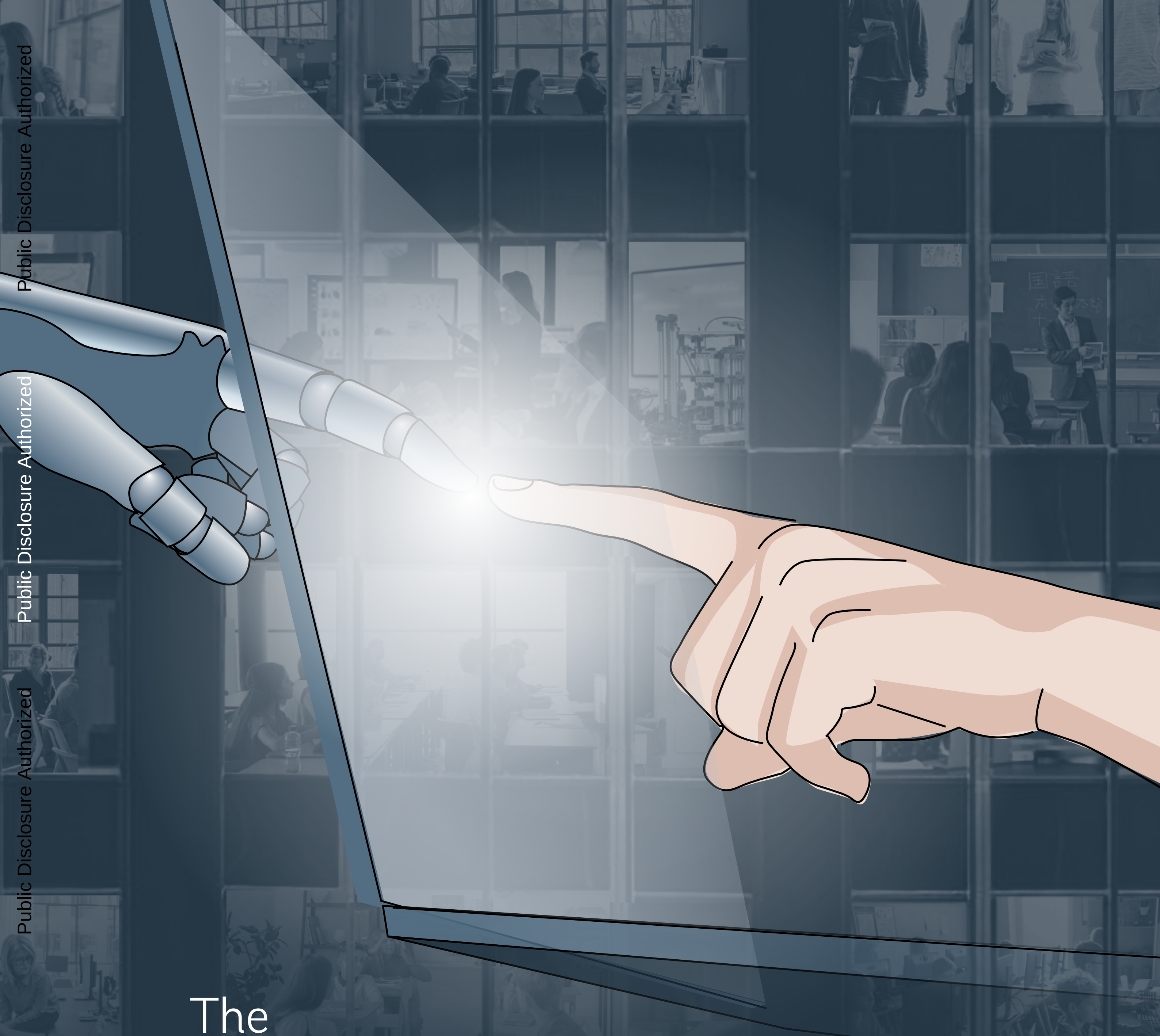

The FUTURE of WORK

Implications for Equity and Growth in Europe

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OVERVIEW Technological Progress to Benefit All

"The notion of thinking about the future as a prediction exercise neglects the fact that the future is a creative exercise—it is something that we are building."
David Autor

Technological progress is the best expression of human ingenuity—the result of an environment enabling human capital accumulation, innovation, scientific knowledge, and free competition. Technology is the engine of productivity and economic growth and has made possible the unprecedented human wellbeing we enjoy today. But the most relevant and widespread technological progress is disruptive. It triggers what the Austrian economist Joseph Schumpeter named "creative destruction," where old ways are abandoned to give rise to new ones. The process of creative destruction results in winners and losers and often affects established interests. It always generates both positive and negative outcomes.

