and ethnographic visits to the case production sites. A total of 53 interviews were conducted with 47 individuals working within the sector; including managers across Operations, HR, Technical and IT functions in the case study organisations, but also including managers of other non-case organisations and representatives from companies which build, supply and support technology in the sector.

Chapter 3. Skill Demands and Supplies: Findings and Analysis

Skill mismatch

The UK labour market has exhibited some controversial trends over the past few decades. On the one hand, employment has steadily increased since 2011, unemployment rates have remained consistently low in several regions, and the proportion of graduates has nearly doubled compared to the early 2000s. On the other hand, significant challenges persist, including widespread skill shortages in many occupations, low worker mobility across regions and sectors, and a substantial proportion of employees in mismatched roles (Joyce et al., 2022).

Labour skill mismatch can take various forms. This includes overskilling or overeducation where workers have more qualifications than their roles require but might also involve underskilling with workers asked to perform tasks which do not align with their skill sets. Both reduce productivity as firms fail to fully leverage their workforce's potential or high-value tasks being performed sub-optimally.

Vecchi et al. (2023) use ONS data to examine educational mismatches among highly qualified individuals, revealing that one-third of UK graduates are employed in non-graduate roles (known as vertical mismatch), while another one-third hold jobs for which their degrees are poorly suited (known as horizontal mismatch). Overeducation has consequences primarily for the workers themselves. The extensive literature on this topic suggests these workers earn lower wages compared to what they would receive in roles suited to their skills, and these lower costs compensate firms, to some extent, for their lower productivity. However, arguably, undereducation or skill shortages have the greater impact on productivity as they may prevent firms from adopting new technologies or innovating more generally.

Stansbury et al. (2023) show that the ratio of wages of graduates to those whose highest qualification is A-levels has been declining in all regions of the UK, except for London. They conclude from this that the expansion of higher education has helped alleviate the prior scarcity of graduate skills relative to demand. However, when they examine STEM (Science, Technology, Engineering and Mathematics) skills, they find that the wage premium for university-level STEM skills has hardly fallen – and even, in some regions, has risen, at a time when STEM attainment has been rising rapidly Vignoles et al. (2011). This suggests demand for STEM skills among graduates appears to have risen as fast as supply. Therefore, a general trend in overeducation due to supply of graduates outstripping demand, can co-exist with shortages for particular types of skills.

Evaluating the extent of skill mismatches requires some method to distinguish between job or task requirements and the skills possessed by the individuals undertaking these tasks. Use of microdata can measure these mismatches using definitions of the skills or educational requirements by tasks or worker's self-assessment of educational requirements, but these data are rarely available. A more commonly used method uses aggregate data, calculating an average education level across a range of occupations, and classifies an employee as overeducated if

their education departs from this using some statistical criteria. For example, Vecchi et al (2021) use data from the UK Labour Force Survey to identify graduates who are overqualified or underqualified for their jobs based on their level of education and the skills required for their occupations. They also examine the extent to which graduates are working in jobs that do not require a degree or that are unrelated to their field of study. Many studies base their analysis of skill mismatch by inferring this based on relative wages, as in the Stansbury et al. (2023) paper. We now turn to research carried out for TPI that has relative wages at its heart.

Graduates and skill biased technical change.

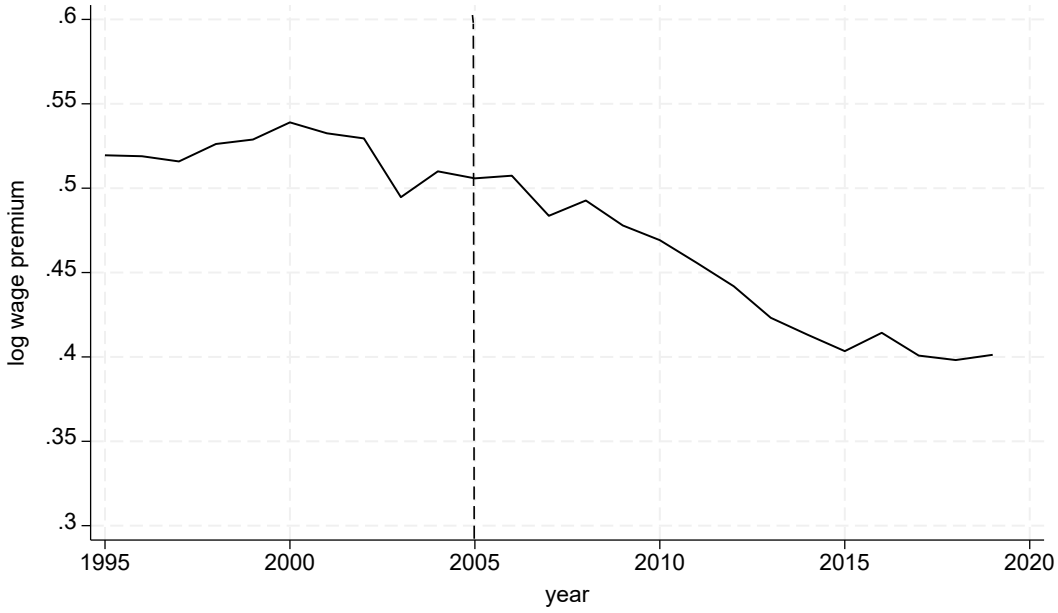
Economists use information on the relative payments to various types of workers to try to separate out the influences of firms' demands for particular skills and the supply of these skills coming from education and training. This in turn is used to gain information on the operation of labour markets and the impacts of skills on productivity. Much of the research in this area makes use of the ratio of average graduate pay to average non graduate pay, known as the graduate wage premium. Over the period 1995 to 2019, graduates earned, on average, about 80- 90% more than non-graduates in the UK, the US and in many European countries.

The graduate wage premium increased during the 1980s and 1990s in several western countries which was linked to the first wave of information and communication technologies (Autor, Katz and Kruger, 1998; Machin and Van Reenen, 1998). These technologies raised the demand for highly educated labour faster than its supply, a phenomenon known as skill biased technical change. However, since the global financial crisis in 2007, the trend in the skill wage premium has flattened in the US (Beaudry et al. 2016), and reversed in many European countries (Green and Henseke 2021). This is despite technological advancements due to a new wave of digital technologies.

In addition to the development of digital technologies, there has been increasing recognition of the importance of intangible assets in the production of goods and services (Corrado, Hulten and Sichel 2009; Haskel and Westlake 2018). Intangibles include activities like R&D, which have been typically related to skill upgrading (Machin and Van Reenen 1998) and organisational changes, which complement ICT technologies (Bresnahan, Brynjolfsson and Hitt 2002). In addition, the move from a centralised organisational structure towards higher decentralisation and more flexible work arrangements, have been found to favour high skilled labour in what has been defined as skill biased organisational change (Blundell et al. 2022). This highlights the importance of accounting for the role of both digital technologies next to other innovative activities and organisational changes in the study of the skill wage premium.

In research carried out for TPI, O'Mahony, Robinson and Vecchi (2026), revisited the empirical evidence on skill biased technical change. Using Industry data from EU KLEMS the authors showed that the wage premium declined since the mid-2000s, averaged across industries and countries (see Figure 3.1). This decline occurred in all major European countries, and all industries. In the US there was a flattening of the premium rather than an absolute decline.

Figure 3.1: Mean wage premium of high skilled workers, 1995-2019

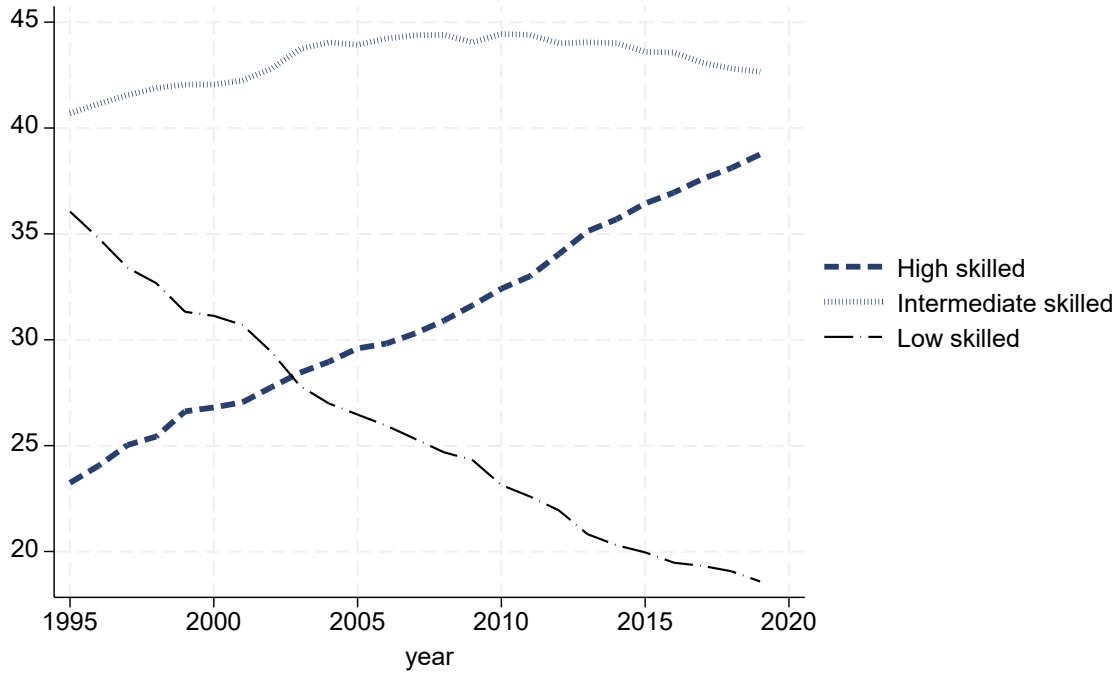


Source: calculations using data from EUKLEMS & INTANProd (https://euklems-intanprod-llee.luiss.it/).

Using the EU KLEMS industry by country data, O'Mahony et al. (2026) ask if skill bias associated with new technologies continues to hold after the financial crisis. In general, the extent to which the demand effect dominates the supply effect will determine whether the wage premium for the high skilled continues to grow. This idea underpins the models presented by Acemoglu and Autor (2011) and Autor et al (2020), capturing the race between education and technology and this model is used as the framework in O'Mahony et al. (2026). They estimate the supply effects and the extent to which demand effects are influenced by ICT capital and intangible capital, dividing the latter into innovative property (R&D, design etc.) and economic competencies (brand, organisational capital and firm provided training).

In their data high skilled labour has been growing rapidly, as illustrated in Figure 3.2, largely at the expense of the low skilled with intermediate skill shares relatively stable. Their econometric results show significantly negative impacts of the growing supply of graduates on the wage premia. These estimates tend to imply a greater elasticity of substitution between graduates and other workers than in the previous literature, mostly US based.

Figure 3.2: Average employment shares for different types of workers (%)



Notes: Calculations for the total sample. Source: EUKLEMS & INTANProd. (https://euklems-intanprod-llee.luiss.it/).

Turning to the technology indicators that impact demand, the authors show that digital technologies, captured by the ratio of ICT over total capital assets are always positive and significant, revealing complementarity between this technological asset and high skilled labour. In addition, this skill biased technological change intensifies in more recent years. Regarding intangibles, economic competencies also increase demand but the coefficient on innovative properties is negative, although insignificant. This negative effect may be explained by the fact that these investments lead to the introduction of new technologies that are substituting for 'abstract' skills, as documented in vom Lehn (2018). The diffusion of AI, is replacing not only routine repetitive tasks but also cognitive tasks typically associated with tertiary education. To better understand this, the authors divide their sample into AI creating and AI using sectors, using a typology developed by the OECD (Calvino et al., 2024 based on Baruffaldi et al., 2020). O'Mahony et al. (2026) find that in the most innovative sectors – AI creating industries - innovative properties strongly complement skilled labour, and the effect intensifies after 2005. In the rest of the economy the two assets that drive the wage premium are ICT and economic competencies. Overall, their analysis concludes that technology continues to be skill biased. In addition, given that economic competencies include investments in organisational capital that complement new technologies, their evidence provides some support to the assumption of skill biased organisational change, as discussed in Blundell et al. (2022), but only in AI-users sectors. Hence, distinguishing between AI creative and AI users allowed effectively capturing differences in the way technology and skill demand interact with wages.

Given the complementarities between technology and the demand for skills, supply factors must act as the main driver of the declining wage premium across the board. Although holding a degree still correlates with higher earnings, this advantage has diminished over time, particularly since 2005. This may be due to a skill downgrading trend, whereby high skilled graduates are moving into lower skilled and lower paid occupations. It might also reflect declining abilities of the average graduate, as universities enrol more people with lower grades, although this claim is quite contentious.

Regional Skill Demand and Supply

Skills versus qualifications

So far we have looked at qualifications as a proxy for skills but this raises the question of how good a proxy. Skills can be defined as a vector of the different abilities needed to perform specific job tasks (Autor et al., 2003). Skills can be specific, such as developing software or more generic such as effective leadership and communication. Using data from job advertisement platforms, O'Mahony et al. (2026) develop measures of digital skills demands by firms and describe how they vary across UK local regions, taken as Travel to Work Areas (TTWA), a measure of local labour markets. This paper also describes industry differences in digital skills, focusing on the strategic sectors identified by the government as areas of potential high growth. In a companion paper, De Coulon et al. (2026) use administrative data to measure the supply of skills coming from education in local areas and combine these with the demand side data to get a picture of the extent of skill mismatches across regions.

Much of the previous literature on measuring digital skills is broad based, outlining competencies and proficiency levels and linking to particular types of qualifications, often based on a broad range of data sources and expert advice. In O'Mahony et al. (2026) the authors use the keywords available in the Lightcast data to examine demand for the technical skills required for digital technologies, which they call digital technical skills.

The Lightcast data distinguishes about 28,000 skill keywords that appeared in at least one job advert in the time period considered. They are a mix of specific knowledge such as the Salesforce software packages or International Financial Reporting Standards; tasks such as Database Administration; and generic skills such as Leadership. Lightcast divides these skills into Software skills (approx 6,700 keywords), Specialised skills (about 19,000 excluding Software) and General skills (about 2,500 in addition to Software and Specialised). In this paper, the authors define digital technical skills based on the list of Software skills and some Specialised skills keywords, giving approximately 8,000 keywords. They then divide digital technical skills into three groups, namely advanced, intermediate and basic skills. Advanced are those that involve knowledge of programming language, artificial intelligence or data science, which facilitate change and innovation in firms. Intermediate skills are those that involve employing standard software packages in business processes but do not require any knowledge of programming, or advanced statistics, or mathematics. The Basic skills category covers a limited number of keywords such as Microsoft Office which are required for a broad range of tasks.

The data were classified into the above three categories using information on the keywords that appeared in IT, Engineering and Research Occupations and manual examination of the keywords, searching for particular words or phrases. For advanced skills these included words such as scripting, SQL, Java, etc. in the software category and the use of AI, Machine Learning, Large Language Models and Data Science and their associated mathematical and statistical skills in

the specialised skills category. Intermediate skills were based on phrases such as customer relationship management (CRM), enterprise resource planning (ERP) and accounting and auditing, and basic skills were those which are widely used and/or require low levels of technical knowledge such as Microsoft Office, Google Docs and Zoom.

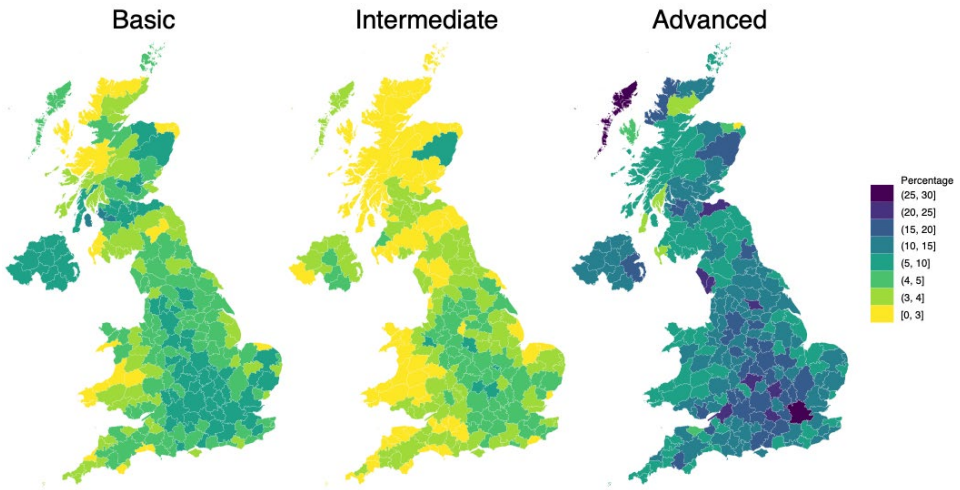
Once the keywords were classified to the three groups, the authors used a number of methods based on keyword occurrence to allocate job adverts to the three groups plus a fourth residual group of adverts that required no digital technical skills. On average, across the sample period about 30% of job adverts required digital technical skills. The shares of Intermediate and Basic digital technical skills in total adverts showed steady increases over time but the share of Advanced digital technical skills was more variable, showing a pronounced rise over the period affected by the Covid-19 pandemic and a large fall in the final three years. AI related skills increased throughout, but these represented only a very small share of total Advanced skills (less than 1% of job adverts).

The Demand for Digital Technical Skills.

The first main finding from this analysis was that Advanced digital technical skills were very concentrated around the London, Oxford and Cambridge areas, generally known as the Golden Triangle (see Figure 3.3). There were also high shares of Advanced in areas dominated by particular industries such as Leamington Spa, the Centre of the UK Games industry and Barrow in Furness. Home to BAE Systems. The share of Advanced skills was also relatively high in major cities such as Birmingham, Manchester, Edinburgh and Belfast. It was also high in some remote areas such as the Scottish Islands, but this reflected the very small number of jobs advertised online in these areas.

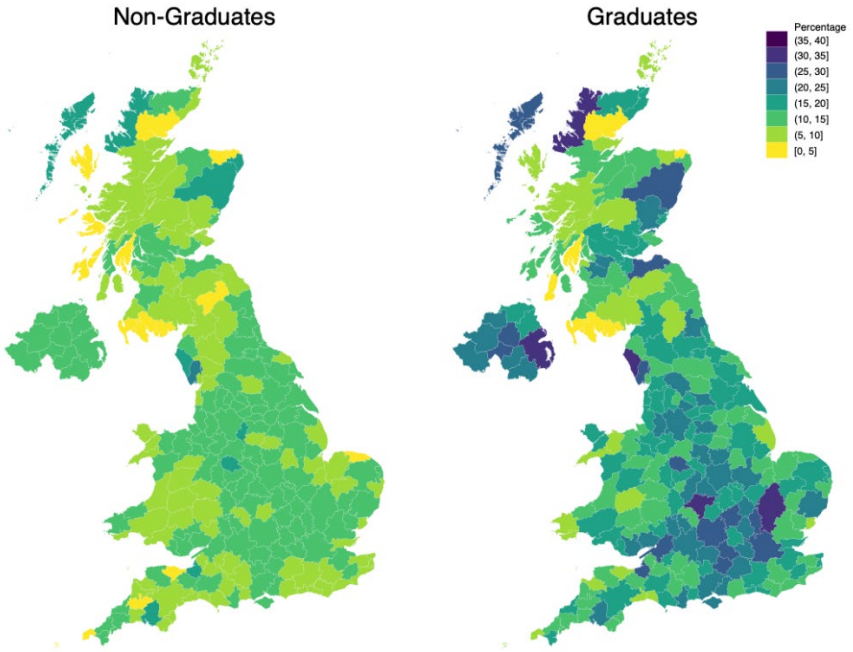
In contrast the share of intermediate and Basic skills were much smaller but spread out more across the country, with Basic skills the least concentrated.

Figure 3.3. Shares of digital technical skills in job adverts by region, average 2023-25.



O'Mahony et al. (2026) also divided advanced skills into graduates and non-graduates for the about 40% of the sample where education could be identified (shown in Figure 3.4). This shows an even greater concentration of demand for graduates in the golden triangle areas whereas demand for graduates with these skills are more spread out. This suggests that firms outside the golden triangle are willing to hire non-graduates with these advanced skills to make up for shortfalls. Finally, the demand for AI related skills are even more concentrated in the golden triangle, although they represent small shares of total adverts.

Figure 3.4. Share of Advanced digital technical skills.



Some of the variation across regions are likely to reflect industry concentration, such as the high digital skill requirements in the financial services and information technology sectors that tend to be concentrated in the South. However, industry composition is not the whole story. The authors calculated expected shares in each TTWA based on their industry composition and shares of digital technical skills for the total UK by industry. The golden triangle areas tended to advertise for more advanced skills than would be expected given their industrial structure while many smaller cities and rural areas showed the opposite pattern.

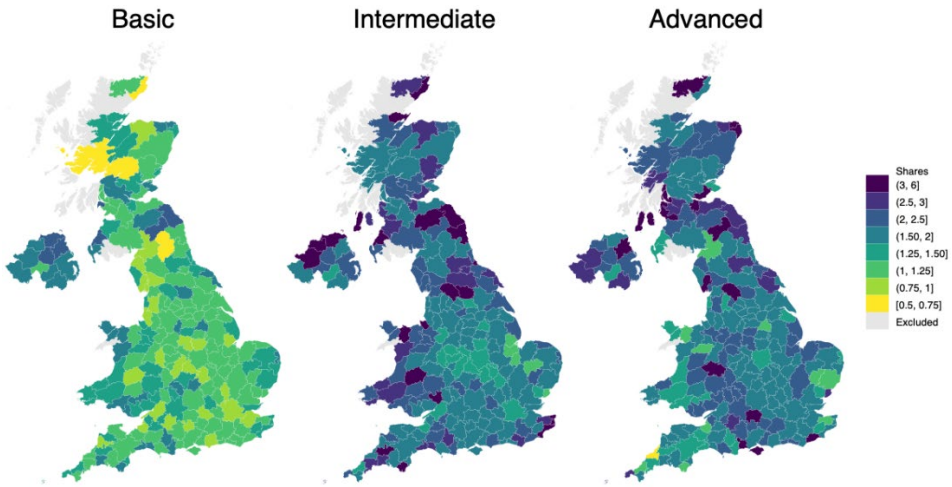
The authors then looked specifically at the sectors identified in the government's Industrial Strategy as key for growth[7]. These sectors Advanced Manufacturing; Clean Energy Industries; Creative Industries; Defence; Digital and Technologies; Financial Services; Life Sciences; and Professional and Business Services. The Department for Business and Trade (DBT) developed a Standard Industrial Classification[8] for seven of these sectors, plus 'frontier sectors' within these SIC codes, enabling matching with the Lightcast data. However Clean Energy Industries cut

[7] https://www.gov.uk/government/publications/industrial-strategy
[8] https://www.gov.uk/government/publications/industrial-strategy/industrial-strategy-sector-definitions-list

across too many SIC groups to be identified on this basis. In addition, only part of the Defence sector matches SIC codes.

