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Human capital and productivity: a call for new interdisciplinary research

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Abstract

This paper calls for an interdisciplinary approach to understanding the contribution of human capital to productivity, building especially on recent theoretical and empirical insights from the fields of employment studies and innovation studies. This focus is motivated by the urgent need to address four economic puzzles that characterise trends and patterns of human capital and productivity, with specific reference to the UK:

i) high skill demand lags behind high skill supply;
ii) real wages are not keeping up with the higher skill supply;
iii) the assumed skill bias of new technologies is uneven and possibly even absent; and
iv) multiple organisational factors make the skill-technology-productivity equation highly contingent and uncertain.

Evidence from the employment and innovation literatures shifts the frame of analysis away from a transactional approach to the supply and demand of human capital and towards improving knowledge about the use, development and transformation of human capital within organisations and sectors and its contingent relationship with productivity.

The paper concludes with a call for research in five core areas to address the challenges of rapid technological change, macroeconomic uncertainty and pressures to transition to a more sustainable path of development

Human capital and productivity: a call for new interdisciplinary research

Damian Grimshaw and Marcela Miozzo

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July 2021

Introduction

In a context of advanced digital technologies and major policy questions about future employment and productivity growth, this paper focuses on the critical variable of human capital. While tainted by its association with rather crude early human capital theories of the 1960s and 1970s, this paper adopts the term in the spirit of extending its meaning to encompass approaches that recognise the wider developmental purpose of education and training, the centrality of skill, knowledge and human capabilities in driving economic performance and competitiveness, the role of individual and collective forms of learning, and the unevenness of reward, social status and recognition conferred upon skills, in part reflecting social inequalities in society.

This paper has two main aims, divided across sections 1 and 2. Section 1 presents four key puzzles that arise from an analysis of the changing demand for human capital, with specific empirical reference to the UK. These are that: i) high skill demand seems to lag behind high skill supply; ii) real wages are not keeping up with the higher skill supply; iii) the anticipated skill bias of technical change is uneven and possibly absent in the UK; and iv) multiple organisational factors make the skill-technology-productivity equation highly contingent and uncertain. Section 2 proposes a new programme of research on human capital and productivity. It identifies a set of conceptual starting points for empirically grounded, interdisciplinary research, drawing especially on insights from the fields of employment and innovation studies. Five research themes are proposed that are motivated by a specific knowledge gap and that resonate with growing demands for answers in the spheres of public policy and management strategy.

1. The changing demand for skills: old and new puzzles

Human capital models of the 1950s and 1960s (Becker 1964; Mincer 1958; Schultz 1961) effectively challenged the limited understanding of capital in classical economics (namely its focus on physical capital) and had an enormous impact on supply-side education policies around the world. However, they have gradually given way to new economics and inter-disciplinary approaches that pay greater attention to the use, development and transformation of human capital within the organisation and in the wider economy and society, and its contingent relationship with productive performance. At first glance, there are good empirical reasons to focus on the demand for skills: skills and knowledge acquired while at work account for a large proportion of human capital stock (O'Mahony 2011); employers invest heavily in career paths and training but incentives are changing with fast-moving markets, new business models and technologies, raising questions about who should pay for training – especially coming out of the Covid-19 recession and in the context of the apprenticeship levy (Barley et al. 2017; ILO 2021); and productivity and wage returns to work experience over the life-cycle are highly indeterminate for all levels of human capital, with sex and race discrimination contributing to inequalities by gender, race, ethnicity, disability and migrant status (Brown et al. 2020; Glauber 2018).

There are also compelling theoretical reasons that derive from a realisation that the data do not align with the old human capital thinking, provoking puzzles or knowledge gaps for investigation. This section lists four such puzzles drawing on a selection of recent empirical evidence for the UK and comparable countries.

1.1. High skill demand lags behind high skill supply

Increasing the supply-side acquisition of human capital (typically supported by public investment) is a necessary but not a sufficient condition to raise the demand for human capital in sectors of economic activity. A common analytical framing of this issue has been to explore evidence of underutilisation of workers' skills in employment against a backdrop of increasing years of schooling, increasing numbers of graduates and higher levels of qualifications. The stylised empirical picture for the UK is one of relatively effective absorption of the increased high skill supply during the 1990s and 2000s but a growing disconnect in the last decade.

The country context for the rising high skill supply matters. In the UK, as in the United States, the effort to expand human capital investment has focused on higher education; investment in technical and vocational education has not been as much of a priority as in Germany, for example. There have been two phases to the expansion of UK higher education. The first during the mid-1960s was underpinned by a well resourced public funding model, reflecting the distributive purpose of the post-war welfare state, but was interrupted by the 1970s economic downturns. The more significant second phase occurred during the 1990s under a transformed and reduced funding model (public funding was reduced and revenue from student fees increased) and a new higher education structure (with polytechnics registered as universities[1]) (Carpentier 2018). An important parallel trend was the expansion of women's enrolment – from a female share of 20-25% of the age cohort in the 1950s to 55% since 2000. Overall, the UK experienced a rise from 5% age participation to close to 15% during the first phase and from 17% to 34% during the second phase (Mayhew et al. 2004). Continuing the upwards trend, by 2019 the share of the UK population with tertiary education has expanded considerably - up to 39% among older people (55-64 years old) and 52% among younger people (25-34 years old) (OECD data[2]). Between 2013 and 2017 the number of graduates entering employment increased by 15% (Savic et al. 2019).

Against this backdrop of rising supply of high skills, a major puzzle in the UK and many other countries is why employers often fail to upgrade their job skills demand when well qualified labour is available, despite the potentially positive consequences for productivity growth. This is an old conundrum[3] but deserves renewed attention given changes in technologies, market competition and institutions, continued debate about who pays for skills, and high unemployment in the aftermath of Covid-19. There are various indications that skill demand in the UK lags behind the rise in education and, indeed, that the demand deficit has increased in recent years.[4]

A European comparison suggests skill underutilisation in the UK is among the highest. Rafferty (2020) places the UK joint 5th of 30 countries with more than one in three workers (36%) self reporting as

[1] The 1992 Further and Higher Education Act enabled 35 polytechnics to become universities.

[2] OECD (2020) *Education at a Glance*, https://data.oecd.org/eduatt/population-with-tertiary-education.htm.

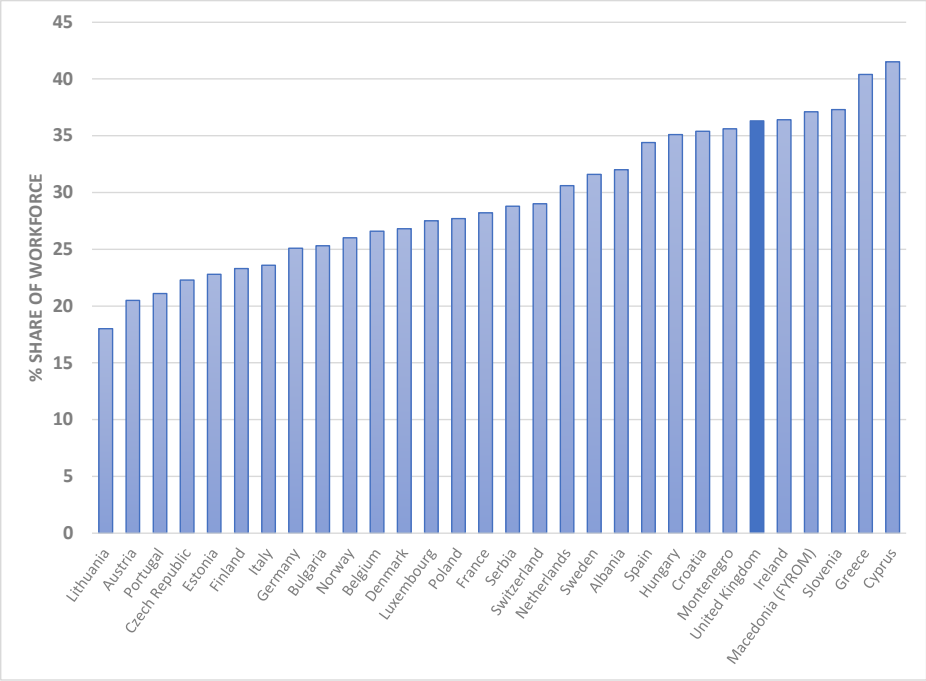
[3] See, for example, Thurow's (1975) notions of job queues, or Keep and Mayhew (1997) on the problem of credentialism. Keep (2020) argues that expanding higher education in England wrongly became the 'default policy position' because of a repeated failure over years to engage employers to train.

[4] Each measure is incomplete and imperfect as a reflection of the complex reality (Green and McIntosh 2007), but they do serve to highlight the UK problem of a high skill demand deficit.

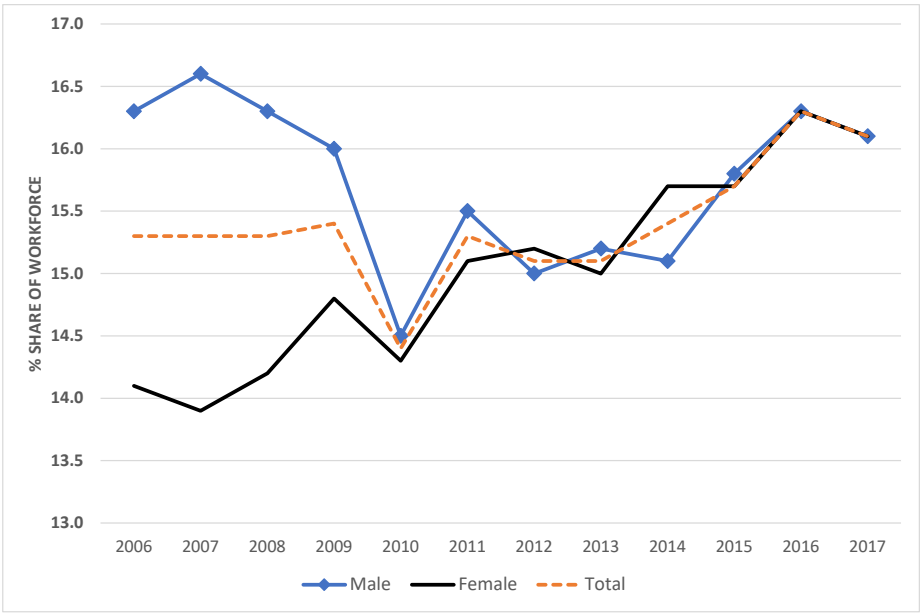
having skills to cope with more demanding duties. Other countries with comparable levels of GDP per capita have smaller shares of underutilised workforce skills, closer to one in four (figure 1a).

Figure 1. Two measures of skill mismatch

a) Skill underutilisation, UK compared to European countries (2010 and 2015 pooled data)



b) Trend in the share of UK workers defined as 'overeducated', 2006-17



Source: a) data sourced from Rafferty (2020), pooled 2010 and 2015 EWCS data; b) ONS data, https://www.ons.gov.uk/economy/nationalaccounts/uksectoraccounts/compendium/economicreview/ april2019/economicreviewapril2019.

According to the ONS measure of educational mismatch, around one in six UK workers (16%) were overeducated in 2017 (Savic et al. 2019).[5] The trend since 2010 is upwards for both men and women along a path of similar shares of overeducation – quite different to the pre-2010 period (figure 1b). While all developed countries face problems of educational mismatch, harmonised OECD data suggest the UK (again) scores a significantly higher share of overeducated workers than the OECD average (30% and 22%, respectively; the UK ranks fourth out of 40 countries).[6] Moreover, the OECD finds that better managerial quality is associated with lower skill mismatch,[7] pointing to the need to improve capabilities, strategy and practices among managers and owners in the UK (see section 1.4). Overeducation is of course a very imprecise measure as it assumes education is a suitable proxy for a worker's skill and experience, not to mention the missing variety of quality and substantive content of education; also, comparative country results are highly sensitive to alternative methodologies (Muñoz de Bustillo et al. 2018). Setting this to one side, we might nevertheless consider it plausible that younger workers are more likely than older workers to be overeducated because they lack other components of human capital (work experience and firm-specific skills, say) required of their job. However, the data suggest the highest risk of overeducation is among mid-age workers (19% for workers aged 35-49 years old compared to 11% for younger workers aged 16-24 years old). Moreover, comparing trends since 2010, it is mid-age and older workers (50-64 years old) who experienced a rise in the share overeducated, not younger workers.[8]

Among workers with tertiary education, various studies identify an emerging problem for their labour market prospects in the last decade and these have amplified with the Covid-19 pandemic. Workers who graduated in the 1990s were on the whole able to find jobs commensurate with their level of qualification, thanks to the emergence of new technical and managerial occupations (Elias and Purcell 2004). Similarly, Skills and Employment Survey (SES) data covering the period 1997-2012 suggest the influx of graduates in the British labour market was absorbed with no rise in overeducation, albeit with greater dispersion of graduate earnings (Green and Henseke 2016; see below on wages).