Firms adopting new technologies must change or adapt their production processes, sometimes reducing the demand for certain types of workers while augmenting that of others. Technology-driven changes in labor demand and its potential effects on wages and employment levels have sprung fear since the Industrial Revolution. Although some of these fears are well grounded, historical evidence shows that, whereas technology has replaced some workers in performing specific tasks, in the medium to long term, technology has also created new tasks, jobs, and occupations for both high- and low-skilled workers (Autor et. al, 2022b).[1]

Over the last 40 years, technological progress and the integration of international markets have had a significant impact on income distribution in rich countries. Jobs in the middle of the skills distribution in high-income countries like the United States (US) and in Europe have been destroyed (Autor et. al, 2022c; Goos et al., 2014). Losing middle-class jobs has increased income disparities, intensifying political polarization on both sides of the North Atlantic.[2] Technological progress will continue for the foreseeable future and could exacerbate income disparities, fueling further political polarization in high-income countries.

This report aims to contribute to our understanding of the relationship between technology, economic growth, and equity by analyzing the impact of technological progress on firm-level productivity, market concentration, and labor market outcomes of workers with different education levels. The analysis focuses on the effects that technology can have in European Union (EU) member states, addressing two main distributional challenges: (i) an increase in market concentration, with a few large and innovative firms hoarding the benefits of technological progress, and (ii) technological progress exacerbating income differences between highly educated and other workers. These two challenges, and the public policies aiming to address them, will shape the future relationship between technological progress, economic growth, and income distribution in Europe.

The first challenge is the impact that technology has on firm performance, market concentration, and economic growth. Technological progress can increase market concentration, expanding the share of national income going to capital and reducing that of labor. Depending on social preferences, an equilibrium characterized by technology-driven higher income inequality could be tolerated if it is considered the price to pay for higher productivity and economic growth. However, ***hollowing the middle***—the loss of jobs at the middle of the skills distribution that has dominated labor markets in high-income countries since the late 1970s—has not come with higher productivity or more growth. Instead, following the great recession of 2008, productivity growth decelerated on both sides of the North Atlantic. This apparent paradox of rising inequality and stagnant productivity during a period of rapid technological progress is explained, at least partly, by an increasing market concentration with a few large, dominant, innovative, and productive "superstar" firms outcompeting smaller, less productive ones (De Loecker et al., 2020)—a process that went along with the fall in the share of national income going to labor and destruction of middle-skills jobs (Autor et al. (2020b); Qureshi, 2018).

[1] Confirming the capacity of technology to create new tasks and jobs, recent work of Autor et. al (2022b) found that 60 percent of occupations in the United States (US) in 2018 did not exist in 1940.

[2] Autor et. al (2020a) and Rodrik (2021) show compelling evidence that the emergence of Trump's populist movement in the US can be traced to the erosion of labor market opportunities for middle-skilled Americans in manufacturing industries caused by trade liberalization. Europe has not been immune to this political process, with the increase in inequality across European regions driving political polarization (Winkler, 2019; Anelli et al. 2019).

Technology also changes the incomes of workers with different skills, posing a second challenge. Over the last 40 years, technology in the firm has typically led to substituting routine tasks while enhancing the demand for higher-skilled workers. Repetitive tasks—manual or cognitive—that follow specific rules that can be codified in instructions are easily automated. Using robots in warehouses to store goods and software to keep track of inventories are examples of routine manual and routine cognitive tasks, respectively, undertaken by current technologies. In addition, technological progress creates new occupations and reduce the duration of job tenure (Bandiera, 2022; Bussolo et al., 2022). Technology-driven, dynamic labor markets introduce important challenges for workers with low skill levels, potentially increasing the wage gaps between highly educated and other workers.

Recent improvements in artificial intelligence (AI) bring the concerns about technology's impact on future labor markets to new levels. Language processing tools driven by "generative pre-trained transformer" (GPT) models have the potential for profound disruptions in the labor market. With these recent AI developments, even nonroutine cognitive tasks such as analyzing data and interpreting different arguments and propositions (what the coauthors of this report are doing here) might soon be performed more efficiently by an AI.

