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Digitalisation and the economy

Discussion Papers

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Discussion papers

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Abstract

Digitalisation has fundamentally changed the global economy and will continue to do so. This paper draws on economic research to identify some of its key implications for labour markets, inequality, e-commerce and the financial system. Beyond its potential to boost productivity and living standards, digitalisation: i) does not necessarily replace jobs on aggregate but changes their content; ii) tends to raise income and wealth inequality; iii) has ambiguous effects on competition; and iv) might change how the retail and financial sectors respond to monetary policy. Developing adequate (re-)training opportunities and providing a labour market, regulatory, and innovation environment which encourages the creation of "good jobs" is essential to improve productivity and equity while avoiding a polarisation of labour markets. E-commerce and fintech will likely lead to a faster transmission of monetary policy. The rise of fintech brings about new risks for regulatory arbitrage and has ramifications for financial stability.

Keywords: digitalisation, inequality, competition, e-commerce, fintech

JEL Codes: D31 (Personal income, wealth, and their distributions), D4 (Market Structure, Pricing, and Design), E52 (Monetary policy), G2 (Financial Institutions and Services)

Non-technical summary

Digitalisation already has had and will further have profound implications for economic growth, employment, wages and consumer welfare, which will change both our economy and society. The technological progress that digitalisation in all its facets brings about has the potential to improve living standards and lead to new (and possibly more rewarding) jobs. At the same time, it is often seen critically, as a disruptive process for existing business models and leading to the disappearance of many jobs.

This paper draws on economic research to identify some key implications of this evolution for the euro area economy and the associated challenges for policy makers. It surveys the evidence, highlights blank spots in current knowledge, discusses its opportunities and risks and likely future evolution in the euro area, and asks how this process can be facilitated by economic policies. Doing so, it focuses on labour markets, inequality, e-commerce, and the financial system.

There is no strong evidence of aggregate productivity gains from digital technologies so far in the euro area, possibly due to slow adoption, among other factors. The limited effects on aggregate productivity in the euro area may be also due to lags in realizing productivity gains, and offsetting effects across firms amplified by concentration in market power in the hands of "superstar" firms. Slow adoption may imply that the euro area falls behind the technological frontier, failing to reap the full benefits of digitalisation.

Artificial intelligence (AI) in particular can have adverse effects on employment of selected sectors and workers, as well as on wages and inequality. Digitalisation enables automation of non-routine tasks (e.g., medical advice or coding), a process that will accelerate with the increasing usage of AI. While digitalisation does not necessarily lead to an overall loss in employment, it can lead to a displacement of workers, i.e., replace existing jobs, but might also create new jobs through reinstatement and through employment gains stemming from higher productivity.

Digitalisation can contribute to increasing income and wealth inequality. Income inequality can increase inter alia to the extent that wages are affected differently across the skill distribution and because of changes in the distribution of high-wage and low-wage firms. Wealth inequality can increase because the rise in demand for capital relative to labour increases returns to wealth, especially in the upper parts of the wealth distribution. In addition, digitalisation lowers the price of

digital products and thereby disproportionately benefits richer households, which tend to spend a higher fraction of their expenditures on digital products than low-income households.

Cushioning the effects on the labour market and inequality will require appropriate policies. To avoid polarisation of labour markets, it is essential to ensure training and re-training opportunities. Active training can contribute to building the skills that are required to capture the benefits of digitalisation. However, increased education and a strong public safety net often are not sufficient to address some of the inclusion challenges in the labour market driven by digitalisation. For instance, there might be an under-provision of "good jobs", defined as those that provide a middle-class living standard, sufficiently high benefits and security, and career prospects. This calls for labour market and innovation policies to contribute to the creation of such jobs, which can jointly improve productivity and equity. In addition, minimum wages can help contain wage inequality in the presence of these structural developments; however, more evidence is needed on their potential adverse effects on employment.

Digitalisation increases the efficiency of information collection, storage, and exchange. First, it makes it possible to collect and process information in a fully automated manner, e.g., executing a credit card payment. Second, it allows storing and querying large amounts of detailed data, e.g., consumer transactions. Third, it rests on a fully automated data exchange, for example between customers and online retailers.

The most salient economic implications of the process innovations induced by digitalisation are economies of scale and network effects, which form the economic basis for the rapid evolution of platforms. The network effects of platforms result from participation (market depth, product varieties) and information externalities. They confer a sizable advantage to early innovators. As a result, platforms are natural monopolies.