The latest evidence, however, suggests something shifted even prior to the pandemic - possibly caused by the changed context of technological change and Brexit uncertainty. The ONS estimates that almost one in three graduate workers (31%) were overeducated in 2017 and the Skills and Employment Survey (SES) finds no significant change in the share of jobs requiring graduate level qualifications (Henseke et al. 2018). Moreover, mirroring figure 1b, the trend comparison of cohorts shows a clear rise in overeducation - from 22% among those who graduated before 1992 to 34% among those graduating after 2006 (Savic et al. 2019). This reflects trends across Europe, although at a faster pace and at a higher level (Green and Henseke 2020). The field of graduate study makes a huge difference, with rates of overeducation varying from 10-15% among (non-recent) graduates in medicine, maths and computer sciences to over 30% in the arts and media studies (Savic et al. 2019); such differentiation is likely to have widened during the Covid-19 pandemic, shaped by the uneven fortunes of tech sectors and the arts, for example. Among workers with postgraduate education, there is further evidence of a high skill deficit: the most recent 2017 SES data suggest one in four worked in a job for which a first degree would have been sufficient and another one in four in a job that did not

[5] The ONS measure is estimated from the Annual Population Survey. It is more problematic than the self-reported measure as it assumes the 'right' level of education is within one standard deviation of the median education level among workers employed in an occupation (4-digit classification). Moreover, the term 'overeducation' would seem to raise different policy implications to that of 'skill underutilisation'.

[6] OECD Survey of Adult Skills (PIAAC) based on what workers consider is the necessary qualification for their job today.

[7] McGowan and Andrews (2015).

[8] There are further interesting patterns by country of birth and by region: workers born outside of the UK are twice as likely to be overeducated as those born in the UK (29% and 13%, respectively); and London stands out with a high rate of overeducation at 25% compared to a range of 13-16% in other UK regions.

require university education (Henseke et al. 2018). Moreover, the 2012-17 trend in jobs requiring professional, undergraduate or postgraduate degree qualifications slowed to a near halt compared to previous trend rises during 2001-06 and 2006-12 (op. cit.).[9] While skills mismatch appears to be a growing problem, graduate education nevertheless still serves as a valuable buffer against unemployment: non-recent graduates consistently experience the lowest rates of unemployment compared to both non graduates of all age groups and recent graduates.[10]

Overall, the headline statistical measures suggest a growing problem of skill underutilisation, which underscores the need to interrogate evidence of mismatch in the use and development of skills within UK workplaces. There are important patterns of variation that lie behind the average measures, by level and type of skill, by workforce group, geography and sector. Interactions remain under-explored, including the regional level varieties of 'economic complexity', reflected by different mixes of sectors, occupations and employment forms. Also relevant, as we analyse below, is the need to understand how these patterns interact with wage trends and, critically, how use of digital technologies across sectors and organisations is fuelling qualitative and quantitative changes in the demand for skills and knowledge.

1.2. Real wages are not keeping up with the higher skill supply

An inter-related reason for the UK's skill mismatch problem is the seemingly dysfunctional role of wages as the mechanism for resource allocation. During a period when more and more people increased their level of education (and at an increasingly higher cost to the individual), real wages nevertheless stagnated. The ten-year period 2008-18 in the UK was the worst for wage growth for more than a century. Real wages fell in the six years after the financial crisis (by around 6% during 2008-14). They then recovered, but very slowly, picking up a little more pace after 2018 and eventually reaching pre-crisis levels only by the first quarter of 2020.[11] The UK has thus suffered a 12-year period of wage stagnation.

How has the UK's poor real wage performance evolved alongside the trend rate of productivity growth? During 2008-19, average annual productivity growth in the UK slowed to around 0.3%, while the previous decade saw rates of around 2%. Also, real wages experienced a fall after the 2008 financial crisis, only reaching a trough in mid-2014, followed by a longer period of recovery compared to the productivity trend (figure 2). This decoupling of trends is not explained by a wage-productivity lag and instead points to a likely structural problem in translating productivity performance into real wage gains.[12]

[9] In 2001 the share of jobs requiring professional, first and second degrees was 29%, rising to 31% in 2006, 37% in 2012 and 38% in 2017, which translate as average annual trend rises of 1.4% (2001-6), 3.2% (2006-12) and 0.5% (2012-17).

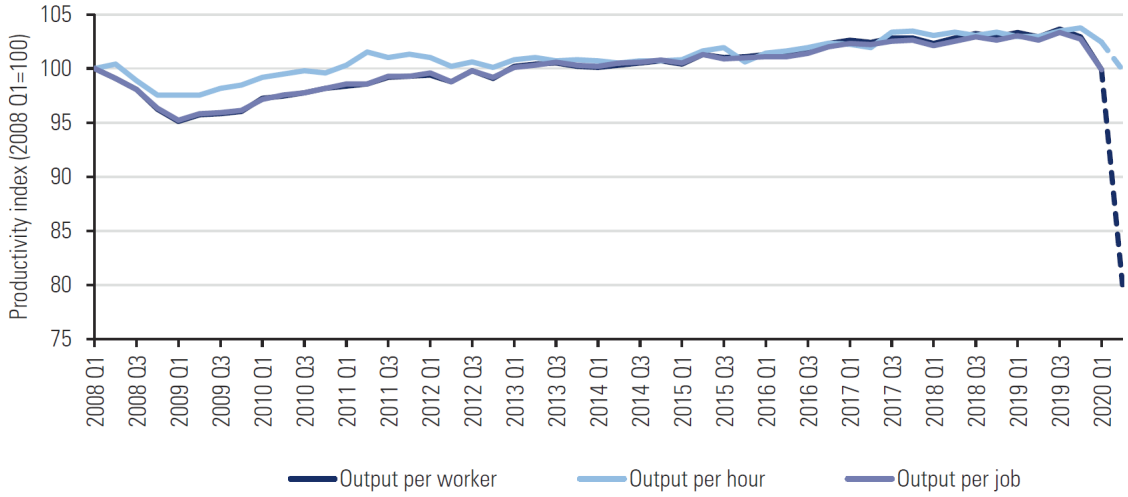
[10] Non recent graduates (who graduated more than five years from the survey date) enjoyed unemployment rates of 2-4% during 2000-17, while the next best protected group, non graduates aged over 30, had rates ranging from 3-7% (ONS data, 'Graduates in the labour market 2017').

[11] ONS real average weekly earnings (regular pay, seasonally adjusted).

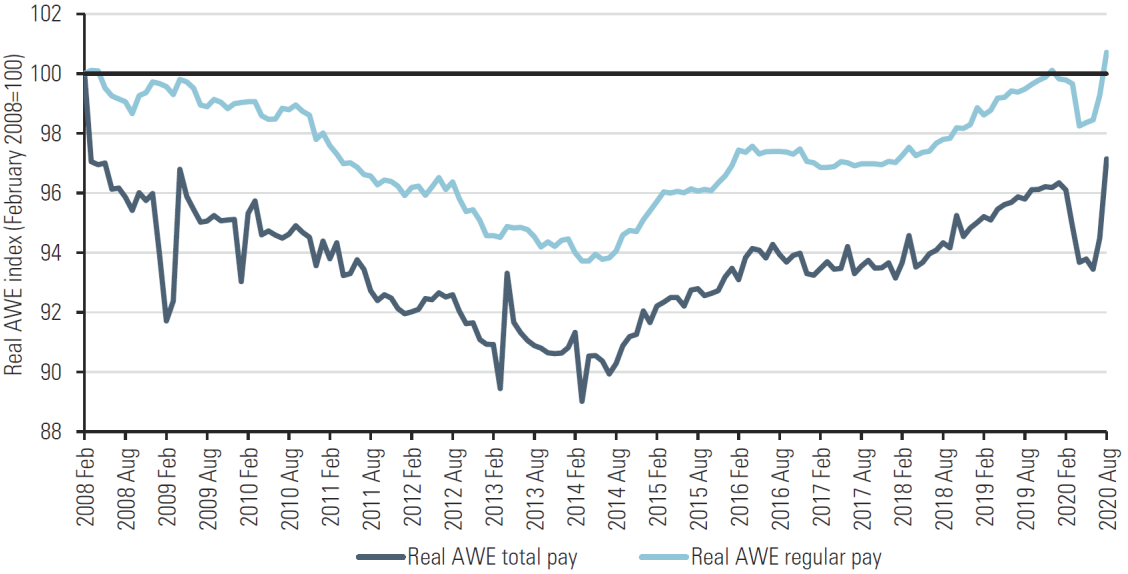
[12] Analysis for earlier periods is difficult to interpret because it conjoins pre- and post-crisis periods of macroeconomic conditions. For example, the OECD's analysis of the 1995-2013 period identifies the UK as one of a minority of OECD countries where real average wage growth was marginally higher than productivity growth (2018: table 2.1; see, also, Pessoa and van Rennan 2013).

Figure 2. Productivity and real wages, UK, 2008-2020

a) Productivity



b) Real wages



Source: a) Low Pay Commission (2020: figure 1.17) ONS quarterly, seasonally adjusted data - output per worker (A4YM), output per job (LNNN) and output per hour (LZVB); b) Low Pay Commission (2020: figure 1.10) ONS data for average weekly earnings (AWE).

What factors might explain the wage-productivity decoupling in the UK? The empirical evidence for the most part highlights three reasons. The first is the unexpectedly poor wage performance among graduates. Dividing the workforce by level of education (as well as by gender and by age) there are two key points of differentiation concerning the experience of falling real wage trends during the last decade (table 1). Workers with tertiary education consistently experienced a larger reduction in median salaries than those without, and women's experience was consistently worse than men's - by a considerable margin among non graduates. Older workers also experienced larger falls in real earnings than younger workers, although the differentiation is less marked than by level of education or by gender. Thus, the group of workers seemingly least likely to enjoy a wage premium for their level of education during the period 2008-2018 were women (young and old), leading to a widening of the gender wage penalty already evident in 2008. In addition, the wage premium for graduate education fell during this period for both men and women. Further analysis might usefully distinguish the sectoral

effects, since a very high share of women graduates work in public services where austerity has impeded relative wage growth.

Table 1. Annual median salaries (deflated by CPI) for graduates and non graduates, by gender and age

		2008	2013	2018	% CHANGE
All graduates	Male	35,000	31,605	31,288	-10.6%
(16-64 years)	Female	27,000	25,021	23,567	-12.7%
All non graduates	Male	22,500	21,070	21,536	-4.3%
(16-64 years)	Female	17,500	16,242	16,253	-7.1%
Young graduates	Male	25,000	22,387	22,755	-9.0%
(21-30 years)	Female	22,500	19,753	19,910	-11.5%
Young non graduates	Male	18,500	16,681	17,879	-3.4%
(21-30 years)	Female	16,000	14,486	15,034	-6.0%

Source: authors' estimates; nominal earnings data from Department for Education (2019) 'Graduate labour market statistics 2018', deflated by CPI data (https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/l55o/ mm23).

The second reason relates to the UK's high share of low-wage work, which at first sight would appear to be a major drag on productivity and average wage growth. However, there are mixed effects. Because the share of workers in low-wage employment is high relative to other economies, there is a negative compositional effect on the average level of productivity in the UK, given the tendency for low-wage work to cluster in low value-added economic activities. At the same time, real wage growth for low-wage workers has outpaced median earnings in the last decade and has therefore disproportionately contributed to overall earnings growth.

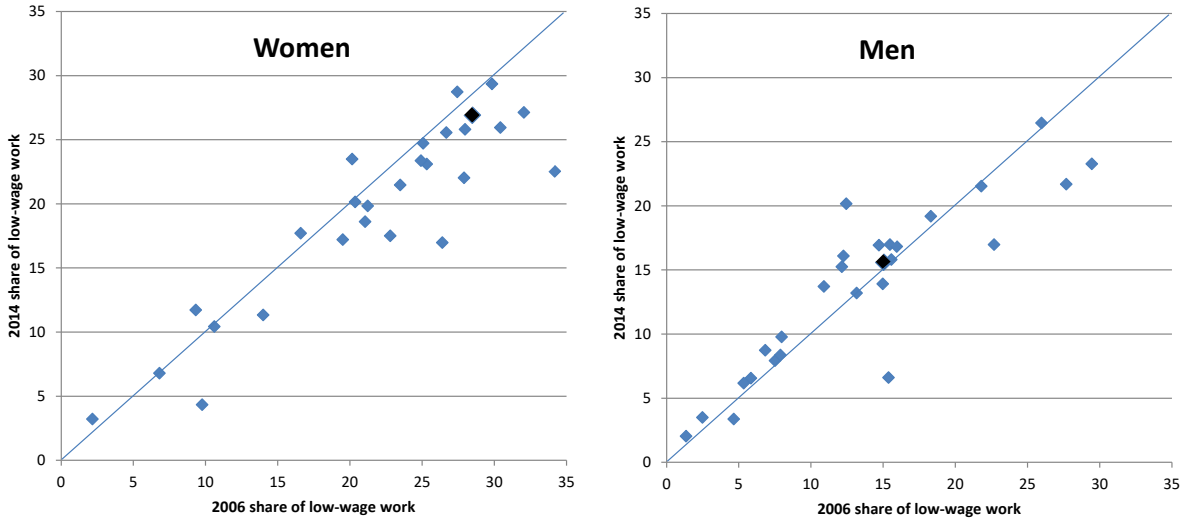
Compared to EU countries, the UK has an average share of low-wage work for men but one of the highest shares of low-wage work for women[13] (figure 3). As such, while women face a higher risk of low pay than men in almost all EU countries,[14] it is particularly high in the UK where women face almost double the risk - a ratio of 1.7. In recent years, however, the share of low-wage jobs among women and men has fallen (from 21% to 16% for all workers, 2014-19, hourly earnings[15]) thanks largely to the institutional intervention of a rising statutory minimum wage (mirroring a recent trend in several OECD countries, see ILO 2020). The UK government intervened in the tripartite consultation process of fixing the minimum wage by setting a target of reaching 60 percent of median earnings by 2020 for all workers 25 years old and over, and to 66 percent by 2024 for all workers aged 21 and over (Low Pay Commission 2020).

