

Aligning Resources for Productivity: A Synthesis of TPI Research 2023-2026

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Preface and Acknowledgements

This report synthesises key insights from The Productivity Institute’s research programme conducted between 2023 and 2026. It draws on the work of more than 100 researchers and synthesises findings from around 80 research papers. The summary chapters are based on five programme-level synthesis reports prepared by the respective research leads:

- Damian Grimshaw, Mary O’Mahony and Anthony Rafferty, [Skills, Organisations and Worker Engagement: Summary of TPI People Research Programme 2023-2026](#).
- Stephen Roper and Chander Velu, [Adoption, implementation, alignment – maximising the performance benefits of digital investment: Summary of TPI Firms Research Programme 2023-2026](#).
- Philip McCann, [Regional Access to Capital and Investment Finance: Summary of TPI Research Programme 2023-2026](#).
- Catherine Mann, [Finance, Investment, and Productivity: Distillation and Synthesis of TPI Finance Research Programme 2023-2026](#).
- Raquel Ortega-Argilés and Philip McCann, [Knowledge Diffusion and Regional Productivity Growth: Summary of TPI Research Programme 2023-2026](#).

We are grateful to the research leads for their leadership of the individual programmes, for distilling a large and diverse evidence base into coherent synthesis reports, and for responding constructively to our comments. We also thank them for their feedback on this summary report. The original research outputs and full lists of contributors are acknowledged in the individual chapters. We thank all researchers involved for their substantive contributions to this programme.

We would also like to thank Tony Venables for originating the design of this research programme, and James Wilson (TPI) for his support in preparing the reports for publication. We acknowledge the Economic and Social Research Council for their financial support of TPI’s research programme (ES/V002740/1).

In preparing this summary report, we have made limited use of Copilot tools to assist with editing and synthesising the extensive research material we rely on. All AI-supported edits have been carefully reviewed, verified and where necessary amended. As authors of this report, we take full responsibility for the interpretation, presentation, and framing of the findings.

Abstract

This report synthesises findings from The Productivity Institute's 2023–2026 research programme, drawing on around 80 studies by more than 100 researchers. It examines both the sources of the UK's persistent productivity weakness and the directions needed to address it. Adopting a systemic and multidisciplinary perspective the research focuses on how productivity outcomes are shaped by interactions and complementarities across people, firms, institutions, and places. The research shows that isolated interventions across skills, digital adoption, finance, regional development and innovation, deliver limited returns when they are not aligned with organisational practices, business models, financial systems and local institutional capacity. Productivity gains are strongest where policy interventions, business strategies and governance evolve in a coherent and mutually reinforcing way. The report concludes that sustaining higher and more inclusive productivity growth in the UK requires coordinated, place sensitive policies and business strategies that strengthen complementarities rather than relying on single lever reforms.

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1. Introduction and Synthesis

Background

Productivity growth is the fundamental driver of long-term economic prosperity. It shapes the success of high-performing firms, creates room for investment and real wage growth, and underpins rising living standards. Productivity supports the sustainability of public finances, determines the capacity to invest in public services, and shapes how effectively economies can respond to structural change. Ultimately, highly productive regions, cities and towns are places where business wants to invest and where prosperity can be sustained over time.

In the UK, however, productivity growth has been persistently weak since the mid-2000s. The slowdown that followed the Global Financial Crisis proved deeper and more enduring than in most comparable advanced economies.¹ More recently, productivity growth has remained subdued in the aftermath of the pandemic, despite a rapid acceleration of technological, and especially digital, opportunities.² These trends have also been apparent in other developed economies, although the United States has recently been less affected by the productivity slowdown while performance in the UK seems weaker than elsewhere.

This underperformance, which is unusual by historical and international standards and cannot be explained by a single factor, has shaped The Productivity Institute's agenda in recent years. In *The Productivity Agenda*³, TPI identified three interrelated structural weaknesses: chronic underinvestment; weak diffusion of productivity-enhancing practices between firms and places; and institutional fragmentation that undermines coordination across policies and actors. These weaknesses reinforce one another, creating low-productivity traps that are difficult to escape.⁴

¹ The UK Productivity Commission (2022). *Productivity in the UK: Evidence review*. National Institute of Economic and Social Research & The Productivity Institute. <https://niesr.ac.uk/wp-content/uploads/2022/06/Productivity-in-the-UK-Evidence-Review.pdf>.

² Pabst, A. and Mortimer-Lee, P. (eds.) (2022). *Covid-19 and productivity: Impact and implications*. National Institute of Economic and Social Research & The Productivity Institute. <https://niesr.ac.uk/publications/covid-19-and-productivity-impact-and-implications>.

³ Coyle, D., van Ark, B. and Pendrill, J. (eds.) (2023) *The Productivity Agenda*. Manchester: The Productivity Institute. <https://www.productivity.ac.uk/research/the-productivity-agenda-report/>.

⁴ McCann, P. (2016). *The UK Regional–National Economic Problem: Geography, Globalisation and Governance*. London: Routledge; Van Ark, B. and O'Mahony, M. (2024) What explains the UK's productivity problem? The Productivity Institute. <https://www.productivity.ac.uk/news/what-explains-the-uks-productivity-problem/>; van Ark, B., Pendrill, J., Penney, K., Wilson, J., & Ortega-Argilés, R. (2025). *Regional Productivity Agenda: A guide to the productivity performance of the English regions and devolved nations*. The Productivity Institute. <https://www.productivity.ac.uk/research/the-regional-productivity-agenda/>.

This prolonged period of stagnation has had profound consequences. Real wage growth has been subdued for much of the past decade; fiscal pressures have intensified as slow growth has constrained revenues while demands on public spending have risen; and regional disparities in income and opportunities have widened. Productivity weakness has also constrained the UK's ability to confront major long-term challenges, including the transition to net zero emissions, population ageing, the disruptive pace of technological change associated with digitalisation and artificial intelligence, and heightened geopolitical and trade uncertainty.⁵

A consistent theme in TPI's work is that the UK's governance system is both highly centralised and deeply fragmented. Decision-making authority and resources are concentrated at the centre, yet dispersed across policy domains and institutions, undermining the delivery of joined-up, pro-productivity outcomes. Public debate often mirrors this fragmentation, focusing on individual issues, such as skills shortages, weak investment, low innovation, poor management, planning constraints, or regional inequality, in isolation. Each is important, but none is sufficient on its own, pointing to the need for a more coherent, long-term, joined-up productivity strategy.⁶

Against this backdrop, the *TPI Research Programme 2023–2026* adopts a systemic view of productivity. A key insight is that productivity depends not simply on mobilising single inputs, assets or resources, but on how well those actions are combined, aligned, and coordinated. In the UK, the core challenge is not simply a lack of technology or scientific excellence, even though skill shortages and limited access to finance are critical issues in many regions. Rather, it is the difficulty of deploying resources in ways that reinforce one another across people, firms, and places.

The need for alignment has become more pressing in the current digital age. While new technologies offer substantial opportunities, their impact depends on being developed and deployed alongside other pro-productivity interventions. Technology without skills, skills without good jobs, investment without organisational change, and innovation without diffusion all tend to deliver limited returns. This research synthesis therefore aims to identify where alignment can be strengthened and where complementarities across the productivity system offer the greatest potential for improvement.

⁵ Coyle et al. op cit.

⁶ Van Ark, B., Millard, S., Pabst, A., & Westwood, A. (Eds.). (2025). *Joining up pro-productivity policies in the UK*. National Institute of Economic and Social Research & The Productivity Institute. <https://www.productivity.ac.uk/research/joining-up-pro-productivity-policies-in-the-uk/>.

Setup of the research programme

In addressing these issues, the *TPI Research Programme 2023–2026* is organised around three interdependent domains: People, Firms, and Institutions. While these domains closely reflect the productivity themes identified in earlier TPI work⁷, the new research highlights how interventions within and across these domains interact and reinforce one another, rather than focusing on their effects in isolation.

This report represents our first attempt to integrate and synthesise findings from the work of about 100 researchers and some 80 research papers. The research programme has brought together a wide range of disciplines, including economics, management and organisation studies, innovation studies, employment relations, psychology, and regional science.

Methodologically, it combines large-scale quantitative analysis, firm-level and worker-level survey evidence, administrative data, qualitative case studies, and international comparisons. This breadth reflects a deliberate choice: productivity is shaped by complex, multi-layered processes that cannot be adequately captured through a single method or disciplinary lens.

People (Chapter 2)

The People programme focuses on how skills are developed, deployed, and sustained over time, and how these processes interact with job design, management practices, and worker engagement. It challenges traditional approaches that treat skills primarily as an education-system output or a static attribute of the workforce.

Instead, the research examines how skills are used within organisations, how they evolve as technologies and tasks change, and how organisational context shapes learning and performance. Key themes include sub-national skill mismatches, the long-term decline in employer-provided training, differences between training breadth and training depth, and the critical role of management capability in translating skills into productivity.

There is also a strong focus on how digital and AI technologies reshape work, highlighting that technological change affects not only task composition, but job autonomy, job complexity, and skill requirements. Employee voice, job quality, and mental health are examined as integral determinants of sustained productivity performance.

Firms (Chapter 3)

The Firms programme examines how organisations adapt to major structural transitions, with a particular focus on digitalisation and the transition to net zero. A central motivation

⁷ Coyle et al. op cit.

is the observed disconnect between the large opportunities offered by digital technologies and the relatively modest productivity gains among UK firms.

The research investigates how firms manage changes in assets, technologies, skills, and business models, and why some firms succeed in translating these changes into performance improvements while others do not. It highlights the importance of alignment between digital tools, skills, management practices, incentives, and partner relationships. Where such alignment is absent, firms experience what the research characterises as “business-model incoherence”.

This programme also explores how productivity is shaped by interactions between firms through platformisation, servitisation, and value-chain reconfiguration. These findings highlight that productivity increasingly depends on system-level coordination rather than isolated firm-level actions.

Institutions (Chapters 4–6)

The Institutions programme broadens the perspective further, examining how financial systems, governance arrangements, and spatial structures shape productivity outcomes.

- **Chapter 4** focuses on finance and investment behaviour, showing that investment decisions are influenced not only by external financing conditions, but by internal governance, ownership structures, hurdle rates, and the lumpy, discontinuous nature of investment.
- **Chapter 5** adopts a spatial perspective, documenting how capital risk premia have varied sharply across UK regions since the Global Financial Crisis, leading to persistent spatial inequalities in investment, reinforcing regional productivity divergence between London and surrounding areas and the rest of the UK.
- **Chapter 6** explores knowledge diffusion, absorptive capacity and regional innovation systems, exploring why the UK’s strong aggregate performance in research and innovation has not translated into broad-based productivity gains across regions.

Alignment and complementarities: why they matter

A unifying theme across the entire research programme is the importance of alignment and complementarities. From an analytical standpoint, complementarities arise when the productivity gains from one activity are enhanced by the presence, scale, or effectiveness of another activity. In such settings, isolated interventions often deliver disappointing results, whereas coordinated bundles of changes generate disproportionately large returns. In other words, productivity growth depends not only on

how much is invested, but on *how well different resources reinforce one another* across the economy.

This perspective provides a unifying framework for interpreting the diverse evidence presented across Chapters 2–6. The research shows that misalignment manifests itself at several levels:

- within organisations, between skills, technology, and work design;
- across firms, within value chains, platforms, and partner ecosystems;
- across regions, between investment, skills provision, infrastructure, and institutions;
- and across policy domains, where initiatives often fail to move together.

Complementarities across people

Chapter 2 provides extensive evidence that skills, job design, management practices, and worker engagement form tightly interdependent bundles. Graduate, managerial, and technical skills are complementary rather than substitutable. Business training delivers strong productivity returns when it is intensive, targeted, and embedded in organisational routines, rather than shallow or generic.

Digital technologies further reinforce these complementarities. Rather than replacing human skills wholesale, many digital and AI tools amplify the value of tacit knowledge and judgement, making the alignment between human and digital capabilities critical. Job design matters critically: productivity grows when autonomy, learning opportunities, employee voice, and managerial support reinforce one another. Conversely, poor alignment manifests in skill underutilisation, disengagement, and rising mental health challenges, especially among younger workers.

Complementarities across firms

Chapter 3 shows that firm-level productivity gains depend on coherent alignment between technology, organisation, and strategy. Digital adoption yields performance improvements when it is combined with skills upgrading, workflow redesign, interoperable systems, and aligned incentive structures.

The same logic applies to business-model innovation. Productivity depends on aligning the logic of value creation (across value chains, value shops, and value networks) with appropriate organisational and digital capabilities. Platform strategies, servitisation, and partnerships can generate substantial gains, but only when firms' internal capabilities and external relationships are mutually reinforcing. Where firms pursue conflicting models or fragment their organisational focus, productivity suffers.

The twin transition to digitalisation and net zero further illustrates the importance of complementarities. Digital tools support climate mitigation and adaptation most effectively when they are embedded in organisational routines and decision-making processes. Fragmented approaches, which treat digitalisation and sustainability as separate agendas, limit both productivity and environmental outcomes.

Complementarities across institutions and places

Chapters 4–6 extend the complementarity framework to finance, geography, and innovation systems. Investment outcomes depend not only on the cost of capital, but on alignment with firm characteristics (such as size), asset type, ownership structures, governance, and timing. Persistently high internal hurdle rates can suppress productive investment even when financing conditions are favourable.

Spatially, misalignment between financial systems and regional economic fundamentals reinforces divergence. Regions with weaker institutional capacity face higher costs of capital and reduced access to long-term investment. Knowledge diffusion depends on the interaction between public R&D, private capability, skills, labour mobility, and institutional support. Where these elements are misaligned, innovation remains geographically concentrated and its productivity benefits fail to spread.

Across all chapters, the central conclusion is consistent: productivity growth emerges from systems of complementary inputs, and failures of alignment—within firms, across regions, and between policy domains—systematically weaken outcomes.

Policy and Business Implications

The findings from the TPI Research Programme underline that productivity growth is unlikely to be achieved through single-lever interventions. Instead, sustained gains depend on aligning skills, technology adoption, organisational practices, finance, and institutions across people, firms, and places. This has important implications for both policymakers and business leaders.

Implications for policy

For policymakers, the evidence points to the need for a more joined-up and place-sensitive approach to skills, innovation, and investment. Education and skills policy should move beyond fragmented, short-term schemes towards a more coherent architecture that links schools, further education, higher education, and employer-based training. Advanced technical and managerial capabilities, acquired through universities and colleges, are crucial but foundational skills (particularly basic STEM skills, such as GCSE-level maths and science) also matter to sustain long term growth. Skills systems should support progression over the life course, recognising that productivity depends

not only on skill supply but on how skills are deployed through job design and management.

Policy also needs to address the long-term decline in employer-provided training. The research shows that training intensity, especially for technical staff and managers together, delivers the strongest productivity returns. This suggests a stronger role for incentives and co-funding mechanisms that encourage firms, to invest in high-quality, targeted training rather than minimal compliance-based provision. Information failures around training options, especially for SMEs, remain a key barrier that policy could help overcome.

Digitalisation policy should equally shift from promoting adoption per se to supporting effective implementation and alignment. Many firms have adopted advanced digital technologies, but productivity gains remain uneven because technologies are not integrated with skills, job design, or business models. Targeted support—such as that provided through programmes, like Made Smarter, peer-learning networks, and knowledge-transfer partnerships, should be expanded beyond manufacturing and scaled across sectors. More bespoke, diagnostic-led support can help firms identify organisational “blockers” and align digital investment with strategy.

At a system level, the evidence reinforces the need to rewire governance and finance to support productivity across regions. Highly centralised decision-making, uneven access to capital, and weak regional institutions continue to constrain investment and knowledge diffusion outside major urban areas. Stronger devolved institutions, longer-term funding settlements, and place-based investment platforms are essential to crowd in private investment, build absorptive capacity, and support productivity growth in lagging regions.

Implications for business

For business leaders, the key message is that productivity gains from technology and skills are conditional on organisational coherence. Digital tools raise performance only when complemented by managerial capability, employee training, effective job design, and clear decision rights. Treating digitalisation as a one-off IT investment rather than an ongoing process of organisational change is a common source of failure.

Firms should invest in complementary skill bundles, including technical, managerial, and socio-cognitive skills, and ensure that jobs are designed to make productive use of these capabilities. Employee voice and engagement are not peripheral concerns: they play a central role in problem-solving, innovation, and continuous improvement, particularly during periods of technological change.

Investment decisions also require greater discipline and strategic clarity. Informal planning, high internal hurdle rates, and weak evaluation of returns risk undercutting

long-term productivity. Firms should embed digital and intangible investments within broader business-model strategies, avoiding fragmented initiatives that create misalignment and dilute returns.

To conclude, as economic change is increasingly driven by intertwined technological, organisational, and institutional forces, productivity gains no longer arise from incremental improvements within individual policy areas, firms, or functions. When connections between skills, technology, organisation, finance, and place evolve in a coordinated way, even small changes can compound into much larger and more durable gains.

2. Skills, Organisations and Worker Engagement

Introduction

People are central to productivity growth in their roles as workers, managers, entrepreneurs and inventors. How they perform their jobs and tasks directly affects the overall productivity of the organisations in which they work. People also play a critical role in the development, diffusion and productive use of new technologies and in driving innovation. Alongside possessing the required skills, including digital skills, productivity outcomes depend on how work is designed and managed. Job design and people engagement shape how skills are deployed, how technology is absorbed, and whether productivity gains are sustained over time.