At the same time, platforms reduce the entry and fixed costs of suppliers and thereby facilitate the entry of start-ups and specialists. Whereas the competition between platforms is limited, the competition of suppliers on a given platform is fierce. The net effect of platforms on competition is therefore ambiguous.

In an unregulated environment, the platform provider can collect a rich set of information about the suppliers and customers active on the platform. Exploiting this information advantage over individual suppliers, the provider can design own products and services superiorly tailored to market demand. In this vein, large technology firms have established themselves as cloud operators in industries with a significant digital goods or services component.

Despite a boost during the Corona pandemic, e-commerce in consumer markets in the euro area is still developing, except for durables and semi-durables, but the general trends are evident: Digitalisation creates room for new products and services, such as e-books or personalized items. It improves the efficiency of inventory flows in both stationary and online retail.

The availability of online information seems to increase price transparency. The ability of online retailers to track and recognize customers, however, also increases their possibilities to price discriminate. Personalised offers impair the comparability of prices, which also might complicate inflation measurement.

Price adjustment frictions in online retail seem lower than in stationary retail, resulting in more frequent price changes. If online bidding platforms gain prominence in business-to-business transactions as well, this might speed up price adjustment after cost shocks.

Information frictions play a crucial role in the provision of financial services. Therefore, the digital revolution could be particularly disruptive for the financial sector. In principle, the entire value-chain of the financial industry can be digitalised, and the potential for bundling financial and non-financial services has the potential to create new interconnections between the financial sector and the real economy.

The proliferation of data (including non-financial data derived from e-commerce activities) favours financial services based on “hard” information, such as credit scores. While this creates efficiency gains and enables larger credit volumes, the diminishing role of long-term relationships may yield a more cyclical financial system. Moreover, economies of scale favour concentration, which can create systemic risk.

The rise of digital platforms poses a challenge for the integrated business model that dominates the banking sector in most advanced economies. Specialised financial services providers are increasingly able to bypass banks’ distribution networks, which increases competition for non-core financial services and thus benefits consumers. Moreover, digital platforms may interject themselves between banks and customers, collecting most rents and potentially monopolizing access to data. In the extreme, these developments could imply a disintegration of the traditional bank business model.

The rapid rise of new technologies and business models in the financial sector poses several regulatory challenges. These include regulatory arbitrage, operational risks, market power, and the potential for market abuse and fraud. Recent developments in crypto-asset markets are a case in point. While new players and infrastructures such as digital platforms and cloud computing promise large efficiency gains, they also create new interlinkages between the financial and non-financial sectors that are not well-understood, and possibly call for tighter supervision and regulation.

1. Introduction

Digitalisation already has had and will further have profound implications for economic growth, employment, wages, and consumer welfare, which will change both our economy and society.[3] The technological progress that digitalisation in all its facets brings about has the potential to improve living standards and lead to new (and possibly more rewarding) jobs. At the same time, it is often seen critically, as a disruptive process for existing business models and leading to the disappearance of many jobs.

This paper draws on economic research to identify some key implications of this evolution for the euro area economy and the associated challenges for policy makers. It surveys the evidence, highlights blank spots in current knowledge, discusses its opportunities and risks and likely future evolution in the euro area, and asks how this process can be facilitated by economic policies. Doing so, it focuses on labour markets, inequality, e-commerce, and the financial system – topics that were covered to a lesser extent in the work stream on digitalisation (2021) or where more recent evidence is available.

There is no strong evidence of aggregate productivity gains from digital technologies so far in the euro area, possibly due to slow adoption, among other factors. The limited effects on aggregate productivity in the euro area may be also due to lags in realizing productivity gains, and offsetting effects across firms amplified by concentration in market power in the hands of "superstar" firms. Slow adoption may imply that the euro area falls behind the technological frontier, failing to reap the full benefits of digitalisation.

Artificial intelligence (AI) in particular can have adverse effects on employment of selected sectors and workers, as well as on wages and inequality. Digitalisation enables automation of non-routine tasks (e.g., medical advice or coding), a process that will accelerate with the increasing usage of AI. While digitalisation does not necessarily lead to an overall loss in employment, it can lead to a displacement of workers, i.e., replace existing jobs, but might also create new jobs through reinstatement and through employment gains stemming from higher productivity.