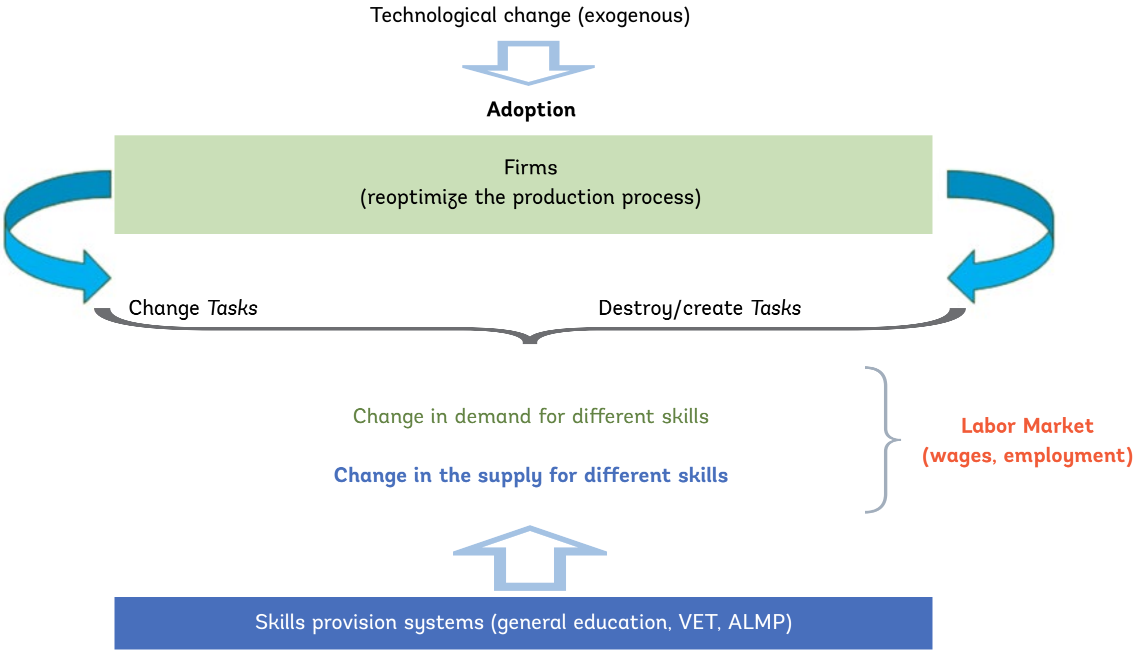
What are the implications of these technological changes for growth and inclusion in Europe? What should EU governments do to make sure technology does not exacerbate income inequality—fueling political polarization? What is the most effective strategy for promoting technology adoption among small firms and avoiding market concentration? What reforms are needed in education systems to provide all future workers (ongoing students) with the necessary skills in a technology-driven labor market characterized by changing tasks and increasing dynamism?

O.1. A framework linking technology, firms, and labor markets

The development of technology connects to growth and income distribution through companies and labor markets. By increasing productivity, profits, and the size of firms, technology can bring benefits. However, if only a few large firms adopt technology, it can lead to market concentration and reduce the share of national income going to labor. This can cause distributional tensions to worsen.

Technology can also affect how income is distributed among workers with varying levels of education. To better understand how technology and labor markets are interconnected, it is helpful to use a simple framework that considers firms, their production processes, the tasks involved, and the demand for workers' skills. The skills provision system, which includes formal education, vocational education, and short-term training courses or ALMPs, plays a vital role in determining the supply of skills. The interaction between the demand and supply of skills in the labor market ultimately affects the wages and employment of different workers. Figure O.1 illustrates the linkages between technological progress, firms, tasks, skills provision systems, and labor market outcomes as analyzed in this report.

FIGURE O.1. Conceptual linkages between technology, firms, and labor markets



This study distinguishes between technological progress, which is seen as outside a firm's control, and the firm's implementation of technology. Obstacles to technology adoption can hinder the potential effects of new technologies on productivity and job markets. When a firm adopts new technology, it changes its production process, resulting in the creation, destruction, and modification of tasks (as depicted by the top rectangle and arrows in Figure O.1). This restructuring within the firm affects the demand for workers with different skills (as illustrated in the middle of Figure O.1).