The people programme at The Productivity Institute focuses primarily on skills and digital technologies. The work consists of three related strands: skill demands and supply; skill changes with digital technologies; and job design and worker engagement. The programme consisted of sixteen separate research projects, each producing one or more research papers, as set out in Box 2.1. A list of researchers and their affiliations with the programme is included in Box 2.2.

The programme uses evidence at several levels, ranging from aggregate statistics on regions and industries to data relating to individuals and organisations. Much of the research is of a quantitative nature, using both standard secondary data sources as well as new sources such as original organisation surveys, administrative and big data. Some projects use qualitative evidence, consisting of organisation case studies and sectoral and ecosystem investigations, collecting original interview and archival data. The research was carried out by scholars from a wide range of disciplines, including economics, employment relations, human resource management, innovation studies, management research, social psychology and work psychology.

Research Objectives

The overarching research questions in the TPI People research programme are how do workers and organisations develop the skills, job design and engagement necessary to ensure productivity gains in the digital era. The research examines how education and training systems, firm-level management practices, job design, and employee voice interact to support or impede long-term productivity and inclusive growth. An important objective was to link the empirical evidence to policy and business strategy, identifying where institutional, organisational, and managerial responses need to evolve to meet the challenges of the digital transition.

Box 2.1: TPI references from People Programme

The research summarised in this chapter has been undertaken by researchers at TPI partner institutions, including King's College London, the University of Cambridge and the University of Manchester, as well as collaborators from other universities and research organisations.

An extensive summary report on this programme is provided here:

- Damian Grimshaw, Mary O'Mahony and Anthony Rafferty (2026), [Skills, Organisations and Worker Engagement, Summary of TPI People Research Programme 2023-2026](#), The Productivity Institute Insights Paper 083.

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Box 2.2: People Programme Contributors

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Research Findings

Skill demands and supply

Technology and skills: Aggregate evidence

Research using data across countries and industries for high income countries shows a decline in the graduate wage premium almost everywhere. The main exception is the US, but even there the graduate wage premium has flattened. An explanation for this common trend is the rise in the share of university graduates in the workforce which would cause a decline in the relative wages of these workers, unless the relative demand for graduates expands more rapidly.

Research Strand: Skill demands and supply

Aim: To provide new measures of skill prevalence by country, region and industry; and to examine factors that influence skill shortages.

Key research questions

Main answers/core findings

<ul style="list-style-type: none">• How have new technologies affected the graduate wage premium over time?	<ul style="list-style-type: none">• As expanding graduate supply outpaced technology-driven demand, new technologies did not prevent graduate premiums from declining
<ul style="list-style-type: none">• How do UK regions and industries vary in their demands for and supply of digital skills?	<ul style="list-style-type: none">• Advanced digital skill demand is highly concentrated in the UK's "golden triangle" and major cities, with uneven regional supply.
<ul style="list-style-type: none">• Is firm training provided effectively in the UK?	<ul style="list-style-type: none">• High intensity, well targeted training, especially for technical staff and managers, yields the strongest productivity gains, but UK firm training has been in a long-term decline
<ul style="list-style-type: none">• How do digital and green skills in the UK compare with other countries?	<ul style="list-style-type: none">• The UK is leader in both digital and green skills across the OECD, with strong complementarities between them.

Comparisons across countries and industries show that, on average, the expanding supply of graduates has mostly outweighed the additional demand from new technologies, leading to declines in graduate wage premiums. However, demand for graduate skills associated with information technologies has remained strong,

suggesting that skill bias from these technologies has continued into the digital era. At the same time, graduate wage premiums associated with complementary intangible investments in innovation are only observable for industries with high shares of workers with digital skills. Intangible investments in organisation capital, marketing and brand development and firm provided training, collectively known as economic competencies, are more likely to raise demand for highly skilled labour in other sectors (O’Mahony et al., 2026a).

UK Regional variation in both demand for and supply of digital skills.

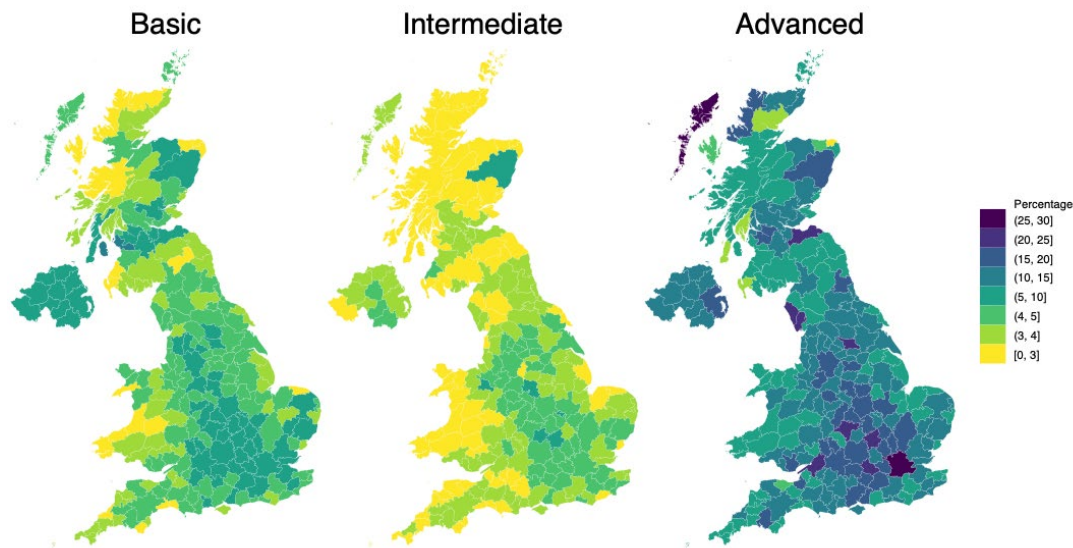
Demand for digital technical skills

Zooming in on the UK, it is possible to construct measures of the demand for Digital Technical Skills (DTS) by region, using data from job platform advertisements. These can be divided into three groups: “Advanced” which require knowledge of programming languages, AI or data science; “Intermediate” which involve employing standard software packages in business processes, such as accounting software; and “Basic” which are required for a broad range of tasks, for example experience with Microsoft Office (O’Mahony et al., 2026b).

Across virtually all regions, firms’ demands for advanced DTS, such as software development and data analytics, which are crucial for technology adoption and innovation, exceed demand for intermediate and basic skills (Figure 1). In every region, the demand for advanced digital skills is particularly strong in sectors targeted by the government’s Modern Industrial Strategy. However, the regional variation is much greater for advanced DTS than for basic skills and, to a lesser extent, for intermediate skills. The demand for advanced DTS is highest in London and its surrounding areas, Oxford and Cambridge (the “golden triangle”) and, albeit at slightly lower levels, in major cities such as Birmingham and Manchester. This regional concentration is particularly evident for graduate-level roles and for AI-related skills. Importantly, these differences are not solely driven by industrial composition; areas with higher (or lower) demand for advanced DTS exhibit stronger (weaker) demand than would be expected given their industry composition alone.

Not surprisingly, 90% of job adverts that require AI skills also demand other advanced digital skills, such as data science or coding skills. However, AI skills are also increasingly demanded alongside intermediate digital skills, which increased from 20% in 2016 to 40% in 2025. This suggests AI is being used more across a broader range of firm practices.

Figure 1. Shares of digital technical skills in job adverts by region, average 2023-25.



Finally, firms outside the golden triangle are more likely to rely on non-graduates to meet their needs. Indeed, the growth in advertised wages of non-graduates with advanced DTS has outstripped that for graduates, most markedly since the pandemic, even though graduates continue to earn more than non-graduates on average. This may reflect a more limited supply of graduates outside the golden triangle, an outmigration of graduates to higher-paid jobs in the golden triangle regions, firms in other regions adapting their business innovation models to rely less on skills only available from graduates, or some combination of all these factors.

Job platform data also indicate that firms are looking for a wider set of skills alongside digital technical skills. The importance of so-called soft skills varies by type of DTS. Job adverts requiring advanced DTS are more strongly associated with problem solving, leadership, and other skills influencing people, which are more commonly developed through higher education. In contrast, intermediate and basic DTS are more frequently associated with soft skills, such as reliable time-keeping and team working.

Supply of digital technical skills.

Science, Technology, Engineering and Mathematics (STEM) skills provide the foundations for digital skills. Measures of the supply of digital skills for those leaving formal education, derived from administrative data by region, can be matched to the demand measures reported above (De Coulon et al., 2026). These supply measures distinguish between foundational (GCSE-level maths and science) and advanced qualifications (A-levels,

technical skills acquired in FE colleges, and university degrees), and account for the migration of university graduates.

The analysis shows that the supply of foundational STEM skills, including school-level maths and science, which are essential for building up digital skills among young people, varies widely across regions. Many areas in the North East, as well as rural and coastal regions exhibit particularly low levels of foundational STEM supply. Advanced STEM skills show a similar concentration as for demand, with supply highly concentrated in the golden triangle and major cities, and substantially lower elsewhere.

Bringing together the demand and supply measures of digital skills reveals several important patterns. For advanced DTS, there are dynamic regions where demand and supply are both high. However, this does not mean there are no skill shortages. In some of these areas, notably London, demand for DTS is exceptionally strong relative to the average region, and while supply is also high, it remains insufficient to fully meet demand. These areas attract graduates, but not in sufficient numbers, and often show deficiencies in skill provision below degree level.

There are also areas, mostly second tier cities, where demand for advanced DTS is high but local supply is low. These regions often struggle to attract or retain university graduates and lack sufficiently strong further education provision to compensate. In addition, some areas exhibit both low demand and low supply of advanced DTS. These places are likely to face a broader set of economic and structural challenges beyond skills shortages alone. When basic DTS are considered alongside foundational STEM skills, these areas also show significant skill mismatches, pointing to the importance of a greater focus on skills provision by the schooling system.

Training

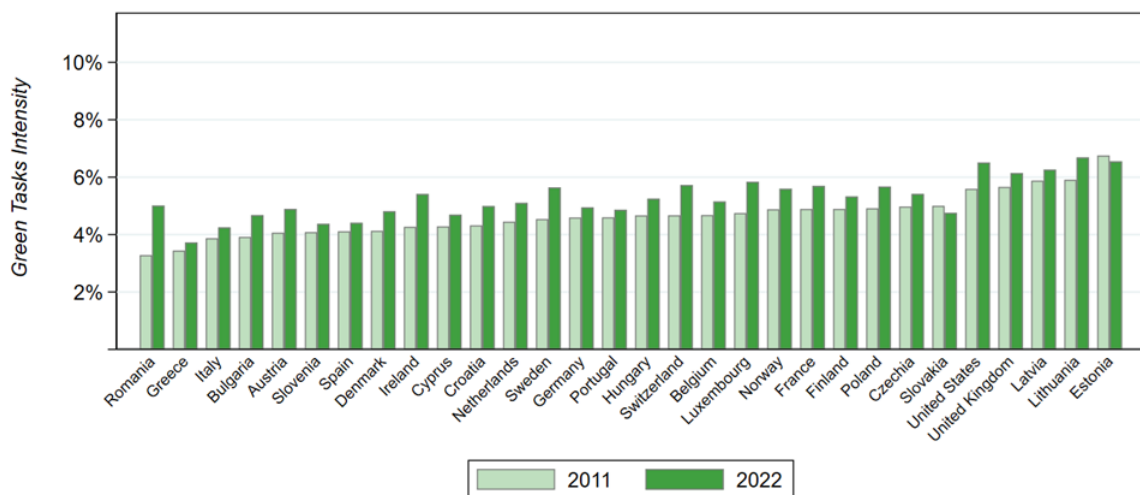
Firm-provided training has been declining in the UK over a long period, whether measured by expenditures by firms or by numbers of training hours delivered. However, training intensity (the quality and depth of training) matters more for productivity than training coverage (for example, the number of people trained) (Swartz et al., 2025). It finds that training professional and technical staff yields the highest returns for firms. It also emphasises the importance of investment in training for managers as well as staff, to avoid miscommunication and better align work processes. Skilled managers are more effective when they have trained staff to work with, and trained staff are more productive under capable management.

Green and digital skills

Analysis of internationally comparable measures of digital and green skills shows that the UK is among the leaders in OECD countries for employment of workers with digital and with green skills (Figures 2a and 2b). Using data on employment by occupation from labour force surveys combined with information on tasks by occupation from the United

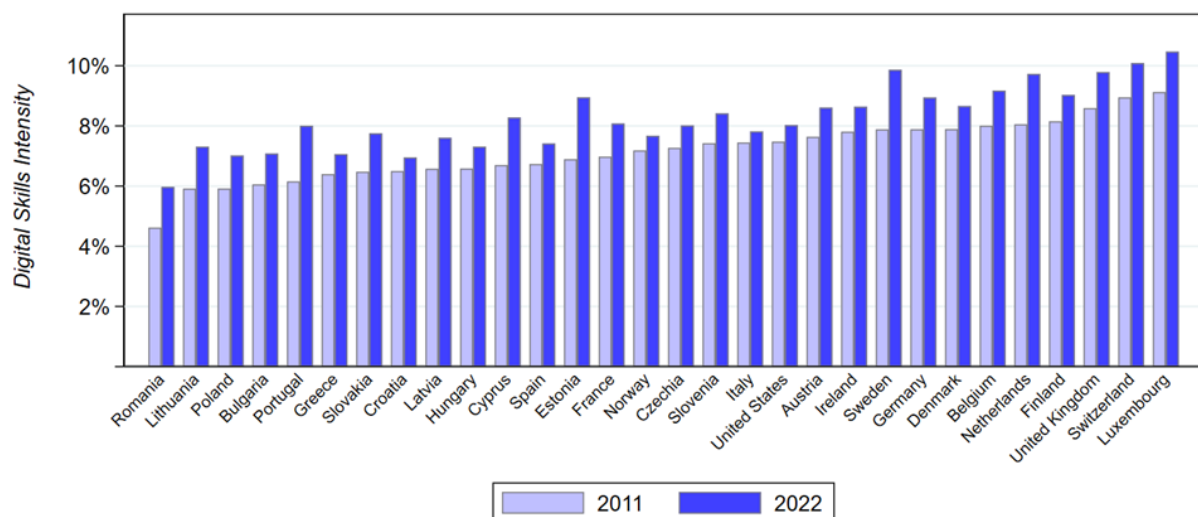
States O*Net database, the evidence suggests that this ‘Twin Transition’ is a two-way process with high correlations between green and digital skills. This transition involves not only greening of digital industries but also leveraging technology to boost the dynamism and adaptability of established green sectors (Smiderle et al., 2026). These findings are consistent with parallel research on the Twin Transition, carried out for the TPI Firms research programme, a summary of which is provided in Chapter 3.

Figure 2a. Green skills intensity, 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.

Figure 2b. Digital skills intensity, 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.

How are skills changing with digital and AI technologies?

From a management and innovation perspective, skill change can be understood from three interrelated perspectives. The first emphasises human agency, focusing on the decisions and actions of managers, entrepreneurs and workers. For example, encouraging worker agency in influencing the design and implementation of digital technologies favours positive skill outcomes.

Research Strand: Skill changes with digital technologies

Aim: To understand how organisations and workers are adapting skills with new AI and other advanced digital technologies (ADTs) for innovation and performance.

Key research questions

Main answers/core findings

- How do AI tools impact the division of labour within and between firms?

- AI enables **outsourcing, role displacement, and task overlap**, reshaping **collaboration and redistributing value** within and across firms.

- How do relations between organisations affect adoption of ADTs and innovation outcomes?

- **Relational, collaborative ties** with technology partners foster learning and innovation; **transactional relationships** constrain knowledge transfer and outcomes.

- How do different ADTs affect work design?

- ADTs shape work differently: **decision-support increases autonomy and creativity**, while **automated execution heightens control and displacement concerns**.

- What organisational capabilities support skill formation?

- Effective skill formation relies on **governance, coordinated use-cases, training, worker agency, and cross-unit knowledge sharing**.

- How do ADTs reconfigure analogue and digital skills?

- **ADTs complement rather than replace analogue skills**, making tacit experiential knowledge essential for interpreting digital signals.

- Is crowdsourcing for knowledge conducive to innovation performance?

- **Crowdsourcing** improves innovation only when combined with **diverse knowledge search and HRM practices** enabling engagement and integration.

Second, one can adopt a broader organisational conceptualisation of skill, which goes beyond measurable attributes related to the job (e.g. task complexity) or the individual (e.g., years of schooling) to include relational aspects of skill linked to the social interdependence of job tasks, job roles and inter-occupational work organisation.

The third perspective focuses on specific action possibilities (or “affordances”) of digital technologies as they inject greater pace, uncertainty and turbulence into organisational change. These dynamics create opportunities for managers and workers to actively reshape skills in ways that support improved performance.

The research reveals a wide range of mechanisms through which skills change, challenging narrow frames such as technology leading to either automation or augmentation. These mechanisms deepen our understanding of how skills evolve in relation to task complexity, tacit knowledge and technology specificity (Grimshaw and Miozzo, 2026).