[3] This paper follows the broad definition of digitalisation adopted in Work stream on digitalisation (2021), including, inter alia, a wide range of information and communication technologies, technologies enabling automation and robotisation, and technologies related to the processing and analysis of digital data, including big data, such as artificial intelligence and machine learning, and edge and quantum computing.

Digitalisation can contribute to increasing income and wealth inequality. Income inequality can increase inter alia to the extent that wages are affected differently across the skill distribution and because of changes in the distribution of high-wage and low-wage firms. Wealth inequality can increase because the rise in demand for capital relative to labour increases returns to wealth, especially in the upper parts of the wealth distribution. In addition, digitalisation lowers the price of digital products and thereby disproportionately benefits richer households, which tend to spend a higher fraction of their expenditures on digital products than low-income households.

Cushioning the effects on the labour market and inequality will require appropriate policies. To avoid polarisation of labour markets, it is essential to ensure training and re-training opportunities. Active training can contribute to building the skills that are required to capture the benefits of digitalisation. However, increased education and a strong public safety net often are not sufficient to address some of the inclusion challenges in the labour market driven by digitalisation. For instance, there might be an under-provision of "good jobs", defined as those that provide a middle-class living standard, sufficiently high benefits and security, and career prospects. At the same time, minimum wages can help contain wage inequality in the presence of these structural developments; however, more evidence is needed on their potential adverse effects on employment.

The emergence of distribution platforms is especially relevant in e-commerce and fintech, with ambiguous net effects on competition. Digitalisation affects both e-commerce and fintech in similar ways, in particular through the emergence of digital distribution platforms (such as Amazon). These profoundly change the market structure in both e-commerce and fintech: Higher information transparency and reduced search costs increase the competition *within* a platform. At the same time, network effects inhibit the competition *between* platforms, providing established platforms with comfortable monopoly rents, and giving a sizeable advantage to early innovators.

The effects of digitalisation in the financial sector could be especially disruptive for the traditional bank business model. As with e-commerce, low-cost digital distribution enables specialised financial services providers to bypass banks' distribution networks. In addition, digitalisation reduces information-related frictions. Financial services face considerable informational frictions which traditionally were overcome by means of relationship lending. As innovations in data collection and processing reduce information-related frictions, they favour business models based on "hard information", which might disintegrate the business model of the traditional universal bank.

There are several implications for monetary policy, financial stability, and regulatory policies as well as competition policies. Lower online price adjustment friction and online competition on offline prices can result in more flexible prices, enhancing their responsiveness to monetary policy by making the Phillips curve steeper, other things equal. Similarly, a more competitive financial system will likely see a stronger pass-through of monetary policy into market rates and financial conditions.

A financial system that is more reliant on hard information and is less built on long-term relationships (which facilitate the smoothing of credit terms over the cycle) is bound to become more cyclical. However, new technologies, business models and processes in the financial sector may not be covered by the existing regulatory framework, suggesting that the regulatory toolkit requires updating. Finally, given the ambiguous effects of digital platforms on competition, it is important that competition policies accompany the digital evolution to ensure appropriate competition also across platform providers.