The shares of advanced skills are much higher for IS sectors, and even more so for IS frontier sectors, than for other industries but shows a similar decline in the final few years. Intermediate skill shares are also greater in IS total and Frontier sectors but basic skills seem equally in demand in total IS sectors as in other industries. However, IS frontier sectors have significantly higher shares of basic skills, especially towards the end of the period. Therefore, all three types of digital technical skills are important in these sectors. There is variation within the IS total, with Defence and Digital and Technologies having the highest shares of Advanced skills, but all subsectors and frontier sectors individual show high demand for these types of skills. Looking across regions, Figure 3.5 shows the ratio of shares of digital technical skills in IS sectors relative to other sectors. This shows a remarkable uniformity. For advanced skills all bar one TTWA, and for intermediate skills all TTWAs show shares higher in IS sectors. Even for basic skills the majority of TTWAs (86%) show higher shares in IS sectors.

Figure 3.5 Share of skills in IS Sectors relative to Other Industries, average 2020-25



Digital Skills Supplies by Region

De Coulon et al. (2026) construct a set of measures of supply of digital skills arising from formal education by TTWA that can be loosely matched to the demand analysis reported above. This is only carried out for England, as LEO is not readily accessible for other countries of the UK, and up to 2019. The longitudinal structure of the LEO dataset allows following individuals as they progress through compulsory education and, if they remain in education, subsequently acquire higher-level skills through university or further education colleges. The authors base their measures on combining various levels of education, schooling to Key Stage 4 (GCSE), schooling to Key Stage 5 (A-levels), further education (FE) and higher education (HE). In any one year potential hires can come from all 4 levels. They also incorporate school test score results, and

assessments at degree and further education programmes to arrive at a measure that covers attainment rather than just attendance.

Since specific software and data analytic skills are not observable in LEO, the authors use a measure of STEM skills, incorporating subjects that develop mathematical, computational, science, and applied technical skills. To derive a measure of potential supply in a TTWA. It is also necessary to know if those completing their education remain in the region where they received their education or migrate to another region. The authors focus on migration of university graduates as previous research suggests that migration is concentrated in graduates. They construct two measures of migration, one based on where students are residing 18 months after graduation, since they had access to LEO data up to 2021. A second approach was to estimate net migration flows across regions for graduates, averaging across a number of years, as it may take more than 18 months before graduates settle in their final location.

The authors distinguish between two components, foundation and advanced skills. For the foundation skills index, comprising Key Stage 4 and Level 2 FE qualifications, they sum the raw number of students with digital technical skills within each TTWA, as these levels are broadly equivalent. For the advanced skills index, which includes A levels, FE colleges levels 3 and 4, undergraduate, and postgraduate education, they first calculate the proportion of students with digital technical skills at each educational stage within each TTWA, normalised by dividing by their respective mean values across all TTWAs. The normalised values are then combined into a weighted sum, with weights reflecting the relative labour market importance of each educational level based on aggregate UK earnings.

Figure 3.6 presents the normalised Foundation STEM skills across TTWAs, which captures compulsory and lower-level vocational education. Above-average foundational skill supply is observed in many areas of the South East, parts of the North West and the West Midlands. In contrast several rural and coastal regions and large parts of the North East, exhibit significantly below-average levels. These disparities suggest that while some regions succeed in equipping students with basic digital competencies, others lag even at the early stages of education, potentially limiting their future digital capacity.

Figure 3.6. Foundation STEM skills index

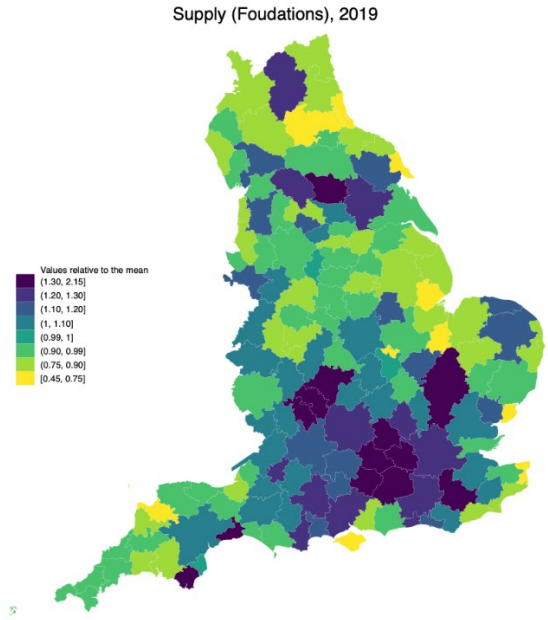
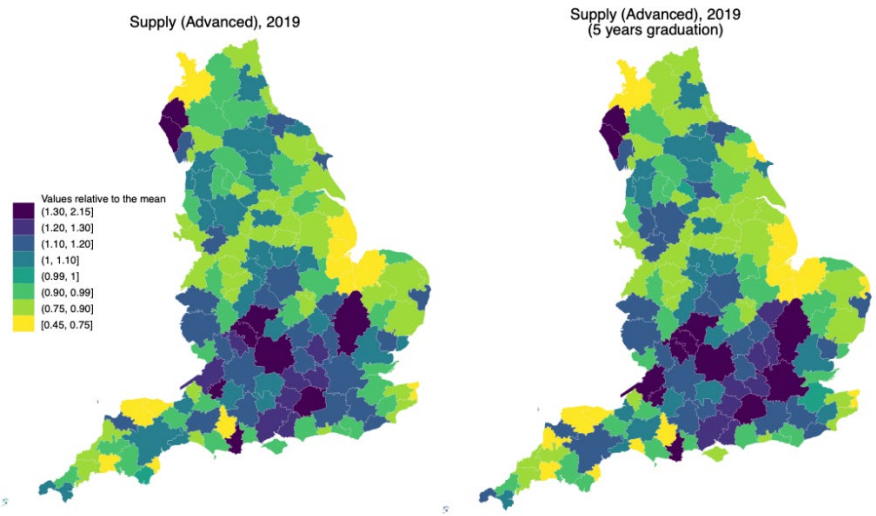


Figure 3.7 focuses on the advanced STEM skills index. The left-hand panel presents the same set of outcomes as the right-hand panel but measured 18 months after graduation, whereas the right-hand panel reports the corresponding proportions five years after graduation, incorporating the net probabilities of migration between TTWAs for both undergraduates and postgraduates. The regional distribution is more concentrated, with the highest values found in the Golden Triangle – London, Oxford, and Cambridge – as well as in parts of the West Midlands and Manchester. Conversely, much of the North East, Yorkshire, and East Midlands show below-average advanced in digital skills. These patterns highlight regional inequalities in access to and participation in higher-level digital education, as well as ability to attract university graduates, which may have long-term implications for local labour markets' ability to meet advanced digital skill demands.

Figure 3.7 Advanced STEM skills index.



De Coulon et al. (2026) bring together the demand and supply sides to get a picture of skill mismatch across regions. To this end, the demand and supply measures are each classified into three categories: low, medium, and high[9], allowing for a granular characterisation of local labour market conditions in digital skills.

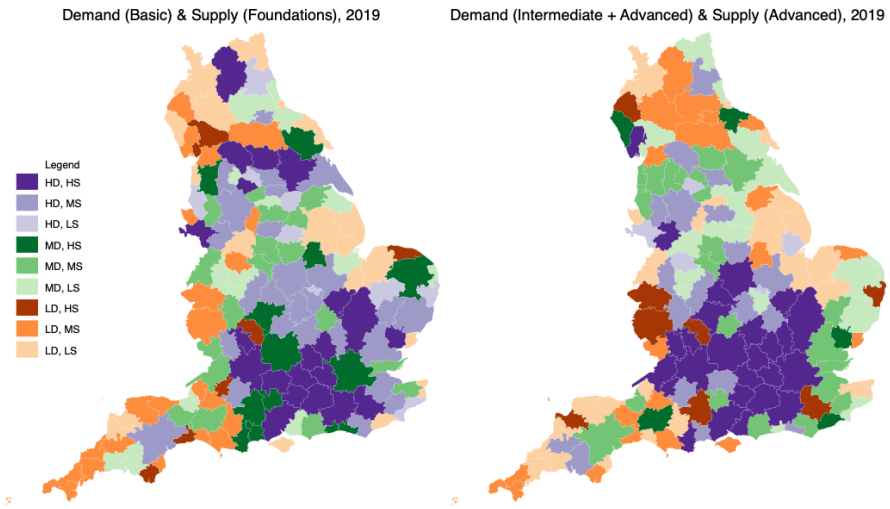
Two broad skill groupings are distinguished. First, basic skills are defined as the combination of demand for basic digital skills and the supply of foundation-level STEM skills. Secondly, advanced and intermediate skills are constructed by aggregating demand for advanced and intermediate-level skills, using relative wages as weights to reflect their different economic importance. This weighted demand measure is then combined with the supply of advanced STEM skills. Together, these constructions enable a structured assessment of mismatches and

[9] These categories are defined using thresholds based on a normalised index, where values below 0.9 are classified as low, values between 0.9 and 1.1 as medium, and values above 1.1 as high.

complementarities between the demand for and supply of digital technical skills across labour markets.

Figure 3.8 shows the results. For basic skills, regions with high demand and high supply (HD, HS) are relatively widespread, extending beyond London and the South East into parts of the Midlands and northern England. This suggests that foundational digital competencies are more evenly distributed across the country, supported by broader educational provision. In contrast, advanced skills exhibit sharper concentration, with HD-HS regions clustered in London, the South East, and the Oxford–Cambridge arc, alongside a few second-tier cities such as Manchester and York.

Figure 3.8



Skill shortages (HD, LS) are more pronounced for advanced skills, particularly in economically significant places like Nottingham, where strong employer demand is not matched by local educational output. For basic skills, shortages are less severe and appear in scattered pockets, indicating that entry-level digital capabilities are generally easier to meet locally. Conversely, underutilised talent pools (LD, HS) are more common in rural and peripheral areas. Finally, `left-behind'' areas (LD, LS) persist across both maps, particularly in the North, North East and parts of the Southwest, highlighting structural challenges that limit even foundational digital capacity. Overall, these patterns highlight that digital skills remain highly concentrated and subject to critical bottlenecks, in particular for advanced skills.

Green and Digital Transitions

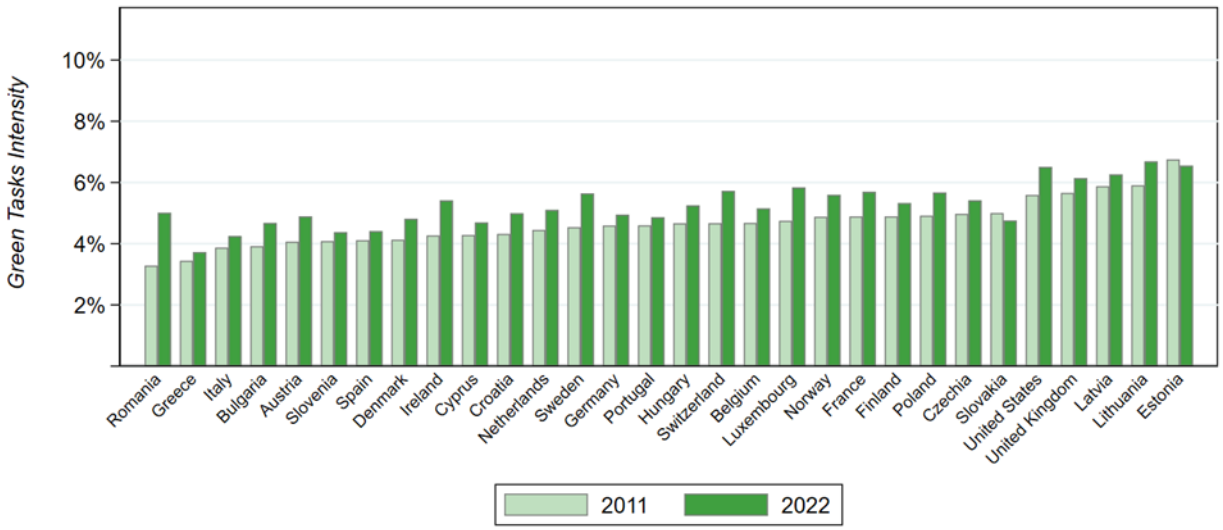
A parallel TPI project developed measures of digital and green skills across industries and countries (Smiderle et al. 2026). The Twin Transition, i.e. the simultaneous shift towards digitalisation and zero-carbon economies, is reshaping labour markets, requiring a better understanding of the intersection between digital skills and “green” occupations. This work presents a novel, harmonised dataset to analyse the Twin Transition and its impact on labour markets across 30 OECD countries. To quantify these dimensions, the authors compute two standardised indicators: 1) a green intensity index measured using a task-based approach from

the O*NET database, representing the share of green-specific tasks per occupation; 2) a digital intensity indicator estimated using a skill-based index from the ESCO database, and defined as the ratio of essential digital skills to total occupational skills required for an occupation.

The authors first attach these indicators to every occupation available in country labour force surveys, and then aggregate them using employment weights to get estimates at the industry and country level.

The empirical results reveal a strong positive correlation between greenness and digitalisation, though significant heterogeneity exists across industries and countries. Figure 3.9 shows the estimates of green tasks intensity across countries over time. While most countries experienced an increase from 2011 to 2022, growth rates were modest, and levels of green intensity were quite heterogenous, ranging from 3.7% in Greece to 6.7% in Lithuania, with the United Kingdom as well as the United States towards the top end. The authors greenness estimates are lower compared to other studies (Causa et al., 2024; Valero et al., 2021) but this is primarily due to their granular, task-based approach. Martin and Monahan (2022) found that in the UK in 2019, approximately 7% to 8% of total working hours were allocated to green tasks. Our estimates yield a slightly lower but comparable 6% green task intensity. The modest growth is in line with previous findings.

Figure 3.9. Green Skills Intensity Across Countries in 2011 and 2022



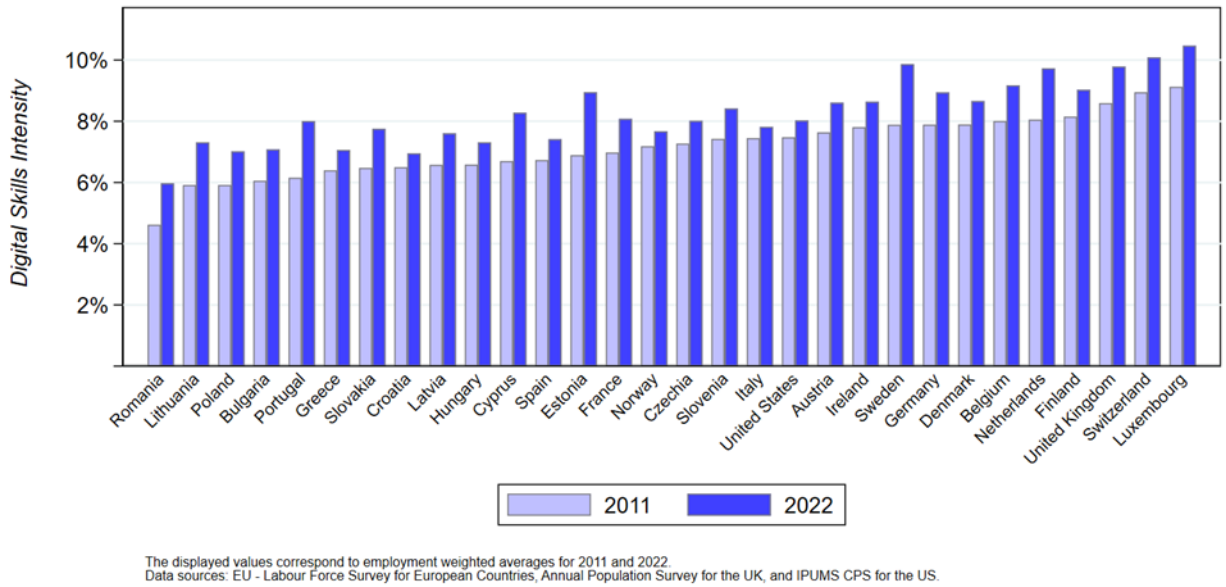
The displayed values correspond to employment weighted averages for 2011 and 2022.
Data sources: EU - Labour Force Survey for European Countries, Annual Population Survey for the UK, and IPUMS CPS for the US.

These country-level statistics mask substantial industrial heterogeneity. Green tasks intensity is higher in high-emitting industries such as Water and Waste Management, Construction, and Energy and Mining and Quarrying. The shift towards higher green employment is more pronounced in key industries such as Manufacturing and in Financial and Insurance Activities, for their potential to redirect capital and funding to renewable energy and sustainable initiatives.

The authors show a more substantial and rapid increase of digital skills intensity (Figure 3.10). Due to the time-invariant nature of their digital indicator, the authors cannot investigate how much the digital skills of the same occupation evolved over time but do capture structural shifts towards occupations with high digitalisation requirements. Since within occupation intensity of digital skills is likely to be an important channel of the digital transition, the growth in Figure 3.10

is likely to be an underestimate. Again, the United Kingdom is towards the top end and outperforms the United States.

Figure 3.10 – Digital Skills Intensity Across Countries in 2011 and 2022



The displayed values correspond to employment weighted averages for 2011 and 2022.
Data sources: EU - Labour Force Survey for European Countries, Annual Population Survey for the UK, and IPUMS CPS for the US.

Smiderle (2026) show a strong positive correlation between greenness and digitalisation across occupations. While the UK demonstrates a stronger green task intensity on average, the correlation between green tasks and digital skills, indicated by the slope of the fit line, is similar to that observed in European countries. Most UK industries, excluding the *Information and Communication* (J) sector, exhibit greater digital skill intensity than their European counterparts and generally show higher green task intensity as well. Notably, the *Professional, scientific and technical activities* (M) sector presents remarkably similar metrics for both areas. This industry's fusion of high digital skill requirements with significant green task content underscores its critical role in advancing technological innovation and sustainability.

Their analysis of the dynamics of greenness within UK industries shows that overall growth has been modest. This limited growth has primarily occurred in sectors that already had high green task intensity. At the same time they show a substantial rise in digital skills, predictably driven by the Information and Communication sector. Notably, a significant part of this digitalisation is happening within traditionally 'green' sectors like Water and waste management. This pattern suggests the Twin Transition is a two-way process: it involves not only greening digital industries but also leveraging technology to boost the dynamism and adaptability of established green sectors. The UK also shows a sustained increase in employment within the Professional, Scientific, and Technical Activities sector which combines the digital and the green dimensions into highly skilled jobs. This demonstrates a significant structural shift in the UK's labour force that is less evident elsewhere, positioning the UK as a leader in building a more skilled, sustainable, and growing economy.

The datasets developed by O'Mahony et al. (2026), De Coulon et al. (2026) and Smiderle (2026) offers insight into important labour market transformations of our time. They provide a critical

foundation for future research linking to productivity. The data are publicly available on the TPI productivity lab.

Soft Skills and Values

The research undertaken by the Institute for the Future of Work[10] highlights the need for soft skills such as communications, leadership and motivation in parallel with digital skills. O'Mahony et al. (2026) investigated co-occurrence of the more popular soft skills mentioned in job adverts with digital technical skills. Problem solving ability and leadership are more likely to appear in job adverts that require advanced digital skills whereas time management and team working are more required for intermediate and basic digital technical skills. However good communications and generic skills such as enthusiasm and motivation do not appear to vary across skill types. It is difficult to identify differences in these skill types using job platform data, as many job adverts contain these as standard requirements.

Another way to consider skills more generally is to look at the behaviours of individuals within the workforce that might affect productivity. In the TPI people research programme, one project focused on the question of mental health conditions among the workforce that might impact on individual productivity. Using nationally representative UK panel data, Luo et al. (2026) show that the youngest cohort, Gen Z faces a distinct psychological disadvantage in work. They are more pessimistic about their careers, more depressed at work, and less motivated to take up training than previous cohorts, even when compared at the same ages with Millennials.[11] The generational gaps remained after controlling for sociodemographic characteristics, general wellbeing indicators (e.g., overall depression and life satisfaction), and job characteristics, indicating unique generational differences in work-related depression that cannot be explained by broader mental health trends or by personal or job-related circumstances.

Luo et al. (2026) also mapped a broader set of potential antecedents and consequences of work-related mental health. Gen Z students were more pessimistic about their future careers and, after entering the workforce, were less motivated to take up training than Millennials. Importantly, individual-level analyses showed that those who felt more depressed about work were less likely to engage in upskilling, suggesting a self-reinforcing cycle in which poorer work-related mental health undermines the very training that could improve future opportunities.

These findings indicate that Gen Z's low workplace wellbeing reflects an interconnected pattern of pessimistic expectations, elevated work-related depression, and lower engagement with work. Thus, Gen Z's psychological difficulties may arise from the convergence of worsening economic conditions and labour-market pressures, making work more challenging than for previous generations and highlighting the need for society-level interventions.

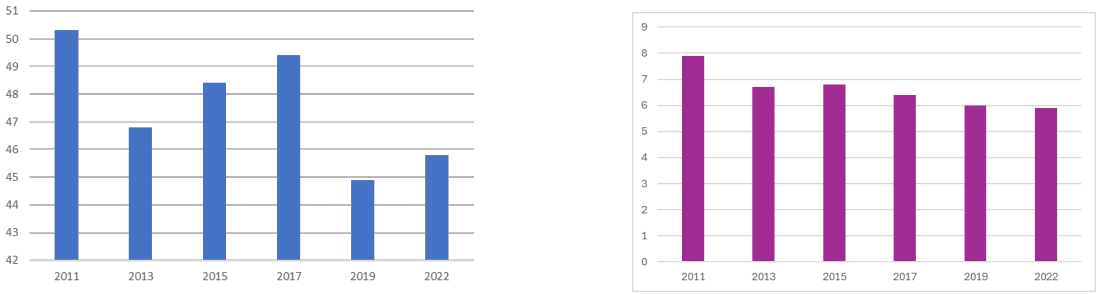
[10] https://www.ifow.org/

[11] Generation Z (Gen Z) are commonly defined as those born between 1995 and 2012 while Millennials are those born between 1980 and 1994.

Firm provided Training

The finding that training provided by UK firms has been falling over time is well documented in the research literature. The main source of information for much of this work is the employer skills survey (ESS). Figure 3.11 showing two measures amount spent on training by firms and number of hours trained from that survey - illustrates this shift.

Figure 3.11. Expenditure on training, £bn in 2022 prices and Average no. days per trainee, England.



Source: Employer Skills survey.

Unlike Germany or Sweden, where governments and industry coordinate to address skills gaps, the UK leaves training decisions largely to individual employers. In a recently published paper, Swartz et al. (2025) provide new evidence on how training investments translate into productivity gains at the firm level.

The authors analysed data on nearly 20,000 firm-year observations between 2011 and 2019. They tested how different types of training affect labour productivity, accounting for the possibility that more productive firms might simply be more likely to train. They highlight three major findings.

First, training intensity matters more than coverage. The conventional policy emphasis has often been on getting more workers into training. Their evidence suggests this misses the point.

Second, training expenditure per trainee, which captures the depth and quality of investment, generates substantially larger productivity effects than simply expanding the proportion of workers trained. A 20% increase in spending per staff member trained delivers 2% productivity gains. For managers, the same increase delivers 3.6% gains. Below 20% annual training coverage (If fewer than one in five staff are trained each year), expanding coverage without improving quality of the training can harm productivity. Poorly designed training disrupts work without building useful skills. Above this threshold, returns increase significantly. Firms gain most from deep, intensive training rather than spreading resources thinly.