Instead of focusing on the reskilling needs of current workers, our study examines the changes in the education system necessary to equip future workers with essential skills. Specifically, we analyze secondary vocational education and training (VET) systems that offer skills to underprivileged youth in Europe and compare them with the skills required to succeed in an unpredictable, technology-driven, and ever-changing labor market (bottom part of Figure O.1).

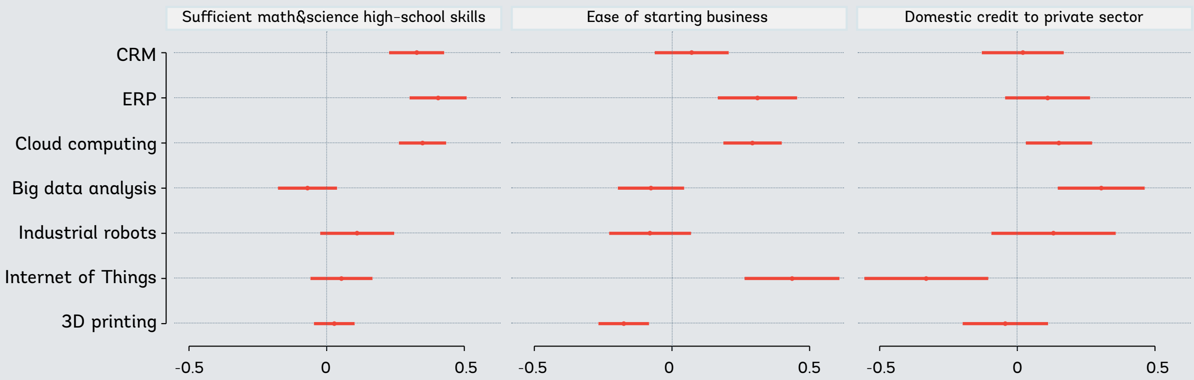
O.2. There is ample space to promote technology adoption in the EU

A survey by the European Investment Bank (EIB) revealed that 20 percent of firms in the EU use no digital technology, whereas only 12 percent of firms in the US use none (European Investment Bank, 2023). The results also show that larger companies in both the US and the EU are more likely than small companies to adopt new technologies, with no significant difference in adoption rates between large firms in the US and those in the EU (European Investment Bank, 2022). However, small and micro firms in the EU are less likely than their counterparts in the US to adopt technology. For example, technology adoption rates[3] for small firms in the US are 39 percent, whereas they are 31 percent in the EU. For micro firms, the rates are 47 percent in the US and 33 percent in the EU.

[3] Technology adoption rate is the share of firms that have reported using a given technology at the time of the survey. This definition does not report how intensely the technology is used within the firm.

Combining several firm surveys covering 32 European countries over the period 2014–22 and aggregated over region and industry, we identify the determinants of technology adoption. Our results show that larger and more productive firms tend to adopt more technology. We also found that in countries and regions with higher levels of human capital, greater access to financial resources, and business-friendly regulatory frameworks are more likely to adopt new technologies (see Figure O.2).

FIGURE O.2. Determinants of technology adoption, EU27+



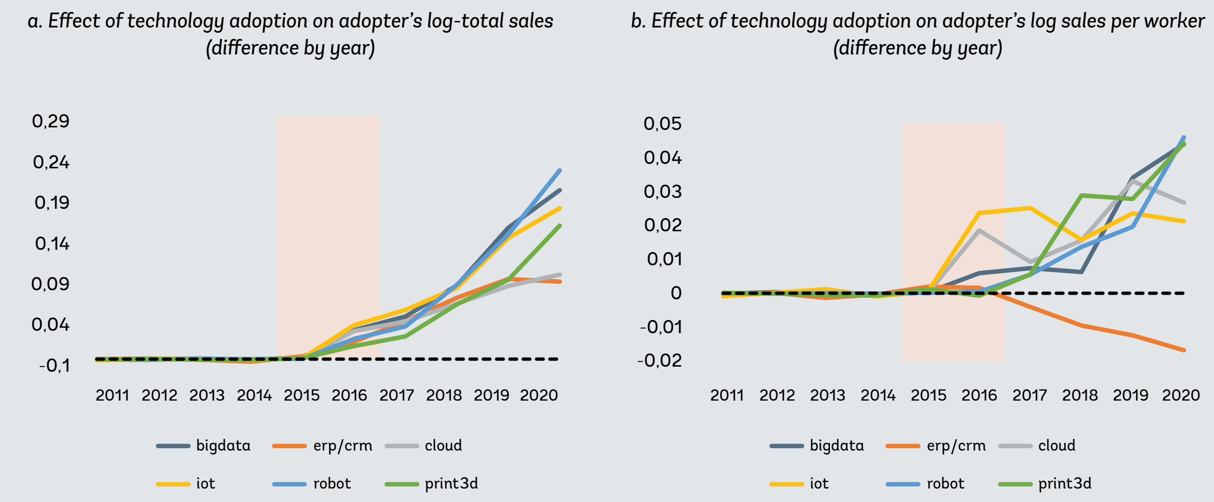
Note: Sufficient math&science high school skills refers to the share of 15-year-olds who are not low-achieving in mathematics or science. The data comes from the Programme for International Student Assessment (PISA), a triennial international survey which tests the skills and knowledge of 15-year-old students. PISA defines low-achieving as failing to reach basic skills level on the PISA scale for core school subjects.

