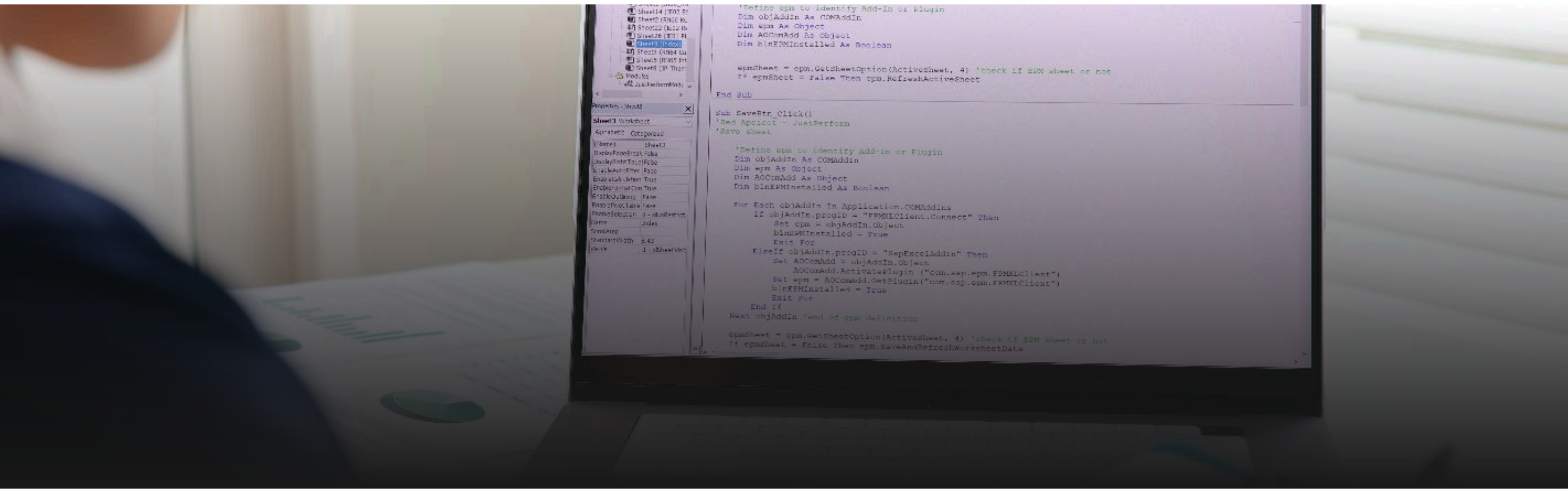

Mirko Draca Max Nathan Viet Nguyen-Tien Juliana Oliveira-Cunha Anna Cecilia Rosso October 29th, 2024

# Britain needs nerds

*Science, technological, mathematical and engineering (STEM) skills have been crucial to economic growth in the UK in the past, but how important are they to the adoption of the latest digital technologies such as AI?* ***Mirko Draca, Max Nathan, Viet Nguyen-Tien, Juliana Oliveira-Cunha*** *and* ***Anna Rosso*** *find diffusion of the latest wave of technologies hasn't followed past patterns and disparities in skills are leading to uneven adoption across the country.*

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Advancements in general-purpose technologies (GPTs), especially artificial intelligence (AI) and the latest generative AI models, have progressed rapidly with applications spanning various sectors of the economy. While these technologies are in the early phases of adoption, many anticipate that this wave of technological transformation could substantially boost productivity.

For advanced economies like the UK, which have sustained prolonged periods of productivity slowdown, a key policy question emerges: what skills will be crucial to the widespread adoption of these new technologies? Are "hard skills", so instrumental to growth in the past, now more critical than ever? If so, what are the societal implications, particularly regarding firm and regional inequality in technology access and benefits?

Our latest research draws on UK data to examine the adoption patterns of two distinct eras in information and communications technology (ICT): the personal computer (PC) wave of the 2000s (the "first wave"), and the more recent wave in 2010s (before generative AI) driven by cloud computing and machine learning (ML)/AI (the "second wave"). The findings highlight how different types of skills – general degree-level skills (proxied by the degree share) and STEM skills (proxied by workforce occupational structure) – play a crucial role in explaining these patterns.