Third, professional and technical staff yield the highest returns, generating gains of around 10.8% increase in productivity per 10 percentage point increase in coverage. This is nearly double the effect of general staff training. Yet only 23% of professional staff receive training each year, notably lower than other occupational groups. The productivity case for professional and mid-career development is substantially stronger than is commonly recognised.

Complementary investment in staff and managers amplifies effects. When firms invest in both manager and staff training together, the combined productivity impact exceeds individual effects by 20–25%. This reflects a fundamental organisational dynamic: Skilled managers are more

effective when they have trained staff to work with and trained staff are more productive under capable management. Conversely, one without the other generates substantially smaller returns. Managers cannot implement improved practices without skilled staff. Staff cannot use new skills effectively without capable management. Policies that target only one group will miss most of the available gains. The productivity returns documented by Swartz et al. (2026) suggest that strategic training investment represents one of the highest-return interventions available to raise UK productivity growth.

While firm provided training has generally been declined there is one aspect that bucks this trend, online training. According to the ESS, in 2022, 67% of training providing employers had funded or arranged online training in the previous 12 months, up from 51% in 2017. A CIPD report published in 2021 suggests that about 57% of firms used online training in 2021 compared to 29% in 2015. The highest growth in online training has been for IT and digital skills, and the report also finds that firms employing more than 250 workers are most likely to spend on online training.

There is a well known argument that firms will underinvest in general skills training as they lose the return if employees move to a rival firm. Digital skills tend to be generic rather than forms specific. Online training has two advantages over traditional training away from the office. First the cost of online courses are likely to be cheaper than face to face teaching, although the prices for good quality accredited course has been rising. Of more importance is that the opportunity cost is lower for firms as they do not lose their employees for long periods of time. Instead, employees can do training during slack periods or even in their own time, as they are the main beneficiaries. This is especially the case for smaller firms who frequently cannot spare their key workers to send them on in-person courses.

Barriers to online training identified in the CIPD report include the digital competence of instructors and the lack of information on quality of providers, especially for small firms. The online training market has become more concentrated in recent years with the growth of some large suppliers such as Udemy and LinkedIn Learning. Although market concentration brings its own issues, it does alleviate the quality issues, as these firms engage in extensive marketing and can pay their instructors well. However, the CIPD report also noted that learners with weak academic preparation and low income backgrounds gain less from online training, so this may not be a solution for providing more basic digital skills.

Chapter 4. How are skills changing with digital and AI technologies? A management and innovation perspective

Overview

Management and innovation research on the question of how skills are changing with AI and other digital technologies (hereafter DTs) probes complementary lines of enquiry viewed from an organisational and industry perspective (Grimshaw and Miozzo, 2026). It builds on three inter-related insights.

First, management research sheds light on key sources of agency - associated with the decisions and actions of management, entrepreneurs and workers. We know, for example, that in contexts where workers have few opportunities to proactively influence the design and implementation of DTs, the risk of skill automation is greater and opportunities to purposefully adapt skills lower (e.g., Heiland, 2021; Kellogg et al., 2020). Conversely, institutional rules that encourage worker agency in governance decisions favour positive skill outcomes (in terms of task complexity) and reduce the risk of automation (Belloc et al., 2022). Collective actions of workers aligned with a specific occupation or profession also steer skill change with DTs. HR managers, for example, may be able to realign their talent management skills by augmenting their workflow with digital HR analytics systems, or equally may be subjected to automation and diminution of professional skills, depending on context (Wiblen and Marler, 2021). Similarly, hospital managers may decide to establish a new career hierarchy with the adoption of new digital tools, disrupting traditional age-skill profiles of the medical profession (Kellogg et al., 2021). As such, human agency is a significant factor in shaping long-term patterns of skill change with DTs.

Second, management research deploys a broader 'organisational conceptualisation' of skill. This captures the measurable attributes of skill - related to the job (e.g. task complexity) and the individual (e.g., years of schooling). It also captures the relational attributes of skill – related to the social interdependence of job tasks, job roles and inter-occupational work organisation (Grimshaw and Miozzo, 2026). With this broader definition, investigation of how skills are changing with DTs can therefore consider the influence of an array of mediating factors, including organisational contingencies shaping demand for particular skills and the valuation of those skills, as well as contestation among management, workers and occupations regarding the nature and level of skill required for a task, role or function.

Third, management and innovation research pays close attention to the specific affordances of DTs and their implications for organisational and industry-wide change (Nambisan et al., 2019). Compared with previous information and communications technologies, DTs inject greater pace, uncertainty and turbulence in the nature of organisational change (Hanelt et al., 2021), product development (Cockburn et al., 2019) and industry structure (Sosa et al., 2025). In doing so, DTs make job and organisational design more malleable. This is significant because it opens up opportunities for managers and workers to exercise agency in reshaping skills for improved performance (Grimshaw and Miozzo, 2026). At the same time, however, the accelerating capacity of generative AI tools to incorporate human skills for contextual discretion and human meaning

(Cheong, 2024) challenges the likely slower pace of deliberative human-led change, especially where decisions arise out of highly institutionalised, collective forums for negotiation.

Building on these insights, management and innovation research investigates patterns of skill change associated with DTs via close scrutiny of the context - especially organisational, industry and institutional features. Furthermore, it reveals a rich diversity of mechanisms of skill change that challenge narrowly conceived skill change pathways of automation versus augmentation. These mechanisms generate skill and organisational performance outcomes that extend our understanding of skill changes related to task complexity, tacit knowledge and technology specificity. Table 4.1 summarises six distinctive skill change mechanisms and their associated skill outcomes.

Table 4.1 Summary of skill change mechanisms and outcomes with digital technologies

Skill change mechanism	Features	Skill outcomes
Replacing skills	• Using DTs instead of workers for routine, encodable tasks • Using DTs instead of workers for non-routine tasks	Displacement of jobs involving routine tasks (cognitive or manual skills) by DTs
Reallocating skills	• Investing in DTs triggers upgrading of skill demand • Investing in training, high-skill recruitment and high skill work organisation for DT application	Growth in jobs requiring non-routine problem-solving skills, creativity and complex communication for DT use and DT innovation
Sourcing skills	• Recruiting experienced workers with skills for DT use • Transferring skills among adopters of DTs • Recruiting workers with non-digital skills essential for DT use	Organisations foster worker mobility to bring firm-, technology- and industry-specific knowledge, integrating skills and tacit knowledge into new products, processes and services
Bridging skills	• Redeploying and integrating incumbent workers with analogue technology skills • Forging common ground for knowledge-building among workers with non-digital and digital skills • Using digital tools for collaboration and change among varied skill sets	Organisations engage in varied processes of recombination, bridging skills of old technologies with skills of new digital technologies, improving innovative performance
Realigning skills	• Adapting the range/depth of core skills among members of a single occupational groups • Repurposing DTs around skill realignment	Experimental learning through new patterns of work organisation involving DTs, enacted by individuals or a single collective occupational or functional group
Reconfiguring skills	• Coordinating skill changes with DT use over time involving new roles and responsibilities among multiple occupations • Contesting skill changes with DT use over time in multi-occupational teams	Skills co-evolve with DTs among social structures of work practices, marked by varied patterns of changing role jurisdictions, power relations and core skills

Source: adapted from Grimshaw and Miozzo (2026: table 1); DTs = digital technologies.

This chapter summaries the findings from the six management and innovation research projects described in chapter 2. We have adapted the original theoretical narrative of each project in order to enable a practical 'read-through' across the research evidence. In doing so, we framed each project around a generic 'context-mechanisms-outcomes' summary analysis to depict how skills

are changing with .[12] Context relates to technological, organisational, institutional and sectoral conditions. Mechanisms refer to one or more of the skill change mechanisms defined in Table 4.1 above. Outcomes capture change in skill and in aspects of performance (e.g., efficiency, innovation) of worker(s), management and organisations.

The UK's independent games industry: Bottom-up innovation, AI, and the changing architecture of work

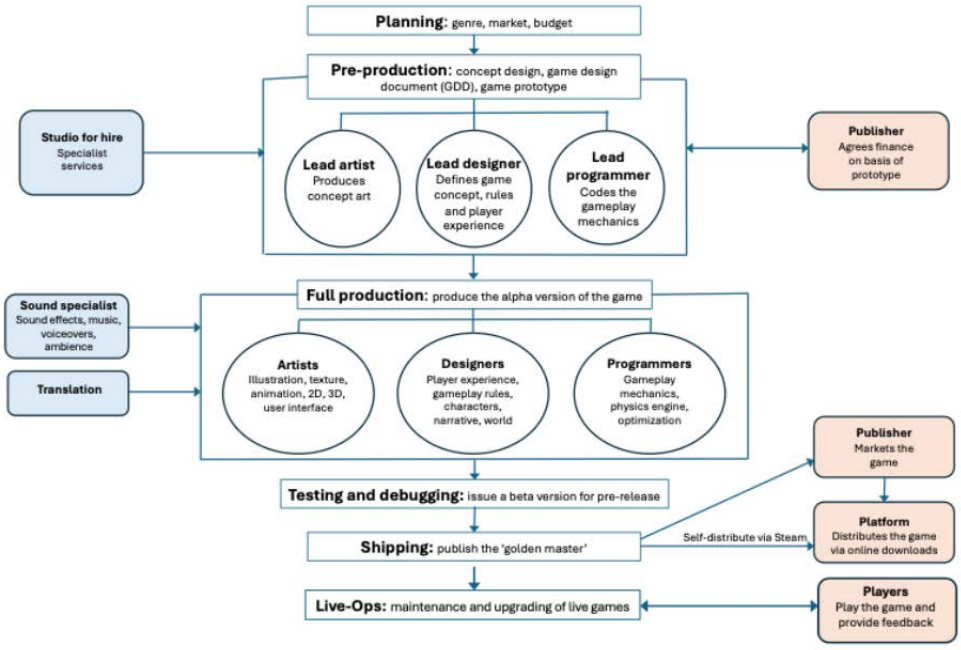
The UK's independent games industry was selected for research because its highly technical work and business processes, as well as the product itself, are highly exposed to AI substitution, placing at risk a large segment of high skilled and creative work. During 2024-26, the sector experienced a decline in employment, with many firms involved in this research making layoffs. Moreover, as the project authors argue, the nature of intense collaborative project work among interdisciplinary teams complicates the assessment of how tasks and job roles are being replaced or augmented (Grimshaw, Miozzo and Sosa, 2026).

Context. The independent games industry is differentiated from the mainstream ("AAA") games industry by committing to a distinctive purpose, referred to as a 'bootstrapping' development strategy. This involves a relatively small number of people in developing a game (up to 20), no external influence and limited publisher funding. Moreover, as other studies show, independent games studios grant creative autonomy to the workforce and tie company success to the fortune of their individual workers (Bowen Martin and Deuze, 2009; Lampel et al., 2000).

As the authors observe, the process of game development is a strongly collaborative endeavour among artists, designers and programmers who each draw on a different knowledge base to perform work. This feature has become standardised among independent game studios in the last two decades (Thompson et al., 2016), with increasingly specialised skills, strong interdependencies and mini-hierarchies that describe a chain of creative influence from higher to lower levels.

[12] We draw on the systematic literature review which applies this analytical categorisation to a large volume of interdisciplinary management studies (Grimshaw and Miozzo, 2026).

Figure 4.1. Production process and collaborative workflow in game development



Source: Grimshaw, Miozzo and Sosa (2026: Figure 1).

Moreover, the various assets of the industry (sound, graphics, code, etc.) are highly exposed to GenAI technologies and their benefits for speed and cost savings are considerable (Grimshaw, Miozzo and Sosa, 2026). On the one hand, the risk of legal challenges for copyright infringement and reputational damage from players has restrained independent studios from implementing a prescriptive GenAI strategy. On the other hand, AI-specialist firms are growing and extending their reach in the industry by advancing a plethora of GenAI toolkits. These industry features generate a strong potential for heterogeneity in use of GenAI in product development (substituting and augmenting human-created content) and, as the authors show, drive ripple effects across interdependencies of work within and between functions and firms.

Table 4.2. Summary of Context-Mechanisms-Outcomes for the Indie games research

Context	Mechanisms		Outcomes
Independent games industry	*Reallocating* and *Reconfiguring skills*:		Varied skill and performance outcomes:
i) Micro & SMEs i) Jobs decline (after strong expansion 2018-21) i) High exposure to AI, including GenAI tools for all game assets i) Collaborative workflows (art, design, code, sound, QA)	i) Reallocating skills by outsourcing low value-added work	⇒	Limited impact
	ii) Reconfiguring skills by displacing inhouse collaborative work	⇒	Reduced prospects for artists; reduced quality threshold for concept design
	iii) Reconfiguring skills by overlapping inhouse specialist tasks in a decentralised workflow	⇒	Faster production workflow; shared skill augmentation
	iv) Reallocating skills by outsourcing work to AI specialist firms	⇒	Enhanced game functionality and value-added, shifting skills and profits from studios to AI firms

Skill change mechanisms and outcomes. Grimshaw, Miozzo and Sosa's (2026) multi-level analysis identifies four categories of skill change associated with reallocating and reconfiguring job tasks and job roles within and between firms. First, AI implementation impacts work by expanding opportunities for games studios to outsource work to specialist suppliers. For example, sound assets previously developed inhouse have been universally reallocated to specialist suppliers. This practice has nevertheless not been disruptive to customary interdependencies of job tasks and roles, since the development of sound assets does not require close interactions with other functions. Nor has it affected the performance of games studios due to the low value-added of outsourced tasks. Moreover, in the absence of added functionality, suppliers have been unable to bargain for a large portion of profits.

Among job roles remaining within the games studio, the authors find that two further categories of skill change with GenAI are reconfiguring job roles - reducing interdependencies and enhancing firm performance, although with no obvious impact on the wider ecosystem distribution of value-added and profits. One category is displacing roles: lead designers use GenAI tools to advance concept design without collaborating with art and programming teams. This increases workflow and variety of pitches to management/funders yet reduces job prospects for artists. Another category consists of decentralised and uncoordinated use of GenAI tools among all technical functions that is characterised by overlapping of role jurisdictions: artists and designers independently use code-writing AI tools (e.g., CoPilot, Llama) to test art/design ideas, overlapping with programmers' tasks in collaborative production workflow; similarly, programmers independently use GenAI tools to undertake design and translation tasks. Unlike the category of reconfiguring/displacing roles, the reconfiguring/overlapping of tasks and activities results in a shared augmentation of skillsets and shared job prospects.

A fourth category involves outsourcing specialist tasks to an AI-specialist firm. The AI firm offers a relatively sophisticated input to the studio with greater value-added and can claim a significant share of game profits. Examples include AI plug-ins that generate non-repeating dialogue for non-playing characters (game characters not controlled by players). The added functionality means the AI plug-in delivers more value to game players than inhouse script writers. As a result, the authors argue that the AI-specialist firm can command higher earnings than the cost of the worker they replaced. Job prospects for highly skilled programmers extend to well-resourced AI-specialist firms, while those of artists and writers are stymied (Grimshaw, Miozzo and Sosa, 2026).

AI technologies at the BBC: A challenge for innovation management, learning and strategy making

In a second related project, D'Ippolito, Miozzo and Zhang (2025, 2026) furthered our collective investigation into the creative sector by securing access to the BBC, the UK's foremost media organisation. The authors completed a rich, detailed case study that improves our understanding of the penetration of AI and the challenges it poses for innovation management and strategy in this complex organisation.

Context. As other studies demonstrate, AI is increasingly framed not only as a productivity aid but as a participant in strategising. It can accelerate a shift to a faster design–validation loop where strategic ideas are rapidly prototyped and tested through experiments (Kohtamäki et al., 2025). Research suggests that AI can improve strategic cognitive processes. And while single, one-shot GenAI ratings might be noisy, the combining of multiple GenAI evaluations can yield more reliable assessments that closely align with expert judgement (e.g., Csaszar et al., 2024).

For a public-service, purpose-driven organisation like the BBC, the key question is not just whether GenAI works, but how its generativity (i.e., its capacity to trigger unprompted, audience-driven change) is harnessed, governed, and scaled in line with public-value commitments (D'Ippolito, Miozzo and Zhang, 2025). In this organisational context, the authors argue that digital transformation and changing skills are likely to interplay across three innovation domains:

1) Organisational innovation concerns new organisational designs. In purpose-driven settings, the emergence of cross-functional coordination roles and mechanisms that enable knowledge integration is particularly salient, allowing digital opportunities to be translated into accountable, legitimate actions (Waardenburg et al., 2022);
2) Process innovation refers to technology-enabled changes in how work is done, by reconfiguring production methods and the underlying information flows, coordination and routines. In services organisations, it typically unfolds via technical upgrades to core production/service processes and digitalisation and automation of back-office processes (Damanpour et al., 2009); and
3) Product innovation concerns the extent to which AI technologies ultimately translate into new or significantly improved offerings for end users. Regarding services, this means reshaping what is offered, how it is delivered, and how users interact with it via recombining AI and digital technologies (Ryu and Lee, 2018).

As such, analysis of how skills change with AI implementation in this organisational context needs to recognise aspects of acquisition, dissemination, and integration. In doing so, the authors' findings capture how new AI skills and expertise are i) sourced or developed, ii) spread beyond an expert core, and iii) embedded in routines so they can persist and scale. Skill acquisition concerns how organisations obtain new digital-transformation (AI-related) skills, either by bringing expertise from outside (e.g., hiring, partnering, contracting) or developing it internally through upskilling (Kulichyova et al., 2025). Skill dissemination captures how skills diffuse beyond an initial expert core across functions (Gorovaia et al., 2023). Skill integration refers to the embedding of AI skills into operational routines and services delivery, shaping how work is performed, rather than remaining as isolated pilots (Salunke et al., 2019).

Table 4.3. Summary of Context-Mechanisms-Outcomes for the BBC research

Context	Mechanisms		Outcomes
Purpose-driven organisations/ the BBC	*Sourcing* and *Bridging skills*:		Two-way coupling of skill and innovation outcomes:
i) AI technologies can be helpful for strategic cognitive processes and for expert decision-making i) AI implementation unfolds across three innovation domains: organisational innovation, product innovation and process innovation i) Skill development changes expected across aspects of acquisition, dissemination and integration	i) Sourcing skills via direct hiring into the BBC's GenAI Programme or apprenticeships	⇒	Increased job roles for individuals with AI skills and those seeking to train
	ii) Bridging skills via formal programme-led training and informal peer-to-peer sharing, paired with governance routines that retain accountability with people	⇒ ⇒	Diffusion of AI-related work practices and associated skills is uneven – a mix of structured and informal/unstructured patterns Multiple examples of innovations: GenAI Hub; new processes; and new product applications

Skill change mechanisms and outcomes. The authors' show that changes in innovation domains shape opportunities for changing skills (D'Ippolito, Miozzo and Zhang, 2025, 2026). Concerning organisational innovation, the BBC's GenAI transformation is organised centrally by a GenAI programme that combines two roles: providing hands-on support to divisions as they develop GenAI use cases; and shaping governance so that adoption stays safe and aligned with editorial policy.

A key organisational mechanism is a centrally managed, programme-wide use-case list, which identifies overlaps across divisions and actively connects units facing similar problems so that solutions can be reused.[13] This model is reinforced by enabling lead staff to hold decision rights, creating a distributed interface: divisions retain control and accountability, while the central programme gains a recurring coordination channel to surface issues, share learning, and reduce duplication. A concrete illustration is the use case 'image alt-text' for the presentation of visual data: the programme logged the work centrally, recognised it was relevant across multiple publishing teams (e.g., News, Sport), and then acted as a bridge so the solution could be rolled out beyond the originating unit.

Process innovations involve news/content workflows and controlled support tasks such as translation, transcription and summaries. Improvements are described by BBC interviewees as 'not massive' and limited by the BBC's low tolerance for 'scaled, unverified output in trust-critical news contexts'.[14] Examples include use of an AI-enabled approach for low-cost virtual production that combines computer-vision functions (e.g., tracking/positioning) with neural/generative rendering or scene-reconstruction to recreate location-like settings in the studio. As the authors document, this shifts some production work from travel- and location-dependent filming towards a studio setup, reducing location costs and making low-budget public-service productions more feasible to deliver. Also, the BBC developed an AI-based anonymisation technique used in filmed interviews to obscure a person's face while preserving facial expressions, to protect identity without altering content. Thus, elements of process automation are present but tentative, and stop short of re-engineering core work (D'Ippolito, Miozzo and Zhang, 2026).[15]

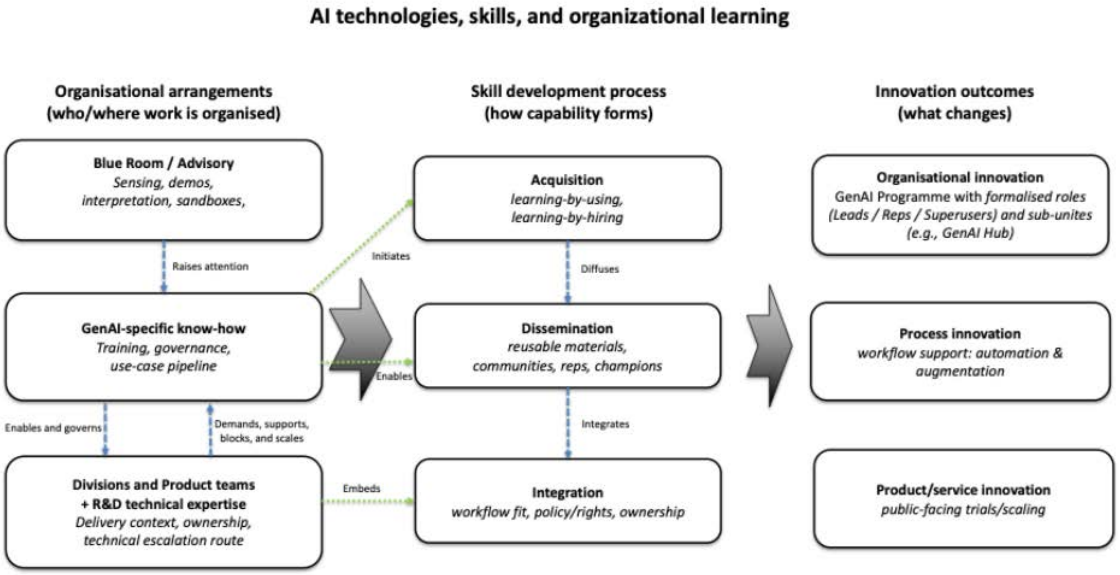
Concerning product innovation, the authors argue that the BBC has moved with caution in implementing GenAI to generate new service concepts, new delivery systems, and new user/audience interfaces. One prominent example is an education chatbot (Bitesize), described as having 'enormous potential' because a chatbot format is inherently scalable and can repackage existing content into more interactive learning. Nevertheless, the innovation is framed as exploratory rather than a mature rollout. A more developed innovation highlighted by the authors is 'My Club Daily,' which produces daily digests of football news for local clubs – something the BBC could not deliver before due to scale constraints.