The adoption of technology is greatly influenced by managerial practices. Studies have found that US multinational companies operating in Europe experience greater productivity gains from information and communication technology (ICT) adoption as compared to European firms due to superior management practices. Research has linked low levels of technology adoption in some EU member states to the lack of managerial capabilities (Calvino et al., 2022; Cirillo et al., 2023).

O.3. Technology increases productivity, market concentration, and the demand for skilled workers

We analyze the effects of technology adoption on productivity and the demand for workers based on an event study comparing output, productivity, tasks performed, and workers employed in Italian firms adopting new technologies versus firms not adopting them. Our results show that adopting new technologies can give businesses an edge over their competitors, letting them expand their operations (Figure O.3, panel a). Firms that embrace new technologies tend to grow faster than those that stick to their old ways. At the same time, our firm-level analysis for Italy shows no evidence that adopting new technologies negatively affects employment. In fact, companies that adopt new technologies tend to see increases in their workforces resulting from their expanding business activities. Furthermore, the total value of sales in companies that adopt new technologies grows faster than their employment, leading to increased productivity (measured as sales per worker) (Figure O.3, panel b). However, if firms adopting new technologies do not experience sales growth, they may reduce their labor demand (due to the change in the production function), which could negatively affect overall employment.

FIGURE 0.3. **Effects of technology adoption on total sales and productivity**



Source: Italian administrative data, ISTAT firm census, EUROSTAT ICT Survey (Italy), and authors' calculations.

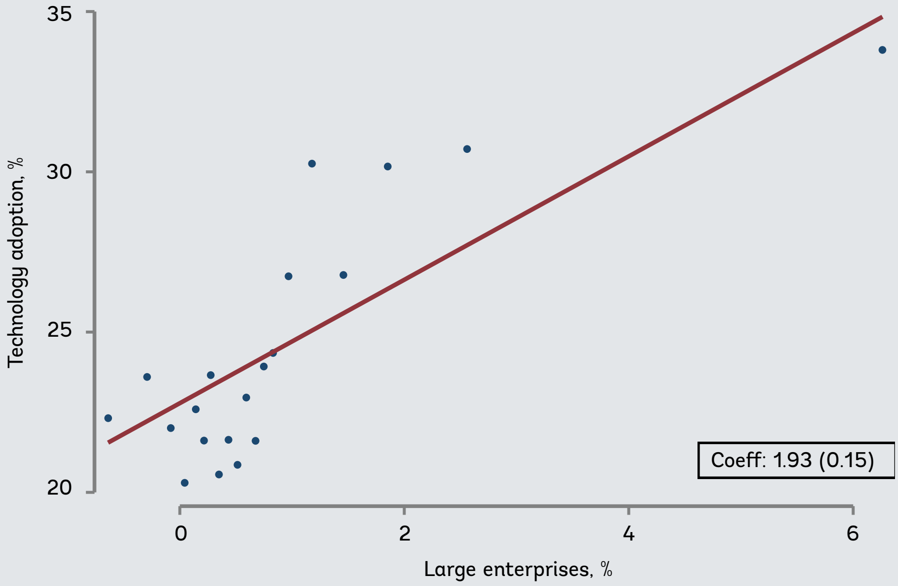
Note: erp/crm = enterprise resource planning and consumer relationship management; iot = Internet of Things; print3d = 3d printing; bigdata = big data analysis. Shaded area in panel b identifies treatment periods.