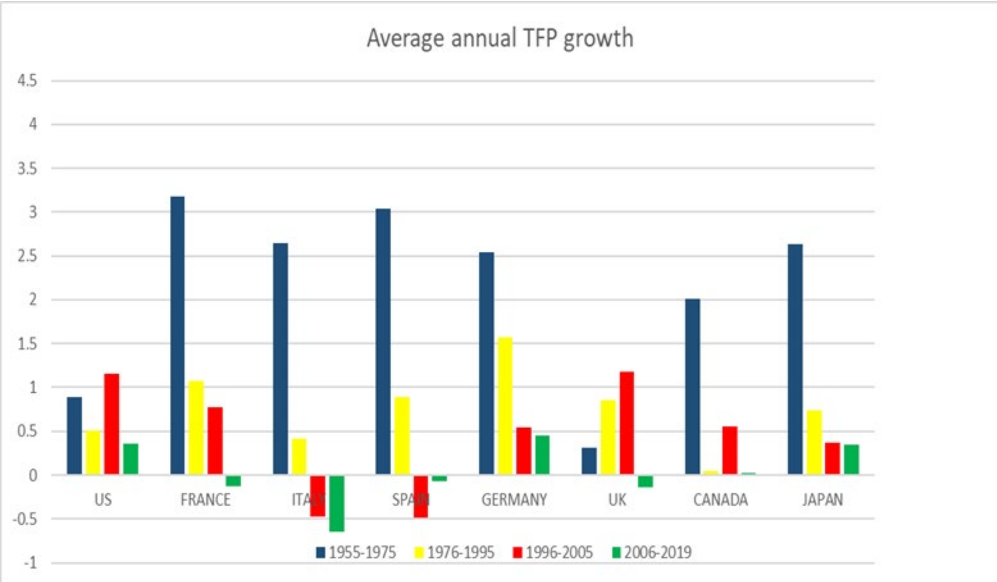
Overall, digitalisation can substantially lift living standards in the longer run, assuming appropriate economic policies. In a 1930 essay on "Economic possibilities for our grandchildren", John Maynard Keynes predicted that 100 years later, living standards would be four to eight times as large as at the time of writing, and the "economic problem" of scarcity and inequality would be solved. He made these predictions at the onset of the Great Depression when commentators feared a decline in prosperity or at least a slowdown in the rapid improvement in the standard of living. His understanding, in contrast, was that "the increase of technical efficiency has been taking place faster than we can deal with the problem of labour absorption", that the "unemployment due to our discovery of means of economising the use of labour" was "outrunning the pace at which we can find new uses for labour". He reasoned that this was only a temporary phase of "maladjustment". Keynes' predictions were remarkably close to the actual development – not with regard to jobs and inequality, but with regard to income. In a similar vein, if our institutions are able to solve the challenges due to the risk of "maladjustment" and labour market polarisation, the technological progress that is brought about by digitalisation certainly has the potential to boost economic growth and support the transformation to an environmentally sustainable economy, for the benefits not only of the current, but also of the coming generations.

The paper is structured by thematic areas. Section 2 focuses on the effects of automation on labour markets and inequality. Section 3 explores the implications of a few other prominent aspects of digitalisation, such as the centralisation of the provision of digital goods and services by a handful of online platforms, with a focus on the retail (e-commerce) and financial sectors (fintech). Section 4 concludes.

2. Effects of automation on labour markets and inequality

2.1 Aggregate effects on productivity and living standards

Figure 1: Total factor productivity growth, 1955-2019, percent



Source: Authors' calculations on World Bank data

Despite the development of digitalisation and artificial intelligence, aggregate productivity growth has been subdued since the mid-2000s. After the protracted productivity slowdown starting in the mid-1970s in most advanced economies, since the mid-1990s productivity growth in the US has been stronger than in the euro area, at least until the Global Financial Crisis (Figure 1). This fact raises the question whether more advanced digitalisation and larger investment in intangibles in the US could have contributed to this difference. For instance, research has linked robot adoption with larger labour productivity growth.[4] However, these developments have also been linked to the decline in business dynamism and the rise of market power in the US economy. In contrast to the US, in the euro area

[4] Graetz and Michaels, 2018

market power has remained quite stable over the last 15 years or so, especially in manufacturing.[5] Some research has tried to reconcile the paradox of the optimism about the potential of AI technologies contrasting with the poor productivity growth measured in the data by alluding to implementation lags: For general purpose technologies (which can in principle affect the entire economy) to raise aggregate productivity, it may take years or decades for new capital stock to accumulate and for complementary assets to be invented, built and installed.[6]

Investment in new technologies boosts productivity for early adopters but may depress productivity for other firms, which may become less competitive or are deterred from entering the market. This phenomenon is particularly salient for intangible investment, such as software, research, and development, which has been rising steadily (as a share of GDP) since the 1980s. The first firms to adopt these technologies have a competitive advantage and may grow very fast, sometimes becoming superstar firms and sizably contributing to aggregate productivity (direct effect). However, productivity and dynamism may be reduced as non-adopters become less competitive and the high fixed costs associated with intangible investment and the increased market power of adopters might deter other firms from entering (indirect effect). The net effect on aggregate productivity is thus ambiguous and likely to change over time.