Proactive skill development practices interact with these innovations (see Figure 4.2): the BBC is sourcing AI skills through hiring into the GenAI hub and utilising its apprenticeship pipelines, and also bridging skills by exposing staff to the use of AI tools and pilots. Two key organisational practices assist in bridging AI skills: a structured 'programme-led' route and an informal 'community-of-practice' route. In the GenAI programme, dissemination is intentionally engineered via recurring learning touchpoints (e.g., lunch and learns that scale participation), self-service online learning, and reusable artefacts (e.g., standardised prompt structures);

[13] Examples include alt-text generation for online images, audience-facing tools for summarising or rewriting content in accessible formats, and internal workflow automations for transcription, research support, and metadata tagging.
[14] Interview data (D'Ippolito et al., 2026).
[15] It is worth noting that Copilot is the most widely used tool. It is the licensed, permissible route for working with BBC proprietary information, and its use is procedurally bounded by editorial training requirements before access.

events such as '*AI Unpacked'* seek to mobilise wider staff participation. At the same time, the authors show that structured diffusion is resource-dependent: when AI reps are fully dedicated, pilots are more likely to spin out; when reps are overloaded, diffusion of skills to adopt a new AI tool remains thin.

Figure 4.2. AI technologies, skills and organisational learning at the BBC



Source: D'Ippolito, Miozzo and Zhang (2026).

Thus, organisational innovation (the BBC's GenAI programme) creates the conditions for skills to scale, supporting bridging of skills, yet durable transformation requires a stable 'receiving' unit that can operationalise the AI capabilities. This explains why skill development has accelerated process innovation but not so much product innovation because the latter requires sustained resources, deeper cross-functional capabilities, and clear end-to-end ownership (Figure 4.2).

Overall, the mechanism of bridging skills remains cautious and uneven. GenAI is still described by BBC interviewees as largely '*absent from active production workflows'*, with the clearest *'business as usual'* embedded traditional AI use being transcription for logging and findability (D'Ippolito, Miozzo and Zhang, 2026). While AI uptake is to some extent actively supported through centrally organised training and mobilisation, the evidence from this study does not reveal deep, end-to-end embedding into specific production and service routines at the BBC.

Digital technology adoption in manufacturing SMEs: Boosting productivity growth through ecosystem relationships

This TPI research project aimed to investigate digital adoption in the UK manufacturing sector with a focus on small and medium-sized enterprises (SMEs). Given their widely observed limited digital capabilities, the research team led by Vecciolini set out to understand how SMEs could benefit from collaborating with specialist technology providers to establish pathways for knowledge and technology transfer, boosting firm performance (Vecciolini, Miozzo, Grimshaw and He, 2026).

Context. Digital adoption in the UK remains uneven, particularly among SMEs in manufacturing, where cost, uncertainty over investment returns, and skills shortages (leadership and operational) remain the primary barriers to deeper digital engagement. Given these constraints,

SMEs often lack the internal capabilities to navigate digitalisation independently. Rapid technological advancement makes it inefficient for firms to build all capabilities in-house, highlighting the importance of business ecosystems where competitive advantage derives from inter-organisational collaboration and knowledge exchange.[16] For SMEs, collaboration with technology providers has therefore become an essential pathway for accessing complementary resources and transmitting codified digital knowledge into SMEs' practical, experiential knowledge bases (Simms and Frishammar, 2024).

Nevertheless, the ability to benefit from such partnerships varies. Barriers to effective knowledge transfer include knowledge stickiness, mismatches in absorptive capacity, and weak learning motivation or misaligned expectations (e.g., Lane et al., 2001; Si and Bruton, 2004; reviewed in Vecciolini, Miozzo, Grimshaw and He, 2026).

For the authors, a pivotal yet underexplored factor shaping learning and innovation outcomes is the knowledge dissimilarity between partners. Importantly, knowledge dissimilarity can both enable and constrain learning. Moderate dissimilarity can create learning complementarities, allowing technologically advanced partners to facilitate knowledge transfer to the less advanced partner through interaction, joint problem-solving and feedback loops (Wang et al., 2023). Yet when dissimilarity is high, excessive cognitive distance impedes mutual understanding and constrains the transfer of tacit knowledge, limiting the innovation potential of the relationship (Nooteboom et al., 2007).

Furthermore, the breadth and depth of relationship also mediate observed outcomes. Broad networks support technology scanning, while deep, trust-based relationships facilitate informal communication, reduce uncertainty, and enable effective knowledge assimilation (e.g., Messeni Petruzzelli et al., 2021). As such, embedded relationships help SMEs access and absorb knowledge transfer, and co-develop solutions tailored to their context (e.g., Bellandi et al., 2018). Understanding how SME firms with less advanced technological capabilities navigate and mitigate knowledge dissimilarities, shaped by embedded relationships, is therefore central to this project's aim to explain variation in their learning and innovation outcomes (Vecciolini, Miozzo, Grimshaw and He, 2026).

[16] Large firms exemplify this partnership model: e.g., Volkswagen's partnership with Microsoft to develop the Automotive Cloud (volkswagen-newsroom.com, 2018) and BMW's collaboration with Amazon Web Services to migrate systems, integrate generative AI, and manage global data infrastructure.

Table 4.4. Summary of Context-Mechanisms-Outcomes for the Manufacturing SMEs research

Context	Mechanisms		Outcomes
Manufacturing sector SMEs	*Sourcing* and *Bridging skills:*		Varied learning and innovation outcomes:
i) Uneven adoption of digital technologies among SMEs, especially in manufacturing i) Inter-organisational collaborations with DT firms important for knowledge transfer and innovation i) Knowledge dissimilarities between partner firms enable and hinder learning opportunities, shaped by embedded relationships	ii) Sourcing skills by adopting from a DT firm underestimates challenges of inter-organisational knowledge transfer processes	⇒	Knowledge transfer impeded by inadequate training; underutilisation of DT systems
	iii) Bridging skills by designing 'knowledge broker' job roles (digital fluency and analogue planning and communications skills) and by embedding the partnership in 'relational ties'	⇒	Improved learning outcomes; aligned DT upgrades with SME business needs

Skill change mechanisms and outcomes. The authors' findings reveal a bidirectional knowledge gap between manufacturing SMEs and DT providers, which shapes how technologies are adopted, used, and co-developed. In their arrangements to purchase DTs, many SMEs revealed limited digital literacy, which constrained their ability to understand, configure, or strategically exploit digital systems. DT suppliers consistently encounter clients with very basic comprehension of a platform's purpose or application. The open-ended and highly configurable nature of many digital platforms increases this burden, as SMEs must self-navigate complex systems without the structured guidance that larger firms often receive. This is reflected in SMEs' own accounts of long learning curves, and having to adopt standardised, off-the-shelf systems (rather than bespoke DTs) due to the challenges of learning (Vecciolini, Miozzo, Grimshaw and He, 2026).

A recurring problem observed by the authors is inadequate training provision, with some SMEs having to piece together knowledge by experimenting, using videos, and relying on help functions. This limited capability often leads SMEs to purchase unnecessary DT systems or underuse major features. Knowledge gaps are also organisational: some SMEs delegated digital systems to IT teams who lacked shopfloor insight, resulting in systems poorly integrated into operational workflows.

While knowledge dissimilarities were striking, the authors also observe a range of practices to bridge skill gaps and forge better learning outcomes. Some SMEs did invest in training provision and/or technical support. Also, some DT firms designed new 'knowledge broker' job roles, by assigning new relationship job tasks to specific staff (e.g., CTOs, customer success managers, business intelligence managers), creating trusted communication channels, enhancing responsiveness, and aligning DT upgrades with SME needs. For example, customer success managers facilitated ongoing usage optimisation, ensuring that SME clients continuously derived value from the system through scheduled interactions; also, implementation specialists provided early-stage guidance, linking business process analysis to technical training and configuration (Vecciolini, Miozzo, Grimshaw and He, 2026).

Analysis of SME-DT partnerships also demonstrated the significance of relational versus transactional ties in shaping the bridging of skills and SME performance outcomes. In relational

settings, SMEs and suppliers jointly addressed technical challenges, exploring options, refining prototypes, and iterating solutions. Examples include collaborations on proof-of-concepts related to data integration and usability improvements; continuous refinement prototypes for improved business solution fit. At their best, the authors argue that SMEs could act as 'design authorities', co-creating major product directions, such as driving the partner DT firm's development of algorithmic scheduling.

By contrast, transactional ties avoid customisation of DT systems and limit feedback channels. SMEs become passive users and neither request modifications nor actively engage with the DT firm's support systems, and often remain unaware of available functionalities. Some SMEs even experienced declining influence over time as DT firms grow and standardise the technology offer, reducing access to system back-ends or custom logic previously permitted. As the authors underline, this shift underscores how increased structural disparities can erode formerly relational dynamics (Vecciolini, Miozzo, Grimshaw and He, 2026).

Overall, this research demonstrates that the skills required for digital transformation extend beyond technical proficiency to include supply chain management capabilities and strategic planning. SMEs require foundational digital fluency among both managers and operators to reduce dependence on single 'super users' and build more resilient internal capabilities. Moreover, as the authors argue, the observed relational and transactional dynamics suggest that the relational quality of SME-DT supplier ties is a key determinant of whether digital tools are adopted strategically or simply used as standalone operational add-ons. Relational ties, supported by rich engagement and joint problem-solving, foster deeper alignment and more effective technology evolution, while transactional ties constrain influence, limit learning and the bridging of skills, and establish a more reactive approach to digital adoption.

Forging 'common ground' with AI technologies in the livestock sector

Extending TPI research into sectors that have not been investigated to the extent of manufacturing, original research by Grimshaw, Miozzo and Kyriakopoulos aimed to understand how new AI technologies in livestock farming are changing skills and the core business functions. The research is especially revealing in its investigation of how analogue, experiential modes of knowledge are bridged together with digital knowledge through efforts to forge 'common ground' (Grimshaw, Miozzo and Kyriakopoulos, 2026).

Context. With a shift towards 'precision farming' (or smart farming), livestock farmers are seeking to deploy new data-driven digital technologies (DDTs) to better inform a range of strategic and practical decisions. Designed and supplied by specialised suppliers (agritech companies), DDTs collect and analyse real-time data through a variety of electronic sensors and inform decisions concerning animal behaviour and welfare (e.g., early diagnosis of disease), livestock feeds and yields (e.g. automated data-based water supply), and environmental footprints (e.g., minimising land degradation through real-time, grazing data).

Examples of DDTs highlighted by the authors include automated robotic milking, activity monitoring collars (using GPS positional data), and herd management software (e.g., to monitor milking duration and milk flow rate). Farmers anticipate that adopting DDTs could bring positive effects for the welfare of their livestock, higher production yields, improved environmental sustainability, and benefits for labour management, including a reduced reliance on labour in a

context of recruitment difficulties (Grimshaw, Miozzo and Kyriakopoulos, 2026; see, also, Edwards et al., 2020).

While initially lacking in digital skills, farmers bring a great deal of accumulated (over generations) experiential and scientific knowledge and skills about the livestock farming business, especially aspects of animal welfare and production yields. A farmer's tacit knowledge is typically acquired over years of attentive livestock management and experience in rearing and caring for animals, and will likely remain central to the work of livestock farming. In addition, farmers routinely seek advice from veterinary specialists to monitor and diagnose animal health and general welfare.

A further key aspect of context is that livestock farmers in the UK work in a state of constant vigilance (see Table 4.5). This concerns animal welfare: animals become ill, escape, or become distressed with little warning, and farmers rely on deep tacit knowledge to recognise, and react to, behavioural changes. Vigilance also concerns financial investments: UK livestock farms tend to be small[17] and operate with tight profit margins in internationally competitive markets, meaning even small financial losses can have serious consequences. Many farms have been in the same family for generations, so farmers act with a strong sense of shared inter-generational history and forward-planning. Vigilance thus frames attitudes towards, and investments in, new technologies. It also prevails in a wider context of protective regulations. These centre around the Animal Welfare Act (2006) and include the Welfare of Farmed Animals Regulations (2007) and the Mutilations Regulations (2007).

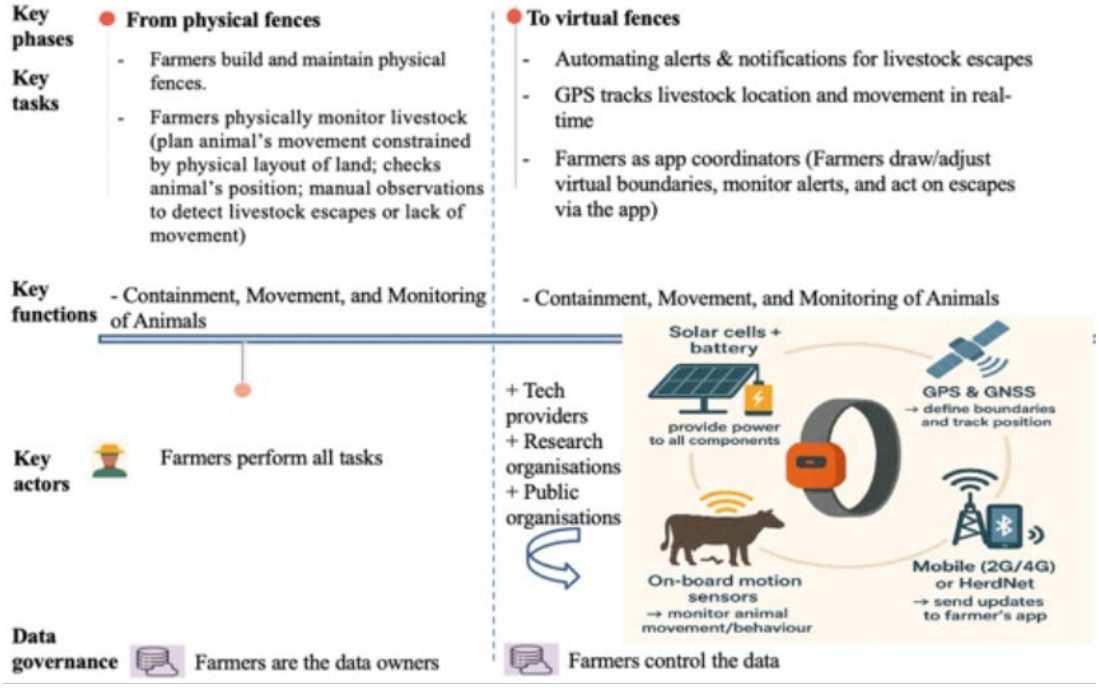
Table 4.5 Summary of Context-Mechanisms-Outcomes for the Livestock farming research

Context	Mechanisms	Outcomes
Agriculture/ livestock farming	*Bridging* and *Realigning skills*:	New interrogative capabilities requiring digital skills and valuable livestock experiential/tacit knowledge
i) Precision farming requires data-driven digital technologies (DDTs), designed and supplied by a vibrant 'agritech' sector i) Livestock farmers draw on their cumulative, experiential and scientific farming knowledge i) Farm businesses are characterised by a state of constant vigilance (concerning their animal welfare, financial investments, product market competition) bounded by governmental animal welfare regulations	i) *Bridging skills* by comparing initial experiences with DDTs with networked farms and specialist advisors	⇒ Acquisition of technology-specific skills required to trust full application of DDTs
	ii) *Realigning skills* by reducing physical and observational labour and increasing digital labour	⇒ New digital skills required to perform digital labour effectively
	iii) *Bridging skills* by learning how to augment experiential knowledge with digital cues for precision livestock farming	⇒ Augmented digital-experiential skills, but new business risks (false digital signals) restrained a full shift to digital knowledge mode and sustained the value of tacit knowledge

[17] The agricultural sector contributed £7.7 billion to total UK GDP in 2024 with a workforce of close to 300,000. Nearly half (47%) of all English farm holdings are dairy and grazing livestock farms. Average farm business income for these farms is relatively small: dairy farms registered £150,000 and grazing livestock farms £70,000 (England, 2024-25) (DEFRA data).

Skill change mechanisms and outcomes. The authors show that changes in skills occurred in phases, from pre-implementation of the specific DDT to early experimentation and full application. The project tracked these changes through detailed investigation of three cases of DDTs in detail: virtual fencing; digital twins; and AI monitoring. For reasons of space, we report the evidence for virtual fencing only (Figure 4.3). Commercialised in 2021 in the UK, virtual fencing consists of a solar-powered GPS collar for livestock (cattle, sheep, goats) and a mobile app that enables farmers to define and manage virtual grazing boundaries, providing real-time data on livestock movements. There are currently over 140 farm users of the technology in the UK and uptake is increasing.

Figure 4.3 Illustration of Virtual Fencing digital technology



Source: Grimshaw, Miozzo and Kyriakopoulos (2026).

During their initial experimentation with new virtual fencing technologies, the research shows how livestock farmers sought to bridge the skill gap by sharing their experiences with other farms, as well as with specialist advisors. In doing so, the authors contend that they were able to engage in trusted processes of learning about the DDT and, if necessary, gained the knowledge required to recalibrate their expectations and the value proposition of the new technology prior to its full application.

During this next phase, farmers realigned their core job tasks and activities as they became more familiar with working with the DDTs. As well as removing the need to build and maintain physical fencing for their livestock, continuous real-time GPS tracking of the animals in principle freed farmers from frequent on-site monitoring and supervision. Instead, they developed new skills in the interpretation of digital cues – e.g., learning to read digital outputs, or identifying technology failures (e.g., battery status, error codes, GPS accuracy, connectivity signals). In doing so, the authors document how farmers adopted new tasks (and learned the requisite skills) associated with remote DDT livestock monitoring and control: checking and fixing GPS collars; responding to error codes; and performing software updates. Moreover, i*n* realigning their activities, farm owners also delegated specific DDT tasks, generating a new division of labour among family members and casual labourers (Grimshaw, Miozzo and Kyriakopoulos, 2026).

During the mature phase of full application of DDTs, the authors find that farmers experienced both complementarities and tensions in the bridging of analogue and digital modes of knowledge, which informed their day-to-day business decisions. On the one hand, farmers found that the digital cues often complemented and augmented their experiential knowledge and equally that their tacit knowledge was foundational in interpreting and acting on the digital signals. Examples include using the precise animal movement data to inform decisions about boundary adjustments, land management (avoiding over-grazing and environmental damage), or when to intervene to safeguard animal welfare (e.g., evidence of predators).

On the other hand, farmers remained vigilant about false data readings and DDT analyses, and this restrained a complete switch to a digital mode of knowledge and decision-making. Farmers found that changes in weather or the canopy cover from trees, and even differences in inclines and nature of terrain, could adversely affect the precision and consistency of GPS signals, creating false digital prompts. As such, farmers still walked the fence boundaries regularly and were vigilant in cross-checking DDT prompts against observed livestock behaviour.

Overall, the authors argue that farm businesses are unlikely to arrive at a position of full confidence in DDTs as a guide to strategic decisions. Nevertheless, the findings suggest that they have established an important 'interrogative capability' that can enhance their inter-related business functions, informed by valuable data (Grimshaw, Miozzo and Kyriakopoulos, 2026).

Digital crowdsourcing of knowledge: How does it shape organisations' skills, capabilities and innovation performance?

Despite the large volume of research investigating the new business models and capabilities of the fast-expanding digital platform economy (or 'gig economy'), very few studies have explored the impacts from the perspective of the client business. Organisations across all sectors of the UK economy rely on digital platforms to source freelance labour to complete specialist tasks and solve other problems that require a type of expertise unavailable inhouse. The research team led by Hsing-fen Lee designed an original business survey to understand the impact of 'crowdsourcing' on the client business capabilities and innovation performance (Lee, Miozzo, Grimshaw and Rani, 2026).

Context. Advances in digital technologies (DTs) have enabled organisations to open up their innovation and reach beyond their immediate networks by crowdsourcing innovation tasks (Table 4.6). Crowdsourcing involves assigning a work task to a 'crowd' of workers, whose work is coordinated by a digital labour platform. This mode of subcontracting presents a digital alternative to allocating the task to in-house employees or subcontracting the task as part of a larger package of activities to a designated supplier. As the authors argue, engaging in this search for external skills by soliciting solutions from a digital labour platform gives the organisation access to 'distant knowledge.' This can potentially be novel for the organisation and promote success in exploratory forms of innovation, especially when instrumentalised as an input at the front end of exploratory innovation (e.g., Afuah and Tucci, 2012; Boons and Stam, 2019; Franzoni et al., 2025; Piezunska and Dahlander, 2015).

Nevertheless, the authors observe a gap in our understanding about the specific skill change mechanisms that can enable this positive contribution of crowdsourcing for innovation performance. Once the organisation selects a solution from those provided by digital platform crowdworkers, there remains the challenge of integrating the solution within its innovation

process. Extant research has largely focused on organisational tools that facilitate knowledge absorption and organisational learning through internal knowledge articulation and codification processes (e.g., Carlile, 2004). With this project, Lee and colleagues sought to improve our understanding of this process by focusing on organisations' complementary HR practices as a potential mechanism for enhancing the use of crowdsourced knowledge for exploratory innovation.

Table 4.6. Summary of Context-Mechanisms-Outcomes for the Crowdsourcing research

Context	Mechanisms		Outcomes
SMEs from all UK sectors	*Sourcing* and *Bridging skills*:		Potential for enhanced skill and innovation performance outcomes:
i) Growing presence of digital labour platforms that provide crowdsourced services i) SME firms make increasing use of crowdsourcing to complete specific work tasks	i) Sourcing skills by using crowdsourcing via digital labour platforms to access 'distant knowledge'	⇒	Sourcing skills has no direct effect on innovation performance, unless it involves a high level of 'distant search breadth'
	ii) Bridging skills by using 'Extended HRM practices' to strengthen connectedness and engagement with external crowdworkers	⇒	Bridging skills enhances exploratory innovation performance

Skill change mechanisms and outcomes. Organisations are sourcing skills from crowds of workers coordinated by digital labour platforms for the purposes of completing specific tasks and work activities. Nevertheless, the authors' survey data show that the practice of crowdsourcing alone is not, on average, conducive to exploratory innovation. Only those organisations that engage in a process of what the authors define as 'high-level distant search breadth' benefit from a statistically significant improvement of exploratory innovation. Breadth of search involves searching knowledge across a wide range of knowledge categories and/or from diverse sources of knowledge (Lee, Miozzo, Grimshaw and Rani, 2026).