Sustaining employee productivity through better digital work design

This strand of the research programme draws on an original four-wave panel survey of employees, complemented by interviews with digital technology leads, to shed light on why firms introduce new advanced digital technologies (ADTs) (Bindl, de Roche and Fay, 2026).

The interviews suggest that the organisational rationale is primarily centred on improving cost efficiency, streamlining processes, and, ultimately, increasing profitability. In several cases these anticipated benefits were achieved, with additional outcomes such as improved customer satisfaction and reach, and greater competitive advantage. However, productivity improvements were often hampered by a range of implementation challenges, including poor overall communication of digital changes to staff; insufficient training, limited understanding of employees’ day-to-day work practices, lack of consideration of employee feedback, poor integration with existing digital systems; and underestimation of the time and resources required for effective implementation.

Positive skill change outcomes are mostly associated with work designs in which digital technologies provide guidance or suggestions for work processes, while humans retain responsibility for action and decision-making. This form of work design is associated with higher levels of worker autonomy and a realigning of job-related skill requirements, resulting in greater skill variety, which drives enhanced innovation in the workplace.

The survey data reveal that some employees reported that this mode of ADT-enabled work helped them generate better ideas and supported brainstorming and creative problem solving, for example by using generative AI (GenAI) to plan client sessions or to produce and review content. Employees also appeared to benefit from management practices that provided them the time, trust, and feedback needed to explore these new ways of working.

Concerns about job displacement were most closely associated with work designs in which digital technologies played a dominant role in executing tasks and workflows. While business leaders were generally optimistic about the potential to increase efficiency and productivity, many employees voiced concerns about the lack of management support for training in new digital technologies. In response, employees reported proactively seeking to upskill themselves to learn more about emerging ADTs, remain competitive and safeguard their employability.

Overall, it is important to pay attention to the specific characteristics of ADT-work design when seeking to understand and reshape patterns of skill change and performance outcomes. Digitalisation has fundamentally altered core aspects of work and skills requirements, increasing the likelihood that employees will actively engage in crafting their jobs in ways meaningful to them. This underscores the need for management to provide a clear strategy around which employees can reshape the nature of their work.

Three case studies

Three case studies have been undertaken that consider skill mechanisms and outcomes such as efficiency, productivity and innovation in specific contexts. The studies illustrate that firms in diverse sectors are reorganising their operations and developing skills through adoption of advanced digital technologies in different ways. While progress has been gradual and uneven, the studies nonetheless demonstrate the significant potential of these technologies to raise productivity.

Independent games studios.

The first study focuses on independent games studios, which are typically small or micro firms. After a strong expansion between 2018 and 2021, the sector has seen a decline in employment in more recent years. Game development is a strongly collaborative endeavour among artists, designers and programmers who draw on distinct but complementary knowledge bases. The industry's core assets (sound, graphics, code, etc.) are highly exposed to GenAI technologies, which offer considerable benefits in terms of speed and cost savings (Grimshaw, Miozzo and Sosa, 2026). The risk of legal challenges for copyright infringement and reputational damage from users has restrained independent studios from implementing a prescriptive GenAI strategy. At the same time, AI-specialist firms are growing and extending their reach in the industry by developing a plethora of GenAI toolkits.

Four distinct categories of skill change can be identified, each associated with reallocating and reconfiguring job tasks and roles within and between firms. First, AI implementation expands opportunities for games studios to outsource work to specialist suppliers, such as sound asset productivity. These activities tend to be low value-added tasks and have limited impact on firm performance or employment outcomes.

Two further categories focus on reconfiguring job roles. One involves the displacement of roles, where lead designers use GenAI tools to advance concept design without engaging art and programming teams. This increases workflow and range of pitches to management or funders but reduces job prospects for artists. Another category involves the decentralised and uncoordinated use of GenAI tools among all technical functions. For example, artists and designers may independently use code-writing AI tools, while programmers employ GenAI for design and translation tasks. This overlap and reconfiguration of tasks and activities results in the shared augmentation of skillsets and job prospects, while enhancing studios' performance.

A fourth category concerns the outsourcing of specialist tasks to AI-specialist firms that offer more sophisticated, higher value-added inputs. While this can improve production capabilities, these firms often claim a significant share of game profits. As a result, job opportunities for highly skilled programmers increasingly shift to well-resourced AI-specialist firms, while prospects for artists and writers are stymied.

Purpose driven organisations – the BBC

The second case study examines the BBC, a public-service, purpose-driven organisation (D'Ippolito, Miozzo and Zhang, 2025). The key question is how GenAI is harnessed, governed, and scaled in line with the organisation's public-value commitments. The research identifies three innovation domains where digital transformation and skill changes are likely to interplay.

First, 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 to enable the reuse of solutions. For example, a use case focused on the presentation of visual data was logged centrally and recognised as relevant across multiple publishing teams (such as News and Sport). This then acted as a bridging mechanism, allowing the solution to be scaled beyond the originating unit.

Second, process innovation refers to technology-enabled changes in how work is done, by reconfiguring production methods and the underlying information flows, coordination mechanisms and routines. In this domain, there is less room for change as the BBC must safeguard trust in its outputs. Nonetheless, there are examples of AI tools that shift aspects of production away from travel- and location-dependent filming towards studio-based setups. This reduces location costs and makes low budget public-service productions more feasible. In general, while elements of process automation are present, they remain tentative and fall short of re-engineering core work.

The third innovation domain, product innovation, concerns the extent to which AI technologies translate into new or significantly improved offerings for end users. The BBC has taken a cautious approach to deploying GenAI to develop new service concepts,

delivery systems, and user or audience interfaces, although there are some examples of change in this area.

Proactive skill development practices interact with these innovation dynamics. The BBC sources AI skills through recruitment into its GenAI hub and utilising its apprenticeship pipelines, while also bridging skills by exposing staff to AI tools and pilot projects. Overall, these bridging mechanisms remain cautious and uneven. While AI uptake is to some extent actively supported through centrally organised training and mobilisation efforts, the evidence does not show end-to-end integration of AI into specific production and service routines across the BBC.

Livestock sector

The third sector case study highlights how livestock farmers are adopting new data-driven digital technologies developed and supplied by specialised agritech companies. These technologies collect and analyse real-time data through a variety of electronic sensors to monitor animal behaviour and welfare, feed management and yields, and environmental footprints (Grimshaw, Miozzo and Kyriakopoulos, 2026).

While often lacking in digital skills, farmers bring a great deal of accumulated experiential and scientific knowledge and skills. The use of the data-driven digital technologies leads to sequential skill changes from pre-implementation of the specific technology to early experimentation and full application. An example is digital fencing, which consists of a solar-powered GPS collar for livestock and a mobile app that enables farmers to define and manage virtual grazing boundaries and track livestock movements.

Livestock farmers bridged the skill gap by sharing experiences with other farms and specialist advisors to gain knowledge and understand the technology's value. They realigned core tasks by learning digital cues to monitor livestock. In the mature phase of adoption, farmers experienced both complementarities and tensions between analogue and digital knowledge. Digital signals often augmented experiential and tacit knowledge, particularly on how to safeguard animal welfare. However, concerns about false data readings and poor GPS signals, meant farmers remained vigilant and regularly cross-checked digital prompts against observed livestock behaviour.

Building digital capabilities in SMEs

Manufacturing SMEs & digital services firms

Small and medium-sized enterprises (SMEs) often lack the in-house capabilities needed to scale up digital adoption. TPI's research on UK manufacturing SMEs shows that collaboration with specialist technology providers can improve performance by enabling knowledge, technology transfer and learning complementarities (Vecciolini et al, 2026). However, many SMEs have limited digital literacy, which constrains their ability to understand, configure, or strategically exploit digital systems. Likewise, digital

technology suppliers report that clients often only have very basic comprehension of a platform's functionality. These knowledge gaps constrain the transfer of tacit knowledge impacting innovation outcomes. Inadequate training often leads SMEs to rely on experimentation, online videos, and help functions, resulting in purchasing unnecessary systems or underusing key features. Organisational knowledge gaps further exacerbate these challenges when digital systems are delegated to IT teams who lack shopfloor insights, leading to poor integration with operational workflows.

Some SMEs invest in training provision or technical support, and some technology providers facilitate ongoing usage optimisation through scheduled interactions to ensure sustained value from digital systems. A key distinction is between relational and transactional ties. In relational settings, SMEs and suppliers jointly address technical challenges by exploring options, refining prototypes, and iterating solutions. By contrast, transactional ties limit customisation and feedback, leaving SMEs as largely passive users of digital systems. In sum, relational, collaborative ties with technology partners foster learning and innovation; transactional relationships constrain knowledge transfer and outcomes.

Crowdsourcing

An alternative form of engagement with digital providers is crowdsourcing which involves assigning a digital work task to a 'crowd' of external workers coordinated through a digital labour platform. By sourcing skills in this way, organisations can access knowledge that is difficult to acquire internally and that may be novel, potentially supporting exploratory innovation. However, a survey of about 180 UK SMEs shows that crowdsourcing alone does not, on average, enhance exploratory innovation (Lee et al., 2026). Innovation gains arise only when firms search across a wide range of knowledge domains or draw on diverse knowledge sources. In addition, the benefits of crowdsourcing are amplified when organisations adopt specific HRM practices that foster engagement and connectedness with crowd workers, such as timely feedback, opportunities for interaction and some control over the training process.

Job design, people engagement and productivity

People management practices are key to productivity outcomes, determining how organisations can make those outcomes more inclusive and sustained in the long term. Effective productivity strategies integrate job design, employee voice, flexible working arrangements, diverse employment contracts (including self-employment and part-time work), skills development and technology adoption.

Research Strand: Job design and worker engagement

Aim: To explore how job design and people management practices have the potential to impact productivity.

Key research questions

Main answers/core findings

- How does job design and work organisation shape skill use, learning, wellbeing and performance?

- **Well-designed, learning-rich jobs with supportive management** enhance skill use, mitigate strain, and raise productivity for more inclusive outcomes.

- How does job complexity relate to task performance, learning, well-being, and job strain?

- **Resource complexity** boosts learning; **challenge complexity** raises performance but increases strain; **hindrance complexity** undermines performance and wellbeing.

- How do different forms of employee voice and participation contribute to productivity?

- **Systematic, responsive voice (especially organisation-level forums)** drives engagement, innovation, process improvement, and discretionary performance.

- What factors shape worker voice strategies and outcomes?

- **Skills, confidence, managerial responsiveness, training, time, and perceived impact** strongly shape voice participation and effectiveness.

- How do HR practices (e.g., part-time work, self-employment, hybrid/homeworking practices) interact with productivity, technological adoption and inequalities?

- **Flexible contracts** affect productivity through skill investment, retention, and inequality; **unmanaged self-employment** and **part-time work** risk long-term productivity.

- How can digital presenteeism overcome biases against marginalised workers?

- Digital visibility reduces assessment distortions for remote workers but risks long hours, threatening wellbeing and productivity.

- Do younger cohorts experience challenges that negatively affect skills and productivity?

- **Gen Z experiences higher workplace-related depression**, reducing training uptake and negatively affecting individual productivity.

Job complexity, learning and wellbeing

Job complexity is a critical characteristic of work that influences a wide array of employee outcomes. It is broadly defined by the extent to which job tasks are varied, unstructured, and dynamic. For example, senior specialist positions, such as hospital consultants, involve a high degree of job complexity due to the multifaceted and evolving nature of their responsibilities whereas routine assembly-line work is characterised by relatively low task complexity. Different types of job complexity can have distinct implications for productivity and wellbeing (Holman et al., 2026a, 2026b). *Job resource-complexity* - where work provides autonomy, opportunities for skill use and meaningful variety - enhances performance, learning, and well-being while reducing strain on workers. *Job challenge-complexity* - where work involves high cognitive and attentional demands - improves performance and learning but increases strain, highlighting trade-offs where complexity is insufficiently supported. Finally, *job hindrance-complexity* - where work involves role conflict, ambiguity and frequent interruptions - is linked to negative outcomes.

The effects of job complexity are further shaped by organisational and institutional context. The most important moderating effect was found to be employee learning. 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. When training is not provided, high job complexity enables employees to develop skills needed to cope with job demands, thereby enhancing positive outcomes.

Worker voice

Worker voice, which can be broadly defined as the mechanism through which employees can influence organisational decisions, has been consistently associated with higher engagement, job satisfaction, productivity and well-being. An integrated, interdisciplinary investigation, combining interviews with managers across four case studies and an employee survey, shows ample evidence that employee voice supports continuous improvement, positive changes in business processes, reduced waste and costs, and innovation (Findlay et al., 2026).

Despite these benefits, most organisations do not appear to adopt a systematic and integrated employee voice strategy but rely more on ad-hoc arrangements. While participation in department- or organisation-wide meetings, employee focus groups, and surveys is linked to the most positive outcomes, the most used voice channels are one-to-one meetings with line managers, team meetings (often conducted online) and employee surveys. Participation in team meetings and online forums showed the most negative associations with outcomes.

Workers exhibited mixed motivations for exercising voice, with a strong emphasis on “fixing problems” rather than engaging in appreciative enquiry. Some workers remain

silent because they believe voicing concerns will make little difference, while others express disinterest in sharing their views. In contrast, those who feel sufficiently skilled and confident to speak up are significantly more likely to engage. Trade union members and employees with supervisory responsibilities are also more likely to exercise voice in the workplace.

Managers express particular interest in whether employee voice “works” for them and for organisational performance. However, they generally show limited awareness of the extent and patterns of worker participation across existing voice channels. They are often unable to explain how these channels connect as part of an integrated employee voice system.

Both managers and workers identify several barriers to exercising voice, including time constraints, lack of training to support effective voicing, self-selection into managerially sponsored voice channels, and limited or inaccessible feedback from voice channels. In two cases, increased managerial attention to supporting employee voice was reported by managers to have led to substantial improvements in employee engagement and business performance. A critical finding is that senior management responsiveness to voice is a stronger predictor of positive outcomes than line management responsiveness, particularly for well-being and discretionary behaviour.

Mental health

There are important behavioural aspects of working that can influence workforce productivity. Notably, differences in mental health conditions among the working population, especially between generations (Wei et al., 2026). Members of Generation Z, which are those born between 1995 and 2012, are more likely to experience work-related depression than older generations. This has an adverse impact on their willingness to take up training and on their individual productivity.

These findings suggest a paradox: younger workers, who are most likely to possess the up-to-date digital skills required by firms, also face greater challenges in adapting to workplace demands. Firms should therefore place particular emphasis on this cohort when designing workforce engagement, support, and development practices.

Self-employment, gender and part-time work

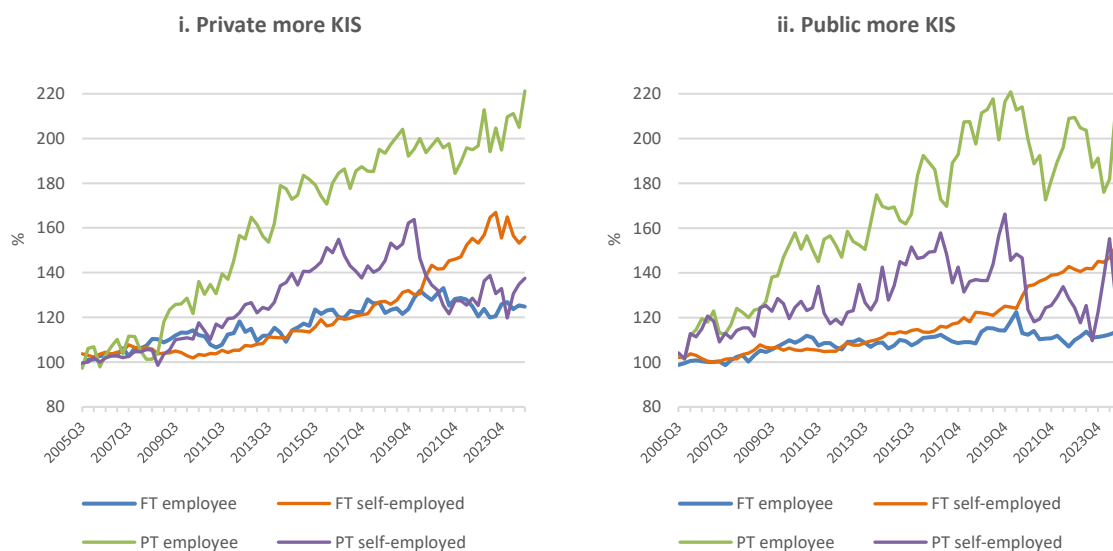
The nature of the employment relationship is fundamental to how human capital is utilised in the economy. Differing forms of employment contracting such as outsourcing, self-employment, part-time work and non-standard fixed term or temporary contracts, can have diverse effects on the performance of both organisations and employees. Much of the existing debate on labour markets and productivity has focused on job polarisation, which argues that adoption of ICT and subsequent digital technologies causes a hollowing out of middle-income and middle-skill jobs and an increase in higher-skilled and less routine work. However, shifts towards greater outsourcing and self-

employment, such as the growing use of consultants and contractors in human capital sourcing strategies in knowledge-intensive industries, also play an important role in shaping productivity outcomes (Rafferty et al., 2026).

The 2008/9 recession marked a critical juncture, accelerating trends toward greater self-employment. Although the immediate recovery was 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, especially in public and private knowledge-intensive sectors, while a shift towards self-employment is less visible in other sectors (Figure 3).