Technological progress has generated a steady increase in living standards, which has been unequally distributed. In the United States, average real incomes have increased by 60% since the 1980s, but stagnated for the bottom half of the distribution, implying large improvements for the top of the income distribution.[7] In contrast, in Europe while inequalities also increased in most countries, the incomes of the poorer half rose by 40% between 1980 and 2017.[8]

The emergence of new digital technologies with AI breakthroughs enables automation of non-routine tasks, raising new concerns about the impact of these new technologies on labour markets and inequality. Between 1990 and 2010, wage and job polarisation accelerated as both low-skill low-pay jobs and high-skill high-pay jobs experienced higher demand, whilst many middle-skilled workers, mostly in routine-intensive jobs, were displaced due to computerisation. In contrast, the period since around 2010, on which we focus in this section, is characterised by the emergence of AI breakthroughs,

[5] Cavalleri et al., 2019
[6] See, e.g., Syverson, 2019 and ECB, 2021
[7] Piketty, Saez and Zucman, 2018
[8] Blanchet, Chancel and Gethin, 2019

including advancement in robotics, supervised and unsupervised learning, natural language processing, machine translation, or image recognition among many other activities, that enable automation of human labour in non-routine tasks in manufacturing but also services (e.g., medical advice or writing code). This raises new concerns about the impact of these new technologies on labour markets and inequality.

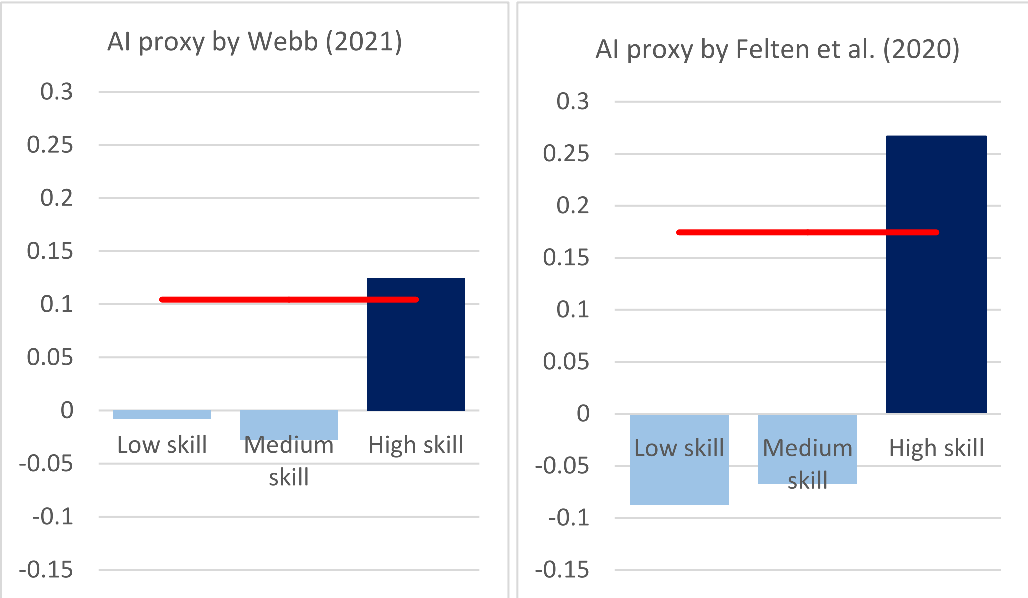
2.2 Employment

Automation, including AI, impacts overall employment through various channels. In general, the overall employment effect of new technological developments depends on the relative strength of three channels. First, new developments destroy jobs because they automate tasks (displacement effect). Second, they might complement human labour, thereby increasing productivity and indirectly resulting in more jobs due to an increase in demand for products of some firms (productivity effect). Third, a combination of both effects, with some tasks and jobs being replaced but new ones being created – the so called "reinstatement" effect.

Digital technologies enhance globalisation as they make it easier to trade services across borders but can adversely affect employment and wages of some workers. This pre-existing trend of "globotics" (globalisation and robotics) has been compounded by the substantial expansion of work from home during the pandemic, which may persist into the future. While increased trade in services may result in aggregate productivity gains, it can adversely affect employment and wages of some groups of employees in services, such as office work, who were not much impacted by the first digital wave.[9] In contrast, in manufacturing, to the extent that the introduction of robots results in a decreasing weight of wages in total costs, automation lowers the incentives to open new manufacturing plants in low-wage economies, ultimately pushing for the relocalisation of manufacturing back into high-income countries -- an issue that has gained increasing attention following the supply chain disruptions triggered by the pandemic and the war in Ukraine.