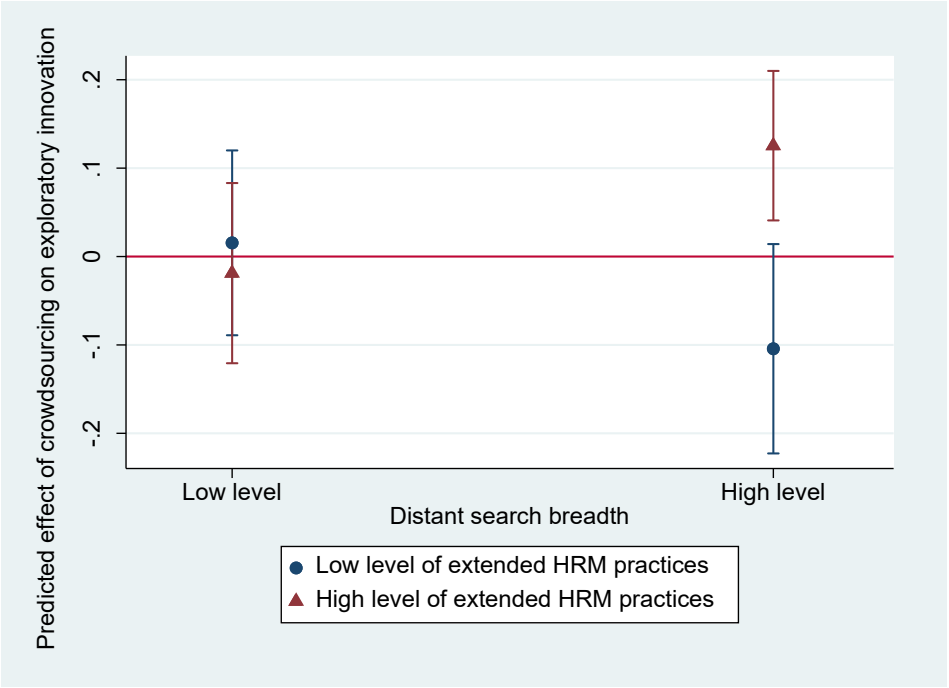
A key finding is that the benefits of crowdsourcing are accelerated for organisations that apply a specific approach to HRM; the authors define this as 'Extended HRM practices' (Lee, Miozzo, Grimshaw and Rani, 2026). This involves specific HRM practices designed to build a degree of connectedness and engagement with external crowdworkers. Examples of Extended HRM practices include:

- timely feedback;
- opportunities for interaction;
- opportunities for some level of control over the training process; and
- structured opportunities to participate in subsequent work activities.

The authors show that the influence of Extended HRM on crowdsourcing is significant. In its absence, crowdsourcing for knowledge has little observable benefit for exploratory innovation - with or without broad distant search. When it is present, crowdsourcing is effective in improving exploratory innovation, especially when the organisation undertakes a high level of distant search breadth (Lee, Miozzo, Grimshaw and Rani, 2026). Figure 4.4 illustrates this key finding.

Figure 4.4. The predicted effects of crowdsourcing on exploratory innovation improvement

(by levels of distant search breadth and extended HRM practices -with 90% confidence intervals).



Source: Lee, Miozzo, Grimshaw and Rani (2026: Figure 3).

Sustaining employee productivity through better digital-work design

The final related project in this suite of 'Skill changes with DTs' research aimed to map how adoption of digital technologies could sustain improved employee productivity by reconfiguring what the authors call digital-work design. Led by Uta Bindl, this research conducted interviews and analysed original survey data to explore management and employee perspectives (Bindl, de Roche and Fay, 2026).

Context. The authors' interviews with leaders of digitalisation initiatives across UK businesses suggest that the organisational rationale for introducing a new DT was primarily to increase cost efficiency, streamline processes, and, ultimately, to increase profit. In several cases these anticipated benefits were achieved, with additional outcomes including improved customer satisfaction and reach, as well as competitive advantage.

Nevertheless, productivity-related outcomes were not always achieved. The authors identify the following reasons:

- poor overall communication of digital change to staff;
- lack of (bespoke) training for employees to work with the new DT;
- implementation of the digital change without detailed understanding of employees' work 'on the ground';
- lack of consideration of employee feedback;
- poor integration of new DT with existing digital software; and

- incorrect/under estimation of the time and resources involved in setting up DTs and/or transferring across systems.

UK employees' expectations about the impact of digitalisation on their work primarily involved increased efficiency and reduced administrative burden, freeing up their time and cognitive resources for completing more high-value work, thus expecting a positive effect on their own productivity (Bindl, de Roche and Fay, 2026).

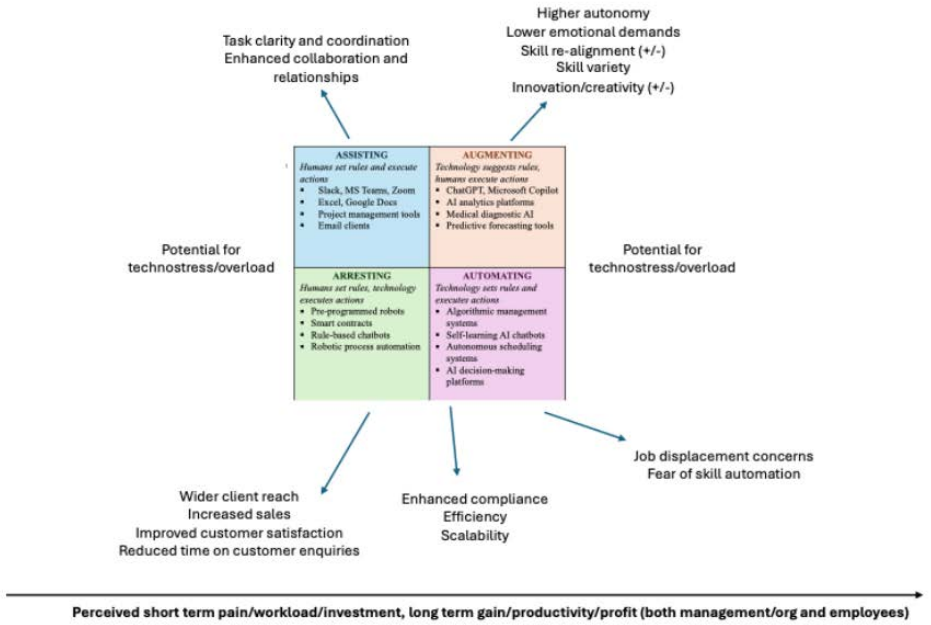
Table 4.7. Summary of Context-Mechanisms-Outcomes for the Digital-Work design research

Context	Mechanisms		Outcomes
All UK sectors, all firm sizes, all UK regions	*Realigning* and *Replacing skills*:		Varied skill and performance outcomes:
i) Increasing incorporation of DTs in all sectors **i)** Corporate leaders highlight cost/efficiency imperative	i) Realigning skills by enabling DTs to suggest work protocols and humans to execute work actions	⇒	Greater variety of skills in the job and enhanced innovation at work but no change in job performance
	ii) Replacing skills by using DTs to automate the execution of work actions	⇒	Fears of skill automation and job losses in the future, combined with management satisfaction with enhanced potential for efficiencies, scalability and long-term profit

Skill change mechanisms and outcomes. The authors' quantitative survey data analysis reveals a complex picture of skill change with DTs. The nuanced findings can be captured via an appreciation of the alternative modes of DT-work design, specifically to identify the degree to which DTs reshape the rules underlying 'protocol development' (do DTs create or modify the procedures that govern how work is performed?) and action selection (do DTs exercise control over what actions to take?).

Positive results for skill change outcomes are mostly associated with modes of DT-work design in which DTs suggest work protocols and humans take charge of executing actions (upper right cell in Figure 4.5). The authors reveal that this form of work design is associated with higher worker autonomy and lower emotional demands at work. It is also associated with a realigning of skills required for the job, resulting in greater skill variety in the job, and appears to drive enhanced innovation at work. Furthermore, employees reported that this mode of DT-work design helped them generate better ideas and assisted with brainstorming and creative problem solving; e.g., by using generative AI to brainstorm and plan for client sessions or to produce and review content. It would also appear that employees benefited from management providing them the time and trust to explore this new way of working, as well as feedback. Nevertheless, the survey data reveal that some employees experienced an undermining of creative work processes in situations where this mode of DT-work design replaced and put at risk certain core skills.

Figure 4.5. Typology of digital-work design and consequences for work and performance



Source: Bindl, de Roche and Fay (2026: Figure 1).

Job displacement concerns (replacing skills via automation) were associated with modes of DT-work design characterised by high engagement of DTs to execute actions in work tasks and workflows (lower right cell in Figure 4.5). While employees tended to perceive the risk as distant and possibly not affecting their own career, especially among older survey respondents, the findings suggest that many were frustrated about the lack of management support for skill training in new DTs. The authors find that the perceived risk of job replacement was particularly salient when DTs (of any kind) were not implemented with positive change management practices such as communication and involvement, and with relevant training opportunities. In the context of perceived job threat, interviewees discussed seeking to upskill themselves in order to learn more about emerging DTs to stay ahead of the curve and to remain employable (Bindl, de Roche and Fay, 2026).

Nevertheless, business leaders were upbeat about the potential for this mode of DT-work design to bring significant benefits. These included enhancing compliance and meeting regulations, high efficiency, scalability, and potential for long-term profit gains. In some cases interviewees reported their organisation already experiencing productivity gains from the new digital technology, for example through reducing time spent dealing with customer enquiries, obtaining more work/bringing in more business from customers/clients and from a wider reach of customers/clients, selling more to customers/clients (from online retail, to estate agency) (more augmenting tech), reducing waste (retail), employees being able to process case work more quickly, machines being able to complete, e.g. manufacturing and engineering tasks, quicker and more accurately than humans completing them manually.

Overall, the authors' novel findings suggest a need to pay attention to the specific characteristics of DT-work design in understanding and reshaping patterns of skill change and performance outcomes (Bindl, de Roche and Fay, 2026). The UK employee survey demonstrates that digitalisation has driven significant changes in the core characteristics of work (and skills needed

to complete their work), impacting (positively and negatively) productivity-related indicators ranging from employee wellbeing to attitudes such as turnover intentions, career satisfaction and job engagement, as well as key performance-related indicators such as innovation. Digitalisation also means employees are likely to engage in crafting their jobs in ways meaningful to them. This indicates the need for management to provide a clear strategy around which employees are able to reshape the nature of their work.

Chapter 5. Job design, people engagement and productivity

Introduction

The job design, people engagement and productivity theme explores new avenues for understanding productivity in relation to people management practice. The research draws insights from a range of disciplines including work psychology, human resource management and employment relations.

While the relationship between people management practices and productivity has been considered within labour economics, the contribution of these distinct but interrelated fields to date has featured less prominently in productivity debates. The first strand of research examines job complexity, defined as jobs characterised by the extent to which job tasks are varied, unstructured and dynamic (Campbell, 1988). Given potential effects on wellbeing, learning and task performance, job complexity is likely an important factor that enhances the links between skills, technology and productivity (Holman and Rafferty, 2025). The second asks how do alternative arrangements for employee voice shape productivity? The final strand of research focuses on how human capital is sourced and utilised through employment contracting and working arrangements. This includes longer term increases in part time work and self-employment and recent growth and access to hybrid and work from home (WFH) arrangements. Underpinning the well-known 'low skill equilibrium' is a set of HR practices and 'low road' business strategies, including underinvestment in skill development, cost led outsourcing and the use of insecure and non-standard employment contracts.

The complex effects of job complexity on skill use and well-being

In Study 1, (Holman et al., 2026a), a meta-analysis employed a mixed-methods approach, synthesising quantitative data from 71 primary studies (N = 71,038 employees) with various designs, including cross-sectional, longitudinal, and time-lagged studies. Data sources included published and unpublished studies, with effect sizes corrected for reliability. Data were extracted from primary studies identified through systematic literature searches across Scopus, Web of Science, and PsycINFO databases, including both published and unpublished sources. Moderator analyses examined influences of study design, article characteristics, and demographics such as age. The study used a multilevel random-effects meta-analytic model accounting for dependency among multiple effect sizes within studies. Effect sizes were reliability-corrected correlations. Moderator analyses tested the impact of study design (cross-sectional vs. longitudinal), hypothesis presence, and age on effect sizes. Publication bias was assessed with funnel plots and Egger's tests, finding no significant bias.

The meta-analysis confirmed that the effects of job complexity on employee outcomes varies according to the type of job complexity. Job resource-complexity enhances performance, learning, and well-being while reducing strain. Job challenge-complexity improves performance and learning but increases strain, reflecting its dual stimulating and depleting nature. Job hindrance-complexity could not be empirically tested due to data limitations but is theoretically linked to negative outcomes. There was no strong evidence that these effects were moderated by demographic factors such as age. The findings highlight the nuanced roles of different job

complexity types and their implications for managing work design to optimise productivity and employee health.

Study 2 (Holman et al., 2026b), employed the European Working Conditions Survey (EWCS) to test how such effects occur within differing national institutional settings. Findings were consistent with those hypothesised and reported in Study 1, namely that: job resource-complexity is positively associated with performance, learning, and well-being and negatively associated with job strain; job challenge-complexity is positively associated with performance, learning and well-being but increases strain, and; job-hindrance complexity is negatively associated with performance, learning, and well-being and positively associated with job strain. For moderating effects, the most consistent effects were found regarding the relationship between job complexity and employee learning. Specifically, the nature of the moderating effects suggested that, in learning poor contexts (i.e., those characterised by lower skills, lower manager support, lower training) the effects of job resource complexity and job challenge complexity were stronger. This suggests that in learning poor contexts, employees direct greater effort to learning opportunities presented by high job complexity. In other words, job complexity can, to some extent, compensate for the lack of learning opportunities in learning poor context. Similar effects also occurred at the national institutional level in terms of institutional differences in learning environment contexts, but only when comparing Nordic regimes with Eastern, Southern and Coordinated regimes.

Effective worker voice and pathways to productivity

Qualitative interviews and survey findings highlighted some of the managerial logics of employee voice in relation to employee and organisational performance (Findlay et al., 2026). Although some highlighted a moral or democratic case for voice, managers expressed interest in whether voice 'works' for them and for performance. This was generally more widely defined rather than in terms of 'productivity,' which often remains outside the parlance of managers. In the different case contexts, voice was considered operationally important to support continuous improvement and learning, service quality, cost containment and for staff retention. In two cases, management had targeted improvements in voice and engagement to improve business performance, and in one, voice was considered crucial to delivering required productivity improvements.

A key issue concerned whether organisations had a systematic and integrated employee voice strategy or whether arrangements were more ad-hoc. Management focussed largely on the provision of voice opportunities – longer standing channels and more recent initiatives (e.g. using online tools). These had developed organically leading to multiple overlapping and non-overlapping voice channels that appeared fragmented and messy to some employees, and no managers could point to how the channels connected as an integrated voice system. Except for engagement surveys, voice channels across the cases were not evaluated in any systematic way. The configuration of voice channels varied across the case studies but in aggregate the most commonly used voice channels were one to one meetings with line managers (43% of survey respondents used; range = 19% to 63% across cases), followed by team meetings (41% used; range = 13%-60%) and employee surveys (40% (18%-62%). Non-union representative fora were least likely to be available or used. Only one case study organisation had trade union recognition, and 19% of survey respondents had engaged with the TU committee in this case.

A further research question considered what drives employees to exercise voice? Interviews highlighted mixed motivations for workers to voice but (like managers' reasons for seeking voice)

a strong emphasis on 'fixing' things rather than appreciative enquiry. Some workers, however, reported not speaking out because they perceived their voice would make little difference, a view shaped by previous experience, or because they were concerned about negative consequences. Others voiced disinterest in sharing their views. Managers had limited insight into the extent of worker participation in existing voice channels.

Both managers' and workers' interviews identified barriers to exercising voice: time; lack of training to support voicing; lack of access to technology-based voice channels for manual workers; rotating membership at managerially sponsored voice events limiting opportunity to build up knowledge and experience; self-selection on to managerially sponsored voice channels; and limited or inaccessible feedback from voice channels. Differing views were offered on the existence of multiple voice channels: while some believed this gave options to voice on different areas of interest, others reported that it lacked coherence.

Drawing on the survey data, the drivers of voice were analysed by looking at whether workers' ability, motivations or perceptions of voice opportunities influenced whether they used any voice channels or preferred silence. Perhaps surprisingly, on both voicing and silence, motivations and perceptions of voicing opportunities were not significant predictors of voice actions. Whether people were motivated negatively (to criticise) or positively (to offer ideas) did not significantly affect their propensity to voice. While those who were motivated to voice in order to show their capabilities and progress at work were significantly more likely to exercise their voice, this association was no longer significant once we control for trade union membership and supervisory responsibility.

The only strong predictor of silence was voice ability - people who reported feeling sufficiently skilled and confident to speak out were significantly less likely to report remaining silent. Other factors — including demographics — do not significantly predict whether respondents voice or remain silent toward management. Trade union membership and supervisory responsibilities are, however, significant: trade union members and those with supervisory responsibilities are more likely to exercise their voice in the workplace.

On the relationship between voice action and pro-productivity worker outcomes, the consensus across the stakeholders, consistent with the wider literature, was that most employees want a voice. Most stakeholders also held a strong belief in a positive link between voice, employee engagement and discretionary performance, and that voice has a positive impact on job satisfaction and wellbeing. While all four case organisations used engagement surveys, three reported falling participation in these surveys. It was widely perceived that this was driven by concerns over a lack of follow up to the surveys.

The survey data showed variation in how participation in different voice channels was associated with these worker outcomes. Participation in department or organisation-wide meetings was significantly positively associated with job satisfaction, yet participation in team meetings was significantly negatively associated with job satisfaction and negatively associated with wellbeing and discretionary behaviour (both marginally significant). Participation in online fora was also negatively associated with discretionary behaviours. Voicing through employee focus groups was positively associated with wellbeing, and voicing via employee surveys was positively associated with discretionary behaviours.

Voice channels were grouped to create five types, two representative (union and non-union) and three direct: line management focused (one to one meetings; team meetings); passive (employee

survey; all department or organisation meetings) and employee-focussed (online forum or employee focus groups.) Those who voiced through a trade union channel reported significantly lower job satisfaction. Those who engaged with passive voice channels were significantly more likely to report discretionary behaviours but also slightly more likely to report an intention to quit their job. While those who voiced through employee-focussed channels were more likely to agree that working for their employer supports their wellbeing, the reverse was true for those who voice through line management channels. Turning to controls, disabled people were significantly less likely see their employer as supporting their wellbeing and more likely to report lower job satisfaction. Interestingly, those who reported ease with speaking out irrespective of consequences were also more likely to engage in discretionary behaviours, suggesting that voicing with confidence is not inconsistent with pro-productivity behaviours.

Across the cases, stakeholders perceived a clear link between voice actions and pro-productivity organisational outcomes, identifying examples of where employee voice had driven continuous improvement, positive change in business processes, reduction in wastage and cost, and innovation. In two of the cases, increasing managerial attention to supporting employee voice had – according to management respondents – dramatically enhanced employee engagement and business performance.

Factor analysis of survey data on organisational outcomes (dialogue helps support good performance; respond flexibly; introduce change; support trust between management and workers; deliver stable employment relations; and managing conflict) suggested one underlying concept. Those reporting voice in team meetings and trade unions report better perceived organisational outcomes, though the latter is only marginally significant.

A further research question concerned whether the impact of voicing on pro-productivity worker or organisational outcomes was mediated by managerial responsiveness to voice. Variation in line management's ability to encourage, engage in and support voice was widely acknowledged in the interviews. Some organisations tried to support line managers through training, but without training (in one case), survey findings highlighted the lowest assessments of line management interest, encouragement and listening. From the survey data, management responsiveness significantly predicts all outcomes but much more so for senior than line management responsiveness. Senior manager responsiveness is almost twice as influential as line managers for employees' wellbeing. This suggests employees distinguish clearly between line managers and senior managers, and that senior management responsiveness to voice supports satisfaction, wellbeing, retention and positive discretionary behaviours.

Self-employment, gender, part-time work and productivity

The nature of the employment relationship is fundamental to how human capital is utilised in the economy. Differing forms of contracting such as outsourcing, the use of self-employed workers, part time employment and non-standard fixed term or temporary contracts may confer varying advantages and disadvantages to both organisations and employees. The advent of prior waves of digitalisation through ICT adoption has further reduced the transaction costs of outsourcing and the use of external providers to organisations, potentially reshaping the employment and productivity landscape.

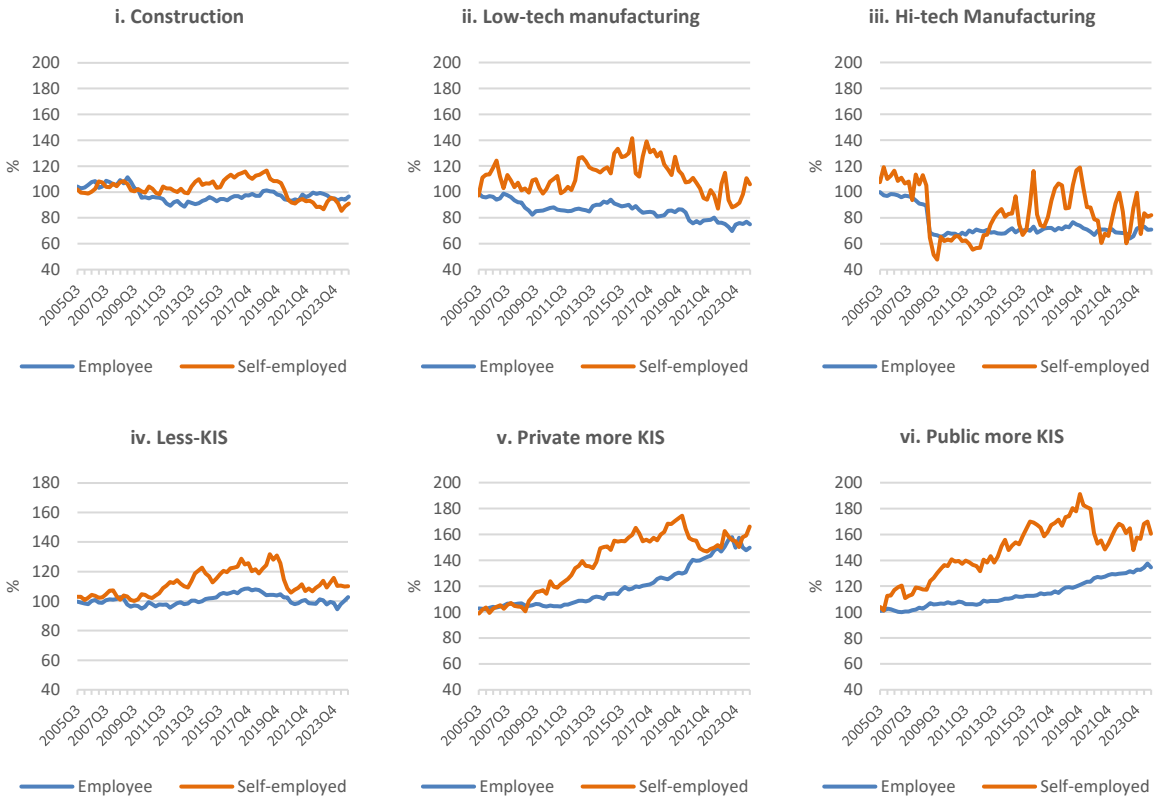
The first part of the self-employment, part time work and productivity research strand considered long term trends in self-employment and part time work (Rafferty et al., 2026). Of particular interest was the extent to which trends in part time work and self-employment interface with

broader national and international debates on labour market polarisation and occupational structure. Based on the Routine Biased Technological Change accounts, early waves of automation are purported to have led to a hollowing out of middle income or middle skill jobs and polarisation through an increase in higher skilled or paid work and less routinisable skilled work. For example, as higher income work increases, demand for lower paid less routinisable personal services that cannot be automated, which are consumed by higher income households, may increase, leading to a pattern of polarisation across wage deciles. Where such changes occur within firms or occupational labour markets, a decline in middle level jobs may hold implications for human resource development and transitions between lower and higher-level positions, thereby constraining pathways to employee productivity increases and human capital matching.