It is possible that the rising minimum wage has had a positive influence on UK productivity by encouraging better use of technologies, more investment in training and improved quality of products and services. The theoretical reasoning is firstly, that changed norms of fairness or trust encourage workers to commit to programmes of training or to exercise their initiative in a way that benefits organisational performance, and secondly, that a rising minimum wage can spur employers to seek more innovative ways to improve productivity and competitiveness other than to reduce labour cost

[13] In 2014, the UK ranked fourth after Estonia, Germany and Latvia in the share of women workers low paid (ESES data).
[14] The two exceptions are Bulgaria and Romania in 2014.
[15] Annual Survey of Hours and Earnings data, https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/bulletins/lowandhighpayuk/2019#measuring-the-data.

(Grimshaw and Rubery 2013). UK evidence suggests employers have responded to a rising minimum wage with increased production efficiency (Riley and Bondibene 2015).

Figure 3. Trends in low-wage employment in the UK and Europe, 2006-14



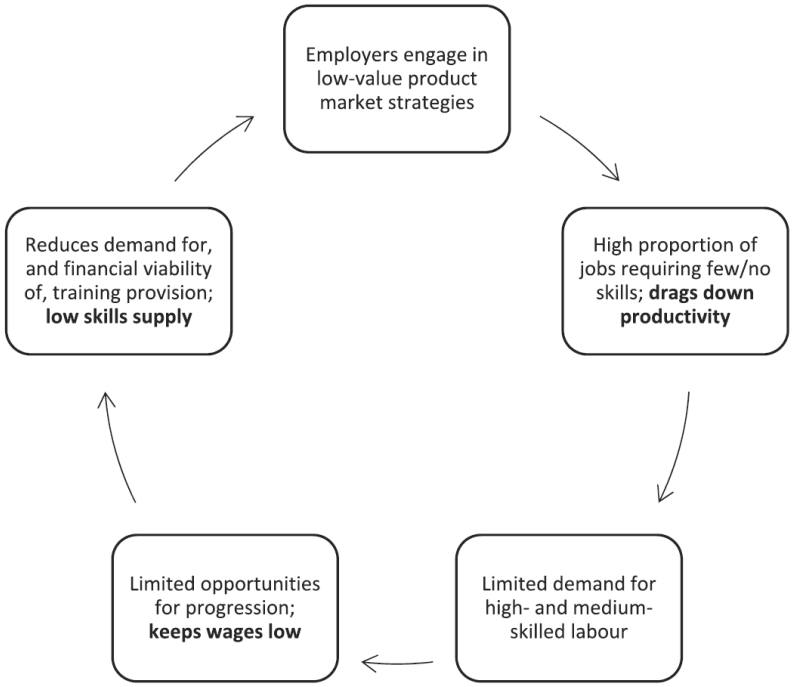
Source: Eurostat Structure of Earnings Survey, Low-wage earners as a proportion of all employees (excluding apprentices) by sex [earn_ses_pub1s], defined as wages less than two thirds of median earnings, limited to organisations with 10 or more employees.

Nevertheless, while the minimum wage has secured a reduced share of low-wage work measured by hourly pay, it has not had a significant effect in reducing the share measured by weekly pay. The reason is that employers have tended to cut working hours and/or increased their use of precarious employment contracts with highly variable hours – namely, zero hours contracts and irregular part-time and agency contracts; the share of employees whose weekly earnings are below the low-wage threshold has only marginally fallen, from 29% to 27% during 2014-19. Similar trends in other countries have led to new rules to protect minimum working hours.[16] In the UK, the growing numbers in irregular hours work who are seeking both more working hours and more stable income add to the aggregate labour market slack (alongside the unemployed) which is a drag on productivity and wage growth (Clarke and Gregg 2018).

The wider problem concerns persistent UK evidence of low-skills low-wage traps in specific regions, characterised by entrenched business attitudes to numerical, cost-led flexibility, low trust employment relations, low-value product market strategies and limited incentives to invest in training (Green et al. 2020; figure 4), even among leading multinational companies in the UK (Butler and Hammer 2020). Green and Henseke's worrying analysis of UK LFS data show the general decline in volume of training provided by employers during 2011-18 was twice as large for workers with the lowest education as for the whole workforce (2019: table 3); one of their possible explanations is that many employers are 'embedded in a "low-skills equilibrium"' (p22).

[16] For example, French legislation sets a minimum of 24 hours per week for part-time work and also includes various other protections to restrict unanticipated variability of hours of work.

Figure 4. The low-skills, low-wage, low-productivity trap



Source: Green et al. (2020: figure 1).

The third reason for the wage-productivity decoupling is the weakened capacity of workers (for all skill levels) to bargain real wage rises that keep up with productivity growth. Low and falling union density and collective bargaining coverage in the UK private sector means the bulk of workers lack the collective power resources to press for real wage gains, as well as for indirect wage improvements via employer financing of training and career development. This is a major driver of the UK's falling wage share of national income. European comparisons systematically show that countries with higher shares of collective bargaining coverage have a lower share of low-wage employment and that solidaristic wage policies can be more effective at distributing the income gains from productivity growth (Grimshaw and Johnson 2018). The UK problem is that:

a) trade unions for private sector workers no longer provide the institutional mechanism for promoting wage growth with skills development and performance gains;
b) post-2010 austerity policies in the public sector have restricted the capacity of unions to deliver wage gains even in areas with high union density; and
c) in a weakened union context, non-union forms of worker voice and employee engagement do not appear to be delivering the necessary results either (see section 1.4).

While a more extended review of the many factors shaping wage trends is beyond the scope of this paper, further research is needed to interrogate the reasons for the disconnect between productivity growth and real wage growth, especially the inter-related organisational, technological and institutional factors, employer training and career paths, and shifting patterns of labour market segmentation (especially by gender and skill). The character of employee engagement (or worker voice) is likely to be important, as well as the use of standard or non-standard forms of employment, technology use and competitive strategy (section 1.4).

1.3. The skill bias of new technologies is uneven across sectors and workforce groups

Advanced economies have been transformed by the diffusion of information and communications technologies, and now advanced digital technologies. And yet this has coincided with a slowdown of productivity growth, fears of major job losses and growing doubts about the presumed 'skill bias', or job enhancing effects, of new technologies.[17] There is little doubt that technological change in the long term can generate sustained improvements in skills, wages and productivity, but it depends on a two-way adjustment between new technologies on the one hand and economic and social structures and institutions on the other (Pianta 2005; Vivarelli 2011).[18] In the short to medium term, research has focused on two issues. The first concerns the scale of job losses associated with new technologies. This matters because if productivity growth depends on a smaller proportion of people in employment then there are major implications for how countries distribute the fruits of economic advancement (Grifell-Tatjé et al. 2018; OECD 2019). The second issue concerns evidence for the skill bias of technological change, especially advanced digital technologies, alongside corresponding questions about the extent of routine-biased technical change and job polarisation. Job polarisation analyses have extended understanding about the differentiation (or dispersion) of productivity growth during a period of technological change (Autor et al. 2006), but raise questions about: a) the assumed uniformity of technological change, especially regarding the potentially differential effects of product or process innovations, and b) the interactions between new technologies and country institutions in shaping skill bias outcomes (Antonucci and Pianta 2002; Fernández-Macías 2012; Grimshaw and Figueiredo 2012).

While several high profile studies argued that new technologies would lead to massive job losses (e.g. Brynjolfsson and McAfee 2012; McKinsey 2017), alternative modelling suggests that the labour displacement effects of automation and artificial intelligence are likely to be accompanied by several important countervailing effects. These include: a productivity effect (which reduces prices, raises demand for goods and services and thus increases demand for labour, including in customer and supplier industries and to perform non-automated tasks); a capital accumulation effect (triggered by new investments that increase the demand for labour); a deepening of automation effect (that improves the productivity of tasks that have already been automated); and a growth of jobs effect to complete new tasks (in areas where humans have an advantage over machines) (e.g. Acemoglu and Restrepo 2018, 2019; Autor and Salamons 2018). This more holistic perspective tends to emphasise the interconnections between high tech and low tech sectors of the economy, gaps between frontier and laggard firms, the positive and negative aggregate multiplier effects of new technologies on prices and productivity, and the way in which technologies often substitute for labour at the level of work tasks rather than entire occupational groups (Grimshaw 2020). This cautiously optimistic thinking is summed up well in a recent flagship report from UNIDO:

> *Advanced digital production technologies applied to manufacturing production offer huge potential to advance economic growth and human wellbeing and to safeguard the environment. . . . Although a large number of jobs will be vulnerable to automation . . . , it is also likely to create new industries and new job opportunities in more skilled and knowledge-based sectors (2019: v).*

[17] The skill bias of technological change refers to the idea that the jobs associated with new technologies require higher levels of skill.

[18] Technological change tends to be under-conceptualised in growth models. In neo-Schumpeterian models, the disequilibrating nature of technological change is emphasised. It therefore takes time before new technologies are matched (in a process of mutual adjustment) "by organisational changes, new institutions and rules, learning processes, the emergence of new industries and markets, and the expansion of new demand" (Pianta 2005: 571).

Nevertheless, there are likely to be uneven employment and productivity effects by country, industry, worker skill and gender (table 2). Country differences arise because of their differential capacity to absorb new technologies and exploit opportunities for job and business transformation (UNIDO 2019). The world is characterised by highly unequal divisions between leader, follower and latecomer countries concerning the production and use of new technologies,[19] rooted in differences in capabilities and endowments, industry structure (e.g. the share of small and medium-sized enterprises), as well as infrastructural and institutional conditions. While latecomers may be able to leapfrog into new technologies (including through collaborations or joint ventures), minimum levels of technological and production capabilities are nevertheless still required (Katz 1987; UNIDO 2019: 49-60).

Table 2. Examples of the uneven effects of new technologies on employment

Uneven effects by:	Examples
i) Country level of economic development	Differentiated country capabilities to exploit new technologies – between leader, follower and latecomer countries – shapes likely employment effects (job displacement and job transformation) High income countries less likely than middle-income countries to have export industries at high risk of robotization Potential for job gains associated with reshoring of previously offshored jobs by high-income countries, but empirical evidence limited Digital platform work promises (transformed) job opportunities, but also collapses geographical barriers so that outsourced activities have uncertain domestic employment effects
ii) Industry	Job gains in digital-intensive industries and falls in non-digital industries Differential effects among manufacturing and services industries, in part due to the varied forms of knowledge sourcing and transformation
iii) Skill	Low and mid-skilled workers in routinised jobs are more exposed to the risk of automation/ job loss than higher skilled and those in non-routine jobs Decline of mid-skill and routinised jobs due in part to automation, leading to job polarisation in certain contexts Analytical, technology-related and soft skills likely to be in greater demand
iv) Gender	Women face greater risks of job displacement than men due to over-representation in routine jobs and limited access to better quality and more protected jobs The costs of displacement are higher for women than for men due to uneven entitlements to employment and social protection Gender pay gap in web-based forms of digital platform work

Source: adapted from Grimshaw (2020: table 3).

Job effects by industry are likely to vary by technology characteristics, such as the degree of digital intensity or the share of jobs/tasks replaceable by robots, although as we elaborate in section 2, a detailed 'sectoral systems' approach provides a more nuanced understanding. Growth of e-commerce through digital platforms may have delivered welfare gains by reducing prices and making more consumer goods accessible to a greater share of the population, but it is undoubtedly displacing a growing share of workers from traditional less digital-intensive enterprises (World Bank 2020). In the retail sector, for example, evidence for the United States points to a drop in employment, as well as a

[19] For example, the top ten economies in the world account for 91 percent of all global patenting of advanced digital production technologies (UNIDO 2019: 49).

relative decline in wages and job stability, for workers in stores that neighbour Amazon fulfilment centres compared to other stores (Chava et al. 2018).