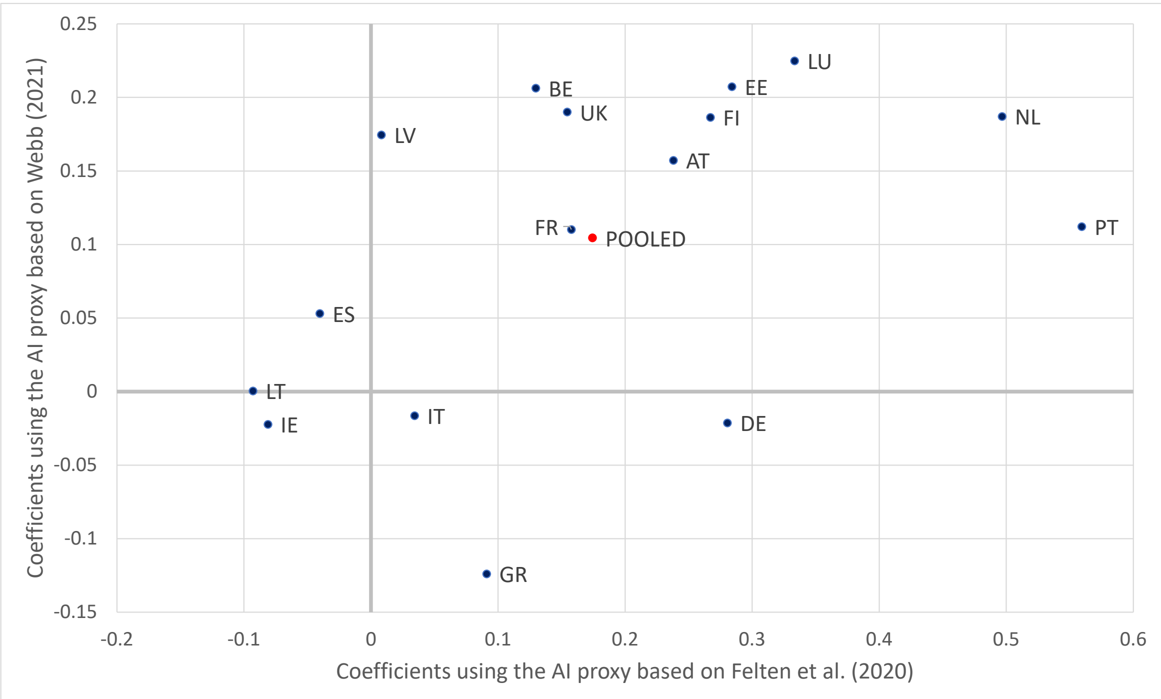
[9] Baldwin, 2019

Figure 2: Exposure to AI and changes in employment share, by skills



Notes: Regression coefficients measuring the effect of exposure to AI on changes in employment share. Each observation is a ISCO 3 digits occupation times sector cell. Observations are weighted by cells' average labour supply. Sector and country dummies included. Sample: 16 European countries, 2011 to 2019. The coefficient for the whole sample is displayed by the horizontal line. Coefficients that are statistically significant at least at the 10% level are plotted in dark shaded colour.
Source: Albanesi et al. (2022)

Figure 3: Exposure to AI and changes in employment share, by country



Notes: Scatter plot of regression coefficients measuring the effect of exposure to AI on changes in employment share. X-axis: regression coefficients using the AI proxy based on Felten et al. (2020); Y-axis: regression coefficients using the AI proxy based on Webb (2021). For further details see notes to Figure 2.
Source: Albanesi et al. (2022)

The empirical evidence on the overall effect of automation on employment is mixed. Much of the literature, focusing on the US, estimates that automation has a positive net effect on the total number of all jobs, but tends to reduce the number of low-skilled jobs.[10] In contrast, some recent work for France[11] highlights that the introduction of automation technologies can have a positive effect also on the employment of unskilled industrial workers. The benefit for low-skilled workers is mostly driven by aggregate productivity gains in the French manufacturing sector that are shared between workers and firm owners. For Europe, estimates[12] suggest that AI enabled automation is associated with employment increases and is mostly driven by occupations with relatively higher-skilled workers, while the effect on low-skilled jobs is small and statistically insignificant (Figure 2). Across countries, one expects that the impact of these technologies will vary depending on their distribution of employment across sectors and occupations, which are differently exposed to the technologies. However, while there is heterogeneity in the magnitude of the estimates, the relationship between AI and employment tends to be positive also at the country level (Figure 3).