Our results also show that firms that incorporate technology into their operations tend to increase the number of nonroutine cognitive tasks that workers perform while decreasing the number of routine manual tasks that workers perform. This is achieved by hiring more employees with university degrees.

We examine the relationship between sectoral market concentration and a sector's technological intensity, exploiting country-sector variation in the share of large enterprises and technology adoption. Figure 0.4 presents the results for all technologies and points toward some evidence that those country-sectors that are characterized by higher market concentration, measured by a larger share of large enterprises, are also the ones that experience higher levels of technology adoption. The partial correlation coefficient (after controlling for time-invariant country and technology characteristics) is large at 1.93 and statistically significant. A positive relationship between technology adoption and market concentration is consistent with recent patterns observed globally by De Loecker, et al. (2020) and with the rise of "superstar" firms, which could eventually have ambiguous effects on future innovation and growth.[4]

[4] On the one side, larger firms and more concentrated sectors characterized by higher markups could lead to higher innovation because these ***superstar*** firms have greater capacity to invest in R&D and exploit economies of scale in generating new ideas (Autor et al, 2020b). On the other side, these dominant firms could also innovate less as lower competition reduces incentives to innovate, leading to lower productivity growth (Gutierrez & Philippon, 2020; Gutierrez et al. 2019), a scenario that could be defined as "inefficient concentration" (Covarrubias et. al., 2020).

FIGURE O.4. Sectoral concentration and technology adoption



Note: Residuals of technology adoption against residuals of large enterprises, after controlling for country and technology fixed effects. Slope coefficient and standard error (in parentheses) are presented in a text box. The figure is a binscatter plot of the residual of technology adoption rate after controlling for country and technology fixed effects and the residual of large enterprise share after controlling for country and technology fixed effects.

The microdata from Italy shows that firms that are bigger and more productive are more likely to adopt new technologies. As shown above, firms adopting new technology grow faster in terms of both size and productivity. These two effects combined lead to an automatic increase in market concentration, with bigger firms adopting more and becoming even larger relative to their competitors. The relationship between adoption and market concentration thus underscores the risks that a high concentration of technology adoption among a few firms could have for markets and consumers.

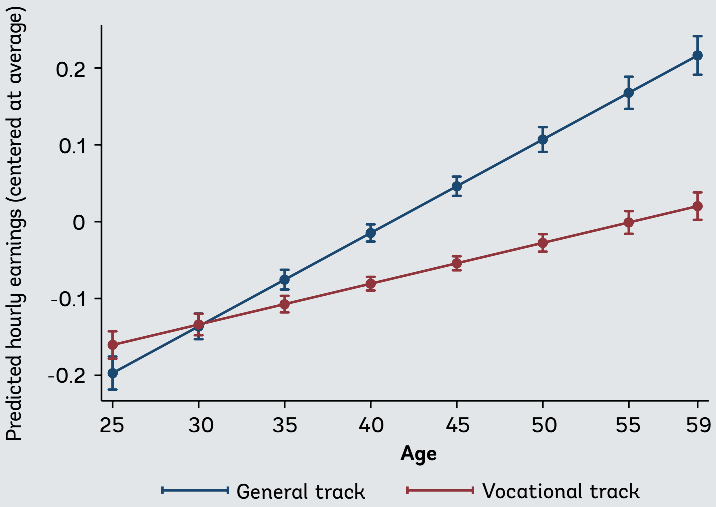
O.4. European VET systems in an ever-changing labor market

Do European education systems provide their graduates with the skills needed to face the change in demand triggered by technological change? Building the right skills, especially among disadvantaged youth, is one of the most critical challenges to ensure that technological progress does not exacerbate income inequality in the EU. School-based VET systems in Europe provide formal schooling to almost half of the students enrolled in upper-secondary education, most of them from a disadvantaged socioeconomic background. Given its size and importance for equity, our analysis of the "skills provision system" concentrates on upper-secondary VET.[5]

Our research using the EU Labor Force Survey (EU-LFS) shows that upper-secondary VET graduates enjoy favorable employment outcomes compared to their peers with general secondary education degrees who did not attend university. But this advantage disappears five to seven years after entering the labor market. Moreover, our analysis using data from the Programme for the International Assessment of Adult Competencies (PIAAC) data shows that wage-income profiles for VET graduates are flatter than those for non-VET secondary graduates, with earnings for the latter overtaking those of the former around age 30 (see Figure O.5).