Most economics analyses of the skill effects of new technologies tend to combine two simple ideas: firstly, that of skill bias, whereby new technologies exert an upgrading pull on worker skills at the expense of low skilled labour (Acemoglu 2002); and secondly, the idea of non-routine task bias, which involves complementarity between ICT and all those jobs consisting of non-routine cognitive or non-routine manual tasks (Autor et al. 2003). These ideas are said to explain evidence of polarisation of changes to the employment structure, demonstrated for the UK (Goos and Manning 2007) and the United States (Autor et al. 2006). It is the occupational category, not industry, that does most of the empirical work in these studies.[20] This differs from the analyses of 'sectoral systems of innovation', which privilege the very differentiated employment effects of innovation by sector (Malerba 2004; see section 2). Instead, the occupational focus to some extent parallels sociological ideas about labour market stratification and class. However, as Fernandez-Macias (2012) argues, the difference with sociology is the lack of consideration to the way institutions and employers shape skills, the bundles of tasks for occupational roles and the spectrum of relative wage costs (see, also, Gallie 2007). Overall, the skill bias and routinisation arguments offer a partial explanation for observed job polarisation, but are constrained by technology determinism.[21]

In terms of workers' actual experience of technical change, UK Skills and Employment Survey data suggest those in more skilled jobs are more likely to experience technical change in their job, but also that the incidence of technical change has been falling since the early 2000s across all skill levels. The correlation between the intensity of technical change and graduate-level qualification requirements fell from 0.32 to 0.20 during 2001-17 (Henseke et al. 2017). Moreover, there is evidence that new vintages of ICT may have passed the peak of diminishing returns to productivity; only one in ten survey respondents stated that additional computing skills would enable them to do their job much better, down from one in four (25% to 12%, 2001-17) (op. cit.). There is also evidence that employers reduced their investment in skill development, with major falls in the time workers spend learning or training at work during the period 2006-17 (op. cit.). As the authors of this authoritative study put it:

> *'The skills bias nature of ICT may thus have been transitory. As has been suggested in other research, the maturing of ICT and its more widespread use, makes the adoption of new vintages of general-purpose ICT a familiar and less skills-intensive process'* (Henseke et al. 2017).

Because women tend to be over-represented in jobs involving routine tasks, studies also point to the likely gender inequality effects of job loss caused by technological change (Nedelkoska and Quintini 2018). Research on the uneven gendered consequences of technological change highlight adverse risks for women associated with constrained access to higher quality and more protected jobs caused by employer stereotypes and sex discrimination, uncertain prospects for relational skills, uneven entitlement to employment and social protection and greater irregularity and uncertainty of working hours (Howcroft and Rubery 2019; Piasna and Drahokoupil 2017).

The adverse skill effects of new technologies are particularly highlighted in recent evidence for the various forms of work organised by digital platform companies. Online or web-based digital work, for

[20] The OECD has also contributed numerous studies drawing on the PIACC survey.

[21] Fernandez-Macias also takes issue with some of the assumptions in a widely cited study of job polarisation for Europe by Goos and colleagues (2009). A key problem is their use of wage data for the UK to rank all jobs in 15 European countries, which ignores country differences in jobs ranking. More careful comparative empirical studies utilise available country wage rankings and produce greater heterogeneity of job polarisation, job upgrading and job downgrading results (Fernandez-Macias 2012: 12-13).

example, involves the algorithmic unbundling of jobs into 'micro tasks', which significantly reduces the skill required for the overall job, although the aggregate short-term productivity of the company may increase. International survey data of microtask workers shows that despite the high education of most online platform workers, the work tends to be (in the words of workers) 'repetitive', 'boring' and 'mindnumbing' (Berg et al. 2018: 84-85). Moreover, online digital platforms typically select workers for their ratings or profile (based on platform task completion) rather than educational qualifications, which explains why the most recent ILO evidence finds no significant difference in hourly earnings between online workers with and without a university degree (ILO 2021: 184-5). The rapid growth of this form of work is thus expected to aggravate problems of overeducation:

> *"The risk is that crowdwork, particularly microtaskwork, has the potential of deskilling work and also displacing or replacing some forms of skilled labour with unskilled labour, as jobs tend to be broken down into smaller tasks. … public investments in education, particularly in STEM undertaken to promote innovations and country-specific leadership in IT, risk being wasted or underutilized"* (Berg et al, 2018: 89).

Nevertheless, there are notable differences across the different platform types: while 84% of microtask workers report being overeducated for the tasks they regularly complete, the figure is only 2% for those engaged in competitive programming tasks (ILO 2021: figure 4.24). Further research is needed since the implications of digital technologies are not confined to the archetypal digital platform landscape of Uber, Deliveroo and Amazon Mechanical Turk; many companies are internalising digital platforms in an effort to radically transform their organisational structure (e.g. Hamel and Zanini 2018), and/or utilising digital algorithms to redefine organisational processes, especially affecting recruitment and performance management (e.g. Moore and Hayes 2017; Woods et al. 2020). Since organisational and institutional conditions are likely to shape skill and productivity outcomes, new research might identify possible alternative routes to enskilling (by organisation and country) that involving the purposeful re-engineering of client job requests to maximise the skill content of work and fulfil the skills and expertise of available online workers.

Overall, there are knowledge gaps concerning the way overlapping intersections of skill level, industry and gender shape the heterogeneous and contingent effects of new technologies on the UK's long-term high-skill structure and productivity performance. As section 2 details, there is a need for new research that addresses the specific characteristics and consequences of digital technologies, the geography of skill and productivity gains, and the re-bundling of tasks as old jobs are reconstituted, or recrafted, and new jobs designed. Much also depends on shifting business strategy and human resource practices, as we detail next.

1.4. Organisational factors make the skill-technology-productivity equation highly contingent

There is a long tradition of qualitative research that examines the role of organisational factors in shaping the equation between skills, new technologies and productivity. These include the classic early NIESR cross-national studies (e.g. Steedman and Wagner 1987, 1989; Mason et al. 1994) and research on strategic choice of 'high road' or 'low road' HRM approach (Appelbaum and Batt 1994; Cooke 2001; Lloyd and Payne 2006; Osterman 1994), as well as analyses of linkages between HRM and innovation (Michie and Sheehan 1999; Womack et al. 1991) and investigations of trade union effects on productivity (Nolan and Marginson 1990) and British management failings (Nichols 1986). Building on these insights, more recent quantitative and qualitative studies (drawing on matched employer-employee surveys and detailed case studies) incorporate a raft of valuable data on organisational and sectoral characteristics to understand the contingent relationship between human capital and

productivity. Variables include the type of work organisation, use of outsourcing, the nature of employee engagement, quality of management practices and type of employment – whether temporary or permanent, part-time or full-time, for example.[22] Table 3 lists five organisational factors and summarises the variables and findings of a selection of studies, chosen to illustrate key analytical points relevant to the UK.

Table 3. Organisational factors that shape the skill-technology-productivity equation

Organisational factors:	Illustrative studies	Selected independent variables	Innovation/productivity effects (UK evidence)
Work organisation (e.g. autonomy, task complexity, teamwork)	Arundel et al. 2007; Lorenz & Valeyre 2005	Four types of work organisation (Learning, Lean, Taylorist and Simple) with alternative combinations of worker autonomy, task complexity, teamworking, etc.	'Learning' type best associated with multiple measures of innovative performance, but 'Lean production' dominant in the UK
	Green, Felstead, Gallie & Henseke 2021	Computer use &/or automated technologies, Teamworking, Repetitive tasks, Incentive pay, Quality circles	High and rising work intensity (especially due to computer use) alongside upskilling; productivity effects likely moderated by adverse wellbeing
Outsourcing	Miozzo and Grimshaw 2005	*IT outsourcing:* Contract features; Proactive relationship management; Inhouse client retention of IT capabilities; Transfer of staff from client to IT supplier firm.	Limits to innovative performance and effective skill use caused by underdeveloped client-supplier interface.
	Grimshaw et al. 2019	*Cleaning outsourcing:* Contract features (incl. performance monitoring, cost savings); Pay practices; Employment form; Inhouse training; Staff retention; CSR practices	Outsourcing speeds up labour cost reductions as main route to performance gains; some limited opportunities for innovation via shared training and job redesign
Worker voice, participation & trust	Bryson and Green 2015	Union and non-union covered workforce	For both work intensification and learning requirements – faster trend rise among unionised workers and to a higher level than non-unionised workers
Quality of management practices	Bloom & Van Reenen 2007; Bloom et al. 2012	18 management practices aggregated into one indicator of quality	Positive and significant effect on firm productivity (as well as profitability and annual rate of sales growth); compound effect for high skill, human-capital-focused, high quality management practices
Employment form	Michie and Sheehan 2003	Use of part-time, temporary, casual and fixed-term contracts; labour turnover; functional flexibility; detailed HR practices and trade unions	Negative correlation between atypical employment and process innovation

[22] This list of organisational factors is not exhaustive. Other major factors include the form of corporate governance arranagement.

	Zhou et al. (2011)	Numerical flexibility (% fixed-term, staff turnover), functional flexibility (internal mobility), workforce qualifications	High use of temporary contracts is bad for 'new to market' product innovation but good for imitative innovations. Functional flexibility is positive and highly significant.

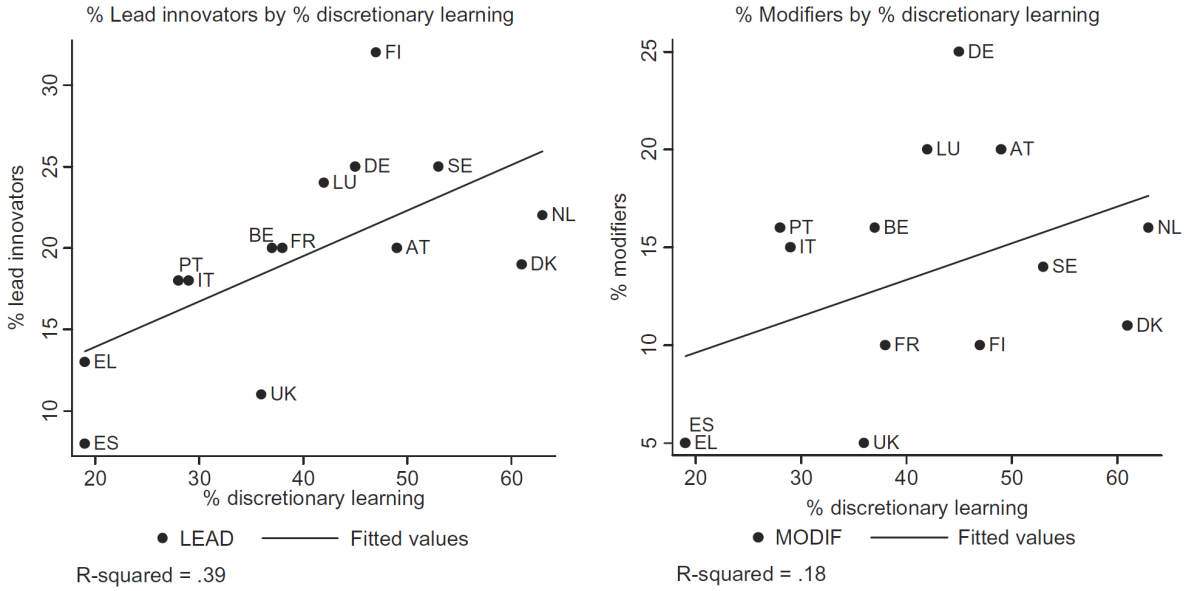
The nature of **work organisation** directly impacts upon productivity performance primarily due to its consequences for skills and innovation. Firstly, work can be organised to stimulate interaction among people with varied experiences and skills, spurring creativity and new ideas for products and processes. Secondly, delegation of responsibility for problem solving can help extend the sourcing of new ideas and also act as a catalyst for further skill development. Analyses of alternate forms of work organisation demonstrate its potential to raise productivity via forms of teamworking, multi-skilling, employee engagement and organisational flexibility (Appelbaum et al. 2000; Felstead et al. 2020; Gallie et al. 1998; Lloyd and Payne 2006).

The series of papers by Lorenz, Valeyre and colleagues are especially valuable because they have an explicit concern for work organisation on the one hand and quality of innovative performance on the other. They find a clear relationship between four distinctive types of work organisation and innovation performance[23] (Arundel et al. 2007; Lorenz and Valeyre 2005). Each type combines different configurations of a raft of variables - including work autonomy, teamwork, task complexity and hierarchical constraints on work pace, among others – and varies in relative importance across sectors. The most sophisticated in terms of autonomy, task complexity and opportunities for workers to learn and problem solve is labelled 'Discretionary learning'. The next best approach is labelled 'lean production', with high scores for teamwork and job rotation, but also with high constraints on work pace and a relatively high degree of task monotony.