Across the two waves, strong correlations emerge between technology adoption and the availability of both general and STEM skills at the regional level. To analyse the first wave of PC adoption, we use data derived from the database of Harte-Hanks, a marketing company with a long historical presence in the ICT equipment supply industry. Meanwhile, we track second-wave technology adoption using job advert data from Lightcast following the Bloom et al. (2021) method. This is similar to the approach suggested by 2024 Nobel laureate Daron Acemoglu, who argues that technology adoption often leaves a "footprint" as firms hire workers specialised in those technologies.

But when we account for other factors, such as population density, industry composition, unemployment rates, and country-specific effects (including a London-specific effect), STEM skills show a distinct advantage. They are more strongly associated with the adoption of second-wave technologies like machine learning/AI than general degree-level skills.

## Firm-level insights

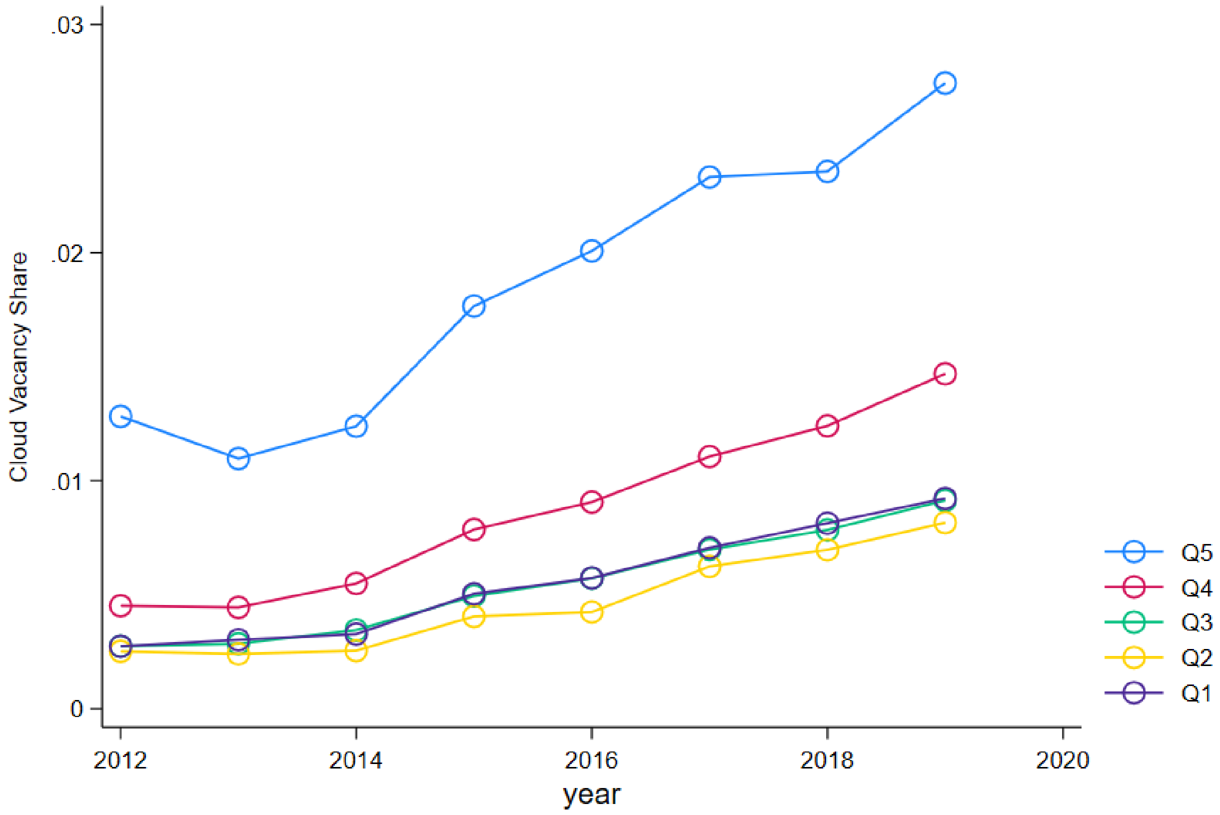
Our firm-level analysis provides more granular insights, reinforcing the broader finding that STEM skills play a critical role in technology adoption. The relationship between initial firm-specific STEM skills and the adoption of second-wave technologies, like cloud computing and machine learning/AI, is particularly strong. This relationship is over and above the effects of general high-skill levels. When we include STEM-specific skills measures in our technology adoption models, the coefficient for high-skill is reduced by nearly half.