Using data for employees only, some of the evidence supports job polarisation but also a pattern of occupational upgrading. However, once the self-employed are included, the decline in employment in lower deciles of the income distribution is less pronounced. This might suggest that part of the hollowing out of middle-skilled employee jobs and the decline in lower-skilled work may reflect a shift towards greater self-employment and external contracting.

Figure 3. 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).

Part-time work is another important issue shaping firms' productivity. Part-time workers may be segregated from full-time employees through internal labour market-divisions within the firm or through outsourcing to service providers that rely predominantly on part-time labour. Related to this is a key distinction between part-time employment as an employee-centred retention strategy (for example, supporting women returning from

maternity leave), or as an employer-centred flexibility strategy aimed at achieving scheduling flexibility in response to fluctuating demand.

Part-timers in professional and white-collar occupations, which account for about 45% of all part-time jobs and about one-fifth of that type of employment within those occupations, are more likely to be employed for retention purposes. In contrast, part-time workers in service and elementary jobs, where as many as half of employees work part-time, are more likely to be hourly paid and expected to do paid overtime in line with their role as flexible employees, minimising staffing costs to deal with varying customer demand.

Both models have distinct implications for productivity. Retention-oriented part-time work may help firms to maintain investments in human capital and reduce turnover, although part-time workers may still face limited opportunities for further skill development. Employer-centred part-time work may create short-term productivity gains through flexibility but is often associated with limited prospects for training or career advancement.

Hybrid working, flexibility stigma and inequality

The rise of hybrid working highlights both productivity potential and its associated risks. The expansion of working from home (WFH) since the pandemic has narrowed overall ethnic gaps in access to flexible work. However, analysis of UK Labour Force Survey data shows that significant inequalities persist for specific groups, particularly migrant workers, Black men and some Asian groups, and for parents—especially fathers from minority ethnic backgrounds. Evidence from the UK Survey of Working Arrangements and Attitudes demonstrates that WFH is often accompanied by high levels of digital presenteeism, driven by ideal-worker norms and flexibility stigma. Women with dependent children and ethnic minority workers experience particularly strong pressures to remain digitally visible.

Analysis of UK managers' behaviour shows that digital responsiveness strongly shapes evaluations of commitment, productivity and promotion potential, especially for remote workers (Chung, 2026). Home-based workers often receive lower evaluations in terms of commitment, productivity, collegiality, and promotion prospects than office-based workers. However, when remote workers raise their digital presenteeism, they are generally evaluated as positively as digitally present office-based worker. By contrast, 'digitally absent' remote workers are viewed most negatively even compared with similar absent office workers. While digital presenteeism can mitigate bias against some marginalised groups, it risks entrenching long-hours cultures and undermining wellbeing, threatening the sustainability of productivity gains from hybrid working.

Precarious and migrant work

Sectors which rely strongly on precarious and migrant labour have historically reduced incentives to invest in automation and digital technologies. A case study of the food manufacturing sector, which accounts for 24.2% of manufacturing turnover in the UK and is a major source of employment, shows how the post-Brexit landscape has presented considerable labour market challenges (Bowkett et al., 2025). Following a rapid increase in migrant labour in the early 2000s, the sector has faced much tighter labour supply in the post-Brexit and post-pandemic period, causing some firms to reassess their dependence on migrant labour.

However, technology adoption remains uneven and closely intertwined with employment practices, skill strategies and wage arrangements. Firms that continue to rely on low-cost, flexible labour face heightened risks of stalled productivity growth, while those investing in technology alongside investments in skills and job quality are more likely to achieve long-term productivity gains.

Implications for Policy and Business Practice

TPI's People research programme identifies a range of implications for policy and business strategy.

Education and skills policies

A first set of challenges concerns education policy at national and regional levels. Preparing students for changes in the labour market brought about by technological changes requires more joined up provision across schools, FE colleges and universities. The inadequate architecture for skills policies has produced many short-lived schemes that are often poorly funded and weakly coordinated with other policies. Funding schemes will require sustained, long-term reform.

Policies also need to differentiate more clearly between basic and advanced skills. This implies a focus on inclusion and connectivity for foundational skills in coastal and rural areas, alongside targeted capacity building for advanced skills in high-demand urban centres. However, education policies across schools, FE and HE have largely operated on a 'one size fits all' or 'place blind' basis, although there is some progress in England with the creation of Mayoral Combined Authorities.

In recent decades, UK educational policies have relied heavily on the assumption, similar to the United States, that market incentives are sufficient to encourage people to acquire skills. This has led to under-investment and short-termism in the UK. It contrasts with policy practices in many other advanced economies, where institutions were created to address training gaps when left to private companies and individuals. Rethinking incentives and institutional frameworks for long-term and inclusive skill development,

particularly at intermediate and high-skill levels, should therefore be a priority. In particular, policy could help address information gaps on training, especially for SMEs and on-line training.

Employer challenges: training, digital transformation and organisational alignment

Employers face a parallel set of challenges, particularly around incentives to invest in workforce training and how organisational capabilities evolve in response to worker shortages and disengagement. Organisations should design training schemes that balance investing in the untapped skill potential of all employees together with management upskilling. Organisational alignment is critical: while HR managers often prioritise training and employee development, other departments may focus more strongly on innovation or on cost efficiency. Demonstrating clear returns to training investment, especially in high-skill professional roles that support technological and strategic needs, can help strengthen coordination across internal functions and reduce organisational (and inter-organisational) fragmentation.⁸

Organisations also 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. This requires closer scrutiny of how digital investments support broader strategic goals, the development of internal structures to engage effectively with technology providers, and improved cross-functional communication, particularly between operations and IT teams. Knowledge gaps can be bridged through sectoral learning, including the sharing of experiences with ADT among organisations with established relationships.

Developing organisational capabilities involves establishing a shared baseline of AI and digital proficiency, combining formal programmes with peer-based and community learning, and committing to bespoke training tied to work redesign and improved pay. Investment in staff time for experimental learning is also important, as is support for collective efforts to realign occupational skills and promote bottom-up, worker-led innovation. Identifying lead users (individuals or teams) that pilot new technologies and support colleagues through expert sessions and feedback loops can further strengthen continuous improvement. For freelance workers on platforms, extended HRM practices such as transparent evaluation criteria and detailed feedback on completed tasks, can improve the search for and absorption of external knowledge.

⁸ See also TPI's work on strategic productivity, for example, B. van Ark van M. Devine (2024) Productivity Through People: New Opportunities for CHROs, The Productivity Institute and The Conference Board. <https://www.productivity.ac.uk/research/productivity-through-people-new-opportunities-for-chros/>

Job design, job quality, and employee voice as foundations of productivity

There is also a need for business leaders to engage more directly with job design as a vehicle for enhancing skills and organisational capabilities, and with employee engagement and voice as central mechanisms in this process. First, job quality and learning may be embedded within productivity strategies, recognising 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. Second, job resource complexity can be enhanced by encouraging autonomy, task variety, and social support at work, helping to reduce job strain while improving learning and performance outcomes. At regional and local levels, workforce development programs can support managers in designing jobs with appropriate complexity bundles.

Senior management responsiveness to employee voice is critical to realising productivity gains, including those associated with digitalisation. Even when managers recognise the importance of voice, it is often viewed as an informal feature of daily organisational life rather than a strategic management practice. More explicit consideration of the purposes and design of voice mechanisms could strengthen their contribution to productivity. Employee involvement and participation may also require capacity building, particularly in more complex situations of decision-making where employees may lack the necessary knowledge or competencies to express their voice.

Part-time work, hybrid working and flexibility to promote inclusivity

Finally, greater attention is needed to part-time and hybrid work as part of a more inclusive approach to skills enhancement and organisational performance. Access to high-quality flexible and part-time work across occupational levels can be improved through employment rights, good-practice standards and employer incentives. Part-time work should enable progression and support workers managing life-course transitions, especially women with childcare responsibilities given ongoing constraints in childcare availability and affordability. More broadly, flexible and hybrid working should be normalised to reduce stigma and unequal treatment. Work from home should be positioned as a standard element of good work design, with performance evaluation aligned to outputs rather than physical or digital presence. Manager training is essential to reduce mistrust and implicit bias in hybrid settings.

3. Adoption, implementation, alignment – maximising the performance benefits of digital investment

Introduction

In the modern economy, the integration of digital technologies into business is key to achieving productivity improvements. For example, as TPI research shows, UK firms using at least one advanced digital technology are far more likely to report productivity improvements than those that don't (Massini et al., 2025). Digitally affected activities already account for more than one fifth of nation-wide gross value added⁹, while some projections suggest that emerging technologies, including AI, are projected to raise UK GDP by 8.4% by 2035¹⁰. At the same time, as this chapter shows, there are significant concerns about barriers to adoption ranging from immature or poorly integrated digital tools to unclear regulatory requirements and limited interoperability across the value chain.

Digitalisation is not only a major contributor to growth and productivity in its own right; it is increasingly recognised as a key enabler of the green transition and vice versa. For example, firms in regions which are relatively strong in the digital domain are significantly more likely to also specialise in green innovations, with twin-transition sectors exerting the strongest mutual influence.¹¹ However, the twin transition of digital and net zero also reflects the complexities of two interconnected structural transformations with potential implications for firm growth and productivity.

The overarching objective of this chapter is to examine how digital adoption, business model innovation, climate strategy, investment decision-making, and organisational alignment influence the productivity and sustainability performance of firms. The research uses diverse methods—including UK-wide surveys, large international datasets, and in-depth qualitative research.

So far, the programme has produced ten research papers, as set out in Box 3.1. A list of researchers and their affiliations with the programme is included in Box 3.2.

The evidence delivers a clear message: digitalisation offers substantial performance benefits, but only when complemented by additional investments, organisational coherence, and strategic alignment. Adoption alone is rarely sufficient.

⁹ Office for National Statistics (2023), [UK Digital Economic Research: 2020, Updated estimates of the economic output of the UK's digital economy](#).

¹⁰ PWC (2024), [The wider economic impacts of emerging technologies in the UK](#), Report for the UK Government Office for Science.

¹¹ Cicerone, Losacker and Ortega-Argilés (2026) in chapter 6 on knowledge diffusion.

Box 3.1: TPI references from Firms Programme

The research summarised in this chapter has been undertaken by researchers at TPI partner institutions, including Warwick Business School, King's College London, the University of Cambridge and the University of Manchester, as well as collaborators from other universities and research organisations.

An extensive summary report on this programme is provided here:

- Stephen Roper and Chander Velu (2026). [Adoption, implementation, alignment – maximising the performance benefits of digital investment: Summary of TPI Firms Research Programme 2023-2026](#), The Productivity Institute Insights Paper 084.

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- Chen YP, C. Popper, C. Velu and F. Putra (2025), How to Address the Incoherence of Business Model Innovation in Digital Transformation, Working Paper 05/2025, Institute for Manufacturing, University of Cambridge. <https://www.ifm.eng.cam.ac.uk/uploads/Cambdige-and-TCB-White-Paper-on-BM-Incoherence-May-2025.pdf>
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- Massini, S., M. Sanchez-Barrioluengo, X. Yu, M., P. Chen and C. Velu (2025). Adoption of Advanced Digital Technologies and Platforms: Insights from a UK national survey, Working Paper No. 049, The Productivity Institute. <https://www.productivity.ac.uk/research/adoption-of-advanced-digital-technologies-and-platforms-insights-from-a-uk-national-survey/>
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- Qi, P., Chen, YP., Velu, C., & Kim, M. (2026). Robot Adoption and Productivity of Buyer– Supplier Alliance. Working Paper, Institute for Manufacturing, University of Cambridge, Mimeo.
- Velu, C., N. Kazantsev, S. Rama Murthy, D. Danaei and D. McFarlane (2026), Transforming Digital Commerce Beyond Platforms: The Case of Open Network for Digital Commerce (ONDC) in India, Mimeo.

Box 3.2: Firms Programme Contributors

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Research Findings

Adoption of Digital Technologies by UK firms

Evidence from an original survey of senior decision-makers across over 3,000 UK firms indicates widespread adoption of advanced digital technology (ADT). When asked about the use of six different ADTs – AI, Big Data, Cloud Computing, 3D Printing, Internet of Things (IoT), and robotics – 80% of firms reported using at least one ADT. Adoption is most prevalent for cloud computing (around 80%), followed by AI (around 50%) and Big Data (around 37%) (see Figure 1). Notably, AI has the highest rate of “tested, but did not use” (10%) responses, which is more than twice that of any other ADT. Importantly, joint adoption of ADTs is common, highlighting complementarities across digital technologies (Massini et al., 2025).

Research Strand: Digital Adoption Across UK Firms

Aim: To examine the extent of adoption of advanced digital technologies (ADT) by UK firms.

Key research questions

Main answers/core findings

• What percentage of firms adopt ADTs?

• **Eighty percent of UK firms** use at least one advanced digital technology, with cloud and AI leading adoption.

• Does this vary by firm size, industry or geographic location?

• **Adoption differs strongly by firm size and sector**, with only **modest regional variation** across the UK.

• Why do firms adopt ADTs?

• Firms adopt ADTs to **modernise processes, improve quality, and automate tasks**, varying by technology type.

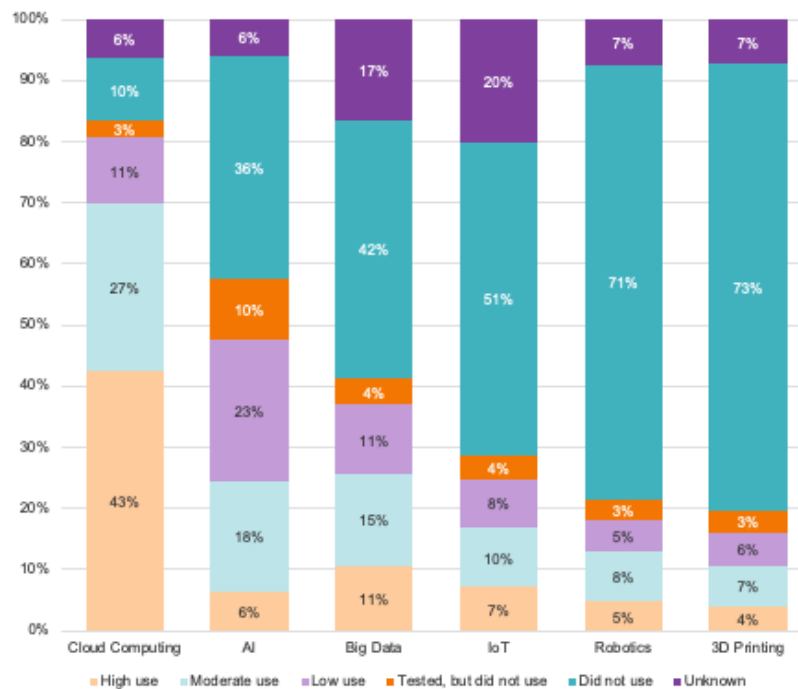
• What are the main barriers to adoption?

• **High costs, skills shortages, security risks, and technology immaturity** remain key barriers to ADT uptake.

The survey examined both the motivations behind firms' adoption of advanced digital technologies (ADTs) and the barriers that hinder uptake. Overall, firms adopt ADTs chiefly to modernise outdated processes, raise the quality of their products or services, and increase automation. The specific motivations vary by technology: automation is the dominant driver for AI and robotics, while improvements in product or service quality matter most for Big Data and 3D printing. Cloud computing is mainly adopted to replace or upgrade legacy systems. Reported impacts on delivery times and production costs are mixed, with roughly 26–28% of adopters reporting positive impacts and 21–23% reporting negative impacts.

Firms also face substantial barriers to adoption. Common concerns relate to the maturity and cost of the technologies, risks around safety and security, the need for significant organisational change, and shortages of skilled workers. These challenges again differ by technology. Cloud adoption is particularly constrained by security concerns. AI adoption is limited mainly by perceptions of immaturity, followed by safety issues and skills gaps. For Big Data, the dominant barrier is a lack of specialised human capital.

Figure 1. Adoption of ADTs per type of technology



Source: Massini et al., 2025

Patterns of adoption vary more strongly by sector and firm size than by region. Large firms and businesses in manufacturing and utilities are the most advanced adopters, whereas SMEs lag behind because of higher per-unit costs, skills shortages, and uncertainty about the benefits. Regionally, London shows slightly higher adoption overall, particularly for AI and Big Data, but geographical variation is modest compared with sectoral differences.

The effects of adoption also differ across technologies. Firms using AI report notable improvements in product and service quality, but often also face higher process costs and longer delivery times. Data-driven technologies such as Big Data, cloud computing, and IoT show similar patterns: quality gains are common, but cost and delivery time pressures also increase. These technologies additionally support diversification of products, services, and customer segments. Manufacturing-oriented technologies—3D printing and robotics—stand out for increasing production volumes, although a significant share of robotics adopters report longer delivery times and higher production costs.

The survey shows that ADT adoption has positive implications for human capital. Firms report increases in employee skill levels and in the share of STEM-skilled workers, with the strongest effects among adopters of Big Data, 3D printing, and robotics. Nearly two-thirds of firms provide training related to ADT adoption, although the incidence varies across technologies. Training is most common for cloud computing and somewhat less so for AI and Big Data, while fewer than one in four firms train workers for the remaining

technologies. Most training occurs on the job or through blended approaches, with fully off-the-job training being less common.