Like other Northern European countries, the UK is found to have moved away from more traditional Taylorist models of work organisation, but unlike Germany, the Netherlands and the Scandinavian countries, the UK has tended to rely on lean production and to a lesser extent on learning (also evidenced by declining the volume of employer training in the UK and no sign of enhanced training quality -Green and Henseke 2019). This puts the UK at a disadvantage because the analysis finds a strong relationship between the relative use of learning forms of organisation (as opposed to lean) and several performance measures, including a country's volume of patent applications, the relative sale of products that are new to the market and the relative size of intramural R&D. The reproduced data in Figure 5 suggest the UK's low share of 'lead' or 'modifier' innovating firms is in part the result of it having a relatively low incidence of discretionary learning forms of work organisation. While a valuable mapping, what we do not yet know is *why* the UK performs worse on indicators of innovative forms of work organisation than its more dynamic European neighbours, although new data highlight the recent decline in forms of employee involvement, workplace support and HR development in supporting employees' willingness to contribute innovative ideas (Felstead et al. 2020).

[23] The data sources are the Eurofound European Survey on Working Conditions and the Community Innovation Survey.

Figure 5. Correlations between the incidence of 'discretionary learning' forms of work organisation and the share of innovating firms



Source: Arundel et al. (2007: figure 1).

Research on work intensification provides further insight into the patterns and trends of work organisation in the UK and its consequences for productivity. There is convincing evidence to suggest that the bulk of productivity growth in the UK derives from a prolonged and steady rise of work intensification, itself the result of endogenous design and application of new technologies in ways that increase pressures on worker performance. Green and colleagues show that this is caused by the 'effort bias' of technological change (Green et al. 2021). Unlike earlier periods of work intensification when other features of job quality were increasing (most notably real wages), the past years (2001-17) have witnessed a sustained rise in the aggregate 'work intensity index' alongside falls in workers' task discretion, training opportunities and real wages. The rise in work intensity is widely distributed among most industries, occupations and regions and is composed of increasing shares of workers who report higher paced work, stricter deadlines and very hard work (op. cit.: table 1). The key causal factor is intensity of computer use (accounting for around one third of work intensification), adjusted for levels of complexity. Moreover, the level of worker skill and the learning requirements of a job are both positively associated with the processes of work intensification, which runs contrary to earlier thinking about the deskilling consequences of technical change and worker control:

> *"The onetime assumption that greater job skill meant lower management control and less power to intensify work has been thrown into question" (Green et al. 2021: 23).*

Strategies of **outsourcing** or subcontracting are a further significant organisational factor that can shape the skill-technology-productivity equation for better or for worse. In many areas of services, where outsourcing has expanded in recent years, commentators have extolled its productivity-enhancing potential. Outsourcing of knowledge-intensive business services (such as IT services), for example, is sometimes claimed to have the potential to improve productivity, knowledge infrastructure and skill investment by concentrating expert capabilities in specialist firms (Wolff 2002, Miles 2002). Nevertheless, the empirical evidence suggests realising such economic benefits is complicated.

A much used concept in figuring out how outsourcing may or may not advance organisational innovation and productivity is that of modularity: modular inter-organisational systems involve standardised 'rules of the game' made up of processes and measures that cover financial and non-financial performance, product and service quality, customer satisfaction, delivery targets and innovativeness (Baldwin et al. 2000; Sturgeon 2002). Many studies of outsourcing do indeed find evidence of standardised contracts, especially covering agreed instruments for measurement and monitoring. However, there are important contingencies and obstacles that limit the applicability of modularity. Many types of services outsourcing do not easily fit with the usual notion of modularity: an outsourced function or activity often comprises an intangible, difficult to measure or monitor element; it may be difficult to split apart the outsourced activity from the client business operations; and, relatedly, it may require some idiosyncratic knowledge (including worker skill and experience) of the client. Importantly, by shedding competences in seemingly non-core knowledge capabilities firms may lose their ability to draw on external 'complementary assets', which are often crucial for appropriating returns on core capabilities (Teece 1986).

As such, many studies demonstrate that the presumed positive performance effects of outsourcing are contingent upon a closely coordinated client-supplier business interface and inter-organisational human resource practices. When outsourcing IT services, for example, client organisations must retain some IT expertise and also ensure that their own IT staff transfer over to the new subcontractor firm if they are to exploit the economic gains of outsourcing (Miozzo and Grimshaw 2005). At the other end of the skill spectrum, outsourcing of cleaning services seems to be mostly associated with a speeding up of labour cost reductions. There were some positive opportunities for new learning and job redesign to feed innovative performance, but only when client managers recognised the benefits of training subcontracted cleaners to meet the client's operational needs in ways that extended job roles[24] rather than simply speeding up their work pace (Grimshaw et al. 2019: 88-89).

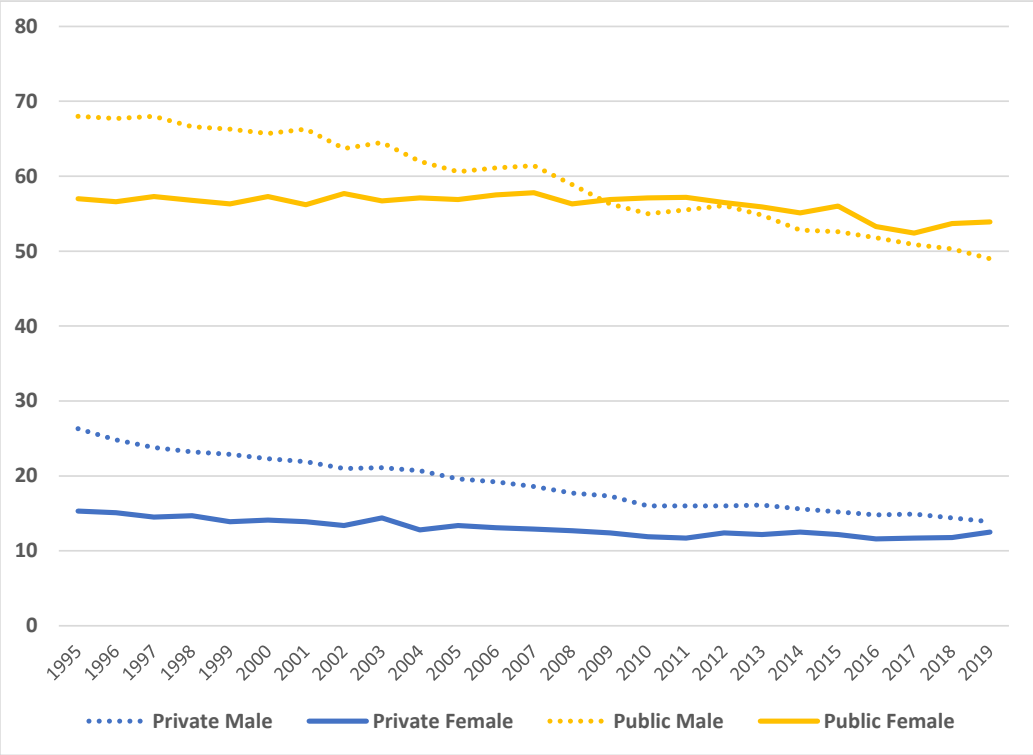
Therefore, in both high skill and low skill services outsourcing, performance gains can be impeded by conflicts between client and supplier over costs, continuity of staffing (to retain much needed organisation-specific knowledge versus cutting back on senior staff costs) and application of customised versus standardised technologies. While outsourcing may be a short-term lever for cost cutting, the positive consequences for innovative performance seem to require not just a simple transactional substitution of externalised for in-house activities but a more complex process of knowledge transfer, reciprocal learning and fair worker treatment. Further research is needed to illuminate the organisational actions and institutional conditions that might support pro-skill and pro-innovation forms of outsourcing.

Worker voice, a third inter-related factor, can provide a critical organisational lever for substantive employee participation in decisions about skill use, innovation and performance, and also contribute to trusting workplace relations between management and workers with possible benefits for productivity. The main institutional prop for worker voice is the trade union. However, UK unions are no longer a countervailing force in the bulk of private sector workplaces and as such are not expected to be as significant in terms of their nation-wide effect as they once were in shaping UK patterns of skill-innovation-productivity. The dominant paradigm has shifted in the last 40 years or so, more than in any other West European country, from a form of employment relations described by 'joint regulation' (Millward et al. 2000) to one where (again in the private sector) employers most often adapt the wage-effort bargain unilaterally via human resource management. Trade union density has

[24] For example, a hospital might seek to extend the remit to achieving the goal of reducing hospital acquired infections.

fallen from 39% in 1989 to 23% in 2019, with the steepest drop, and to a lower level, among men in both public and private sectors (figure 6). This is not to say that other forms of employee engagement are not present. Indeed, the emergence of various 'direct voice' (non-union) mechanisms is reflective of a continuously shifting and variegated terrain of conflict between managerial prerogative and social legitimacy (Marchington 2007); more research on the direct and indirect consequences for productivity is needed.[25] In the public sector, by contrast, trade unions play a continuing important role. They negotiate pay and other terms and conditions for the vast majority of UK public sector employees and have secured major improvements in a number of areas of HR practice, including flexible working, equality and diversity, fair pay deals for the lowest paid and, especially in the health and education sectors, for outsourced low-wage workers.

Figure 6. Trade union density in the public and private sectors by sex, 1995-2019



Source: Trade union membership as a proportion of employees (LFS data, BEIS 2020).

Where workers in the UK are covered by unions, recent data uncover a worrying change in the degree to which unions have upheld the wage-effort bargain (Bryson and Green 2015). According to 2012 data from the Skills and Employment Survey, union-covered workers were significantly more likely than non-union workers to say they had to work 'very hard' (after controlling for differences in demographic and job characteristics), opening up a new gap not present in the years prior to 2012; the shares reporting they strongly agreed that 'my job requires I work very hard' were 51% of union-covered workers and 40% of non-union workers (up from 29% and 31% in 1992, respectively). Moreover, while unionised workplaces used to provide a significant wage premium in the 1980s and 1990s, this compensation has shrunk substantially (again, after controls) (table 4). The union influence in negotiating an advantageous wage-effort bargaining thus appears to have eroded, although the

[25] It is also worth noting that while the share of employees in the private sector whose pay and conditions are affected by trade unions - whether or not they are a member because they may work in a workplace where one or more unions are recognised for pay bargaining – is very similar, 15% compared to 13% union density, the share who work in a workplace where one or more unions are recognised is significantly higher, 32% (2019 data).

precise causal mechanisms are unclear and deserve further investigation, especially given the significance for the nature and pace of productivity effects. The one bright spot concerns a new pattern regarding the learning requirements of jobs. For the first time in 2012, union jobs were significantly more likely than non-union jobs to stretch the learning capabilities of workers. This is likely to reflect the proactive role of 'union learning representatives' established under the 2002 Employment Act, part funded by government and coordinated by the TUC (Rainbird and Stuart 2011; Stuart et al. 2011) - although the government abolished funding in March 2021 in an explicitly political intervention that ignored the positive contributions of union learning reps.[26] More generally, whether or not the learning opportunities identified in table 4 are advantageous depends on the relationship with their perceived value for the organisation, with opportunities for worker promotion and with other improvements in employment status. Such factors, in turn, are likely to be contingent on the nature and quality of union involvement and opportunities for integrative, mutual gains bargaining with the employer (Stuart and Huzzard 2017; Kochan and Osterman 1994). More research on the changing dynamics of unions' efforts to shape the wage-effort bargain and the implications for career pathways and for productivity is needed.

Table 4. Union coverage effects on the wage premium, worker effort and learning requirements

	Wage premium		**Work very hard**		**Learning requirement**	
	Raw wage gap	With controls	Raw gap	With controls	Raw gap	With controls
1986	0.204***	0.084***	--	--	--	--
1992	0.214***	0.104***	-0.017	-0.038*	0.0310*	-0.0204
1997	0.226***	0.093***	0.025	-0.013	--	--
2001	0.117***	0.039***	0.016	-0.007	0.0741***	0.0258
2006	0.143***	0.026**	0.043***	0.018	0.0746***	0.0174
2012	0.166***	0.040**	0.110***	0.093***	0.1458***	0.0597**

Source: adapted from Bryson and Green (2015: tables 7.2 and 7.4).

A valuable set of papers by the economists Bloom, Sadun, Van Reenan and others investigates the relationship between the **quality of management practice** and the level of productivity in a growing number of countries. Drawing on international survey data, the research analyses 18 management practices, covering operations (e.g. documenting process improvements), monitoring (e.g. regular appraisals), targets (e.g. operational or financial) and incentives (e.g. promotion criteria). For example, for France, Germany, the UK and the US, Bloom and Van Reenan (2007: table 1) report a strongly positive and significant relationship between the quality of management practices and labour productivity, after controlling for inter-firm differences in R&D, computer use and a range of other workforce and industry controls. The analysis also finds clusters of high quality practices (especially related to human resource management) among firms operating with a high skill workforce.