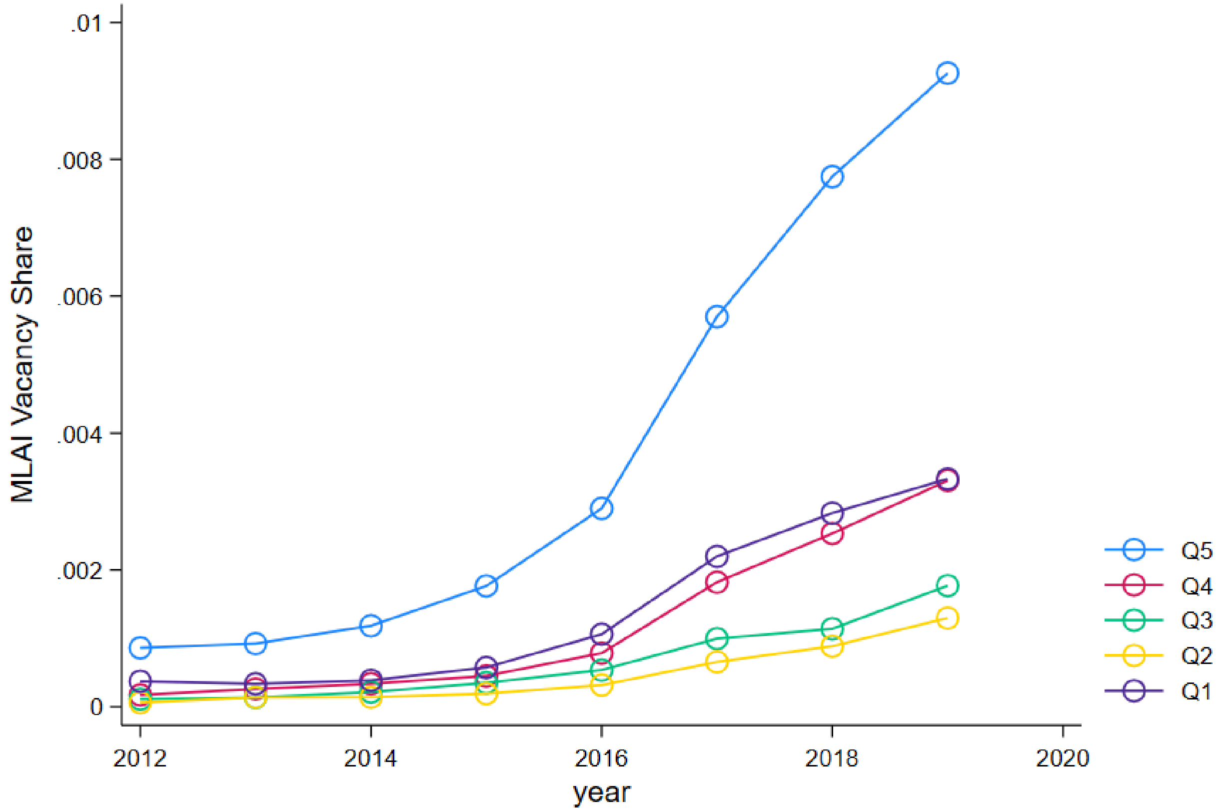
We break down STEM skills into occupational sub-groups and compare them to non-STEM benchmarks, such as managerial, legal and sales-related skills. The results consistently show that non-STEM professional skills, including advanced soft skills like those in legal, administrative, sales, and executive roles, have a more limited role in driving technology adoption. When looking within the STEM category, we find further distinctions: ICT professional skills (like programming) are more crucial for cloud technology adoption, whereas scientific skills (represented by formal scientific occupations) are the dominant factor in the adoption of machine learning/AI.  In short, these findings confirm that "hard" STEM skills are more strongly associated with the adoption of cutting-edge technologies than even the most advanced soft skills.