Taken together, the evidence shows that ADT adoption does not automatically generate efficiency or productivity gains. Outcomes vary widely across firms, and benefits depend heavily on complementary investments, particularly in skills and organisational change.

How Firms Make Digital Investment Decisions

The effects of the business environment – such as uncertainty and capital costs – on investment have been the subject of extensive research, which is discussed in the chapter on Finance (Chapter 4). However, what drives investment decisions and the decision-making process within the firm is much less clear. A specific survey of over 1500 UK firms, of which about 300 had invested in digital technologies, aimed to address this gap (Golubova and Roper, 2026).

Research Strand: How Firms Make Digital Investment Decisions

Aim: To understand how firms make digital investment decisions and what shapes their planning and outcomes.

Key research questions

Main answers/core findings

- What motivates firms to undertake digital investments?

- Firms invest in digital technologies mainly to **boost efficiency, productivity, profitability, and long-term business growth.**

- What type of investments co-occur with digital investments?

- Digital investments typically coincide with spending on **software, training, machinery, and wider IT infrastructure upgrades.**

- What planning processes do firms follow in making investment decisions?

- Many firms use **informal planning**, with limited evaluation of returns or structured decision-making procedures for digital investments.

Digital investment is integrated with broader investment portfolios. Investment in digital technologies is closely integrated with that in software, training, machinery, and IT infrastructure. On average, digital investors surveyed made five significant investments (of more than £5,000 each) between 2019 and 2024. They also frequently invested in physical IT equipment or systems and staff training or education (Table 2). In particular,

digital investors allocated an average of 9% of their turnover to intangible assets. The majority relied solely on internal company funds to finance their intangible investments, including digital ones. It was very uncommon for external funding to be the sole source of finance for intangible assets.

Businesses that made digital investments did so for various reasons, usually aligned with core business objectives such as increasing efficiency (cited by 89% of firms) or enhancing productivity (88%). However, the most important reason for investing was increasing company profit and growth or boosting business efficiency (in both cases 27% of firms), with productivity cited far less often as the primary reason for investment (11%).

Table 2: Types of investment made by digital investors

Tangible investment sub - types	%	Intangible investment sub - types	%
IT equipment or systems excluding software	73%	Computer software or databases	100%
Machinery	62%	Staff training or education	72%
Other equipment (excl. IT)	58%	Branding or brand recognition	54%
Buildings or plants	54%	Business structure or organisation	40%
Inventory or stock	47%	R&D	40%
Vehicles	37%	Customer goodwill	31%
Land	10%	Intellectual property products	17%
Other	2%	Entertainment, literary and artistic originals	16%
		Other	3%

Source: Golubova and Roper, 2026.

A significant proportion of businesses which make digital investments do so without a formal investment plan. About one in four firms neither developed a business case nor evaluated the investment proposal or measured expected returns. Although 78% of firms monitored their investment's performance after completion, fewer pursued a threshold rate of return (42%). Key decision makers who proposed the investment were usually in senior roles, and typically remained responsible for the project throughout the investment process.

Overall, the survey underscores that digital investment is central to business growth and efficiency. However, the prevalence of informal planning and financing constraints may hinder its full potential (see also Chapter 4 on Finance). Informal processes may limit firms' ability to align digital investment with broader strategic objectives, reducing potential productivity gains.

Digitalisation and Business Model Innovation

The organisation of production resources – whether internal to the firm or externally sourced through collaborative partnerships – differs fundamentally depending on how a firm creates and captures value, that is, its business model. The research by Chander Velu and colleagues at the University of Cambridge provides robust empirical evidence linking digital adoption with business model innovation (BMI). Their studies, covering UK, India and the US, suggest that conventional business models based on the mass production of standardised items are proving inadequate. The paradigm needs to shift from a rigid “make-and-sell” model to a responsive “sense-and-act” model that quickly detects changing customer preferences and adjusts production capabilities accordingly. Productivity gains occur only when technology choices, organisational processes, incentives, partner relationships, and the firm’s business model develop in a coherent and mutually reinforcing way (Ye et al., 2025).

Research Strand: Digitalisation and Business Model Innovation

Aim: To understand how digital technologies drive business model innovation, shape productivity, and enable firms to adapt and maintain coherence.

Key research questions

Main answers/core findings

• How do emerging technologies shape business model innovation?

• They push firms to shift from rigid “**make-and-sell**” models toward flexible, data-driven “**sense-and-act**” approaches.

• What are the components of business model innovation, and how do they influence productivity?

• Productivity depends on aligning the three archetypes of business model innovation — **value chains, value shops and value networks**—with supporting digital capabilities.

• How do firms adapt their business models amid rapid technological change?

• Firms adopt **servitisation, platformisation, and open-source networks** to reshape value creation and reduce adoption risks.

• How can companies strengthen business model coherence to raise productivity?

• Business model coherence can be strengthened by **removing blockers** across physical flows, information flows, decision rights, incentives, and partner alignment.

Value chains, value shops, and value networks

Business model innovation (BMI) can be divided into three distinct archetypes: value chains, value shops, and value networks – each using digital technologies differently.¹² Value chains describe firms with linear production processes that convert inputs into outputs; value shops focus on firms with processes tailored to specific customer requirements, such as in healthcare or legal services; and value networks centre on connections and exchanges between different customer groups and service providers.

Value chain innovation is primarily driven by changes in production capabilities, such as new processes, which often span multiple firms and reshape relationships with partner firms. For example, robotisation improves partner productivity up to a tipping point; beyond that, too much technological asymmetry diminishes partner performance and weakens cooperation (Qi et al., 2026). When one firm adopts robots, its improved capability can positively affect the partner firm, enhancing its productivity. However, the adopting firm also gains bargaining power and can capture a larger share of the value created. This creates a tension between productivity improvement from technology adoption and power dynamics due to asymmetric adoption rates.

Manufacturers that traditionally are in the “Value Chain” archetype business model are increasingly adopting “Value Shop” features to escape the commoditisation of the “make-and-sell” model. For example, global automobile manufacturers now offer embedded services and financial products to capture customers more effectively, acquire customer information, tailor offerings, and boost core products sales. However, these additions can also distract from core activities, raise managerial costs and create strategic tensions. An analysis of embedded financial assets as a share of total assets for producers in the durable goods sector shows a clear tipping-point dynamic: moderate financialisation improves customer insights and sales, but excessive levels, beyond 35–40% of assets, have an adverse impact on productivity (Bock et al., 2026).

Servitisation and platforms

Heavy capital costs and unproven functionalities present significant barriers to early adoption by producers of novel technologies. Servitisation can help manufacturers shift from selling products to selling outcomes. By taking on maintenance and upgrades in return for a regular fee, firms can reduce risk for the client and encourage uptake. However, does servitisation universally contribute to higher productivity for the provider? Evidence for manufacturers producing durable goods, shows that servitisation can smooth cash flow and accelerate technology adoption. Yet, it may also create conflict with existing value creation if not carefully managed (Kim et al, 2026a). As with

¹² Stabell, C.B. and Fjeldstad, Ø.D. (1998). Configuring value for competitive advantage: on chains, shops, and networks. *Strategic Management Journal*, 19(5), pp. 413–437. <https://doi.org/10.1002/smj.946>

financialisation, the key distinction is between "industrial services" that support the core product and "non-industrial services" that are unrelated.

The use of platforms in business models has expanded rapidly in recent years. For the value network archetype, it is helpful to distinguish between Operations-Centred Platforms (OCPs), which integrate internal assets such as machines and production systems, and Distribution-Centred Platforms (DCPs) which integrate firms with external markets by connecting them to customers and suppliers. A survey of about 3,000 UK firms examining platform adoption, productivity and interactions with technologies such as AI, Big Data, and IoT, reveals a dichotomy based on firm size (Kim et al, 2026b). OCPs amplify the productivity gains of large firms, especially when combined with AI and Big Data, creating a strong compounding effect. In contrast, DCPs benefit smaller firms by opening new market channels and providing steady, incremental productivity gains. Crucially, adopting both types of platforms simultaneously creates conflicting strategic logics. This leads to business model incoherence, where complexity undermines productivity gains that platforms might otherwise deliver.

Open source networks

Finally, this research strand examined market power and open source networks through a case study of India's government-backed Open Network for Digital Commerce (ONDC). Built on open protocols, ONDC aims to make digital commerce more inclusive by enabling firms and customers to plug into the network easily and gain direct supplier and customer base access without needing an intermediary such as platform firms. Interviews with network participants across a range of industries show that ONDC differs in important ways from the conventional platform business model. Platforms can provide assurance on delivery and returns for complex and high value products due to their market power over suppliers, whereas ONDC relies on insurance mechanisms and trust-building among stakeholders. While ONDC provides anonymised aggregate information, platforms aggregate information to design personalised offerings. Moreover, ONDC needs to enable open connectivity among participants to foster innovation whereas platforms can orchestrate partners to share information (Velu et al., 2026).

To summarise, the gap between what is technically feasible with new technologies and what is actually achieved stems largely from "business model incoherence." Digital adoption often happens in isolated pockets of the organisation, with individual functions responding to short-term pressures rather than a shared strategic direction. This creates misalignment between a firm's evolving business model - how it creates value - and its operating model - how it delivers it. When these are out of sync, the business model becomes less effective, and the expected productivity gains may not materialise.

Several "blockers" to business model coherences need to be better aligned for digital transformations to succeed:

- The physical flow, ensuring raw materials and finished products are delivered at the right time and place.
- The information flow, confirming that accurate and timely data reaches the right individuals or systems to enable high-quality decisions.
- Decision rights, clarifying whether the authority to make decisions is given to the right individuals or AI systems.
- Incentives systems, encouraging stakeholders for timely and cohesive action.
- Partner engagement, ensuring that the partner firms' processes and objectives are aligned with the focal firm, strengthening collaboration across the value chain.

To help executives and policymakers navigate this complexity, a Business Model Coherence Scorecard (BMCS) can serve as a diagnostic framework to help leaders identify misalignments in how organisations create value and prioritise corrective actions. It emphasises that value creation varies across the three business model archetypes. Because value chains, value shops and value networks each operate through a distinct logic, the components requiring alignment for strong performance differ accordingly.

The Twin Transition: Digitalisation and Firms' Climate Strategies

Digitalisation and the green transition are increasingly recognised as interconnected structural transformations shaping firm growth and productivity. Digital technologies can improve information flows, enable more efficient use of resources, support innovation, and enhance firms' ability to respond to both regulatory and physical climate risks.

To understand barriers and opportunities to this twin transition, it is essential to distinguish between climate mitigation and climate adaptation.

- Climate mitigation involves actions to reduce greenhouse gas emissions or limit environmental impacts, such as investments in energy efficiency, cleaner technologies or renewable energy generation, to help prevent further climate change.
- Climate adaptation focuses on adjusting business practices, assets, and processes to reduce exposure to physical climate risks, including the use of insurance instruments to manage climate-related losses.

While mitigation typically generates broader social benefits, adaptation often yields more immediate, firm-level returns that directly affect productivity. There are potential synergies between the two climate strategies, and digitalisation can be an important enabler of such integration by supporting organisational learning, coordination, and information processing. A firm's ability to adopt integrated climate strategies depends on its organisational capabilities to recognise external challenges, process information, and translate strategic intent into action. These capabilities are driven by accumulated routines and managerial practices. Digitalisation therefore can be seen as a

transformational process that reshapes organisational activities, not merely the deployment of digital tools.

Research Strand: The Twin Transition: Digitalisation and Firms' Climate Strategies

Aim: To examine how digitalisation influences firms' climate strategy choices and the intensity of their mitigation and adaptation actions.

Key research questions

Main answers/core findings

- How does the adoption of digital technologies help firms respond to climate change?

- Digital technologies act as **affordance generators**, enhancing climate-risk sensemaking and enabling coordinated, data-driven operational and strategic action.

- How is this related to climate mitigation or climate adaptation?

- Digitalisation most strongly promotes **integrated mitigation-adaptation strategies**, reducing reliance on standalone actions through better data and coordination.

- How is the ability of firms to adopt integrated climate strategies affected by their organisational capabilities.

- Strong **organisational routines and managerial practices** determine whether digital tools translate into coherent, integrated climate action.

This work draws on the notion of digital affordances, which is defined as the actions that digital technologies can create when combined with a firm's capabilities, objectives, and organisational context. Digital affordances shape what firms can perceive and accomplish, depending on how digital technologies are embedded within organisational structures. Two types of digital affordances are particularly relevant for climate responses. First, digital technologies enhance sensemaking by improving the collection, monitoring, and analysis of information on emissions, energy use, supply chains, and exposure to physical climate risks. Second, they support action and implementation by enabling more effective coordination across functions, locations, and activities.

Choice of climate strategy and intensity of action

An analysis of 22,500 firms across the EU and US, using European Investment Bank Investment Survey data, identifies strong empirical links between digitalisation and integrated climate strategies (Figure 1). As firms become more digitalised, the probability of having no climate response declines markedly. Digitalisation is most strongly

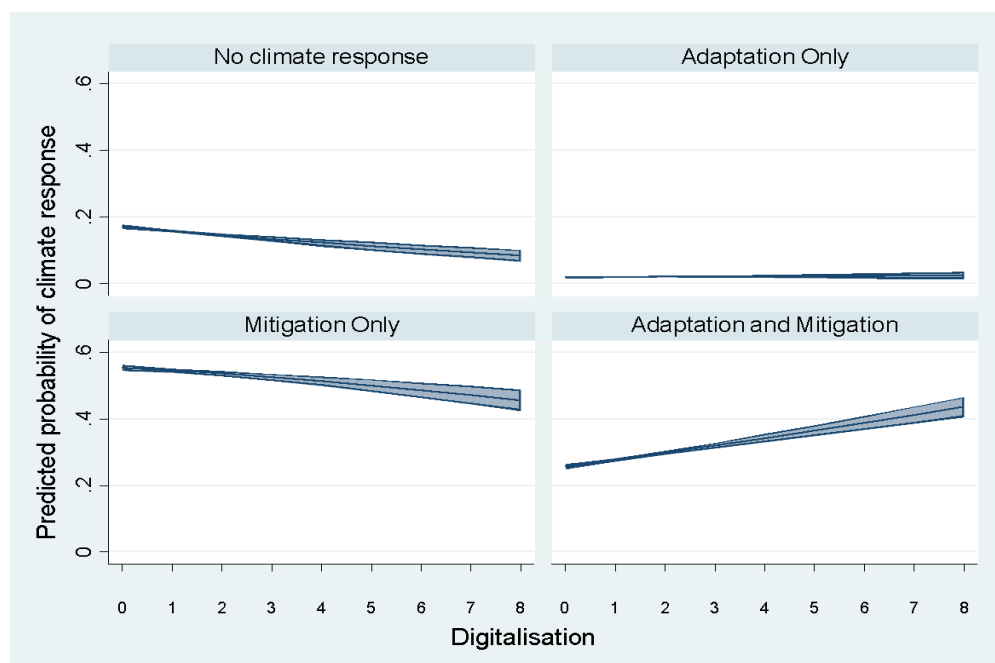
associated with the adoption of integrated strategies that address both mitigation and adaptation, while standalone strategies become less prevalent (Kalantzis et al. 2026).

Digitalised firms undertake a broad set of mitigation actions, such as energy efficiency improvements, cleaner technologies, and waste reduction practices. They also engage more actively in adaptation actions, investing in measures that reduce exposure to physical climate risks and improve operational resilience. These findings are in line with those showing associations between digital and green skills, covered by the People research programme summarised in Chapter 2.

However, these benefits are not automatic. Digitalisation creates enabling conditions by improving information flows, coordination, and the capacity to act. These conditions only translate into stronger climate responses when digital technologies are sufficiently embedded in firms' operations. Partial or fragmented digital adoption is less strongly associated with integrated climate strategies or higher action intensity.

The link between digitalisation and firms' climate responses is observed across sectors, including manufacturing, services, construction, and infrastructure. However, smaller firms which are typically less digitally advanced, are less likely to adopt integrated climate strategies. This does not imply that the digital-climate relationship is weaker for smaller firms, but rather that fewer reach the levels of digitalisation associated with more comprehensive responses.

Figure 1. Predicted probabilities of climate change strategy alternatives



Digitalisation acts as an “affordance generator”, enhancing firm’s ability to make sense of climate risks through better data, monitoring, and analysis, and enabling coordinated action and operational change. While digital technologies create potential, realising these benefits depends on managerial practices, strategic autonomy, and the capacity to integrate information across functions. Digitalisation supports the twin transition by helping firms perceive and respond to climate risks and opportunities more effectively, provided organisational capabilities allow digital tools to be fully utilised.

Digital alignment for net zero

In-depth interviews with managers from 19 construction sector firms in France and Germany, show that managing sustainability to reach net zero carbon emissions is highly complex. It requires companies to collect, monitor, and analyse large amounts of new data that previously received little attention. Although most firms adopt digital technologies to existing organisational processes, they often demand significant changes in how these processes operate. Digitalisation can motivate firms to rethink outdated methods, yet strong path dependencies often slow progress as firms tend to stick to familiar routines. As firms confront technological change, long-established core competences can thus turn into core rigidities (Pinkse et al., 2026).

Research Strand: Digital Alignment for Net Zero

Aim: To examine how effectively firms align their digitalisation efforts with the organisational changes required to achieve net-zero targets.