In this and other papers (e.g. Bloom et al. 2012), we find further empirical details about possible causes of heterogeneity of quality management practices, most notably the degree of product market competition and ownership (private tends to trump public, and professional management beats family management). However, the research can be questioned on the basis that it seems to promulgate a type of universalist thinking that there is one best way to managing the contemporary organisation. This runs counter to the detailed historical and comparative analyses of business which document

[26] In their evaluation, Stuart et al. (2011) report that by 2008, there were 22,000 newly trained union learning representatives, 847 learning centres, 1,557 employer-union learning agreements and more than 600,000 learning opportunities.

persistent inter-country variety in the ways economic activities are coordinated and governed. Despite strong pressures for convergence attributed to internationalisation and new technologies, the evidence points to a variety of policy responses and management strategies to develop specific organisational and technological capabilities, rather than the evolution of a uniform 'best practice' (Hall and Soskice 2001; Miozzo and Walsh 2006; Whitley 1999); such reasoning can of course explain the multiple routes to economic failure and success (see Rubery 1994 for the UK). If firms in different countries (and possibly sectors) develop a plurality of competences and forms of economic competitiveness then it may not be appropriate to evaluate the performance of all firms against a single standard of managerial quality. This is especially true at a time when conventional notions of economic performance are questioned because of their failure to account for negative environmental externalities or the costs of social inequalities. Instead, a diversity of performance criteria may be necessary that recognises alternative paths of economic development and long-term success (Whitley 2007; section 2 below).

A final organisational factor that shapes the skill-technology-productivity equation concerns employer use of standard and non-standard **employment forms.** New forms of flexible production that can promote 'open innovation' or 'outside-in knowledge' are sometimes argued to require flexible access to worker skills via temporary, part-time or freelance contracts (Chesbrough 2011). Studies of Silicon Valley highlight companies' use of temporary specialist knowledge as critical to successful inter-firm networks (Benner 2008). However, the social structuring of different employment forms is important. In the UK, employment forms that are not full-time or open-ended often lack the stability and security that can encourage workers to commit to organisational goals and to transfer their tacit knowledge, which matters for productivity growth founded on new process and product innovations. Moreover, atypical employment forms in the UK are often managed within a hierarchical, 'lean' managerialist model (see above). As a consequence, research suggests that high use of flexible employment forms in the UK negatively interacts with innovation and productivity (for a review, see Rubery et al. 2015). For example, in their survey of manufacturing firms, Michie and Sheehan (2003) found that the more innovative firms were less likely to rely on short-term and temporary contracts and more likely to pursue 'functional flexibility' underpinned by employment security; those firms that did use a high share of part-time and/or temporary contracts were less likely to register process innovations. Also, Zhou et al. (2011) find that firms (in the Netherlands) with higher shares of temporary contracts performed worse in sales of 'new to market' innovative products, but better at imitative (or 'new to the firm') products. Instead, they argue that functional flexibility with open-ended employment forms is beneficial because of its role 'in reducing barriers to knowledge sharing and building multiple competencies of employees in internal labour markets' (op. cit.: 959).

In sum, given the above puzzles and knowledge gaps, further research on the range of heterogeneous business strategies and HR practices, especially as they relate to forms of work organisation, outsourcing, worker voice and employment form, is needed to understand better the changing association between human capital, innovation and organisational performance. This would likely require more fine-grained details about the organisation-level drivers – including how organisations respond to uncertainty, how they adapt learning in a digital era via interactions between producers, users and frontier firms, how workers (collectively and individually) drive improvements via worker voice, and how employers and workers develop, use and transform the skill-mix internal and external to the organisation. Such research could seek to identify the bottlenecks to improving innovative capabilities and organisational performance, with attention also to the wider macro competitive context, patterns of R&D spending, employment rights and protections, and the shifting policy arena that can stimulate pro-innovation, high-skill working environments.

2. Inter-disciplinary research for a way forward

With the aim of charting a prospectus for future research, this section begins by listing some conceptual starting points and then identifies five themes for research. Each theme is motivated by a specific knowledge gap in response to the puzzles identified above with the goal of improving our understanding of the relationship between human capital and productivity, especially in the UK.

2.1. Conceptual starting points

Embracing an interdisciplinary approach to the question of human capital and productivity means appreciating the social, political, psychological, geographical and economic characteristics of human capital, its differentiated influence on productivity and the significance of a range of mediating factors and conditions that may be conflictual or complementary. It is useful to set out the key conceptual starting points to a research programme guided by an interdisciplinary approach.

Firstly, human capital is both an economic construct and is *socially structured*, meaning that its character, value and composition are shaped and reshaped by changing institutions, technologies, policy goals and cultural norms (Eyraud et al. 1990; Rubery 1994); as such, skill investment and development is as much a social policy as it is a competitive economic policy. Ideas about what kinds of skills are in demand, and at what value, are continuously reshaped in a context of the changing 'social relations of productivity growth' (Brown et al. 2001). Policy goals to boost the knowledge economy, for example, have changed perceptions about the productive function of skills in problem-solving, trust-building, creativity and communications (e.g. Sasso and Ritzen 2019), and ongoing UK policy reforms are shifting the balance of financial support (and incentives) for delivery and take-up of vocational education and higher education (Augar 2019; Lewis 2020). Increasing attention to so-called soft skills (interpersonal and social) have raised questions in the management and sociology literatures about how best to harness and reward the emotional and creative energies of a rising share of the workforce (Hurrell 2015; Nickson et al. 2009; Warhurst et al. 2017). The social status of women in society is a further strong determinant of skill value and what constitutes fair reward, in a context of high levels of sex segregation by industry and occupation (Anker 1998; Auspurg et al. 2017; Rubery et al. 2005);[27] some change has occurred in the wake of the global pandemic with several countries upgrading the value of health and social care skills in response to the increased visibility of essential care work[28] (Folbre et al. 2020).

It is also necessary to situate the relationship between human capital and productivity within the varied types of authority hierarchies that constitute the *employment relationship* (Whitley 2003). As elaborated in section 1.4, employer willingness to delegate authority, foster autonomy and involve employees in decision-making are major differentiating factors in explaining how firms learn and develop new knowledge, with direct benefits for innovation and productivity growth (Grimshaw and Miozzo 2006; Holm et al. 2010; Lorenz and Valeyre 2006). Use of the 'open-ended employment relationship' (as opposed to utilising freelance, subcontractors and short fixed-term contracts) is

[27] The differentiated results concerning human capital investment are perhaps most clearly revealed with respect to empirical evidence of gender inequalities. For example, caring skills are less rewarded not because of their lower contribution to value added, but because women tend to be over-represented in care work (Folbre 2017). Also, women with tertiary level education in the UK are rewarded less than men after controlling for occupation, industry, type of university, degree type, social background, ethnicity and working hours (Cornell et al. 2020).

[28] For example, in Germany's 2020 wage agreement for municipal and federal government workers, a set of supplementary payments were included for health and care workers (https://www.epsu.org/article/germany-latest-agreement-boost-pay-health-and-care).

explained by the functional flexibility it provides organisations to manage complex, tacit and uncertain activities (Marsden 1999; Simon 1951), which are especially relevant for knowledge-intensive and innovative activities (Lazonick 1993).[29] By contrast, dis-investment in open-ended employment forms in favour of more unstable and precarious forms of worker attachment is associated with a 'disposable labour model' that risks undermining skill investment, obstructing innovation and impeding sustained productivity growth (Rubery et al. 2016). The shifting terrain of conflict that drives changes in the employment relationship also shapes the question of who pays for skills and who bears the risk (and debt) while awaiting uncertain returns. Recent trends in the UK, accelerated by developments in the gig economy, suggest capital has shifted more of the cost and risk of skill investment to the individual (Fleming 2017), although the new apprenticeship levy on employers is an example of a policy that can offset this trend to a degree.

The third point is that human capital comprises of, and is bound up with, *different types of knowledge* that are associated with *alternative forms of organisation structures and work organisation*, which in turn are moulded by wider (institutional) governance arrangements for skills, knowledge and innovation (Lam 2000). Three issues arise from this conceptual perspective. The first is that a great deal of knowledge is tacit (and therefore intangible) and is held by groups or teams (and therefore delinked from the individual); this means that an individual's human capital is formed and shaped through interdependencies of different forms of knowledge with co-workers, which influences their career path and wages (Neffke 2019). Secondly, the emergence of learning opportunities and tacit knowledge is shaped by the organisational configuration of horizontal and vertical hierarchies for problem solving (encompassing platform work, virtual organisations, subcontracting, etc.). Narrowly defined jobs subject to tight hierarchical supervision provide limited opportunities for learning and tacit knowledge, while coordinated forms of teamworking enable more opportunities for skill development (Lam and Marsden 2017). Varied combinations of formal and informal organisational structures matter (Kotter 2014), but an especially important influence is the way technology is reconfiguring organisational structures, including the internalisation of digital platform business models, such as at the Chinese appliances company Haier (Hamel and Zanini 2018). Third, the organisational structures that shape tacit and group forms of knowledge (including authority relations, inter-organisational relations, shared human resource practices, and organisational routines and processes designed to articulate or codify knowledge) have a direct influence on a) the propensity of the organisation to hire from the external labour market or retain and invest in the incumbent workforce, and b) the types of skills acquired from (and supplied by) the labour market (Marchington et al. 2011; Miozzo and Grimshaw 2005). However, it is not only the organisation that imparts value for knowledge. For example, tacit experience (organisation-specific and general) is a critical complement to a person's formal education, but its value for the individual and the organisation is likely to vary according to labour market and institutional variables, including worker bargaining power and the institutional relationship between management and financial investors (Aoki 2010; Jacoby 2005).

The ability of an organisation to capture and exploit human capital as knowledge relates to its 'absorptive capacity', defined in the management strategy literature as a set of routines and processes by which it uses knowledge to produce a *dynamic organisational capability* (Cohen and Levinthal 1990). By developing complementary capabilities of acquisition, assimilation, utilisation and transformation (of knowledge), an organisation can promote the productive use of skill for

[29] Relevant empirical evidence suggests technological intensity reinforces the positive relationship between skills and job duration and points to the productive accumulation of firm-specific human capital (Silva and Lima 2017).

competitive advantage.[30] An organisation's approach to recruitment and selection signals a great deal about its intentions concerning the incorporation of skill in the creation, sustaining and/or adaptation of organisational routines. However, the process of assimilation adds further explanatory weight. Assimilation is a two-way process since new recruits need to know what to do and how to do it (Nelson and Winter 1982: 107) and senior managers need to understand and interpret the new knowledge and expertise acquired (Zahra and George 2002: 189). For example, the skills acquired from a specialist subcontractor may embody tacit knowledge that is not easily comprehended by the firm, slowing down its contribution to the firm's potential to innovate. This risk is higher, the more the subcontracting relationship is managed at 'arm's length', as Gospel (2021) reports for the UK's electrical contracting sector. Importantly, however, while acquisition and assimilation are necessary features of an organisation's absorptive capacity, the triggers for translating skill into innovative organisational performance most likely lie with the features of utilisation and transformation. In other words, an organisation may be proficient at acquiring and assimilating new skills into its routines but in the absence of capabilities to utilise, develop and transform these skills there will be limited impact on performance.[31] Cross-country analysis confirms the importance of both high and intermediate level skills in converting knowledge into innovative outputs (Mason et al. 2020; Rupietta and Backes-Gellner 2019). Moreover, workers with these different skill sets may play inter-locking roles in these processes, as Lewis's study of the UK life sciences sector demonstrates:

> *"Very highly qualified engineers and scientists play a significant role in identifying new technologies, thereby contributing to potential absorptive capacity. But once that knowledge has been identified, a firm's technicians make an important contribution to its ability successfully to deploy it in the workplace, thereby contributing to the firm's realised absorptive capacity"* (Lewis 2021: 3-4).

Overall, an explanation about how organisations vary in their ability to generate value from their skill base is likely to require a better understanding of the variation in their capabilities to utilise and transform skills.

A further conceptual starting point for future interdisciplinary research is that the consequences of human capital investment for productivity are highly *differentiated, uneven and constantly changing.* This requires applying an empirical lens that is able to capture the full possible variety of effects rather than focus on average trends. This mirrors the viewpoint among scholars of technical change, who point to its differentiated character and its varied effects on jobs, sectors and countries, as well as on workers subdivided by skill level, gender, geography, employment form and other characteristics (Vivarelli and Pianta 2000; Barbieri and Consoli 2019). Similarly in the management literature, differences in organisational capabilities are a well-known important source of intra-industry performance variation (Teece et al. 1997). Institutional explanations for differentiation point to the weakness or absence of industry, product market or technology standards, the ineffectiveness of labour market rules and the exclusiveness of workforce coverage by institutions such as vocational training, employment protection, trade union representation and collective bargaining. As such, comparative institutional analysis reveals that the UK has far greater scope for differentiation (across firms and workforce groups) thanks to the relative absence of 'beneficial constraints' imposed by encompassing and effective institutional arrangements. As elaborated in section 1, the UK's average

[30] Given the importance of all four features of its absorptive capacity, it is noteworthy that the empirical focus of economics research is predominantly on the acquisition of knowledge, reflecting the fact that the market transaction is still considered the main piece of evidence for what a firm actually does.