Although earlier studies in the US and the UK suggest that such polarisation and hollowing out, particularly prior to 2010 (Cavaglia and Etheridge, 2020; Salvatori, 2018; Goos and Manning, 2007), overall, the UK and international evidence remain mixed (Fernandez Macias, 2017). A further issue is that, due to difficulties in the collection of income data among the self-employed, such research focuses on employees. Given broader shifts in self-employment, an important concern whether changes reflected in polarisation studies in part reflect a shift towards greater outsourcing linked to greater self-employment, such as where consultants or contractors are used in human capital sourcing strategies in more knowledge intensive industries. Such developments may also hold implications for firm level productivity, where knowledge and skills that were once developed and transmitted within organisations become custodian to or firewalled in external contractors, thereby affecting longer-term skills pipelines and human resource development activities.

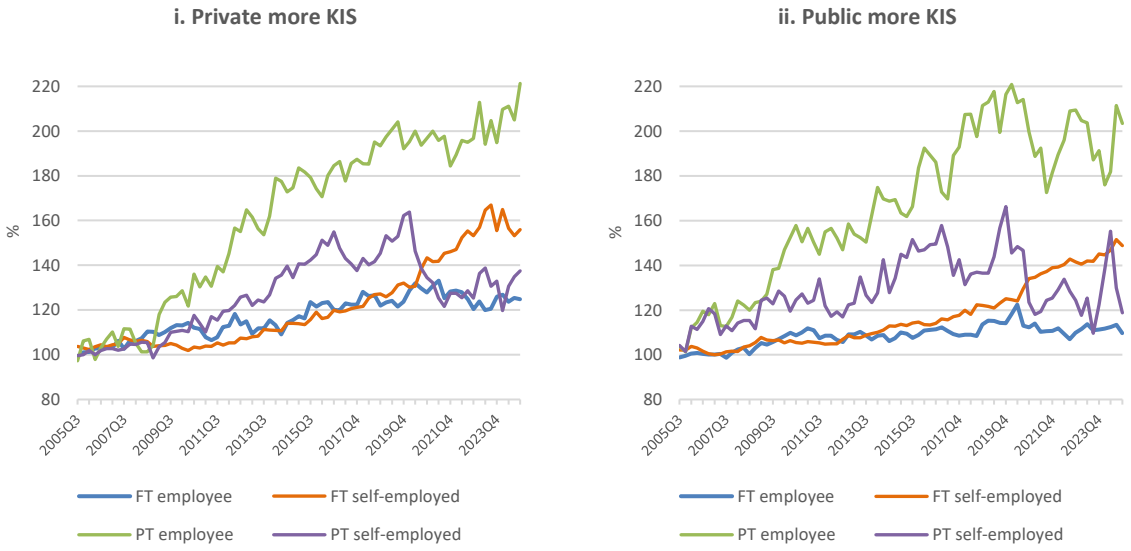
Figure 5.1 shows that the 2008/9 recession marked a critical juncture in accelerating trends toward greater self-employment (Rafferty et al., 2026). This effect was particularly acute within more knowledge intensive sectors. Although the recovery was particularly marked by an increase in part time employee jobs, a shift towards greater part-time self-employment after the recession, and full time self employment in more recent years, is noticeable in both public and private more knowledge intensive sectors (Figure 5.2).

FIGURE 5.1. Percentage change in employees and self-employed by sector (2005-2024(Q4))



Notes: (Base 100= 2005 Q3). KIS = Knowledge intensive services. High KIS public sector are 2 digit KIS industries in public sector dominated sectors (Health, Education and Public Administration). SIC 2007. Weighted.

FIGURE 5.2. Percentage change in number of employees and self-employed by sector, part-time and full-time workers (2005-2024(Q4))

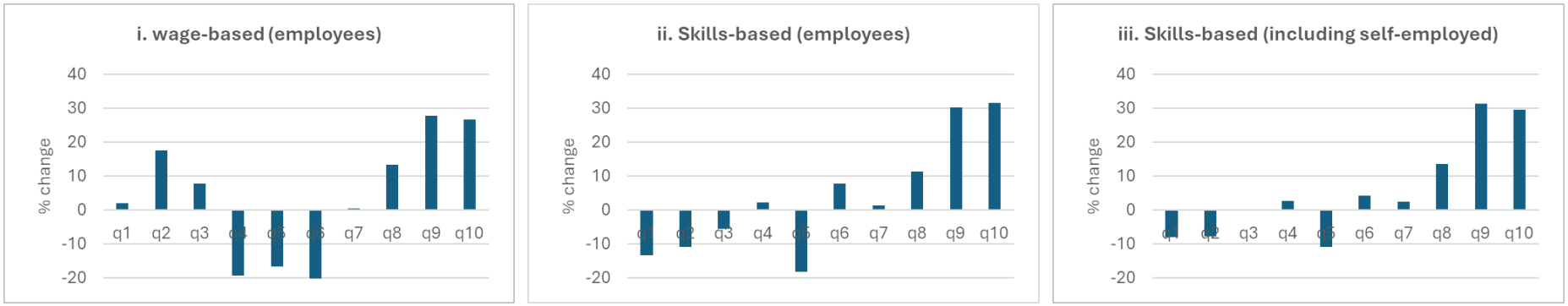


Notes: (Base 100= 2005 Q3). Part-time= <30 hours per week. KIS = Knowledge intensive services. High KIS public sector are 2 digit KIS industries in public sector dominated sectors (Health, Education and Public Administration). SIC 2007. Weighted.

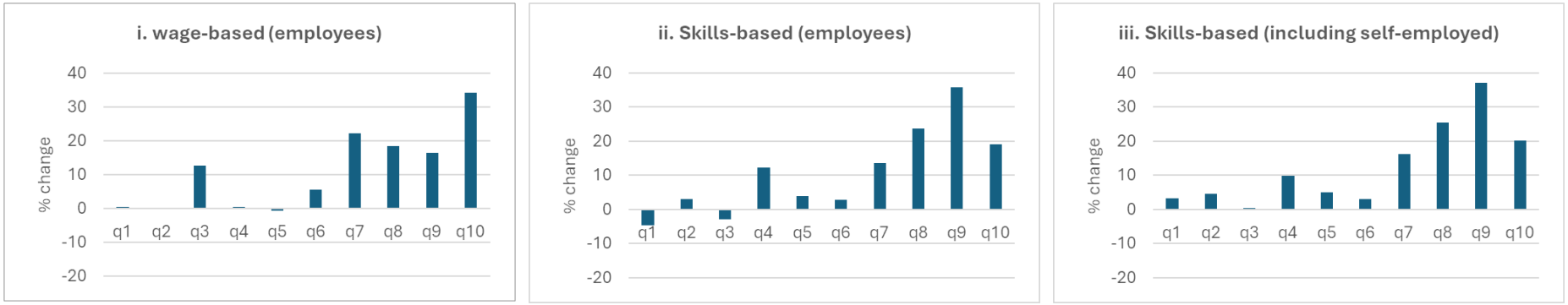
Using both the 'wage based' and 'qualification-based' jobs method, Figure 5.3 considers changes in the job distribution between 2001-10 and 2011-19. Restricting the analysis to employees, both methods suggest a hollowing of middle income and skill level occupations between 2001 and 2010, although this trend was more pronounced using the wage-based method. However, a notable divergence occurs regarding changes at the lower end of the jobs distribution. While the wage-based approach suggests a pattern more consistent with labour market polarisation, with increases in employment in both the lower and higher deciles and a decline in middle deciles, the skills based approach suggests a decline within the lower deciles and therefore a pattern of occupational upgrading. Figure 5.3 further considers changes in the distribution of the employment structure after including the self-employed. While an increase in employment in the higher skilled deciles is evident, the level of 'hollowing out' of middle skill level jobs (e.g. decile 5) is considerable smaller. Furthermore, the decline in employment within lower deciles is less pronounced once the self-employed are included. Tentatively, this could suggest that part of the hollowing out of middle skilled employee jobs and decline in lower skilled work has reflected a shift towards greater self-employment and external contracting rather than current explanations such as automation.

Figure 5.3. Change in job deciles by median wage and qualifications (2001-19)

i. 2001-10



ii. 2011-19

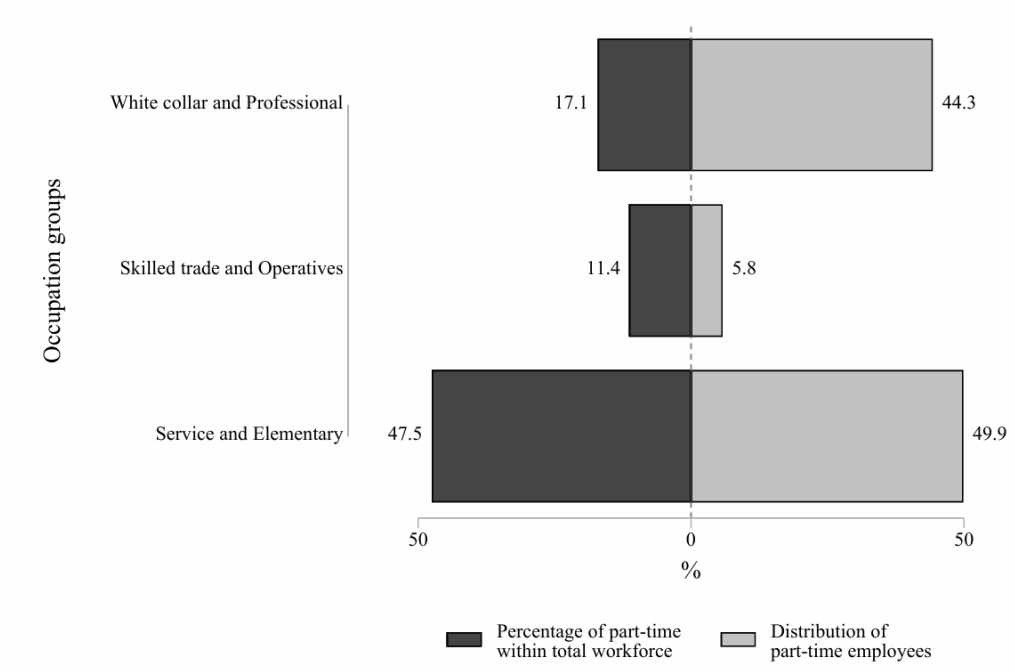


Gender, part-time work and productivity

Part time work may contribute to productivity simply by helping women to remain integrated into employment, given women's employment internationally has been estimated to accounted for at least a fifth of overall productivity growth in recent decades (OECD, 2018; Rubery et al., 2026). Arguably, policy aims should go further to ensure that all have opportunities to use their talents and avoid extended periods of work that are difficult to combine with a stable and fulfilling life. An important issue shaping part time work productivity may be the way this group is managed and the quality of part-time work. For example, part time workers may be segregated from full time through divisions within a company's labour force or through outsourcing to a mainly part time service company. This may facilitate the offer of differentiated pay and conditions (Baron and Kreps, 1999). Alternatively, part-time employees may be integrated within the company's main workforce structure, but still possibly unable to access the training or experience needed for further progression. Consequently, the extent of segregation by sector and occupation and the patterns of integration or segmentation within an organisation could impact on the productivity outcomes.

Although part-time work is historically associated with lower skilled elementary and service work, this group now account for only half of part-time employees, with 44.3 per cent of part-time employees being within professional and white collar work. If we look at the share of part time in these occupational groups' total workforce, the picture changes: part time jobs account for 47.5 per cent of the total workforce in the service and elementary occupations but only for 17.1 percent of the total white collar and professional job workforce and 11.4 percent of skilled trades and operatives workforce (Figure 5.4).

FIGURE 5.4. Part-time work by occupational group



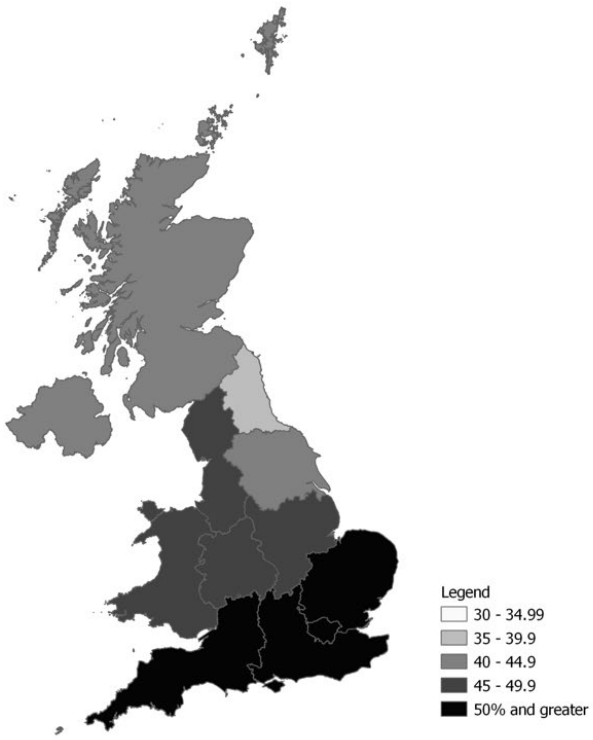
An important theoretical distinction can be made between whether part time employment reflects retention jobs focussed on employee flexible working goals (e.g. the retention of women following maternity) as a route to human capital retention and attraction, or more employer-centric flexible working focussed on achieving scheduling flexibility such as in response to changes in demand (Figure 5.5). Part-timers in white collar and professional occupations are more likely to be employed for retention reasons (as indicated by a higher probability to be salaried employees and working unpaid rather than paid overtime, in line with condition for full-time employees in these occupations) while those in service and elementary jobs are more likely to be hourly paid and to do paid overtime in line with their role as flexible employees to minimise staff costs in sectors with varying customer demand (see Rubery et al. 2024, figure 9).

Both types of part-time work have potential impacts for productivity, that is for both firm productivity and the longer-term opportunities for productive lives. Retention part-time jobs may help employers maintain their investments in human capital and reduce costs associated with turnover. However, those working part-time may not be given opportunities for further skill development and may be less able to change jobs due to lack of rights to work flexibly or part-time (only legally having the right to request). In employer orientated part-time work, such as to achieve flexibility in relation to demand, although employers may experience short term productivity increases there are often limited prospects for training or advancement.

FIGURE 5.5. Three stylised types of part-time working		
Type of Part-Time	**Hourly Productivity (GVA per hour of employment)**	**Person/life course productivity**
Type 1. Retention-type part-time – (reduced hours work within mainly career-type jobs,)	Positive effects for employers related to reduced costs of recruitment and training due to better retention. Employers may also find it convenient to have qualified employees who accept lower pay and prospects. Negative productivity effects compared to full-timers may be due to lower experience/ less opportunities for skill upgrading (may widen over time) plus issues such as start-up time, motivation, coordination issues with co-workers and clients, willingness/ unwillingness to complete tasks in unpaid hours.	Opportunities for reduced hours – should reduce gap in full-time/ part-time trajectory over life course as avoids occupational downgrading and reduces risk of burnout compared to working full-time. But lack of training or challenging work opportunities and promotion may lead to underdevelopment of skills and talents. Right to work part-time for another employer restricted leading to entrapment. Productive life opportunities may also depend, given poor opportunities for part-timers, on opportunities to return to full-time work (and if workload associated with full-time work is not excessive)
Type 2. Regular but not career-integrated part-time work	Positive productivity effects for employers stem from lower pay costs (if employee in weaker bargaining position), opportunities to vary staffing levels to match predictable variations in demand, fewer paid breaks and enables cover for full-timers without premium costs. Negative productivity effects for employers may arise from start up times, motivation, coordination issues with co-workers and clients, willingness/ unwillingness to complete tasks even if paid overtime.	Most regular non career part-time jobs offer limited opportunities for skill or pay progression. Opportunities to transition back to full-time may be limited. In some part-time work areas, the problem may be the low monetary value attached to the work not the low intrinsic value/ productivity of the work. Financial insecurities may offset benefit of shorter hours on health and well-being.
Type 3. Variable hours part-time work to match service delivery flows	Positive productivity effects for employers from fragmented/short shifts that target peak demand and increase work intensity, plus lower costs due to subsidies for short hours work through national insurance system. Measured productivity is higher if actual work time longer then paid for time. Negative productivity effects for employers may arise from problems of recruitment and retention, motivation and service quality.	Fragmented work leads to higher GVA per paid hour but lower wages and unpaid/unproductive 'waiting for work' time for employee. Consequently, low income/underemployment or excessive work hours to achieve reasonable income all may have negative impacts for health and wellbeing. Possible high stress looking for more work (for financial reasons or to meet benefit regulations) and managing care commitments alongside flexible schedules.

Regional disparities in access to higher skilled and higher paid part time employment may lead to further barriers to women's opportunities to lead productive lives. Figure 5.6 shows that in the North East only 38.1 percent of women in part time jobs are in white collar jobs, over ten percentage points below the average UK share at 48.6 percent, followed by Northern Ireland (42.8 percent). The South East has the highest white collar share at 55.7 percent, seven percentage points above the average. This variation in women's part time work is greater than for male part time workers where the average share of white collar and professional occupations is 31.3 percent, the lowest in the North East (24.5 percent) and highest in the South East (41.2 percent).

Figure 5.6. Percentage of women part-time employees in white collar occupations



Hybrid working and productivity: Exploring flexibility stigma and ethnic inequalities

Findings from the UK Labour Force Survey suggest that during the expansion of work from home (WFH) arrangements following the Covid-19 pandemic, the gap in access to such arrangements between ethnic minority and employees who self-identify as White based on UK Census definitions narrowed (Chung and Yuan, 2025).. Before COVID-19 only about 5-8% of workers worked from home regularly. Drawing overall comparisons between white and non-white populations, non-white men were less likely to have such arrangements that than white men, while white and non-white women exhibited similar levels of homeworking. By 2022–2023 overall levels of working from home rose to 25-30% and there were no significant differences in such arrangements between white and non-white populations, both for men and women.

At the same time, important differences remained across specific ethnic minority groups by gender. Black men ('Black African, Black Afro-Caribbean or 'Black Other') and Chinese/ 'Other Asian' men and women based on Census categories continued to have lower WFH use than white workers, even when accounting for occupations and sectors. Migrant status and parental status further shape these patterns¡.Lower WFH rates among Black and Chinese groups were driven largely by migrant workers whereas UK-born workers within these groups were often more likely to WFH than White workers. Black fathers were much less likely to WFH than White fathers. Chinese/Other Asian and Pakistani/Bangladeshi men with no dependent children were also less likely to WFH than comparable White workers.

Using the UK Survey of Working Arrangements and Attitudes (SWAA-UK) findings suggest that home workers, mothers, and ethnic minority groups show higher levels of digital presenteeism (Chung, 2026). Homeworkers consistently feel more pressure to stay digitally visible, across all types of the considered forms presenteeism (Wang and Chung, 2026). Women with dependent children were especially likely to actively contact or email colleagues or customers outside normal working hours and felt a stronger psychological pressure to do so than all other groups. One potential explanation is that this is a way to compensate for bias managers may have about mother's commitment to work and responsibilities in caregiving. Ethnic minority workers showed the highest levels of passive presenteeism (frequent checking or monitoring).

A key finding is that an "always on" workplace culture increases digital presenteeism. Strong ideal-worker norms generally push worker to be more responsive online, across all types of presenteeism for all worker groups. Furthermore, flexibility stigma increases the psychological pressure to be more engaged in such presenteeism behaviours.

At the same time, organisational and broader cultural norms and pressures appear to affect groups differently. When ideal-worker norms are strong within organisations, homeworkers (3 days a week) face greater pressure to engage in digital presenteeism, using online visibility to replace physical presence. However, under strong flexibility stigma, mothers appear to increase their active digital presenteeism the most. Under strong flexibility stigma, childless men experienced the strongest psychological pressure, likely because they are assumed to have no other responsibilities and therefore (should) always be available. Fathers, by contrast, are often viewed as stable, committed earners, potentially benefiting from a 'fatherhood bonus,' and thus they may feel comparatively less pressure to signal commitment through digital presenteeism.

Findings from the experimental survey study suggest digital responsiveness is a strong and consistent factor shaping manager evaluations. Employees who responded to digital communications received significantly higher ratings across nearly all measures: commitment, productivity, collegiality, promotion potential, and expectations to work long hours. Managers appear to use availability and responsiveness as a primary signal of dedication and competence, which suggests that digital forms of visibility now function much like physical visibility in the workplace.

However, the meaning of digital presenteeism differs for some groups. Mothers received especially strong boosts in their evaluations when they were digitally responsive compared to women with no dependent children or fathers. This may be because managers do not expect mothers to be responsive due to assumed care responsibilities, and when they diverge from such assumptions, they may receive a more positive evaluation. Similarly, digitally present Nigerian women saw the largest gains in promotion assessments, compared to Nigerian men or 'white' people as identified by English surnames. The result may also indicate that with regards to

penalties of setting stronger boundaries between work and private spheres of life, mothers and black women may face a stronger penalty.

On explanation here is that, even without overt bias, digital responsiveness may carry different symbolic value for different groups where those who are expected to be experience most bias against their work evaluation benefit most by deviating away from the expectation.

Remote settings amplify reliance on digital responsiveness as performance criteria. Compared to office-based workers, home workers received lower evaluations in terms in commitment, productivity, collegiality, and promotion potential. However, when remote workers perform digital presenteeism, the bias they experienced attenuated to the point that digitally present remote workers were evaluated as positively in most cases as a digitally present office-based worker. In comparison, a digitally absent remote worker is viewed most negatively, even compared to digitally absent office workers.

When examining the buffering effect of digital presenteeism on manager evaluations of workers by gender and childrearing responsibilities, the penalising effect of working from home whilst being unresponsive appeared strongest for mothers in relation to expectations regarding working long hours when needed. On the other hand, the positive effect of responsiveness when homeworking seems to be stronger for men with dependent children. One possibility is that managerial perception of the availability of employees to put in long hours could be taken as a proxy for the capacity to take on more difficult “hard projects” which in turn is taken as an indicator of future potential career progression potential and success. The penalising effect of being not responsive when homeworking appears to be strongest for black women in terms of managerial evaluations of promotions chances.

Employment and Technology Adoption Strategies in Food Manufacturing

The food manufacturing sector contributes £37 billion to the UK economy, representing 24.2% of manufacturing turnover. As a major employer, around 486,500 workers are directly employed within the sector, situated in a broader supply chain of around 4.2 million UK employees (FDF, 2025). The post-Brexit landscape has presented considerable labour force challenges to the sector. Food manufacturing is a major user of migrant labour, with 40.4% of workers born outside the UK (ONS, 2023). These recruitment practices emerged during the 2000s where a shift from mainly domestic labour to migrant workers mainly from EU A8 countries occurred (Hopkins, 2011; James and Lloyd, 2008). These changes were underpinned by a broader policy shift to flexible labour markets (Rubery et al., 2016), with these segmented labour markets being underpinned by migrant labour (MacKenzie and Forde, 2009; Scott, 2012; McCollum and Findlay, 2015). During the 2020s, Brexit combined with economic growth within EU A8 economies however restricted the availability of migrant workers leading to labour shortages (ECB, 2023).