## Productivity disparity

The consequences of this STEM-biased adoption effect for the regional distribution of technology are illustrated in Figure 1, in which we plot how adoption rates change over time by area – where the areas are defined by the proportion of workforce working in STEM. The data show a steady increase in technology adoption rates in the top quintile, the most STEM-intensive areas,  which adopted machine learning/AI technologies nearly three times more than the lower quintiles. A clear gap emerges between the top quintile and the rest, emphasising the concentration of adoption in areas with high STEM intensity.

**Figure 1. Cloud and machine learning/AI adoption by STEM quintiles**




*Lightcast. Notes: This figure plots average levels of technology adoption across five quintiles of area STEM workforce shares as defined in 2011 (UK Census data). N= 206 TTWAs. These are unweighted means across the approximately 40 TTWAs in each quintile. Q5 is the quintile with the highest STEM intensity.*

A similar pattern of concentration is observed at the firm level. In 2012, the top 20 firms accounted for about 60 per cent of all machine learning/AI-related job vacancies, which dropped to 40 per cent by 2019. This reduction indicates that diffusion of these technologies occurred during the 2010s, but the concentration remains significant. Even in 2019, just 20 firms accounted for 40 per cent of all technology-related vacancies, and when considering the top 100 firms, this figure jumps to an astonishing 80 per cent.

Overall, our findings for cloud and machine learning/AI technologies highlight not only the distinctive STEM bias in adoption, but also how this adoption is concentrated among a relatively small number of firms and regions. This concentration persists even when examining firms within the same industry, underscoring the current uneven distribution of technological progress.

## Uneven technology diffusion

This pattern raises significant concerns, as our measures of technology adoption show a strong correlation with UK area-level productivity (measured by gross value added/hour), even when controlling for factors such as industry composition and firm size. Both the area-level and firm-level evidence consistently indicate that the adoption of cloud and machine learning/AI technologies is skill-biased, with a particular emphasis on STEM skills.

The time coverage of our data allows for a comparison between two technology waves: the largely complete adoption wave for PCs in the early 2000s, and the ongoing adoption wave for cloud and machine learning/AI technologies in the 2010s. However, unlike the classic diffusion pattern where technology adoption reaches a saturation point across a population, adoption rates for cloud and ML/AI have not followed this trend. Instead, the gap in adoption rates has widened over time, particularly between regions and firms with higher concentrations of STEM skills and those without.

Given that cloud and ML/AI technologies are closely linked to higher productivity, this widening adoption gap suggests that these new technologies are more likely to increase, rather than reduce, productivity disparities between firms and regions. The concentration of cloud and ML/AI-related vacancies within a small number of large firms further reinforces the potential for these technologies to drive greater divergence in productivity, rather than contributing to a more balanced growth across the economy.

## A budget for skills?

The new government has signalled its commitment to digital technology and skills development. The recent Industrial Strategy Green Paper Invest 2035 lists “digital and technologies” as one of its eight priority growth sectors, and emphasises the importance of diffusion of digital technologies including AI – with the newly established Skills England to play a key role. As the Autumn Budget approaches, addressing firm and regional disparities in technology adoption and skill development should be a priority. A place-based approach aimed at removing barriers to skill reallocation and closing the STEM skills gap across the country could help realise the benefits of new technologies and ensure that these benefits are more evenly distributed. Without targeted interventions, this new wave of technologies – despite its potential for significant productivity gains – risks worsening regional and firm-level inequalities.

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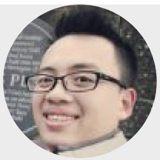

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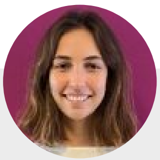

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