[31] In the framework for absorptive capacity, Zahra and George (2002) compartmentalise acquisition and assimilation of knowledge as 'potential absorptive capacity' and the exploitation and transformation of knowledge as 'realised absorptive capacity. The ratio of realised to potential absorptive capacity is termed 'the efficiency factor'.

performance on a range of human capital and productivity measures has not been shared evenly by all workforce groups, with particularly stark lines of segmentation by level of education, gender, age, ethnicity, disability, sector of employment and employment form. Attention to the varied institutional shaping of human capital and productivity is essential for incorporating the range of pressures on the employment relationship and opportunities for new technologies that help explain change and its differentiated effects.

2.2. Five themes for human capital and productivity research

The above conceptual starting points for interdisciplinary research provide a basis for responding to the analytical puzzles identified in section 1 in a novel way. Five inter-related research themes are identified here. Each is designed to contribute to our knowledge about the relationship between human capital and productivity. Each theme is also described with specific empirical application to the UK (to meet the remit of the Productivity Institute) with due regard to the challenges of rapid technological change, macroeconomic uncertainty and pressures to transition to a more sustainable path of development.

Theme 1: Using 'systems of innovation' to analyse changes in skills and productivity

While there are multiple macro-level analyses of changing job structures that explore the consequences of new technologies for skill demand (section 1), few have injected a serious concern for innovation and productivity, nor for the associated institutional arrangements that might enable transitions towards green and digital skills. There is therefore scope for new theoretical and empirical research that brings together the insights from the specialist study of skill structures and institutions, on the one hand, and national and sectoral systems of innovation, on the other. Insights from the latter suggest that the major sectors of an economy are highly differentiated in their learning and innovation processes, firm and inter-firm dynamics, appropriability mechanisms, boundaries with other sectors (in terms of interdependencies and links) and institutions (Malerba 2004). Distinctive sectoral logics of innovation and production, rooted in national settings, mean that there is considerable variety in patterns of technological change and these are likely to have a range of consequences (qualitative and quantitative) for the changing demand (level and composition) for human capital and for productivity growth allied to green and digital skills.

The study by Bogliacino and Pianta (2010) provides a valuable point of departure. Categorising sectors into four types (following the 'Revised Pavitt classes') reveals that distinctive sectoral innovation strategies generate diverse employment effects (table 5). Science-based sectors[32] have a strong strategic focus on technological competitiveness, based on new products and new markets that require substantial internal innovative efforts (R&D, design, patenting and investment). Analysis for Europe suggests this strategy is a significant determinant of employment growth, while innovations designed to reduce labour costs have no effect. By contrast in Supplier-dominated sectors,[33] which rely heavily on innovations for cost competitiveness, there is a strongly negative association between innovation strategy and employment.

The sectoral innovation focus further reveals two distinctive labour market effects via wages (neoclassical) and growth in the number of firms (Schumpeterian). The latter is strongly evidenced for Science-based sectors (table 5), suggesting that the Schumpeterian dynamic of innovation, characterised by new products and markets, is sustained and reinforced by new firms that bring job

[32] Examples include pharmaceuticals, electronics and IT services, although the categorisation is constantly changing as sectors change.

[33] Examples include retail, hospitality and food and drink manufacturing.

creation. Importantly, wage growth in these sectors does not discourage employment growth, suggesting that the usual negative labour demand curve does not hold. The opposite holds for Supplier-dominated sectors, where wage growth exerts a strongly negative effect on employment growth and the net entry of firms has no significant effect (Bogiacino and Pianta 2010).

Table 5. The effects of innovation strategies on employment growth by type of sector (Europe data)

	Science-based	Specialised Suppliers	Scale & Information Intensive	Supplier-dominated
Technological competitiveness[1]	Positive	--	Positive	--
Cost competitiveness[2]	--	Negative	Negative	Negative
Wage growth	--	Negative	Negative	Strongly Negative
Change in number of firms	Strongly Positive	--	--	--
Growth in value added	--	Positive	Positive	Strongly Positive

Notes: 1. Share of turnover from new products; 2. Share of firms innovating to reduce labour cost.
Source: adapted from Bogiacino and Pianta (2010: table 2).

More recent and complementary work, building on task-based analyses of changing jobs, develops our understanding of the skills and knowledge requirements of jobs involved in producing complex goods and services across diverse sectors in specific country settings, as well as the necessary forms of employer training investment for the development and transformation of human capital. In Lo Turco and Maggioni's (2020) study of United States Metropolitan Areas, the authors point to the importance of occupational complexity in driving local economic growth. They also show that STEM skills and knowledge, as well as critical thinking, play a critical role in producing complex goods and services, and in enhancing long-run innovation processes, economic leadership and economic development (op. cit.). A similar approach (also for the United States) has analysed the types of skills required for a labour market transformation that fosters 'green jobs'. Exploiting both traditional measures of human capital and the O*NET taxonomy of occupational tasks, Consoli et al. (2016) find that green jobs have a higher intensity of human capital indicators and less routinised tasks.

Building on these insights, what is required is a more fine-grained sectoral innovation categorisation that can also incorporate data on the diversity of jobs by skill levels, patterns of employer investment in human capital and utilisation of employment forms. New research along these lines could usefully contribute to a deeper sectoral understanding of the inter-related factors shaping innovative performance, skill use and productivity, with the possibility also of extending the lens to cross-national comparative research where this can illuminate UK specificities and reveal the potential for investments in human capital allied to green jobs and digitalised jobs.

Theme 2: Understanding firms' 'experimentation' with skill and innovation strategies in a context of digitalisation and uncertainty

How organisations learn and develop new knowledge is central to understanding how human capital shapes competitiveness, particularly in an era of rapid technological change and macro uncertainty (associated with the recovery from Covid-19 and, in the UK, Brexit). Different organisations, located in different sectors and supply chains, and embedded in varied institutional arrangements, generate competing organisational forms and capabilities and in this way constitute a crucial mediating variable between a given supply of human capital and the economic results. However, very little is known about how organisations in the UK are responding to digitalisation and uncertainty through

'experimentation' with new skill and innovation strategies (Cantwell et al. 2010).[34] There are likely to be qualitative differences across sectors and among firms within sectors, especially between lead multinational firms and others. Also, because firms are increasingly interconnected with local and national networks of actors, there is likely to be great potential for system-wide institutional experimentation and heterogeneity as a result of new business strategies (op. cit.).

An empirical focus on the capabilities of firms in the most innovative sectors in the UK – including, for example, pharmaceuticals, computer services, telecommunications, automotive and engineering – would fill a major knowledge gap. There are three aspects to this. The first concerns how leading innovators are responding to an environment of increasing technological complexity and disruption. Current advances in digital technologies (including new digital platform business models) are blurring the boundaries between sectors and product markets and requiring firms both to make strategic changes in the nature and scope of activities (tasks and job roles) and to respond to opportunities for 'experimentation' around new activities linked to innovation (Cantwell et al. 2010). The second aspect concerns a firm's capabilities to adapt its sourcing, assimilation and utilisation of knowledge ('absorptive capacity') by reconfiguring human resource practices, including training programmes (initial and continuous training), inter-organisational knowledge networks (via competitors, suppliers, clients) and employment forms (including subcontracted, freelance, variable hours and open-ended employment) (Zahra and George 2002; Lenihan et al. 2019). Such strategies may also involve lowering coordination costs for production and innovation activities, moving away from traditional hierarchical employment relationships and leveraging uncertain future skill needs (such as data analytics for example) (Alvarez et al. 2020). The third concerns the leading innovator firms' strategic relationship with their international and local context, since skill and innovation strategies are deeply entwined around questions of international business structure on the one hand and, on the other, a seemingly persistent appreciation of the value of close ties forged via local networks of collaborators, spanning further and higher education institutions, clusters of SMEs, local trade and employer bodies, and public agencies (Jackson and Deeg 2019; Tregaskis and Almond 2019).

New research under this theme is needed to interrogate the following questions: given an environment of fast changing digital technologies, how are the leading innovative firms in the UK adapting their skill and innovation strategies for improved performance?; to what extent are firms reconfiguring their networks of collaboration with other organisations across sector boundaries and with what effect?; and what is the evidence for, and character of, value-creating activities involving a) cross-border internationalisation and/or b) local embeddedness in one or more UK regions?

While the UK ought to be the centre of detailed qualitative research for this theme, it is possible that cross-national comparative analyses of, for example, matched firm-in-sector case studies, would be valuable. Such comparative analysis might extend to consider the varied skill, knowledge and innovation strategies of multinational companies with operations in the UK and other countries.

Theme 3: The regional dynamics of labour market inequalities, skill underutilisation and productivity growth

There is a need to update and extend analyses of job upgrading and polarisation (section 1) in order to consider the implications of labour market inequalities and skills mismatches for productivity growth across the regions of the UK, with special attention to the characteristics of intermediate skill

[34] This focus on experimentation approaches firms as non-optimising organisations that learn through trial and error, in a context where innovation is a major source of potential profits, through experimental search and exploration (Nelson and Winter 1982).

demand. Measures of skills underutilisation and underemployment (meaning the desire for more paid hours of work) are increasingly recognised as important measures of labour market slack (along with unemployment) and are significant variables in an explanation of the UK's productivity gap (section 1). Also, problems of 'job polarisation' remain under-theorised and under-investigated, posing questions about the causes of the apparent drop in demand for mid-level skills in the UK and the implications for productivity. This research theme will investigate the relationship between the shifting structures of skill demand, institutions for skill formation and patterns of wage inequality, on the one hand, and, on the other, the distribution of skills underutilisation, underemployment and unemployment.

There is particular scope for investigating the regional spatial variation in changing patterns of jobs (see Autor et al. 2013). Studies often assume that the upgrading of jobs - with more high skilled jobs generated by new technologies - brings with it an increasing demand for (non-tradeable) low-wage or low-skill jobs, implying physical proximity. Evidence for the spatial boundaries of polarised job growth, as well as detailed interrogation of the capacity of new jobs to meet conditions of skill utilisation, and for which workforce groups, would therefore provide a valuable contribution. Interrogation of the role of large employers as anchor institutions, as well as community models of inclusive growth, would be welcome. In an analysis for Australia, Denny (2019) highlights growing inter-regional economic divergence as a key contributor to polarisation, as well as other drivers such as the rising demand for social care associated with an ageing population. Disaggregation of results by workforce group, especially for older and younger workers, male and female, and by ethnic and migrant status, would add further clarity to the complex reality of shifting job opportunities by level of skill and wage prospects.

This theme also welcomes new qualitative research on the relatively neglected categories of jobs requiring intermediate skills, with the aim of understanding the real-world shifts in supply and demand of those 'hollowed out' jobs and skills referred to in the sweeping claims about job polarisation. Examples of occupations include the many 'associate professional' roles and the way they are recalibrated in ways that affect productivity of high and mid-skill roles (see Kessler et al. 2015 on health sector roles). In an innovative combining of ideas from human capital and innovation theories, Lewis (2020) finds that employer efforts to train technicians to deploy new technologies in the UK were hampered by the inadequacy of training providers to respond to employer demand. This is a point emphasised by Vona and Consoli (2015), namely that the reconciling of new skill content of jobs with changing technologies requires a process of 'knowledge systemisation' involving the adaptation of institutions of education and training. Others emphasise the UK problem of a 'missing middle' (Edwards et al. 2002), comprising of local business networks or forms of business support, necessary to diffuse good practice and sustain better management capabilities, especially among SMEs.[35] In their absence, labour markets suffer a kind of institutional or 'system' failure, as distinct from the traditional kind of market failure, which can drive a hollowing out of intermediate skills. In an early analysis of maintenance engineers in the UK, Cooke (2002) finds that they play an important potential role in technological change, but the effects are contingent upon management style, product market conditions and type of technologies/equipment. Given the current demands of digital technologies, there is a clear need to review the changing circumstances for jobs requiring intermediate skills, situated in their organisational and sectoral context, with consideration to the enabling and hindering

[35] A comprehensive evaluation of a local programme of SME business support in the UK ('People Skills') found that take-up was mostly limited to getting the basics of people management right rather than transformational interventions and that its longer-term success depends on building a scaffolding of sustainable local networks involving LEPs and chambers of commerce (Atkinson et al. 2017).

role of VET institutions (especially the new T levels and apprenticeships) and diverse employment forms (e.g. Collier and Shakespeare 2020).