[5] Post-secondary vocational education is also an important component of the broader VET system in Europe, but we focus on the upper secondary component of the VET system because it is the largest one in terms of size and expenditure.

FIGURE O.5. **Age profile of earnings of VET and general secondary graduates**

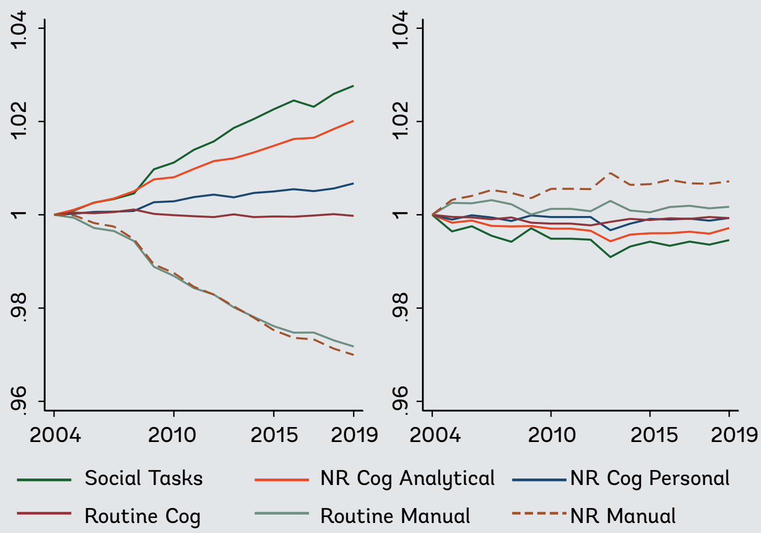


Note: this figure plots the predicted log hourly earnings (centered at the country mean) at different ages of general secondary graduates (blue line) and VET graduates (maroon line). The values are derived from a linear regression of log hourly earnings, which includes an interaction factor between age and educational track and country, gender, parental education, numeracy, and literacy as control variables. The sample is restricted to individuals from 25 to 59 years old whose highest educational attainment is upper secondary (ISCED 3) or postsecondary nontertiary education (ISCED 4). Countries in the sample are Belgium, Czech Republic, Denmark, Finland, Greece, Ireland, Italy, Netherlands, Norway, Poland, Slovak Republic, Slovenia, and Spain.

Source: authors' estimations using PIAAC data.

Unlike what has happened for most workers, the task content of jobs performed by upper-secondary VET graduates has changed little in recent years (Figure O.6). Our results show that VET graduates have skills that do not complement the new technologies because they are still engaged in routine and manual tasks at a high risk of being automatized, and they are less engaged in nonroutine cognitive tasks and the use of social skills in the job. Part of the explanation for the lack of complementarity between the tasks performed by VET graduates and those demanded by new technologies is the low foundational skills—numeracy, literacy, and socioemotional skills—among students with a technical diploma. Cognitive, foundational skills are highly associated with nonroutine cognitive tasks complementing technology.

FIGURE O.6. **Change in task contents of jobs, all workers versus VET graduates**



Note: this figure plots the evolution of the average task intensity of jobs, indexed to a value of 1 for 2004, for different employment and age groups across 20 countries in the EU-LFS microdata. The intensity of nonroutine cognitive analytical tasks, nonroutine cognitive personal tasks, routine cognitive tasks, routine manual tasks and nonroutine manual tasks is calculated using the procedures detailed in Hardy et al. (2018). The intensity in social tasks is calculated using the definition of Deming (2017) on the use of social skills in the job. Values are population weighted. Panel a corresponds to the average values for all employed individuals excluding VET graduates. Panel b corresponds to the average values for VET graduates only. NR = Nonroutine. Cog = Cognitive.

Source: authors' estimations using EU-LFS.

Our results cast doubt on the social and economic returns of the higher investment in producing upper-secondary VET graduates—a monetary cost roughly 15 percent higher per pupil compared to a general secondary education graduate. If vocational systems do not provide a labor market advantage over general education graduates, European education systems could be reproducing or even exacerbating existing inequalities, reducing social mobility, and weakening the social contract, particularly in technology-driven, dynamic labor markets. Modernizing education systems in Europe to guarantee that all graduates (regardless of whether they are on the VET or general track) have the necessary foundational skills could unleash productivity and promote economic inclusion.