Key research questions

Main answers/core findings

- How do digital technologies support net-zero processes in firms?

- Digital tools improve **monitoring, analysis, planning, execution, and knowledge sharing** but often **lack integration and embedded expertise**.

- What limits the impact of digitalisation for achieving net-zero targets?

- **Path dependencies, legacy infrastructure, uneven data quality, and coordination challenges** undermine cross-process digital alignment.

- How effectively do firms align digitalisation with organisational change to achieve net zero

- Firms face **organisational and institutional barriers outweighing technological potential** across fragmented processes, making alignment difficult.

The construction sector was chosen as it combines long-standing, traditional work practices with growing reliance on digital technologies such as building information modelling (BIM) to assist firms in managing large volumes of product data and to coordinate modelling efforts among multiple partners.

One can distinguish five key processes through which digital technologies are transforming the construction sector, with substantial upsides for productivity growth:

Monitoring: Digital tools enhance the accuracy of activity monitoring, allowing production processes to be optimised for lower emissions more effectively than traditional manual checks. However, significant barriers remain, including the frequent reliance on human operators to input data manually, lack of relevant data and reluctance among actors to share data.

Analysis: Some firms use specialised software to assess the carbon footprint of their products, but these assessments are often complex as different supervisory bodies require different indicators. Firms also utilise digital technologies to analyse data, but many tools do not provide a comprehensive and integrated view of all relevant indicators, and the accuracy of the analysis is constrained by the quality of the underlying data.

Planning: Digital technologies such as scenario-generation tools allow firms to create and compare alternative scenarios using predefined criteria that can aid net zero planning. Because low-carbon transitions depend on local biophysical conditions and material availability, they require tailored and customised solutions. Digital technologies can also assist in optimising low carbon design phases, but many digital tools are still unconvincing; they lack the embedded knowledge necessary to produce reliable outputs.

Execution: Digital technologies such as 3D printing, automated factories, and digitally controlled machines can automatically perform physical tasks, translating a digital model into robotic action. These tools can play a crucial role in scaling more sustainable construction methods. However, successful digital execution depends on the digitalisation of physical assets, which is not always achieved, because plants can be decades old particularly in cement and concrete production. Limited digital expertise among core employees further limits adoption.

Knowledge sharing: Digitalisation can support organisational decision-making by shaping how knowledge is created, organised, and shared. It also facilitates the knowledge exchange across organisations. However, gaps persist between what providers of low-carbon solutions supply and what decision-makers require. Coordination challenges increase as firms interact with a large number of actors whose digital capabilities vary widely. A lack of digital continuity across the construction value chain also creates barriers, for example, when building design software is incompatible with the software used by digital cutting machines.

Overall, digitalisation shows strong impact within specific processes, but its effectiveness weakens across those processes. Limited embedded expertise, uneven data availability, and the challenges of modelling emerging technologies reduce the practical value of digital tools and perpetuate misalignment across processes. Organisational and institutional barriers outweigh technological ones, and legacy infrastructure limits automation. The sector's fragmented structure, characterised by short project cycles and numerous partners, also hampers alignment. Digital transformation for net zero requires coordinated organisational change, not merely the deployment of new technologies.

Implications for policy and business

While digital adoption is increasingly common among UK businesses, both adoption and use of digital technologies remain limited to specific sectors and larger companies. Many organisations are still likely to postpone decisions about digital adoption or expanding their digital capabilities. Policy measures that support digitalisation and productivity growth will be essential, especially for smaller firms. For example, policies promoting the formalisation of business case development and ROI evaluation could improve outcomes. Expanding grant programs or tailored financial instruments could accelerate digital adoption and reduce the heavy reliance on internal funds. High rates of investment in staff training underscore the need for workforce development policies aligned with digital transformation.

Scalable, cost-effective interventions are likely to be most beneficial. The Evolve Digital trial, supported by the Department of Business and Trade (DBT) under the Business Basics initiative, offers one promising approach by using peer-learning groups to foster digital confidence and uptake (Jibril et al., 2022). Such approaches may complement automation tools, such as the digital navigator app highlighted in the Technology Adoption Review 2025.

Policy support to encourage stronger alignment between digital investment strategies and wider organisational transformation processes are inherently more complex and require tailored approaches that reflect the specific needs of individual organisations. The digital adoption element of the Made Smarter programme offers such bespoke support through a digital roadmap and potentially financial assistance for skills development and capital investment. Currently, such support is limited in scale and scope with a primary focus on manufacturing. As highlighted in the Technology Adoption Review 2025, extending Made Smarter to other sectors could be beneficial. Other support models may also be effective, including the Knowledge Transfer Partnership programme, which has facilitated digital transformation projects within firms.

Policy should actively encourage embedded or “industrial” financial services that promote industrial firms to develop core manufacturing competencies – for example, financing schemes to accelerate the rollout of electric vehicles (EVs). At the same time, it should discourage purely financial or “speculative” activities that undermine the productivity of non-financial firms. Policies should recognise the complementarities between manufacturing and services activities within digitised firms. What matters most is the depth of integration between the two, not simply the breadth of services offered by manufacturing firms. By promoting activities central to firms’ core business models, policy can help align business model innovation with broader national goals, such as carbon emission reduction.

In terms of platformisation, the policy emphasis should shift from generic digitisation encouraging interoperability standards and support platform diagnostics, allowing firms to plug into the most appropriate networks without becoming locked into unsuitable or inflexible architectures.

These policy lessons also carry important implications for businesses themselves. Within supply chains, firms should be aware not only of their own level of automation but also that of their partners, ensuring they “keep up” and avoid excessive divergence that can undermine productivity. Likewise, when embedding financial services or pursuing servitisation, managers should strike an appropriate balance, avoiding the temptation to pursue unrelated services that promise quick returns but erode core competitiveness.

Platformisation suggests differentiated strategies between large and small firms. Whereas large firms should leverage operational capability platforms (OCPs) to enable deep tech integration, SMEs can benefit more from digital capability platforms (DCPs) that expand market reach. Attempting to do both risks creating a “productivity penalty.”

Achieving digitalisation’s full sustainability potential requires investment not only in digital tools but also in digital literacy, organisational redesign, interoperability, and shared standards. Without these complementary capabilities, digitalisation risks reinforcing existing silos rather than enabling the integrated, cross-functional processes essential for effective sustainability management.

4. Finance, Investment, and Productivity

Introduction

Business investment plays a central role in driving productivity, whether that be investment in new ideas, in new locations for expansion, or in technology to change workplace practices and production. UK business investment has been weak for decades, was particularly sluggish after the Global Financial Crisis, and has slowed further since Brexit and Covid. Explanations point to sluggish global demand, weaker competition, greater uncertainty, underexploited agglomeration and network effects, spatial inequalities, growing financialisation and earnings management, and the rising role of institutional investors. The objective of this research programme is to take a fresh look at UK investment and assess more closely the role for finance in supporting it.

This research builds on three complementary perspectives: an equilibrium/economist perspective, a demand/manager-owner perspective, and a supply/financier perspective (Mann, 2024). While the economist perspective focuses on the cost of financing vis-à-vis the present value of future earnings, it is the interplay of decisions taken by the owner/managers and financiers – the demand and supply side of finance – that ultimately yields the amount and cost of financial resources for various types of business investment in the economy. Regardless of financing, investment is unlikely to be smooth over time, leading to a fourth perspective which examines the implications of slow (or “sticky”) decision-making and discontinuous (or “lumpy”) investment strategies.

So far, the programme has produced nine research papers, as set out in Box 4.1. A list of researchers and their affiliations with the programme is included in Box 4.2.

The research uses firm-level evidence from survey data, qualitative interviews, and qualitative datasets. Some sources are representative samples of firms, others aim to cover the substantial universe of firms, including both listed and unlisted firms. In terms of understanding the demand and supply side of finance, the analysis covers a wide range of ownership structures, including single owner firms, family-owned businesses, multinational enterprises, and financial institution ownership.

Research Objectives

A central objective of this research is to understand heterogeneity in behaviour across firms—by size, ownership, growth potential, and region—and how financial constraints, internal hurdle rates, and equity gaps affect both tangible and intangible investment. The work also investigates the dynamic nature of investment, including lumpy adjustment, slow-moving decision processes, and lags between financing, investment, and productivity outcomes. By combining firm-level evidence with policy relevant analysis,

the research seeks to inform more effective monetary, fiscal, and structural policies aimed at raising long-term UK productivity and growth.

Box 4.1: TPI references from Finance Programme

The research summarised in this chapter has been undertaken by researchers at TPI partner institutions, including the University of Manchester and the University of Glasgow, as well as collaborators from other universities and research organisations.

An extensive summary report on this programme is provided here:

- Catherine L. Mann (2026), [Finance, Investment, and Productivity: Distillation and Synthesis of TPI Research Programme on Finance](#), The Productivity Institute Insights Paper 085.

Papers and journal publications:

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Box 4.2: Finance Programme Contributors

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Summary of Research Findings

The equilibrium/economist perspective: cost of capital and investment

Cost of capital plays a meaningful role in shaping investment decisions when analysed using firm-level data. This contrasts with research findings based on national-accounts macro data which frequently finds that interest rates are not a significant determinant of business investment. In their anchor paper for this programme, Yongyi Xue and Catherine Mann unravel the relationship between finance, investment and productivity by distinguishing between different financing types and sources, and by examining how their relative cost affects investment by type (Xue and Mann, 2026). Firm-level data up to 2019 offer a detailed perspective on the UK's persistently weak investment performance during a period of historically low interest rates, heightened economic uncertainty, and changed trade relationships with the EU because of Brexit. Different measures of the cost of capital – including cost of debt, cost of equity, return on invested capital (ROIC), weighted average cost of capital (WACC), and internal hurdle rates – affect investment outcomes for both tangible capital and intangible assets, such as R&D. Focusing on the more recent cycle of tighter monetary policy and higher overall interest rates since the early 2020s, external-financed firms face higher baseline costs, show greater sensitivity to rate hikes, and curtail investment more significantly than firms reliant on internal cash flow (Shah et al., 2025a).

Research Strand: Cost of capital and investment

Aim: Assess different measures of the cost of capital and how they shape firm's investment behaviour.

Key research questions

Main answers/core findings

- How do measures of cost of capital relate to investment and firms by type?

- Firm-level investment responds to cost-of-capital measures in heterogeneous ways, with **smaller, unlisted, and financially constrained firms most sensitive to debt costs**.
- Debt costs are negatively related to tangible investment, while intangible investment is largely insensitive to standard cost-of-capital measures.

- Which firms use hurdle rates and what affects the gap between hurdle rates and the underlying equilibrium cost of capital?

- Hurdle rates are **mainly used by large, externally financed firms** and remain **persistently above equilibrium cost measures**.

- How are the transmission channels from monetary policy shocks to investment affected by whether firms use internal funds or external borrowing?

- **Monetary policy effects are amplified through the credit channel**, with externally financed firms responding more strongly than internal funders.

Considering the type of investment, the cost of debt consistently exhibits a significant and negative relationship with tangible investment, whereas intangible investment (R&D) shows little to no responsiveness to changes in the various cost-of-capital measures. R&D investment appears to be driven predominantly by internal cash flow, profitability, and firm-specific strategic considerations rather than borrowing costs or investor return requirements.

There is also significant heterogeneity in investment responses. Smaller firms, unlisted firms, and financially constrained firms are most sensitive to changes in the cost of debt, while listed firms are more responsive to equity-based cost measures. High growth enterprises (HGEs) are less constrained by debt costs, possibly due to stronger internal cash flows, better investor attention, or preferential access to funding (Xue and Mann, 2026). Similar heterogeneity is found for small and financially constrained firms displaying significant negative investment responses to adverse financial shocks while large firms appear unaffected (Görtz et al., 2026).

Factors other than the cost of capital, notably growth potential, impact on investment. Although growth affects both tangible and intangible investment, larger firms, high-growth companies, and those with younger capital vintages exhibit stronger investment responses to business cycle shocks. Firms with high sales growth respond more aggressively to positive shocks, while high-debt firms show greater sensitivity to changes in financial conditions. Other factors impacting on investment include geographic dispersion, market power, heightened uncertainty, regulatory divergence, and exposure to disruptions in trade and labour markets (Görtz et al. 2026).

The demand/manager-owner perspective: hurdle rates and family-firm financing

The behaviour of firms' managers and owners can affect investment decisions. Investment outcomes differ markedly for firms that use hurdle rates – the minimum required rate of return that a firm sets for approving an investment project – compared with the whole sample of firms. Hurdle rates are more common among larger, more productive firms and those using external finance. Notably, hurdle rates are much higher than other cost-of-capital measures and have hardly changed over the period 2013-2022 (Xue and Mann, 2026). This period corresponds to a time when interest rates were very low, suggesting that firms maintained elevated internal return benchmarks even when external borrowing costs declined. Hurdle rates have the strongest negative association with tangible investment, with effects substantially larger than those associated with other cost-of-capital measures. During the subsequent period of rising interest rates, no upward adjustment in hurdle rates was seen either (Shah et al., 2025b). These insights suggest that addressing UK underinvestment requires attention not only to funding costs but also the internal decision processes inside firms, particularly in larger and publicly listed companies where hurdle rates are more prevalent. High and sluggish hurdle rates might act as buffers against uncertainty but might also reflect institutional inertia and managerial conservatism in capital budgeting processes.

To understand how owner behaviour shapes financing decisions, it is useful to look at the relationship between family ownership and equity fundraising in high-growth enterprises (HGEs), and to assess whether the equity gap reflects firms' inability to raise equity or their strategic choices (Deng et al., 2025). Using a comprehensive panel of HGEs in the UK from 2014 to 2021, an inverted U-shaped relationship can be seen between family ownership and equity fundraising. At low to moderate levels of family ownership, families tend to balance growth ambitions with long-term legacy considerations aligning with external investor interests.

Research Strand: Hurdle Rates and Family-Firm Financing

Aim: To understand how managers' and owners' decision-making shapes firms' investment and equity-financing outcomes.

Key research questions

Main answers/core findings

- Why do firms use high hurdle rates, and how do these affect investment?

- **Hurdle rates stay high and unresponsive to interest rates**, significantly depressing tangible investment and reflecting managerial conservatism.

- How do hurdle rates behave over periods of low and rising interest rates?

- Hurdle rates barely adjust during low or rising interest-rate periods, revealing **managerial inertia and conservative capital budgeting**.

- How does family ownership influence equity fundraising in high-growth enterprises?

- Family ownership shows an inverted U-shape: **moderate ownership supports equity raising, high ownership leads to equity aversion**.

However, at higher ownership concentrations, control-oriented objectives become more dominant, leading to equity aversion. The presence of family members on the board further amplifies the negative impact of high family ownership on equity fundraising. While factors such as government grants, macroeconomic uncertainty, and geographic location also influence equity raising behaviour, they do not fundamentally alter the underlying ownership–equity relationship.

The supply/financier perspective: pervasiveness of financial constraints

Firms may seek to finance investment through borrowing or by raising equity, yet financial institutions may be unwilling to offer sufficient funds, or those funds may be too costly, resulting in supply-side financial constraints. Empirically, the relationship between the cost of debt and investment follows a U-shaped pattern. Firms facing moderate financial constraints, being large enough to require external financing but insufficiently creditworthy to secure it at low cost, are the least likely to invest (Xue & Mann, 2026).

Research Strand: Pervasiveness of financial constraints

Aim: To identify how different financial constraints shape firms' investment decisions and amplify their responses to economic shocks.

Key research questions

Main answers/core findings

- How pervasive are financial constraints among firms?

- **Financial constraints are widespread**, with about two-thirds of firms reporting at least one significant limitation.

- How do different types of constraints affect investment and respond to macroeconomic conditions?

- **Cost-of-finance constraints react quickly to interest rates**, while **internal-funds constraints adjust slowly with earnings**.

- How do financially constrained firms respond to economic shocks?

- **Constrained firms show stronger, asymmetric responses**—negative shocks sharply reduce investment, while positive shocks have muted effects.

- How do equity gaps affect high-growth enterprises (HGEs)?

- **Equity-constrained HGEs invest less**—especially in intangibles—though London-based firms are less affected due to deeper capital markets.

Survey evidence from the UK Decision Maker Panel (DMP) allows a deeper investigation of financial constraints by distinguishing between limited internal funds, restricted external funds, and high cost of finance (Ozturk et al., 2025). Large firms with relatively high debt-to-asset ratios are more likely to report financing difficulties, suggesting that indebted firms face tighter borrowing conditions or higher risk premia. In contrast, smaller and medium-sized firms rely more heavily on internal funds. Overall, financial constraints are pervasive as around two-thirds of firms report at least one type of constraint. However, the relative importance of different constraints varies with macroeconomic conditions. Cost-of-finance constraints respond quickly to interest rate changes while internal finance constraints, associated with other balance sheet indicators, adjust more slowly as sales and earnings evolve.

Financially constrained firms also respond more strongly to shocks, and these responses are asymmetric: higher interest rates and adverse sales conditions have much larger effects on investment than equivalent declines in interest rates or positive shocks. Moreover, firms constrained by internal finance respond more strongly to demand shocks than unconstrained firms, which is consistent with internal funds being generated through sales and profits (Ozturk et al., 2025).