While improvements in wages and working conditions provide one strategy for attracting a broader domestic labour pool, supply chain cost pressures continue to present a considerable constraint on HRM strategy. Within this context, technological adoption provides an alternative or complementary strategy to increase productivity, thereby potentially supporting wage growth where productivity gains are in part passed on to workers through wages. However, technology adoption in food manufacturing has tended to be slow and fragmented outside of some key areas of volume production. Low adoption is combined with a slow rate of technological renewal of

technology, described as a 'piecemeal' of new and old machines patched together with human labour (James and Lloyd, 2008, p.226).

Automation is also contrasted with a managerial strategy of 'overstaffing'; throwing people at the problem "to ensure the necessary flexibility of response to their multiple and often competing customers" (Newsome et al., 2009, p.151); resulting from limited managerial expertise with technology adoption and historically cheap labour. Technological adoption nonetheless has the potential for labour-saving and could also deliver increased value through reducing wastage and providing quality assurances (FDF, 2024).

A key issue is whether new technologies now exist that could automate or semi-automate traditional manual processes and be sufficiently flexible and cost effective in their operation to deal with highly variable demand by volume and/or composition. Where the product mix is highly variable, food-related health and safety issues – such as requirements for intensive cleaning between product runs – may limit the cost effectiveness of automated machinery. In addition, robotic dexterity is still not at a level to undertake all the tasks of human operatives to a satisfactory quality level or at an appropriate price.

Not all new investments in technology are primarily focused on automation. Instead, many investments provide potential value to organisations through data capture. In food manufacturing, data capabilities can be important for improving product quality/reducing product waste, for facilitating and improving product health and safety, for automating record keeping for health and safety, stock control, marketing and delivery, and so forth. These investments also do not necessarily directly displace jobs, unlike some forms of 'physical' manual labour automation and can have indirect effects on demand for labour relative to volume and value of production. Buyer dominance keeps margins low, thereby limiting options to finance investment in technology, which could potentially remedy some of these issues, unless directly supported by supermarkets or other clients.

Chapter 6. Conclusions and Implications for Policy and Business Practice

The original TPI research reviewed in this report provides valuable evidence to inform UK policy and business practices for the enhancement of skills, organisational capabilities and the wider work environment. This chapter separates out the issues in order to highlight TPI's core concerns. We address challenges facing education policy at national and regional levels and those facing employers - particularly concerning incentives to train workers and how they should adapt organisational capabilities for the AI era in a context of fast-changing ecosystems. We then consider the need for policy and practice to think more carefully about the nature of job design as a vehicle for enhancing skills and organisational capabilities and the fundamental role of employee engagement (or voice) in this process. These challenges have specific features in different sectors of the UK economy, which we illustrate. There is also an important need to focus on the situation of people in part-time work and how to improve approaches to hybrid work in order to deliver an inclusive approach to skill enhancement and organisational performance.

Improving education policy

Promoting changes in education curricula to better prepare students for changes in the labour market brought about by technological changes is a key policy recommendation. This may require more joined up provision of education at all levels, school, FE colleges and Universities. The challenges of skill formation facing the UK are not helped by the inadequate architecture for skills policy, particularly in England, over the last two decades. The legacy of underinvestment, extreme policy churn and lack of co-ordination associated with successive governments has produced ongoing policy failure, which has held back productivity and earnings growth. So whilst skills and VET - whether in the form of apprenticeships, new technical qualifications (T Levels, Higher Technical Qualifications or new institutions (Centres of Vocational Excellence, National Skills Academies, National Colleges, Institutes of Technology) - have appeared dutifully in a series of successive and short lived economic and industrial strategies, they have typically been poorly funded and badly joined up with other policies and initiatives.

Higher Education in England has been treated as a market, shaped and funded through individual student choice and overseen by a market regulator, the Office for Students (OFS).[18] Numbers in English universities are uncapped and institutional funding for teaching comes through a student loan system. Further Education, however, even when offering similar programmes, is run on strict number controls, budgets and contracts via the Education and Skills Funding Agency (ESFA) – now an inhouse body at the DFE.

Apprenticeships policy is different again. It is funded through an employer levy and regulated by the Institute for Apprenticeships and Technical Education (IFATE). It is not known whether or how often, the OFS, ESFA and IFATEA meet together to consider skills in the round. In England at least, education does not function as a joined up tertiary system as is increasingly evident in Scotland and Wales, as well as in other European countries such as Ireland. A key problem is that government spending on education has not kept pace with the ambition to drive a high skill, high

[18] The Office for Students was established in the Higher Education and Research Act passed in 2017.

productivity economy, falling from about 12% of total public spending in the late 1970s to just over 10% today.

Our analysis of regional demand and supply suggests that policy responses should differentiate between the two skill groups, basic/foundation and advanced, focusing on inclusion and connectivity for basic skills in rural areas, and targeted capacity building for advanced skills in high-demand urban centres. However, each of the different streams of education policy in England - for schools, FE and HE - have largely operated on a 'one size fits all' or 'place blind' basis. The devolution and levelling up agendas and the creation of Mayoral Combined Authorities (MCAs) with strong economic agendas and powers, including over skills, have begun to change this. Mayors in England now have complete responsibility for their Adult Education Budgets. Moreover, in the recently agreed 'deeper devolution trailblazer deals' in Greater Manchester and the West Midlands they are expected to be a template for deeper as well as new deals elsewhere; joint governance boards have been established so that MCAs and DFE will run 16-19 (the main part of FE) together.

So it may be that especially where VET and FE and devolution are concerned that skills policy is beginning to move in the right direction. However, this still leaves a number of major challenges if education and skills are going to play a key role in improving UK productivity performance (see Box 6.1).

Funding across all sectors remains a major issue – and will require sustained, long-term reform. Across the whole of education, the record up to now has been one of limited place based/regional differentiation, extreme policy churn, and poor co-ordination across the education system and with other policy areas that will be equally important.

Box 6.1 Mental Health and young people

There have been many economic challenges throughout history that disproportionally affected young people. Questions remain as to whether additional factors have amplified these impacts in the contemporary context. One possibility that warrants further investigation is that today's technological and social landscape may have intensified these effects. For example, exponential technological growth, particularly in artificial intelligence (AI), may rapidly reshape workplaces. At the same time, the heightened visibility of others' successes through social media may intensify feelings of uncertainty and relative deprivation among individuals already facing economic difficulties. Consistent with an amplification account, recent evidence suggests that social media use may intensify the negative effects of existing poor peer relations (Stuke et al. 2025).

The interplay between these economic and societal forces may create a uniquely challenging environment for Gen Z; one that differs from anything encountered by previous cohorts. Addressing this ongoing mental health crisis will require broader societal responses focused on workplace wellbeing, such as policies that secure employment, improve housing affordability, and provide targeted support in a rapidly changing society. Workplace interventions that specifically target young people might help.

Enhancing the role of employers

Our research evidence highlights the need to improve incentives for employers to train workers, the importance of recognising the need to adapt organisational capabilities for the AI era, and to align, and keep up with, the wider context of fast-changing ecosystems. We consider each issue in turn.

Employer provided training. it is important that we understand what constraints are actually binding for organisations to invest more in training their workers. The research by Schwartz et al. (2025) indicates the optimal training strategy is to prioritise training expenditure for depth and quality rather than merely broad access to training coverage. Further, additional gains can be achieved from complementary investments in training across managerial and staff levels. The results challenge the traditional policy emphasis on lower skilled training alone (Green and Henseke 2019). Instead, it highlights the importance of training staff in professional and associate professional roles, who are frequently responsible for driving productive improvements within organisations.

As employers face worker shortages and disengagement, organisations should also design training schemes to balance staff skill development and management upskilling, investing in untapped potential of all employees (CIPD 2021). Our findings carry implications for organisational alignment. In many organisations, HR managers may prioritise training and employee development, whereas other departments emphasise innovation or cost efficiency (TPI 2024). Demonstrating a clear return to training investment, especially in high-skill professional roles aligned with technological and strategic needs, can foster greater alignment across internal functions and reduce organisational (and inter-organisational) fragmentation. By focusing on training practices, targeting specific employee groups and demonstrating a return to the business, the study by Schwarz et al. (2025) offers stakeholders robust new evidence that investment in employee development results in superior performance.

Finally, our findings speak to the institutional context of workforce development. In recent decades, the United Kingdom has held fast to its belief in a free market for training, similar to the United States. This approach assumes that market incentives are sufficient to encourage people to acquire skills. This differs from countries such as Germany, France, Australia, Japan and Sweden, where institutions were created to address the market failures resulting from insufficient investment in skills when financed only by private companies and individuals (Douch et al. 2020). In particular, the UK's decentralised, voluntarist model places responsibility on individual employers, often leading to under-investment and short-termism. Rethinking the incentives and institutional frameworks for long-term and inclusive skill development, particularly for intermediate and high-skill roles, should be a priority in joined-up industrial policy.

By showing that training returns vary by occupational group, Schwarz et al. (2025) argue for embedding workforce development into sector deals, mission-led innovation programmes and place-based strategies—backed by stronger employer co-investment and institutional coordination. In sum, training should not be treated as a peripheral activity but as a central pillar of industrial competitiveness and inclusive economic growth. Finally, the authors and the CIPD (2021) report both highlight lack of information on training especially for smaller firms, in particular for on-line training, which could be addressed by policy.

Organisational capabilities. The evidence reviewed in this report (Chapter 4) demonstrates that digital transformation is not simply a matter of technology acquisition but of cultivating the relational and organisational capabilities that enable firms to implement, adapt, and derive value from digital tools. TPI research suggests that organisations need to move beyond viewing digitalisation as a one-off investment or discrete IT project and instead approach it as an ongoing process of organisational change (Vecciolini et al., 2026). This requires a new approach to management strategy and structures alongside DT investment, which consists of:

i) Questioning the extent to which (and how) DT investment would aid the overall strategic aims of the organisation (including by forecasting the financial implications over the medium and long-term);

ii) Developing internal structures that can engage effectively with technology providers (e.g., designating internal digital champions);

iii) Improving cross-functional communication (e.g., between operations and IT teams);

iv) Undertaking an open-minded evaluation (with possible amendments for the future) of specific modes of DT adoption based on the ongoing operationalisation of DTs and changing skills.

It also requires the aligning of organisational capabilities with a multi-pronged approach to skill development with AI implementation, by considering some or all of the following: establishing a shared baseline of AI proficiency across the organisation; combining formal programme-led training with peer and community learning; committing to bespoke training tied to work redesign and higher rates of pay; investing staff time and budget in experimental forms of learning; supporting collective efforts to realign occupational skills so as to promote bottom-up, worker-initiated innovation for enhanced worker performance and job fulfilment; and identifying lead users (individuals or teams) to run expert sessions and provide practical support with feedback loops for continuous improvement (D'Ippolito et al., 2026; Grimshaw et al., 2026b).

Fast-changing ecosystems.. Innovations in AI and digital technologies are changing the architecture of industry ecosystems as organisations in all sectors of the economy enter into new relationships with an array of technology providers. The TPI management research (Chapter 4) revealed a variety of new linkages in distinctive contexts: SME manufacturing firms with DT and software firms; independent games studios with specialist AI firms; SME firms in all sectors with digital platform companies; and livestock farm business with data-led DT (agritech) companies.

Evidence from research on the independent games industry highlights the need to follow patterns of job losses, job gains and changing skills across inter-firm linkages (across sectors). As games studios substitute tasks and functions with AI tools and plug-in software development kits, they contribute to the expansion of specialist AI firms that are increasingly able to offer AI-generated functions that can add higher value than the human labour replaced. In this scenario, the studio loses some of its profits to the AI software sector (Grimshaw et al., 2026b).

While knowledge gaps with specialist AI and DT firms provide the fuel for innovation, sustained skill-enhancing performance requires efforts to establish collaborative relationships among organisations in an ecosystem (Vecciolini et al., 2026). Efforts to bridge knowledge gaps can also involve sharing experiences of DT use among other organisations in the same sector where relationships are strong. Depending on the nature of the project or activity, practices may involve: customised interfaces and frequent communications; joint team problem-design and problem-solving; investment in inhouse training and capability building; and adjustment of inter-firm methods to diagnose problems and change aspects of collaborative relationship.

Furthermore, a specific set of 'extended HRM practices' among workers in an ecosystem emerge from the study of how SMEs source skills from freelancers organised by digital platform companies (Lee et al., 2026). To improve the effectiveness of search and assimilation of external knowledge, extended HRM practices directed at platform freelance workers can include any of the following extensions of a firm's inhouse HRM: clear and transparent evaluation criteria; detailed constructive feedback on submissions of completed tasks; integration to online

community forums; extension of reputation systems (e.g., badges, leaderboards); and inclusion in non-financial incentives that signal status and recognition.

A focus on job design

TPI research also underscores the vital need for policy and practice to think more carefully about the nature of job design as a vehicle for enhancing skills and organisational capabilities, improving wellbeing and productivity.

The first recommendation is to embed job quality and learning within productivity policy. Productivity strategies should explicitly recognise job design, learning opportunities and worker wellbeing as foundations of sustained performance. This includes support for employer investment in high-quality job design, progression pathways and in-work learning, particularly in lower-productivity sectors.

The second recommendation is to enhance job resource complexity through effective work design and improve learning. The findings suggest that national policies promoting job designs that increase job resource-complexity can enhance workforce productivity and well-being, particularly in poor learning contexts. Policies encouraging autonomy, task variety, and social support at work could reduce job strain and improve learning and performance outcomes, contributing to national economic growth. At regional and local levels, workforce development programs can incorporate training for managers on designing jobs with appropriate complexity bundles. Supporting local employers in creating motivating work environments may improve employee retention and regional productivity. Businesses should focus on developing clusters of job characteristics that enhance job resource-complexity, fostering environments that support employee discretion, task variety, and social support. Leadership training should highlight the balance between challenging employees and avoiding excessive job strain by managing challenge and hindrance demands effectively. Furthermore, these benefits may be felt in lower skilled occupations and not just higher skilled work where greater complexity is typically expected.

At the same time, job design should seek to manage job challenge-complexity carefully to leverage its positive effects on learning and performance while mitigating job strain. Similarly, there is a need to monitor and reduce job hindrance-complexity factors such as role conflict and interruptions to prevent negative outcomes. Finally, training managers and policymakers on the differentiated impacts of job complexity types provides a route to inform more effective job design strategies.

Employee voice and productivity

Our research highlights the fundamental role of employee engagement (or voice) in organisational processes of enhancing skills and capabilities. While the size of the direct effect of employee voice on productivity remains unclear in broader research, the TPI research provides some key insights about how voice and voice effectiveness can improve productivity directly and indirectly, making investment in effective voice systems a potentially low-cost intervention with reach across every type of firm (Findlay et al., 2026).

Senior management responsiveness to voice really matters in terms of the potential of voice to deliver pro-productivity outcomes, including in response to digitalisation (Box 6.2). Decentralisation of HR (including voice) to line management has dominated debates in recent decades, but the TPI research is an important reminder of the need for visible senior management

commitment to effective worker voice. The challenge is how to incorporate voice practices into management strategy: managers interviewed considered worker voice to be of major significance, but consider it more in terms of an innate aspect of daily organisational life than an HR policy worthy of strategic design.

Part of the problem is that organisations' voice approaches tend to be ad hoc in their development. More explicit consideration of the purposes of voice may be beneficial, particularly in deploying voice to improve productivity. A key research insight was that organisations knew little about what voice delivers, highlighting the potential for applied research that supports better voice practice. Voice channels bring direct and indirect costs (for example, the cost of engagement surveys, or time for their operation), so knowing what they can and do deliver is important.

Box 6.2. Employee engagement with digitalisation

With the implementation of digital technologies, organisations require a new strategy for employee engagement in designing processes of open and shared learning and skill development (Bindl et al., 2026). This likely requires managers, working with specialist employee leads, to establish and diffuse a transparent approach (formal and informal) to experimenting and scaling positive cases of skill enhancement with DT use and innovative performance. In management jargon, it means building absorptive capacity through iterative learning-by-doing.

In brief, it involves engaging in open forms of communication and employee engagement by:

- Avoiding a top-down approach and instead co-designing learning initiatives with expert leads from relevant technical function areas;
- Appreciating the range of options for mutual gains (including across all functional groups);
- Identifying the readiness of diverse groups and teams to engage in more digitalised work.

Source: Bindl et al. (2026).

The research on employee voice suggests two important themes in terms of future policy. First, organisational voice policies are of most insight in the UK context because regulation of workplace voice is relatively weak. The Employment Rights Act 2025 makes provisions of relevance to workplace voice, such as rights to trade union access, but it remains to be seen when, how and how well these will be enforced and what outcomes the ERA will deliver. The research can inform any future plans for extending voice regulation in the UK. Second, influencing employers and their practice is a key lever of state policy beyond regulation (Findlay et al, 2024). Encouraging, incentivising and supporting employers to deliver more effective voice systems may be a fruitful if novel way of addressing the UK's productivity puzzle.

A further recommendation is the need for more in depth evaluation of voice mechanisms in organisations. Greater evaluation of mechanisms against clear voice objectives or in terms of their effectiveness and whether the most appropriate voice mechanism are used could improve employee voice. Similarly, a holistic approach that considers the variety of voice mechanisms can identify unmet needs, or where duplication of channels is necessary or unnecessary, while

also help ensuring there are not too many mechanisms competing for employee attention or causing consultation overload. A lesson for employers may be the need for greater attention to a cost-benefit analysis of voice channels separately and in combination to avoid offsetting positive voice outcomes and continuing to engage in more pointless voice activity.

While context matters – voice configurations are likely to look different in small and large firms, for example – there are important underlying themes and insights from the research that can improve employer practice. That the research identified employer and worker appetite for effective voice – and shared motivations as to what effective voice can deliver – provides a promising platform on which to enhance voice and its outcomes. Voice at work can be, but does not need to be, a wholly contested domain and can be harnessed to deliver on employer and worker objectives.

The research also finds that employee involvement and participation may require capacity building, particularly in more complex decision-making where employees may lack the knowledge or competencies to express their voice. For more complex issues, the expectation that employees can simply turn up and contribute effectively to meetings without a process of broader organisational learning may be sometimes unrealistic. The use of indirect voice through employee representatives provides an alternative mechanism to direct voice where an incumbent (e.g. trade union or consultative committee member) can develop expertise within their position over time. At the same time, staff turnover between roles and the formation and dissolution of different committees may act as an impediment to such organisational knowledge development and retention.

Finally, a climate of psychological safety is essential to effective voice. The findings suggest that multiple and varied motivations for voice don't impact voice actions, suggesting that concerns over whether voice is self-interested or pro-organisational may be of little consequence in encouraging voice. While perceptions of the consequences of voicing didn't seem to deter voice action, it is worth noting that significant minorities of survey respondents (15-35% across cases) reported concerns over negative consequences of raising their voice. Relatedly, the research found that closing the feedback loop is an essential part of employee voice, given employees may lose motivation or not consider voice to be beneficial if no action is taken or feedback is not communicated.

Sector-specific challenges

Across the varied sectors of the UK economy, there is a need to align industrial policy and skills policy with employment strategies, at sector and organisational levels. Sector-focused approaches, particularly in low-wage industries, are needed to avoid technology strategies that displace risk onto workers while delivering limited productivity gains. TPI research investigated the issues in a range of sectors. We summarise some of the issues for policy and practice here.

UK policy for the **manufacturing sector** has increasingly recognised the need for targeted skills support, reflected in initiatives such as the Made Smarter Leadership Programme and digital internships introduced in the North West pilot (Made Smarter, 2019). TPI research supports this and calls for similar interventions to be scaled up nationally, embedded within technical education and apprenticeship frameworks (Vecciolini et al., 2026). Greater coordination between industry, local skills partnerships, and further education colleges is essential to delivering modular, flexible programmes that match SMEs' time and resource constraints. A national skills strategy for digital manufacturing should therefore integrate three pillars:

i) Baseline digital upskilling for the existing manufacturing workforce;

ii) Specialist training for digital transformation leaders within SMEs; and

iii) Incentives for technology providers to develop customer-oriented training and certification pathways.

For **purpose-driven media organisations,** (such as the BBC), well-designed skills and technology practices need policy support so that teams can experiment safely with permissions, data access, and governance processes to apply tools in their workflows (D'Ippolito et al., 2026). A clear policy implication for public media organisations is to establish digital data protocols and share good practice regarding:

i) Investment in accessible, robust data- and permission-governance infrastructure; and

ii) Promotion of controlled experimentation sandboxes where approved tools and datasets can be used within clear guardrails. This reduces the operational 'drag' that otherwise blocks diffusion and creates the conditions for organisations' learning efforts to convert into repeatable organisational practice.

For the **food production sector,** support for automation and digital adoption should be conditional on parallel investment in workforce skills, job quality and voice (Bowkett et al., 2025). While TPI research identified business pressures to maintain a degree of labour market flexibility (e.g. temporary contracts/ seasonal visas), the wider labour market pressures to raise employment standards for the core workforce acted as 'beneficial constraints' by encouraging greater investment in technology. Nevertheless, many firms face difficulties in accessing finance so a key recommendation is for greater availability of longer-term financing. Supporting a successful digital transition, particularly when upgrading existing physical infrastructure and upskilling the existing workforce, requires a long term, and incremental adoption strategy.

There is also an urgent need to address the management skills and knowledge gap around the implementation of data-based technologies in a food production environment. This requires more independent advice (e.g. outside of machine manufacturers/consultants), and access to 'honest brokers' who can advise on benefits and costs across brands and ecosystems (e.g. related to rentier economy; monthly costs to access data etc.). This may include the expansion of existing infrastructure to support technology diffusion (e.g. the Catapult network), and would benefit from additional financial support to reduce cost or financially incentivise firm take up of these services. Provisions for skills upgrading should also extend to the workforce. Firstly, to upgrade shopfloor workers' digital literacy skills, as well as literacy, numeracy and language skills, while attentive also to enhancing certain traditional craft skills (e.g., butcher), technical skills (e.g., food engineer; mechanical engineer; technician; food scientist), and electrical, robotics, IT and data skills.

Self-employment. Part-time work and productivity

Beyond the purported short-term financial benefits of outsourcing models, the longer-term implications for broader internal human capital development and succession require careful consideration. While potential tax incentives to the use of self-employed contractors may seem attractive, the overuse of outsourcing presents several potential issues to productivity. Firstly, the loss of internal human resource development capacity may mean that the mechanisms for human capital transfer between more experienced and less experienced workers become weakened. In effect external consultants may present a 'firewall' between expertise knowledge

and clients to maintain their market value. Secondly, the reliance on a cohort of solo workers who benefited from self-employment trends in the context of an ageing population may further lead to human capital loss when such people retire.

An important recommendation from TPI research is to expand access to high-quality flexible and part-time work. Policy should encourage the creation of progression-compatible part-time and flexible roles across occupational levels, including through employment rights, good-practice standards and employer incentives. This is critical to reducing gendered and life-course inequalities in productive participation**.** At the same time, the long working hours culture in full-time work should be addressed as it presents a further participation challenge for part-time workers. Increases in self-employment within more knowledge intensive service work may further hold implications for firm level productivity, where knowledge and skills that were once developed and transmitted within organisations become custodian to external contractors, affecting skills pipelines.