The Covid-19 recession and recovery raises a further related question in this research theme. What is the role of employers post-pandemic in implementing inclusive programmes of training and retraining against the backdrop of government financial support for different kinds of vocational and higher education and long-term decline[36] in the volume of training provided by employers to workers of all education levels? There is a lack of opportunities for retraining and new starts for those workers made redundant during the recession with major concerns about the 'scarring' effects over workers' life course and the underutilisation of potential talent. It is not clear to what extent 'scarring' may in part be caused by employer prejudice against job applicants who have been made redundant and/or have not followed conventional linear careers. Research is therefore needed since the capacity of UK organisations to absorb, adapt and reskill is essential for productivity growth at a national level, but more evidence is needed to understand changing employer behaviour with respect to recruitment and training practices.

Theme 4: Fair and decent work, human resource practices and employee engagement

Recent years have seen a growing ambition among scholars, commentators and policy makers to place the quality of work, management practices and the character of the employment relationship at the centre of efforts to address social needs, including the desire to make societies more fair and just, and in turn to transition economies on a path of innovation and performance in keeping with principles of sustainability and inclusiveness. This thesis is at the centre of the ILO's (2019a) Global Commission report on the future of work, in which it calls for 'a human-centred growth and development path' with more opportunities for decent work, formalisation of informal work and an end to working poverty. It is also reflected in the UN Sustainable Development Goals, particularly SDG 8 on decent work and sustained and inclusive economic growth (ILO 2019b). In the UK, concern for the casualisation of employment, 'one-sided flexibility' and in-work poverty motivated the UK's Taylor (2017) review on 'good work' with the ambition to address the 'complex challenge of low productivity', among other issues. In Wales, the 'fair work' policy recommendations seek to integrate the pursuit of fair work with industrial strategy, in part to reduce the risk of 'unsustainable, unproductive, precarious work' (Fair Work Wales 2019: 14), and Scotland's 'fair work action plan' calls on employers to put fair work 'at the heart of the Scottish approach to growing the economy' (Scottish Government 2021: 3).

Recognising the potentially favourable political climate, some scholars are also making explicit calls for improved working conditions and actively engaging with business: Warhurst and Knoxx (2020) call for a raft of statutory rules for minimum standards to advance people's quality of working life to support worker wellbeing and in doing so to provide a sustainable route to economic growth and competitiveness; Rubery and colleagues call for the reinvigoration and extension of the rules governing the 'standard employment relationship' to meet changing societal needs, balance the responsibilities between state and employer and mitigate the risks of non-standard forms of employment (Rubery et al. 2018); and a new ESRC funded network of scholars (Lindsay, Findlay, Roy and others) is proactively engaging with business to advance models of employee engagement and better management practices with the goal of boosting productivity (see propelhub.org).

This theme therefore seeks to build new research evidence from a worker perspective. As McCann (2018) puts it in his wide-ranging review of productivity perspectives, 'There is a dearth of empirical

[36] Green and Henseke (2019).

work on workplace social dynamics and performance outcomes'. There are valuable insights from scholars working with the UK Skills and Employment Surveys and the UK Workplace Employment Relations Surveys, as well as the European Working Conditions Survey and qualitative UK case studies of organisations (section 1). However, more research is required to interrogate the contingent relationship between better working conditions, better designed jobs and employer commitments to training, on the one hand, and, on the other, improved social, innovative and economic performance outcomes.

A specific focus on the variety of arrangements for worker voice (formal, informal, union-led or non-union, direct forms) is needed, as well as other voices with a stake in the employment relationship, such as civil society and service users (see Heery et al. 2012; Kessler and Bach 2011). Voice systems and diverse forms of collaborative management can provide an important input to pathways for productivity growth and transformation, yet the fast-changing context of digitalisation presents multiple challenges. Effective worker voice can be instrumental in shaping innovative forms of 'discretionary learning organisation' (Arundel et al. 2007; section 1), trusting relations (Brown et al. 2015), 'collaborative innovation' (Lindsay et al. 2017) and job satisfaction (Lenihan et al. 2019) - each with benefits for performance. However, further detailed qualitative research is required to disentangle the necessary institutional, economic and organisational conditions across diverse sectors in the UK, with specific attention to digital platform companies and companies that are internalising digital business models.

The relative absence of protections, rights and institutional resources for trade unions in the UK private sector leads to a proliferation of diverse *non-union* voice systems. Table 6 lists characteristics associated with three forms of 'direct voice' systems – task-based participation, upward problem-solving and complaints to management.

Table 6. Direct voice systems, the tensions between worker/management goals and performance

Voice system	Voice mechanisms	Worker goals	Management goals	Tensions	Potential performance outcomes
i) Task-based participation	High performance work Self-managed teams Autonomous work groups	More interesting work More control and discretion over work performance	Improved quality and customer service Enhanced worker commitment and satisfaction	Contested notions of autonomy & responsibility Self-control vs management surveillance	Improved staff retention More fulfilling work Improved market share
ii) Upward problem-solving	Offline teams Quality circles Suggestions schemes Two-way briefings	Contribute ideas to improve work Recognise worker skills	Improved quality and customer service Appropriate worker skills and expertise	Employment security and lean production Distribution of rewards from high productivity	Innovation in products and processes Higher productivity Fairer wage-profit distribution
iii) Complaints to management	Grievance procedures Direct complaint to supervisor	Express dissatisfaction about issues Rectify problems	Enable workers to let off steam Address problems	Managerial prerogative vs employee rights Fairness at work	Improved staff retention Improved wellbeing Organisational resilience

Source: adapted from Marchington (2007: table 12.1).

The mere presence or absence of each voice system is no guarantee that it meets worker and/or management goals, since much depends on how they link to other HR practices, the degree of incorporation with (or subservience to) wider business goals, workforce inclusiveness, the balance of short-term instrumentality versus sustained investment, and the wider foundations of institutional support (Marchington 2007). Indeed, even non-union 'voice culture' may be impeded where employers privilege financial shareholder pressures and rely on disposable and fragmented labour practices (Batt and Appelbaum 2017). Overall, the wide variety of union and non-union, direct and indirect forms of employee engagement requires further research that considers the range of possible tensions between worker goals and management goals and interrogates the contingent effects of the changing use and development of skills in workplaces across the UK on organisational performance.

Theme 5: Digitalisation, human capital and productivity

Covid-19 has intensified the pace of technological change in many sectors of economic activity, with record business investments in AI and other digital technologies in 2020 and 2021. Two trends stand out with major implications for the changing relationship between human capital and productivity in the UK: a) the market valuation of digital platform companies increased far more than that of traditional firms; and b) organisations in all sectors of the economy (low-skill and high-skill) have accelerated investments in the digitalisation of management and production processes. The increasing labour market presence of digital platform companies raises important questions about skill needs, employment security and social protection, while the penetration of digital tools in all organisations (whether deployed inhouse or utilised via subcontractor companies) is reshaping business models, encouraging new ways of thinking about skills and transforming the experience of work. For example, the contact centre industry is a major investor in speech and emotional recognition software, chatbots and cloud-based technologies for remote working and real-time monitoring of agent tasks, but these technologies are increasingly found in a variety of sectors.

New research on these twin features of digitalisation can effectively contribute to three key knowledge gaps. The first is to characterise the types of digital technologies adopted in different UK sectors and map them against changing business models. Rapid developments of AI, for example, are enabled by enhanced digital efficiency technologies (e.g., cloud technologies to monitor performance) and digital connectivity technologies (e.g., 5G technologies and Internet of Things). These new digital technologies are likely to be reshaping possibilities for new entrant and incumbent firms, changing business models (including platforms and subcontracting) and transforming worker (and customer) experiences.

The second gap concerns the effects of digital technologies on work restructuring and job quality. There is contradictory research evidence that digitalisation may reduce and polarise employment, as well as diminish prospects for job enrichment, yet at the same time bring new job opportunities and improvements to task complexity and job quality (see section 1). Greater attention to the possible upskilling and deskilling effects of diverse business and HR strategies is needed in new research, as is a focus on the mediating influence of labour institutions (potentially via cross-national comparative research), as well as path dependency effects (which may help explain why managerial capacity in 'low road' organisations does not shift radically from past behaviour). At the same time, 'ed-tech' digital platform companies[37] are offering skills solutions to organisations that claim to tie together talent

[37] Examples include Gloat, Degreed, Workday, Fuel, Talent Guard, Pymetrics and Microsoft (personal communication with Ewart Keep).

matching, career planning, training and assessing, yet we know very little about such tools are reshaping skill development and careers in UK organisations.

The third knowledge gap concerns the influence of collective worker strategies and trade union power resources in shoring up the skills, job quality and work performance effects of new digital technologies. Certain sectors, such as logistics, food processing and contact centres, have been studied as sites of labour conflicts over worker rights, electronic monitoring and precarious work, highlighting how worker choices to resist, embrace or shape new technologies affect work and productivity outcomes (see Lloyd and Payne 2021; Tassinari and Maccarrone 2020). The increasing penetration of digital technologies in all sectors thus merits further investigation of trade union and legal responses in shaping the balance of risks and opportunities.

3. Conclusion

To further inter-disciplinary research that promotes policies and practices for a more inclusive and sustainable path of development, this scoping paper outlined some of the main empirical puzzles that impede a more effective equation between human capital, technology and productivity, before outlining new avenues for further research. The paper focused explicitly on the demand for skills with the central aim of reviewing what we know about the use, development and transformation of human capital within organisations and sectors and its contingent relationship with productivity. This focus necessarily downplayed the raft of issues associated with educational institutions, including the changing policy reforms affecting UK higher and further education, secondary schooling and apprenticeship programmes. In doing so, the paper partly sidestepped an important set of debates about the social, intellectual and economic role of a country's education system in steering its development path (Brown et al. 2020; Caplan 2018). Nevertheless, the research called for in this paper will need to consider the institutional context for education and vocational training, especially because organisations from diverse sectors are increasingly seeking partnerships with colleges and universities to shape and tap into knowledge formation (Keep 2019), because of the continued importance of a well-functioning system for certified skills at all levels and, most of all, because the UK's patchy historical legacy of failed coordination between education, industrial and industrial relations policy approaches make the 'institutional structuring of competitive competences', as Whitley (2007) calls it, very difficult.

The paper highlighted four inter-related puzzles with specific reference to the UK: high skill demand lags behind high skill supply; real wages are not keeping up with the higher skill supply; the assumed skill bias of new technologies is uneven and possibly even absent; and multiple organisational factors make the skill-technology-productivity equation highly contingent and uncertain. Drawing on analyses from different disciplines, the explanation for these puzzles highlighted the current understanding about these puzzles and pointed to knowledge gaps with respect to our understanding of the UK's poor productivity performance. The problem of skill underutilisation is a major problem insofar as it reflects labour market slack, undervalued labour and/or unused productive potential. At stake in further research is the reward to the worker, the ability and willingness of the employer to adapt and reconfigure work organisation (especially through commitment to high quality training programmes), the consequences of digital platform work, the role of trade unions in championing skill enhancement as a catalyst for job enrichment, and the distribution (especially by skill level, age and gender) of opportunities both to access higher skill jobs and to integrate meaningfully within the organisation. This problem is urgent: unless skills in the UK are developed and utilised properly, they will produce limited effects on productivity.

Secondly, the fact that real wages in the UK have not kept pace with, and may have hampered, productivity growth in recent years is becoming more widely acknowledged. Many scholars are now calling for attention to the inequalities in power that have changed the rules of the game so that the super rich and 'super managers' (top corporate executives) gain extremely high compensation packages, even when their contributions to business and society are negative (Galbraith 2008; Piketty 2014; Stiglitz 2012). The resulting context of falling labour income shares makes the capacity for a realignment between real earnings and productivity growth difficult and the pervasive inequalities in who gets a fair reward for their skill and experience more pronounced (Brown et al. 2020). Future research therefore needs to keep in mind the broader picture of an overly financialised UK economy, the power of the 1 percent, the concentrated resources held by high-tech and digital platform companies characterised as 'winner takes most', and the weakened capacity of the traditional countervailing institutions such as trade unions to shift the power balance. These characteristics are worrying all the major international policy organisations, including the UN, OECD and World Bank (Grimshaw 2020), and call for policy interventions to recognise what markets can and cannot do well in the current era to re-set the rules of the game for employers and investors.

The third puzzle raised questions about the anticipated skill effects of new technologies and the associated consequences for productivity growth. In fact, while job polarisation studies have received a lot of attention, there is a lot to learn about the heterogeneous effects of new technologies on the demand for skills, including the role of employers in re-bundling old and new tasks, redesigning jobs (possibly in collaboration with employees), possibilities for digital upskilling and reskilling, investing in training and career paths, and the multiple factors enabling or hindering a hollowing out of intermediate skill jobs. A fuller explanation interacts with the fourth puzzle, namely that a raft of organisational factors makes the skill-technology-productivity equation highly contingent. Changes in the use and development of skills are highly dependent on an organisation's shifting business strategy and human resource practices. If the UK is to escape from its over-reliance on work intensification and lean production as the main motor for productivity growth, then more research is needed to understand those organisational factors that could shift the UK onto a more sustainable and inclusive path of economic development.

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