High growth enterprises (HGEs) may face specific limitations on finance that constrain their investment and growth. Rapid expansion often leads to the early depletion of internal resources and pushes firms toward their debt capacity limits, making equity financing essential for sustaining growth. HGEs that experience equity gaps make significantly fewer capital investments especially in intangible assets, consistent with the equilibrium/economist finding that investment in intangibles is relatively insensitive to standard cost-of-capital measures (Dang et al., 2026a).

HGEs headquartered in London are less affected by the negative impact of equity gaps, reflecting the city's deeper capital market and wider networking and financing opportunities. This regional pattern also matches the insights from the equilibrium/economist view (see also Chapter 5 on the regional finance perspective). By contrast, government grants do not significantly mitigate the relationship between equity gaps and investment, suggesting that they neither substitute well for equity financing nor act as adequate signal or catalyst for attracting further equity financing (Dang et al., 2026b).

Dynamics of investment: lumpiness and lags

Owners/managers or financiers can be slow to adjust to the macroenvironment or new technological possibilities. Evidence on the dynamic links between balance sheet indicators of financial adjustment, such as cash holdings, debt, and equity, before, during, and after episodes of large changes in investment rates suggest that adjustment lags are important (Görtz et al., 2025). Firm-specific fundamentals reflected in profitability and productivity are leading indicators of lumpy investment behaviour. In particular, cash balances lead lumpy adjustments by one year, while debt responds most strongly overall with a peak response in the same year as the adjustment. This pattern highlights the importance of firms' access to credit as a critical precursor to expansions in productive capacity. By contrast, lumpy contractions in productive capacity follow periods in which firms reduce cash balances and hold above average levels of debt. During and after such contractions, firms rebuild cash and significantly reduce debt growth in a concerted effort to restore financial resources by adjusting their productive operations. Notably, small firms increase cash holdings significantly more than medium and large firms during lumpy capital expansions (Görtz et al., 2025).

Although firm investment, business dynamism and macro-outcomes are closely related, there are asymmetric adjustment patterns across different types of firms and investments. Aggregate fluctuations are driven more by changes in the share of firms undertaking lumpy adjustments than by the average size of those adjustments. There is also evidence that sticky hurdle rates, as discussed above, dampen the responsiveness of business investment to monetary policy, shaping aggregate outcomes (Görtz et al., 2025).

Research Strand: Dynamics of investment: lumpiness and lags

Aim: Understand the dynamic links between finance, investment, and productivity to explain lags, asymmetries, and adjustment patterns in firm growth.

Key research questions

Main answers/core findings

- To what extent is investment lumpy and how is this reflected in aggregate macro statistics?

- **Investment is lumpy**, with aggregate dynamics driven mainly by changes in the number of firms adjusting rather than the size of adjustments.

- Are hurdle rates slow to change?

- **Hurdle rates are sticky**, reducing the responsiveness of investment to changing financial conditions.

- Are there lags in translating investment to productivity growth?

- **Financial and investment adjustments lead productivity**, so productivity gains often materialise only with a lag.

Lags can also be observed between financing, investment, and productivity. For example, equity fundraising by UK private firms is followed by a short-term decline in measured productivity, although this effect is temporary and dissipates within three years. The decline is concentrated among firms with high investment intensity and those operating in knowledge-intensive industries. This pattern suggests that the productivity slowdown reflects the time lag between equity-financed investment and the realisation of revenues. As a result, short-term declines in productivity following equity investment may mask the long-run efficiency gains associated with improved access to capital (Dang et al., 2026b).

Implications for policy and business

Cost of capital and investment

High borrowing costs, elevated internal hurdle rates among larger firms, weak competitive pressures, and persistent macro-political uncertainty jointly constrain investment across the UK corporate sector. Improving investment outcomes is therefore likely to require multi-dimensional policy response. This includes measures to strengthen access to finance for SMEs, enhance competition, improve transparency around internal capital budgeting practices, and reduce macroeconomic and regulatory uncertainty.

Within this broader context, the credit channel plays a critical role in the transmission of monetary policy. Policy rate changes do not only influence aggregate investment via

direct cost-of-capital effects but also through differential impacts on firms, depending on their financing structures. Central banks should take this heterogeneity into account, as credit constraints and financing composition amplify and shape the effectiveness of monetary policy.

Equity and High Growth Enterprises

There is also a need for a multi-dimensional approach to closing equity gaps, which expands the supply of patient equity capital, addresses regional imbalances in its availability, and considers firm-level ownership and governance preferences. For investors, the research highlights the importance of longer time horizons and governance structures to support sustained value creation and raise productivity. For firm management, it is key to be aware of trade-offs between retaining control, pursuing growth, and meeting short-term performance metrics when relying on equity finance.

Overall, the evidence suggests that equity finance is essential for unlocking the long-term growth and productivity potential of UK high-growth firms. However, its effectiveness depends on a clear understanding of dynamic effects and institutional context of equity financing and on how those considerations are reflected in policy design and strategic decision-making.

Lumpy dynamics

Lumpy investment dynamics imply that stimulus policies are more effective during economic expansions than recessions. In booms, positive shocks push more firms further from their desired capital stocks, increasing the probability of lumpy adjustments and thereby raising the share of firms responding to incentives. This state dependence suggests conventional fiscal multipliers may understate stimulus effectiveness in good times while overstating it during downturns.

Effective policy design therefore requires developing indicators that can identify firms likely to undertake lumpy adjustments even in the absence of intervention, which in turn depends on measuring the gap between actual and desired capital stock. Policies that reduce adjustment costs or ease financial constraints could have disproportionately large effects by enabling marginal firms to undertake growth-enhancing investments they would otherwise postpone.

5. Regional Access to Capital and Investment Finance

Introduction

The UK's persistently weak productivity growth is often attributed to chronically low levels of both private and public investment. Yet the underlying reasons remain unclear. On the face of it, the UK should be an attractive long-term investment environment: it is highly deregulated, protects investor interests, maintains strong competition across markets, and benefits from deep, liquid capital markets centred on London. Despite these features, UK investment as a share of national income lags behind comparable economies in Europe, North America and East Asia.

A common explanation is that the UK suffers from systemic “short-termism”, with investors favouring quick returns over longer-term gains. While this has intuitive appeal, the drivers of such short-termism are not well understood. It may reflect behavioural tendencies that undervalue the future, or deeper cultural, institutional or economic factors. Alternatively, short-termism may arise from structural features of the UK economy that raise the cost or risk of long-term investment. Understanding UK investment behaviour therefore requires analysing short-termism not as a cause in itself but as an outcome shaped by wider market and institutional influences.

In principle, investment decisions should follow the textbook model: if expected future returns exceed current costs, investment should proceed. Persistent under-investment implies distortions. These may arise from firm or financial-sector governance structures biased toward short-term results; from market failures that prevent investors from capturing the full social returns of investment; or from policy and regulatory settings that inadvertently deter long-term investment.

In the UK context, several specific explanations have been advanced: investment projects may face unusually high costs or delays; investors may place a low value on future returns; or expected returns themselves may be weak. These issues may disproportionately affect certain sectors or regions.

For the UK it is pertinent to examine these distortions through the lens of economic geography. Investment takes many forms—from venture capital and bank lending to public funding for infrastructure, education and R&D—and successful regional economies rely on balanced portfolios of these sources. Yet in the UK, both private and public investment are highly unevenly distributed. Early-stage finance is overwhelmingly concentrated in London and the South East, while public investment in growth-enhancing areas such as R&D, transport and culture has long favoured already-prosperous regions.

Multiple structural features help explain this spatial imbalance. The UK's centralised financial system limits the development of relationship-based local banking and the deep local knowledge that supports risk assessment in other countries. Public institutions and governance structures are similarly centralised, leaving many regions with weak capacity to generate local economic intelligence or coordinate long-term development strategies. Land-use planning rigidities and high infrastructure costs further deter investment, particularly in economically weaker areas where clarity and responsiveness are most needed.

Together, these factors create powerful forces that inhibit capital flows to the UK's less prosperous regions, reinforcing geographic inequalities and constraining national productivity growth.

Research objectives

This research analyses why private investors perceive risk so differently across UK regions, particularly in economically weaker places. It examines the financial, fiscal, legal, governance, and land-market features of successful investment frameworks in the UK and internationally, assessing how these arrangements build investor confidence and stable regional capital bases. The research evaluates the constraints of the UK's current financial-fiscal architecture and benchmarks global best practices to propose realistic institutional reforms that can enhance the capacity of lagging regions to attract and sustain private investment. It also identifies how purpose-built institutional platforms could strengthen coordinated public-private investment. Finally, this strand assesses how Covid-19 lockdowns and the shift to remote work have altered the productivity advantages of different places.

So far, the programme has produced 17 research papers, as set out in Box 5.1. A list of researchers and their affiliations with the programme is included in Box 5.2.

Box 5.1: TPI references from Regional Finance Programme

The research summarised in this chapter has been undertaken by researchers at the University of Manchester, as well as collaborators from other universities and research organisations.

An extensive summary report on this programme is provided here:

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Summary of Research Findings

Capital, Risk and Regional Divergence

Capital market dynamics are central to understanding regional divergence, and there are clear indications that the global financial crisis fundamentally reshaped those dynamics in ways that still reverberate today. Using uniquely detailed, location-specific and transaction-specific data on commercial real-estate investments, Michiel Daams, Philip McCann and colleagues (see Box 5.1) have uncovered how capital markets perceive and price regional economic risks, and how these perceptions shape long-run geographic prosperity. Through their pricing of commercial real-estate investments, investors reveal real-time judgments about the future strength of local economies, providing a powerful way to assess capital market expectations at the city and regional level.

Research Strand: Capital, Risk and Regional Divergence

Aim: To use detailed real-estate investment data to uncover how capital pricing and shocks shape regional risk, investment behaviour, and long-run economic divergence.

Key research questions

Main answers/core findings

- How do investors price risk and allocate capital across regions over time?

- **Post financial crisis capital flight favoured large cities**, creating persistent asymmetries and renewed regional divergence.

- How did the 2008 crisis affect capital allocation in the UK?

- In the UK, the crisis triggered a **strong capital shift to London**.

- How does the banking system's structure influence regional inequality?

- **UK banking structures amplify regional risk premia**, causing inequality and weakening non London growth.

- Is the UK Sterling-zone an optimal currency area versus Europe?

- Post crisis capital adjustments show the **Sterling zone functioning less effectively** than the Eurozone.

- Do national media narratives reflect investors' regional risk perceptions?

- **National media mirror London's economic concerns**, diverging sharply from investment conditions elsewhere.

By examining pre- and post-crisis transactions, yields and risk premia before and after the 2008 Global Financial Crisis, the work identifies persistent post-crisis asymmetry in local capital market conditions and underscores the capital risk safety aspects of agglomeration. Initial analysis for the US shows that before the financial crisis, the allocation of capital across cities broadly reflected underlying fundamentals. However, once the crisis hit, investors undertook a marked “flight to safety,” redirecting capital towards the largest, most diversified and most productive cities in the US. These places were perceived as safer and more resilient, attracting investment even as uncertainty intensified, contributing to a renewed phase of spatial divergence towards the largest and most prosperous cities in the US. These agglomeration effects not only reflect economic advantages but also perceived financial risks and safety (Daams et al, 2024a).

The UK analysis reveals an even more dramatic pattern (Daams et al, 2024b). Prior to 2008, UK regions were not strongly differentiated by investors in terms of risk pricing. The crisis produced an abrupt break as London and its immediate hinterland became the dominant safe region for investment creating a unique case of extreme concentration in capital allocation. Unlike the US, where several large cities benefitted, the UK's safe harbour consists of just London and the Southeast, while most other UK regions were

essentially perceived as junk bond territory and have remained in this category ever since. This sharp divergence in capital pricing has sustained reductions in investment attractiveness and leading to weaker productivity performance.

The institutional structure of the UK's financial system plays an important role in the persistence of those patterns for so long. The external finance premia for firms located outside the most productive regions is substantially higher than in other countries. In effect, companies in many parts of the UK face borrowing conditions comparable to the gap between the UK and an emerging economy, such as Romania. The UK's financial system, especially the banking sector is highly centralised, London-focused and oriented around assets perceived as low-risk, creating structural disadvantages for the rest of the country (McCann, 2025a).

These dynamics also have important implications for monetary policy. It appears that capital price adjustments across UK regions have become less coherent and more uneven since the crisis, meaning that the UK's Sterling zone no longer functions as an optimal currency area. By contrast, both the Eurozone and non-Euro EU regions display more consistent adjustment patterns. This also helps explain why policies such as quantitative easing had substantial effects within London's financial ecosystem but limited traction elsewhere in the UK (Daams et al, 2025b).

Finally, it is striking to see how narratives of regional risk and uncertainty are communicated in the national media. Using large language models (LLMs), it appears national media coverage overwhelmingly reflects the economic concerns of London and bears only limited resemblance to investors' perceptions of risks facing other UK cities and regions. This misalignment creates informational blind spots, distorts public understanding and complicating the design and implementation of effective regional economic policy (Ming-Wei et al, 2025).

Rewiring Financial and Institutional Systems for Regional Growth

The UK's financial-institutional architecture systematically reinforces short-termism, centralisation and risk aversion, producing persistently weak capital flows into lagging regions. Because investment decisions are concentrated in national-level institutions with limited regional presence, capital tends to gravitate toward already successful locations. The problem is exacerbated by the UK's lack of large-scale, long-horizon public intermediaries in other countries, which are characterised by scale, clear mandates, an ability to blend public and private finance and capable of counteracting market myopia (McCann 2023; Frick et al. 2026).

Research Strand: Rewiring Financial and Institutional Systems for Regional Growth

Aim: To understand how UK financial behaviour and institutions shape regional investment, and identify reforms inspired by OECD models to support lagging places.

Key research questions	Main answers/core findings
<ul style="list-style-type: none"> How do UK financial institutions' behaviours and structures influence regional investment patterns? 	<ul style="list-style-type: none"> UK financial institutions' behaviours reinforce short-termism, centralisation and risk aversion, producing structurally weak capital flows into lagging regions.
<ul style="list-style-type: none"> How can the UK's financial-institutional ecosystem be redesigned to support weaker regions? 	<ul style="list-style-type: none"> Redesigning the UK's financial-institutional ecosystem needs new intermediaries, stronger sub-central fiscal powers and coordinated national–local investment.
<ul style="list-style-type: none"> Which governance and fiscal reforms enable effective local development under devolved arrangements? 	<ul style="list-style-type: none"> Effective devolution requires fiscal reform, clearer accountability, planning and land-use changes, and long-term local investment mandates.
<ul style="list-style-type: none"> What institutional models in other countries offer adaptable lessons for strengthening UK regional investment? 	<ul style="list-style-type: none"> State-development-bank models in other countries show how institutional scale, governance strength and long-term financing mandates address regional investment gaps.

The highly centralised fiscal system in the UK is very unusual by OECD standards and structurally misaligned with the objectives of devolution and Levelling Up. It restricts the investment autonomy of city-regions and devolved authorities and limits their capacity to build credible local investment projects, thereby establishing regional productivity disparities. At the same time, restrictive land-use planning and housing-supply constraints undermine infrastructure investment returns and limit regeneration potential, especially in weaker localities. (McCann 2022, 2024; The Productivity Institute, 2024).

Effective devolution requires pairing fiscal reform with stronger accountability, more enabling planning and land-use systems, and predictable long-term local investment tools. Achieving this depends on understanding the systemic interactions between housing markets, land values, planning processes, and infrastructure decisions, all of which shape local development trajectories. Stronger fiscal frameworks and better-aligned planning institutions are therefore essential for unlocking investment and

ensuring local governments can manage and benefit from development over time. (McCann 2026).

Covid-19, Remote Work and the Geography of Productivity

The shift to widespread Work From Home (WFH) has reshaped the spatial pattern of productivity by generating both a donut effect, in which workers move from dense centres to suburban areas, and a shadow effect, which strengthens the reach and productivity of major cities. The shadow effect reflects the expansion of effective market and labour-market areas of large metropolitan centres, thereby reinforcing rather than weakening urban concentration (Bond-Smith & McCann, 2025). Empirical evidence from Sweden confirms that these expanded “productivity shadows” draw workers closer to large cities rather than dispersing activity outward (Bjerke et al., 2025).

Research Strand: Covid-19, Remote Work and the Geography of Productivity

Aim: To examine how the Work from Home revolution reshaped spatial productivity advantages and altered cities’ market areas and labour dynamics.

Key research questions	Main answers/core findings
<ul style="list-style-type: none"> • How has Work From Home (WFH) changed the spatial distribution of productivity? 	<ul style="list-style-type: none"> • WFH creates both a donut effect, favouring suburban areas and a shadow effect, amplifying large cities’ market and labour market reach.
<ul style="list-style-type: none"> • How did it reshape labour mobility in growing vs. declining agglomerations? 	<ul style="list-style-type: none"> • WFH creates very different behaviours of labour mobility between growing and declining agglomerations.
<ul style="list-style-type: none"> • How has it altered commuting cost and the logic for investment in public transport infrastructure? 	<ul style="list-style-type: none"> • New commuting patterns change the marginal costs of commuting time and preferences, requiring a revision to the Generalised Cost of Travel (GCT) framework for public transportation infrastructure.