For organisations, high-quality part-time and flexible work should be viewed as tools for retention, skill utilisation and inclusion, not simply as mechanisms for cost control or demand matching although these logics will differ in economic rationale between contexts. There is an urgent need for greater attention to how jobs are designed and work is organised to create more productive part-time opportunities. Work by Kossek and Ollier-Malaterre (2020) suggested that more attention on how to reduce workloads could enhance the productivity and effectiveness of part-time workers. Collaboratively deciding on which tasks to take away and how to integrate the reduced load among workers within the team and organisation could help. Another alternative, is to have joint or shared responsibilities for clients or through job share schemes. Such an approach requires organisations to undertake serious reviews of workloads and job design for full-timers, as well as part-timers (Kossek and Ollier-Malaterre, 2023). In doing so, managers may find that the workload for full-timers is too high for a reasonable and sustainable working life; excessive expectations of both time commitment and flexibility for full-timers is likely to make it harder to integrate part-time staff on the same career trajectory.

The wider ambition for policy and practice is to generate a context for productive lives for full-time and part-time workers. This means not only the opportunity to learn, develop and utilise skills and talents to the full, as is clearly important for a productive society, but also opportunities to avoid work contexts that may cause stress and ill-health which have negative productivity impacts on both the individual and the society. The TPI research demonstrates that part-time work can be both a mechanism by which people are able to pursue productive lives in both senses but also a cause of constraints on productivity, both limiting talent utilisation and causing stress and associated health and well-being issues.

Workers ought to be able to access part-time work as a flexible strategy to manage lifecourse events and transitions. It may be a lifeline, especially for some women with childcare responsibilities. Nevertheless, in the UK's current environment it can often be a life sentence, trapping those who opt for part-time work in jobs that offer limited opportunities for skill development and in some sectors cause insecurity and stress. The decision for working mothers to undertake part-time work in the UK reflects specific constraints and can be involuntary. Constraints include a lack of affordable and available childcare provision and persistent gender norms regarding the domestic and labour market work that exist both within the household and workplace.

Hybrid working and productivity

Finally, TPI research evidence supports a number of recommendations about working from home (WFH) or hybrid working (Chung et al., 2026). The first is to normalise flexible work to reduce stigma and unequal treatment. The management aim should be to position WFH as a standard, good work design not a special arrangement so workers are not penalised or judged for using it. Performance evaluation should be aligned with results rather than presence, ensuring homeworkers are treated fairly.

Workers' access to WFH should also be equitable as far as is practical. As WFH becomes a core feature of the labour market, ensuring equitable access is essential to prevent the reproduction of longstanding workplace inequalities. This means: monitor WFH access across specific groups, focusing on those consistently under-represented (e.g., Black men/fathers, Chinese/Other Asian workers); and improve job design to expand hybrid/occasional WFH options across a wider set of occupations.

One of the key concerns about WFH is that it encourages the "always-on" culture. As such, TPI research calls for the introduction of policies such as a right to disconnect to protect workers, especially homeworkers and disadvantaged groups such as mothers and BME workers, from constant digital availability. There is a need for organisational guidelines on response times and out-of-hours communication to prevent constant monitoring and "always-on" expectations, and to reduce pressures for digital presenteeism. Managers should be encouraged to model healthy boundaries by avoiding unnecessary late-night messaging.

A further recommendation is for organisations to address flexibility stigma and presenteeism. Flexible working may reinforce inequalities unless supported by inclusive organisational cultures. This means: provide manager training to reduce mistrust and implicit bias in WFH and flexible working especially against the more marginalised groups of the labour market; promote cultures that value outputs rather than presenteeism and (digital) face time; and strengthen HR and trade union support for ethnic minority workers, especially those with overlapping marginalisations (e.g., gender, migrant, and parental status) to reduce fears of negative consequences when requesting WFH.

Finally, we recognise that digital visibility is becoming a new currency of workplace recognition, especially in hybrid/remote settings. Digital presenteeism behaviours is so powerful to the point that it can remediate the negative impact of workers working from home. Digital presenteeism may be especially beneficial for those in more marginalised position in the labour market such as mothers or black women, especially when homeworking. Yet on the other hand we can also conclude that the penalising effect of not being engaged in digital presenteeism when homeworking is stronger for these groups. While the TPI research did not find pervasive bias against marginalised groups, the fact that digital responsiveness is interpreted differently across identities suggests that inequalities could emerge through subtle signalling dynamics, even without explicit discrimination.

References

(TPI funded in Bold)

Acemoglu, D. (2002). Technical change, inequality, and the labor market. Journal of Economic Literature, 40(1), pp.7-72.

Acemoglu, D. and D. Autor (2011). Skills, tasks and technologies: Implications for Employment and Earnings, Handbook of Labor Economics, Volume 4, part B, 1043-1171.

Afuah, A., Tucci, C.L., (2012). Crowdsourcing as a solution to distant search. Academy of Management Review 37, 355–375.

Autor, D. H., Katz, L. F., & Krueger, A. B. (1998). Computing inequality: have computers changed the labor market? The Quarterly Journal of Economics, 113(4), 1169-1213.

Autor, D., C. Goldin and L. Katz (2020). Extending the Race between Education and Technology, AEA Papers and Proceedings, 110(May), 347-51.

Baron, J. and Kreps, D. (1999). Strategic Human Resources. Oxford: Wiley.

Baruffaldi, S., van Beuzekom, B., Dernis, H., Harhoff, D., Rao, N., Rosenfeld, D. and Squicciarini, M., (2020). Identifying and measuring developments in artificial intelligence: Making the impossible possible. OECD Science, Technology and Industry working paper 2020/05

Beaudry, P., Green, D. A. and Sand, B. M. (2016). The great reversal in the demand for skill and cognitive tasks. Journal of Labor Economics, 34(S1), pp.S199-S247.

Bellandi, M., Santini, E., and Vecciolini, C. (2018). Learning, unlearning and forgetting processes in industrial districts. Cambridge Journal of Economics, 42(6), 1671-1685.

Belloc, F., Burdin, G., Cattani, L., Ellis, W. and Landini, F. (2022). Coevolution of job automation risk and workplace governance. Research Policy, **51**, 104441.

Bindl, U. K. , de Roche, I. & Fay, D. (2026). The consequences of digitalisation for sustained employee productivity: A work design approach. Mimeo. King's College London.

Blundell, R., Green, D., Jin, W. (2022). The U.K. as a Technological Follower: Higher Education Expansion and the College Wage Premium, The Review of Economic Studies, 89, 142-180.

Boons, M., Stam, D., (2019). Crowdsourcing for innovation: how related and unrelated perspectives interact to increase creative performance. Research Policy, 48(7), 1758–1770.

Bowen Martin, C. B., Deuze, M. (2009). The independent production of culture: A digital games case study. Games and Culture, 4(3), 276-295.

Bowkett, C., Jarvis-King, L., and Rubery, J. (2025). Digital adoption in UK food manufacturing: opportunities and constraints in post-Brexit Britain. Second International Symposium on Digitalisation, Artificial Intelligence, Work and Employment at the University of Sussex, 13th October 2025.

Bresnahan, T., Brynjolfsson, E., and Hitt, L. (2002). Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence, The Quarterly Journal of Economics, 117(1), 339-376.

Calvino, F., Dernis, H., Samek, L and Ughi, A. (2024). A sectoral taxonomy of AI intensity, OECD Artificial Intelligence Papers, No.30. OECD Publishing, Paris.

Campbell, D.J., (1988). Task complexity: A review and analysis. Academy of Management Review, 13(1): 40-52.

Carlile, P.R., (2004). Transferring, translating, and transforming: an integrative framework for managing knowledge across boundaries. Organization Science. 15, 555–568.

Causa, O., Nguyen, M., & Soldani, E. (2024). Lost in the green transition? Measurement and stylized facts, OECD Economics Department WP No. 1796; https://doi.org/10.1787/dce1d5fe-en

Cavaglia, C. and Etheridge, B. (2020). Job polarisation and the declining quality of knowledge workers: evidence from UK and Germany, Labour Economics, 66: 1-19.

Cheong, B. (2024). How will AI change our jobs? Available at: https://briancheong.medium.com/how-will-ai-change-our-jobs-ddab439616ab (accessed 4 September 2024).

Chung, H. and Yuan, S., (2025). Did COVID-19 level the playing field or entrench it? Comparing patterns of homeworking by ethnicity, gender and migration status, before, during and after COVID-19 in the UK. Industrial Relations Journal, 56(3): 236-250.

Chung, H. (2026). Why we can't log off? Digital presenteeism and manager's evaluation of workers across gender, parental, race, and remote working status, INFER Colloquium Seminar, January 2026.

CIPD (2021). Digital Learning in a post-Covid 19 Economy. CIPD.

Corrado, C., Hulten, C. and Sichel, D., (2009). Intangible capital and US economic growth. Review of income and wealth, 55(3), pp.661-685.

Csaszar, F.A., Ketkar, H. and Kim, H. (2024). Artificial intelligence and strategic decision-making: Evidence from entrepreneurs and investors. Strategy Science, 9(4), 322-345.

D'Ippolito, B., Miozzo, M., Zhang, H., (2026). AI technologies, skills, and organisational learning: A challenge for innovation management and strategy making. Mimeo, University of York.

D'Ippolito, B., Miozzo, M. and Pinkse, J. (2025). Aligning the generative potential of digital technologies with organizational purpose. presented at Academy of Management Annual Meeting, Copenhagen, July.

Damanpour, F., Walker, R.M. and Avellaneda, C.N. (2009). Combinative effects of innovation types and organizational performance: A longitudinal study of service organizations. Journal of Management Studies, 46(4), 650-675.

De Coulon, A., da Silva Marioni, L., O'Mahony, M., Serberis, P., and Venturini, F. (2026). Using New Sources of Data to Understand Skill Demand and Supply: A Regional Analysis, mimeo, King's College London.

ECB (2023). The impact of Brexit on UK trade and labour markets. ECB Economic Bulletin, Issue 3/2023.

Edwards, P., B. Kuhn-Sherlock, B. Dela Rue et al. (2020. Short communication: technologies and milking practices that reduce hours of work and increase flexibility through milking

efficiency in pasture-based dairy farm systems. Journal of Dairy Science, 103 (8) pp. 7172–7179.

FDF. (2024). Future factory: Supercharging digital innovation in food and drink manufacturing. London: Food and Drink Federation.

Findlay, P., Stewart, R., Lindsay, C., McQuarrie, J., & Remnant, J. (2024). Fair work policy levers in Scotland (Report for the Fair Work Convention).

Findlay, P., McQuarrie, J. and Lindsay, C. (2026). Let's talk about voice: the role and potential of employee voice in improving productivity. Mimeo. SCER: University of Strathclyde.

Franzoni, C., Sauermann, H., Di Marco, D., (2025). When citizens judge science: crowd evaluations in Mode 2 knowledge production. Research Policy, 54(5), 105214.

Goldin, C., & Katz, L. F. (1998). The origins of technology-skill complementarity. The Quarterly Journal of Economics, 113(3), 693-732.

Goos, M. and Manning, A. (2007). Lousy and lovely jobs: the rising polarization of work in Britain, Review of Economic and Statistics, 89(1): 118 – 133.

Gorovaia, N., Pajić, M. and Windsperger, J. (2023). Performance of knowledge transfer mechanisms: The case of franchising networks. Industrial Marketing Management, 115, 539-549.

Green, F., & Henseke, G. (2021). Europe's evolving graduate labour markets: supply, demand, underemployment and pay. Journal for Labour Market Research, 55(1), 1-13.

Grimshaw, Damian, and Marcela Miozzo (2026). How Are Skills Changing with Digital Technologies? Clarifying Boundary Conditions in Management Research. Journal of Management Studies, https://doi.org/10.1111/joms.70057.

Grimshaw, D., Miozzo, M. and Kyriakopoulos, P. (2026a). Forging new common ground with data-driven technologies in the livestock sector. Mimeo. King's College London.

Grimshaw, D., Miozzo, M. and Sosa, L. (2026b). Bypassing with AI at work: Identifying the ripple effects of broad technology on the architecture of work. Mimeo, King's College London.

Hanelt, A., Bohnsack, R., Marz, D. and Antunes Marante, C. (2021). A systematic review of the literature on digital transformation: Insights and implications for strategy and organizational change. Journal of Management Studies, 58, 1159–1197.

Haskel, J., & Westlake, S. (2018). Capitalism without Capital: The Rise of the Intangible Economy. Princeton University Press.

Heiland, H. (2021). Controlling space, controlling labor? Contested space in food delivery gig work. New Technology, Work and Employment, 36, 1–16.

Holman, D. & Rafferty, A. (2025). Global and national factors shaping work design, in S. Parker, C. Knight, F. Kloneck and F. Zhang (eds) Transformative work designs: synthesis and new directions. The Society for Industrial and Organizational Psychology Organizational Frontiers Series, Oxford: Oxford University Press.

Holman, D., Gabr, H. and Rafferty, A.L. (2026a). The complex effects of job complexity: A meta-analysis of job complexity and employee outcomes, Mimeo, University of Manchester (under peer review).

Holman, D., Rafferty, A.L. and Gabr, H. (2026b). Job complexity and employee learning in Europe, a multi-level analysis, mimeo, University of Manchester.

Hopkins, B. (2011). Informal hierarchies among workers in low-skill food manufacturing jobs. Industrial Relations Journal, 42, 486–499.

James, S., & Lloyd, C. (2008). Supply chain pressures and migrant workers: Deteriorating job quality in the United Kingdom food-processing industry. In C. Lloyd, G. Mason, & K. Mayhew (Eds.), Low-wage work in the United Kingdom (pp. 211–246). New York: Russell Sage Foundation.

Joyce, K., Postel-Vinay, F., Spittal, P., and Xu, X. (2022). Job opportunities after the pandemic. IFS Report, Institute for Fiscal Studies.

Katz, L. F., Murphy, K. M. (1992). Changes in relative wages, 1963–1987: supply and demand factors. The Quarterly Journal of Economics, 107(1), 35-78.

Kellogg, K. C., Myers, J. E., Gainer, L. and Singer, J. (2021). Moving violations: Pairing an illegitimate learning hierarchy with trainee status mobility for acquiring new skills when traditional expertise erodes. Organization Science, 32, 181–209.

Kellogg, K. C., Valentine, M. and Christin, A. (2020). Algorithms at work: The new contested terrain of control. Academy of Management Annals, 14, 366–410.

Kohtamäki, M., Rabetino, R., Parida, V. and Ritala, P. (2025). Strategy in the digitalization era. International Journal of Management Reviews, 27(3), 309-323.

Kossek, E.E. and Ollier-Malaterre, A. (2020). Desperately seeking sustainable careers: Redesigning professional jobs for the collaborative crafting of reduced-load work Journal of Vocational Behavior, 117(2): 1-15.

Krueger, A.B. (1993). How computers have changed the wage structure: evidence from microdata, 1984–1989. The Quarterly Journal of Economics, 108(1), pp.33-60.

Kulichyova, A., Kazantsev, N., White, L. and Islam, N. (2025). Digital transformation in large established organisations: Four restructuring dilemmas based on dynamic capabilities. International Journal of Management Reviews, 27(3), 420-450.

Lampel, J., Lant, T., Shamsie, J. (2000). Balancing act: Learning from organizing practices in cultural industries. Organization Science, 11(3): 263-269.

Lane, P. J., Salk, J. E., & Lyles, M. A. (2001). Absorptive capacity, learning, and performance in international joint ventures. Strategic Management Journal, 22(12), 1139–1161.

Lee, H.-F., Miozzo, M., Grimshaw, D. and Rani, U. (2026), Extending HRM to the crowd? Organizational mechanisms to enhance exploratory innovation using crowdsourcing. Mimeo. King's College London.

Luo. W., De Coulon, A., O'Mahony, M and Schnall, S. (2026). Gen Z's mental health in the workplace: Greater depression than other generations? Mimeo University of Cambridge.

Machin, S., & Van Reenen, J. (1998). Technology and changes in skill structure: evidence from seven OECD countries. The Quarterly Journal of Economics, 113(4), 1215-1244.

MacKenzie, R., & Forde, C. (2009). The rhetoric of the "good worker" versus the realities of employers' use and the experiences of migrant workers. Work, Employment and Society, 23(1), 142–159.

Made Smarter (2019). Digital internships: How Made Smarter helps SME manufacturers tap into tech talent. https://www.madesmarter.uk/media/pewdgkvy/digital-internships-white-paper.pdf.

Martin, J., & Monahan, E. (2022, March). Developing a method for measuring time spent on green tasks—Office for National Statistics. Office for National Statistics. https://www.ons.gov.uk/economy/environmentalaccounts/articles/developingamethodformeasuringtimespentongreentasks/march2022

McCollum, D., & Findlay, A. (2015). 'Flexible' workers for 'flexible' jobs? The labour market function of A8 migrant labour in the UK. Work, Employment and Society, 29, 427–443.

Messeni Petruzzelli, A., Murgia, G., and Parmentola, A. (2022). How can open innovation support SMEs in the adoption of I4. 0 technologies? An empirical analysis. R&D Management, 52(4), 615-632.

Nambisan, S., Wright, M. and Feldman, M. (2019). The digital transformation of innovation and entrepreneurship. Research Policy, 8, 1–9.

Newsome, K., & Vorley, T. (2020). Contemporary work and employment and the productivity puzzle. In P. McCann & T. Vorley (Eds.), Productivity perspectives. Cheltenham: Edward Elgar Publishing.

Nooteboom, B., Van Haverbeke, W., Duysters, G., Gilsing, V., & Van den Oord, A. (2007). Optimal cognitive distance and absorptive capacity. Research Policy, 36(7), 1016–1034.

OECD. (2018). OECD employment outlook 2018. Paris: OECD Publishing.

O'Mahony, M., Robinson, C., and Vecchi, M. (2026). Working in an Immaterial World: Intangible Assets and the Supply and Demand for Skilled Labour, Working Paper No. 066, The Productivity Institute.

O'Mahony, M., Serberis, P and Da Silva Marioni, L. (2026). 'Digital skill demand by region and industry in the UK', TPI Working Paper, forthcoming.

ONS. (2023). Migration and the labour market, England and Wales: Census 2021. London: Office for National Statistics.

Piezunka, H., Dahlander, L. (2015). Distant search, narrow attention: how crowding alters organizations' filtering of suggestions in crowdsourcing. Academy of Management Journal, 58, 856–880.

Rafferty, A.L., Rubery, J. & Bi-Swinglehurst, I. (2026). Part-time self-employment and the polarisation of the UK labour market (2005-24), mimeo, University of Manchester.

Rubery, J. Bi-Swinglehurst, I. and Rafferty, A. (2024). Part-time work and productivity, Insights Paper No. 031, The Productivity Institute.

Rubery, J., Bi-Swinglehurst, I. & Rafferty, A. (2026 forthcoming). Ensuring women can lead productive lives: a neglected objective in the productivity agenda, in R. Green (ed) Productivity. London: Routledge.

Rubery, J., Bi, I. & Rafferty, A. (2023). Gender and Productivity. Working Paper No. 032, The Productivity Institute.

Ryu, H.S. and Lee, J.N. (2018). Understanding the role of technology in service innovation: Comparison of three theoretical perspectives. Information & Management, 55(3), 294-307.

Salunke, S., Weerawardena, J. and McColl-Kennedy, J.R. (2019). The central role of knowledge integration capability in service innovation-based competitive strategy. Industrial Marketing Management, 80, 181-196.

Salvatori, A. (2018), The anatomy of job polarisation in the UK, Journal of Labour Market Research, 52(8).

Scott, S. (2012). Migrant–local hiring queues in the UK food industry. Population, Space and Place, 19(5).

Si, S. X., & Bruton, G. D. (2005). Knowledge acquisition, cost savings, and strategic positioning: Effects on Sino–American IJV performance. Journal of Business Research, 58(11), 1465–1473.

Simms, C., and Frishammar, J. (2024). Technology transfer challenges in asymmetric alliances between high-technology and low-technology firms. Research Policy, 53(3), 104937.

Smiderle, I., Bontadini, F., Filippucci, F., Gallo, E., Jona-Lasinio, C., Nicoletti, G. and Saia, A. (2026). Capturing Green and Digital Intensities: Key Metrics for Monitoring the Twin Transition, Working Paper No. 069, The Productivity Institute.

Stansbury, A., Turner, D., and Balls, E. (2023). Tackling the UK's regional economic inequality: Binding constraints and avenues for policy intervention. Contemporary Social Science, 1–39.

Schwarz, S., Du, J., Nduka, U. and Zhang, L. (2025). The impact of staff and manager training on firm productivity: differential and interaction effects, British Journal of Industrial Relations, 1, 148–167.

Stuke, H. et al. (2025). Peer relationships are a direct cause of the adolescent mental health crisis: Interpretable machine learning analysis of two large cohort studies. JMIR Public Heal Surveillance 11, e60125–e60125.

Thompson, P., Parker, R., Cox, S. (2016). Interrogating creative theory and creative work: Inside the games studio. Sociology, 50(2), 316-332.

Valero, A., Draca, M., Li, J., Muller, S., Nguyen-Tien, V., & Riom, C. (2021). Are 'green' jobs good jobs? CEP Reports, Article 39. https://ideas.repec.org//p/cep/cepsps/39.html

Vecchi, M., Robinson, C., Savic, M., and Romiti, M. (2023). Vertical and horizontal mismatch in the UK: Are graduates' skills a good fit for their jobs. NIESR Discussion Paper No. 548, NIESR.

Vecciolini, C., Miozzo, M., Grimshaw, D. and He, Y. (2026). How Interorganizational Dissimilarities Interact to Shape Knowledge Integration Modes. Mimeo. King's College London.

Vignoles, A., De Coulon, A., and Marcenaro-Gutierrez, O. (2011). The value of basic skills in the British labour market. Oxford Economic Papers, 63(1):27–48.

Violante, G.L., (2018). Skill-biased technical change. In The new Palgrave dictionary of economics (pp. 12389-12394). Palgrave Macmillan, London.

Vom Lehn, C. (2018). Understanding the decline in the U.S. labor share: evidence from occupational tasks. European Economic Review, 108, 191–220

Waardenburg, L., Huysman, M. and Sergeeva, A.V. (2022). In the land of the blind, the one-eyed man is king: Knowledge brokerage in the age of learning algorithms. Organization Science, 33(1), 59-82.

Wang, L., Jin, J. L., & Zhou, K. Z. (2023). Technological capability strength/asymmetry and supply chain process innovation: The contingent roles of institutional environments. Research Policy, 52(4), 104724.

Wang, S. and Chung, H., (2026). Revisiting Flexibility Stigma: how framing remote working shapes bias against remote workers. Gender, Work & Organization, online first, published 28th February 2026. Wang, S. and Chung, H., 2026.

Wiblen, S. and Marler, J. (2021). Digitalized talent management and automated talent decision. International Journal of Human Resource Management, **32**, 2592–2621.