0.5. Policy recommendations

It is unrealistic and naive to rely only on market forces and redistribution policies like taxes and transfers to address the challenges of technology adoption. To guarantee a fair and inclusive process of technological change, policies must be in place to ensure an equal distribution of its benefits. Merely relying on ex post redistribution will not be enough to overcome the obstacles posed by the latest technological innovations. Inclusive economic systems that provide equal opportunities for all individuals to participate in and benefit from markets create a virtuous cycle of technology, shared prosperity, and innovation. This report emphasizes the urgent need to develop and implement additional policies that ensure widespread and equitable advantages from technological advancements.

Our analysis has led to three policy recommendations for promoting inclusive institutions and maximizing the positive effects of technology on human wellbeing. First, we suggest promoting technology adoption, particularly among small businesses in Europe. Second, adapting technology to meet society's needs is both possible and desirable. Third, all young people should be equipped with the skills to adapt and reinvent themselves.

Promoting technology adoption: First, to prevent further market concentration and reduce the impact of technology on regional gaps, both the EU and governments of EU member states could introduce policies that ***promote the adoption of new technologies among small businesses***, with a special focus on those in lagging regions. Policies should not just promote "technology drops" but create incentives for making these complementary investments, such as improving managerial practices. A second challenge is the complexities and uncertainties arising from disparate market rules and standards across EU countries that deter small and medium enterprises (SMEs) from embracing new technologies. Europe has a critical agenda in enhancing integration to ensure a fully operational single market. Third, EU governments need to promote competition and market contestability. The new digital economy, particularly with the advent of advanced AI, requires a renewed focus on antitrust policy. Finally, there is a pressing need for improved measurement of technology adoption. Having granular, firm-level measurements can aid in identifying key enablers or obstacles and formulating policies that could enhance technology adoption among SMEs.

Adapting technology to meet society's needs: Through our research, we have found that technology implementation in European companies has led to a higher demand for university graduates, with the challenge of leaving behind those with less education, including workers with a vocational degree. To ensure fair job opportunities for all, it is important to eliminate policies that prioritize capital investment over investment in workers. Countries like the United States and EU member states have tax policies that unintentionally subsidize capital and investment, leading to increased use of machines and automation. By adjusting tax incentives to favor labor-intensive investment, we can create an environment that promotes quality employment and job growth. In addition, EU institutions have a great opportunity to invest in research and innovation to bring about technological advancements that can effectively integrate labor into the production process.

Equipping all youth with the skills to adapt and reinvent themselves: As technology continues to advance and global trade increases, job turnover increases and job tenure become shorter. It is becoming increasingly rare for individuals to stay in the same job for long. This poses a challenge for VET systems to prepare students with relevant professional skills that will remain useful in a fast-changing job market. Balancing the supply and demand of skills is difficult, and predicting which skills will be in demand is almost impossible. Therefore, European education systems must provide all graduates with foundational skills applicable to any career path they choose. By providing this core set of skills, current students and future workers can keep learning throughout their lives and adapt to new professions. Implementing a basic core curriculum shared among all upper-secondary education tracks, including VET programs, can ensure that students have these foundational skills. The practice of tracking students into either VET or general secondary school based on an examination should be reevaluated. Relaxing this restriction and allowing more students to pursue the academic track could improve their education and employment opportunities. Several policies have proven effective in improving cognitive foundational skills, such as high-dosage tutoring, extra instructional time, personalization of learning using new technologies, and teaching to the proper level. It is critical to put in place affective teachers' policies (pre- and in-service professional development, selection processes, in-service evaluation, and recognition, among others) to support any cost-effective intervention to improve learning.

The power of technology is undeniable because it opens new opportunities and creates job prospects. However, it also has the potential to displace existing jobs and industries. The impact of this transformative force is shaped by society's decisions, including how quickly it is embraced and its effect on income distribution and markets. It is important to remember that the future is not set in stone, and we have the power to shape it.

The tradeoff between efficiency and equity caused by technological progress since the Industrial Revolution can now be eliminated with the help of evidence, data, and knowledge on how public institutions affect this tradeoff. Technological progress is not an exogenous factor, but it is determined by social preferences that shape public policies. Social preferences should create incentives to shift from an equilibrium in which technological progress is characterized by ***creative destruction*** to one of ***inclusive innovation***. It is time to harness our social preferences and create a world where technological progress benefits everyone, especially those in need.