WFH also interacts differently with labour mobility between growing and declining urban areas. Evidence from the Finnish high-tech workforce shows that expanding cities are better positioned to capture mobile talent, whereas declining areas experience reduced inflows and weaker job-matching processes (Simonen et al., 2024). Understanding these

asymmetries is essential to interpreting how WFH-induced shadow effects reinforce large-city advantages and accelerate divergence between thriving and struggling regions.

Changing commuting patterns associated with hybrid work alter both the marginal cost of commuting time and workers' preferences over travel frequency and distance. Fluctuating commute intensities reshape optimal investment priorities, with large cities gaining a stronger position for public capital investment. These behavioural shifts require an update to the Generalised Cost of Travel (GCT) framework used to appraise transport infrastructure investments to reflect new spatial equilibria in the UK (Bond-Smith & McCann, 2025).

Implications for Policy

The findings point to a UK finance and investment landscape marked by deep structural distortions that systematically disadvantage economically weaker regions. A central policy implication is the need to rebalance the architecture of financial institutions in the UK. The current highly centralised governance model restricts local agency, undermines long-term investment planning, and amplifies short-termism across both public and private capital markets. The concentration of financial knowledge, decision-making, and brokerage functions in London, combined with the lack of local institutional capacity in lagging regions, creates persistent information deficits that deter investment in those areas.

Addressing this requires policy reform that strengthens sub-central governance, builds robust financial intermediaries with local knowledge, and enhances the stability and autonomy of local institutions to support coordinated development strategies. Likewise, reform of the UK's land-use planning system, which is currently slow, unpredictable, and overly centralised, is essential to lower investment risk and improve the supply of viable development opportunities.

Reforms should focus on strategic, place-sensitive investment frameworks akin to those used in other OECD countries of a more federal and decentralised nature. The UK would also benefit from new financial intermediaries, such as regional development banks or urban/regional wealth funds, capable of crowding in private investment and counteracting market myopia.

6. Knowledge Diffusion and Regional Productivity Growth

Introduction

Since the 1980s, the rise of modern knowledge, information, and communication technologies has reshaped economic activities, organisational structures, and patterns of investment across advanced economies. Despite these profound transformations, their presence is still difficult to detect in official productivity statistics—echoing Solow’s well-known observation from thirty years ago that the computer age appears everywhere except in the productivity data. Although innovation is known to be central to productivity growth and relies heavily on knowledge-generation activities such as R&D, the relationships between these components are no longer understood to be linear. Modern innovation systems reveal complex, multi-layered interactions shaped by institutions, financial systems, labour relations, ownership structures, and cultural environments.

These complexities manifest in several paradoxes, particularly in the spatial organisation of innovation. Productivity effects often show up in regions distant from where the underlying knowledge or innovation originated, reflecting spillovers, clustering, and the strategic decisions of multi-plant, multi-establishment and multinational firms. As a result, the geography of knowledge creation increasingly diverges from that of productivity growth. Moreover, digital technologies appear to benefit certain places and population groups more than others, contributing to widening inequalities across regions, most recently exacerbated by the COVID-19 pandemic. Combined with the expanding role of intangibles, including skills, data, design, organisational capital, these developments continue to reshape innovation processes and blur the boundaries between manufacturing and services.

Haskel and Westlake’s “four Ss” (scalability, sunk costs, synergies, and spillovers) help explain why knowledge-based activities sometimes concentrate spatially and sometimes disperse. For example, scalable and sunk-cost characteristics push towards agglomeration, whereas synergies and spillovers may encourage wider diffusion.¹³

Yet in practice, the balance between centripetal and centrifugal forces varies across countries. In the UK, centripetal forces dominate unusually strongly by international standards. Despite world-class universities and strengths in fundamental research, there is something of a missing link between the UK’s knowledge assets and research-

¹³ Haskel, J. and Westlake, S. (2017). *Capitalism without capital: The rise of the intangible economy*. Princeton: Princeton University Press.

related investments and its ability to translate those into broad-based productivity growth. Compared with similar economies, the UK appears to invest less in R&D, and even where research excellence exists, diffusion mechanisms appear weak. Compounding this challenge, public R&D spending is heavily concentrated in the Golden Triangle, with several billion more invested there than international benchmarks would predict. This has potentially starved other regions of the resources needed to generate and absorb innovation.

The UK economy has been described as a “hub with no spokes”-system, where high-performing centres generate ideas without effective diffusion to firms and regions elsewhere. This pattern spans technological, organisational, and managerial domains and may reflect uneven local capabilities to absorb and apply external knowledge. During the early 2020s, “Levelling Up” initiatives have aimed at rebalancing these disparities, but their eventual impact remains uncertain.

Relatedness and growth-complexity approaches, which are described below, help explain why diversification strategies enable some regions to develop more sophisticated, high-productivity activities, while others struggle to create high-value, growth-enhancing activities. Evidence from other countries shows these approaches offer valuable insights into how local skills, industrial structures, and technological capabilities shape regional growth paths. Yet the UK remains one of the least studied advanced economies in this regard, which this research aims to address.

Research objectives

This research investigates why the UK exhibits weak interregional knowledge diffusion despite its world-leading research base. It examines how knowledge flows between firms, universities, and public research organisations, and assesses the extent to which regional capabilities shape the absorption, adaptation, and commercialisation of knowledge. It aims to map regional technological and skill structures, identifying diffusion bottlenecks, and clarifying how these contribute to productivity disparities. The analysis applies relatedness approaches to determine whether a region has the capabilities needed to diversify, and growth-complexity approaches to assess whether such diversification leads to high-value, growth-enhancing activities. It also evaluates how public and private R&D investments interact with local economic environments and draws lessons from international comparators. Ultimately, the goal is to inform policy strategies that can strengthen knowledge diffusion, enhance regional innovation systems, and improve productivity outcomes across the UK.

So far, the programme has produced eleven research papers, as set out in Box 6.1. A list of researchers and their affiliations with the programme is included in Box 6.2.

Box 6.1: TPI references from Knowledge Diffusion Programme

The research summarised in this chapter has been undertaken by researchers at the University of Manchester, as well as collaborators from other universities and research organisations.

An extensive summary report on this programme is provided here:

- Raquel Ortega-Argilés and Philip McCann (2026). [Knowledge Diffusion and Regional Productivity Growth: Summary of TPI Research Programme 2023-2026](#), The Productivity Institute Insights Paper 087.

Papers and journal publications:

- Badort, A., Caldarola, B., Ciarli, T., and Rony, S. (2026). Skills Demand and Regional Productivity, Mimeo.
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Summary of Research Findings

Knowledge Diffusion, Shocks and Regional Growth & Policy Paradigms

For more than three decades, policy design and funding mechanisms for R&D, innovation, and commercialisation have relied on a view that competitive markets and a well-functioning regulatory system would naturally ensure the diffusion of knowledge generated in the national economic core—especially London—towards the rest of the country. The fragility of these assumptions has become starkly apparent from the UK’s unusual combination of deep interregional inequalities and an exceptionally centralised governance system.

Research Strand: Knowledge Diffusion, Shocks and Regional Growth & Policy Paradigms

Aim: Examine how thinking about knowledge spillovers, regional convergence and divergence, and industrial policy has evolved — globally and in the UK.

Key research questions

Main answers/core findings

- How have theories of knowledge diffusion changed?

- Traditional spillover theories have shifted toward **complex, region-specific diffusion frameworks** recognising divergence across capabilities.

- Why did expected UK spillovers not materialise?

- Diffusion of London's knowledge-based economy has failed because of **over-centralised governance and weak regional institutions**.

- What explains the UK’s regional divergence?

- Legacy policies in the UK ignored structural disparities, allowing **persistent concentration of knowledge and innovation in a “hub no spokes” system**.

- How do protectionist shocks reshape regional innovation?

- **STI (science, technology and innovation) regions** suffer when global knowledge inputs falter, while **DUI (Doing–Using–Interacting) regions** are vulnerable to falling demand and production networks within value chains.

- What does effective place-based policy require?

- Effective diffusion requires **decentralised, place sensitive governance** that empowers regions to **leverage local assets** and **strengthen absorptive capacity**.

In their work on the UK, Philip McCann and Raquel Ortega-Argilés examine the tensions between governance structures and the practical requirements of place-sensitive innovation strategies (McCann and Ortega-Argilés, 2022). Mounting evidence that diffusion has not materialised has prompted renewed interest in devolution and regional policy reform, yet the very centralisation of the UK system continues to constrain effective local policymaking.

Putting these UK-specific challenges within the wider evolution of international spatial economic analysis, shows how traditional thinking on convergence and divergence mechanisms has reshaped empirical approaches to knowledge generation and diffusion. The latest research insights frame a new generation of place-based innovation and industrial policies recognising that knowledge flows are neither automatic nor uniform (McCann and Ortega-Argilés, 2026).

In addition, the recent resurgence of mercantilist policies and protectionism has had different impacts on regional innovation capacities. Global economic shocks, such as tariffs, protectionism and disrupted supply chains, shape regional vulnerabilities by creating both direct demand effects and indirect trade-in-value-added linkages through global value chains (GVCs). Differentiated interactions with innovation modes has increased the complexity of Europe's territorial development and growth challenges. For example, through their participation in GVCs, "Science–Technology–Innovation" (STI) regions depend heavily on global scientific and technological knowledge flows, so that shocks directly affect the external inputs these regions need to innovate. "Doing–Using–Interacting" (DUI) regions depend on more local, experience-based learning and dense intra-regional production networks. For these regions, trade shocks primarily reduce demand, weaken intra-regional production networks, and disrupt local supplier linkages. As a result, innovation in DUI regions is more vulnerable to economic downturns than to global knowledge-flow interruptions (McCann et al, 2026).

R&D Funding, Absorptive Capacity and UK Regional Development

While public R&D funding does contribute to regional economic development, its ability to drive true regional convergence is structurally constrained. The effects of public R&D are largely mediated through private R&D capacity, which is unevenly distributed across the UK. As a result, regions with stronger private R&D ecosystems capture larger benefits in terms of growth. Publicly funded research translates into economic gains primarily through between-region collaborations, which disproportionately involve London and the South East, thereby reinforcing their comparative strength as a region receptive to productivity R&D (Ortega-Argilés and Yuan, 2026).

Complementary analysis based on multi-regional input-output modelling shows that the Greater South East's dominance is sustained not by superior productivity effects alone, but by strong demand multipliers and spillover linkages that magnify the returns to R&D

(Ma et al, 2026). Hence, a more equitable redistribution of R&D investments could promote balanced regional growth without hindering the performance of high-achieving areas like London and the South East.

Research Strand: R&D Funding, Absorptive Capacity and UK Regional Development

Aim: Analyse whether, how, and for whom public R&D investments generate regional development and convergence in the UK.

Key research questions

Main answers/core findings

- How does public R&D funding influence regional development and convergence processes?

- Publicly funded research **enhances regional development mainly by stimulating private R&D**, even though the latter does not generate economic convergence or levelling up.

- Do publicly funded collaborations support regional economic convergence?

- Convergence effects arise mainly from **interregional collaborations**, especially those involving London and diversified project portfolios.

- How does absorptive capacity shape regional returns to R&D?

- Absorptive capacity creates a **strong demand multiplier and spillovers in London and the South East**, while it constrains growth in lagging regions, amplifying inequalities despite increased R&D spending.

- Can redistributing R&D funding support UK regional convergence and Levelling Up goals?

- Redistributing funding does not need to hinder gains in high-achieving areas, while yielding **measurable gains in output, employment, and GVA in underfunded regions**, though human-capital constraints remain.

Scenario analysis provides further evidence that directing more public R&D to historically underfunded regions produce the greatest improvements in terms of output, employment, and GVA, confirming that current distribution patterns are suboptimal for national cohesion. However, absorptive capacity in lagging regions is a binding constraint. Even when additional R&D investment flows to these areas, the institutional, infrastructural, and human capital constraints need to be addressed as well (Ma, Ortega-Argilés & Lyons, 2024).

Together, these studies indicate that while R&D funding can support regional development, achieving convergence requires strengthening the foundational capabilities of lagging regions, diversifying collaborative networks beyond London-centric patterns, and ensuring that institutional and labour-market conditions enable regions to translate public and private R&D investments into sustainable economic growth.

Relatedness, Technological Unconventionality and Diversification

Green, digital, and twin (both green and digital) activities exhibit distinct geographical patterns across UK local authorities. Real-time industrial classification data show that digital sectors cluster strongly in large urban centres, while green and twin activities are more geographically dispersed. Relatedness analyses reveal clear synergies between digital and green, with twin activities acting as powerful bridges linking them, and reinforcing within regional diversification processes (Cicerone, Losacker, Ortega-Argilés, 2024).

Research Strand: Relatedness, Technological Unconventionality and Diversification

Aim: Review knowledge diffusion mechanisms on the basis of relatedness across technologies.

Key research questions

Main answers/core findings

- Are green and digital activities geographically and technologically synergistic in the UK?

- **Related capabilities in one domain** (digital or green) significantly **boost specialisation in the other**, with **twin activities** acting as the strongest connectors.

- Do non specialised but related technologies support regional diversification?

- Linkages to **technologies without local specialisation accelerate diversification**, especially in high-income, complex regional ecosystems.

- How do technologies which are weakly related to existing capabilities influence long-run regional productivity?

- Regions engaging in **unconventional technologies experience stronger productivity gains**, enabling “ladder jumping” in technological upgrading.

The distinction between related technologies in which regions are already specialised and those outside their current specialisation shows that unused but related capabilities

can help regions diversify into new technological domains. This broader and more varied technological structure explains why high-income regions can sustain higher productivity by developing varied and complex local linkages that support future diversification (Cicerone, McCann and Venhorst, 2026).

Evidence from European regional analyses also suggests that pursuing unconventional technologies, which are less related to a region’s existing capabilities, can generate long-term productivity gains. In this way, regions can be better positioned to “jump the ladder” and diversify into more advanced technological domains. Even though green innovation also contributes positively to productivity, it does not interact positively with technological unconventionality, indicating significant adjustment costs (Rocchetta & Iori, 2026).

Regional Skills, Labour Mobility & Structural Change

Skill-demand evidence from millions of job postings across 10 countries shows that new skills (especially digital ones) unrelated to a region’s economic structure tend to boost short-run productivity, as they help firms adapt to rapidly evolving technologies. In contrast, coherent and well-established knowledge bases support stronger productivity growth over the long term. The picture is more complex for green skills, where adjustment costs within existing industries initially suppress productivity, particularly in sectors undergoing greening rather than in those which are already green (Badort et al., 2026).

Research Strand: Regional Skills, Labour Mobility & Structural Change

Aim: Examine how evolving skills, technology, and labour mobility drive diversification, regional productivity and structural change.

Key research questions

- Which skill-mix dynamics drive productivity during rapid technological transitions?
- How does labour mobility contribute to regional structural change?

Main answers/core findings

- New, **unrelated skills boost short-run productivity**, while **coherent knowledge bases drive stronger long-term growth**, though is more the case for digital than for green skills because of high adjustment costs in the latter case.
- **Worker mobility fosters new industrial specialisms**, but **diversification remains concentrated** in already prosperous southern UK regions.

Labour mobility contributes significantly to regional diversification by facilitating knowledge spillovers between sending and receiving regions. Mobile workers bring specialised knowledge that helps regions develop new industrial specialisms. Yet the geography of this structural change remains uneven. Recent diversification is most pronounced in London, the South East, and the South West, with more limited transformation in northern England and Scotland (Ioramashvili & Savona, 2026). This suggests that knowledge diffusion through mobility continues to reinforce existing regional divides.

Implications for Policy

A key takeaway from this work is that weak knowledge diffusion, rather than insufficient knowledge creation, is the major obstacle to achieving innovation-driven regional productivity growth in the UK. For decades, industrial and regional policy frameworks have relied on outdated assumptions that knowledge spillovers from the centre, that is London and South East, would naturally diffuse nationwide, an assumption now proven incorrect.

Prior to recent work, UK R&D funding institutions were essentially “flying blind”, lacking systematic evidence on the regional growth impacts of their own funding. The new research calls for a serious rethinking of UK industrial and regional policy logics, moving beyond legacy assumptions and towards frameworks aligned with modern knowledge diffusion dynamics.

Evidence shows that the region most in need of R&D investment is often the least able to use it effectively. Scenario analyses show that directing additional R&D to historically underfunded regions delivers the largest gains in output, employment, and GVA, and that a more equitable distribution of R&D would support balanced regional growth without harming high performing regions like London and the South East.

Yet redistribution of R&D alone is insufficient to close the innovation and productivity gaps. A dual strategy is required, which reallocates resources and builds the absorptive capacity, including skills, institutions and infrastructures, needed for regions to translate R&D into economic value. This includes expanding higher-level technical skills, improving managerial and organisational capabilities, and supporting innovation adoption among SMEs.

Another key priority is addressing the UK’s highly centralised governance and investment system, which concentrates decision-making, research funding, and financial intermediation in London (see also Chapter X). This centralisation limits regional agency and stifles long-term investment in innovation capabilities in lagging areas. Effective diffusion requires decentralised, place sensitive governance that empowers regions to leverage local assets and build their own innovation capabilities.

Finally, policy should support diversification into both related as well as emerging technologies and encourage labour mobility. Together, these measures would promote more resilient regional economies, strengthen national productivity, and reduce long standing spatial inequalities.