2.3 Labour share and labour market inequalities

Digitalisation affects the relative shares of employment along the skill and wage distribution, directly widening the distribution of labour income. Evidence from the US documents that computerisation and shifts in demand for occupations account for roughly 80 percent of the rise in the wage gap between high- and low-skill workers,[13] substantially contributing to the increase in inequality of earnings (i.e., labour market income before taxes and transfers) since the 1980s.

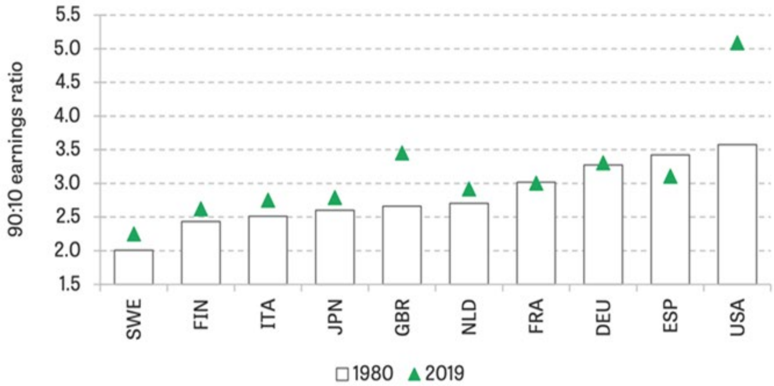
The limited evidence on the net effect of digitalisation on earnings inequality in the euro area suggests a lower impact than in the US. In most euro area countries, earnings inequality has increased much less than in the US over the past few decades, even before taking into account the progressivity of the tax and benefit system.[14] For instance, Figure 4 shows that the ratio between the earnings of workers in percentile 90 and percentile 10 of the earnings distribution has been relatively stable over time in the euro area, particularly compared to the US and the UK, and even over a longer time period (1980-2019). The trends are broadly similar for men and women. Structural changes such as digitalisation impact these indicators, given that they affect the relative demand for workers with

[10] Acemoglu, 2021b
[11] Aghion et al., 2021
[12] Albanesi et al., 2022
[13] Burstein, Morales, Vogel, 2019
[14] Bozio et al., 2020

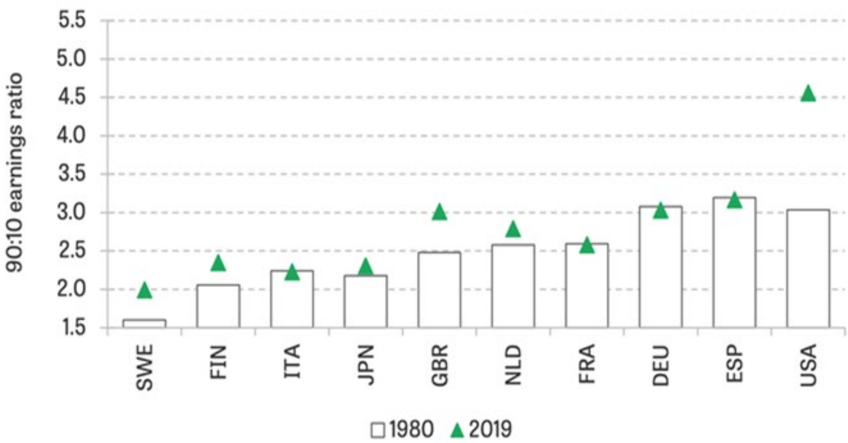
different levels of skills. However, how they ultimately translate into measures of inequality is mediated by productive structures, economic policies, and labour market institutions (which vary across countries).

Figure 4: Evolution of inequality in labour market income, selected OECD countries

Panel A: Men



Panel B: Women



Source: Giupponi and Machin (2022). Inequality is measured as the ratio between the 90th and the 10th percentile of the earnings distribution within gender.

In the US, changes in the distribution of firms due to automation also contributed to rising earnings inequality. The gap in the US between high-wage and low-wage firms has increased, with the former increasingly attracting high-wage workers (increased sorting) and high-wage workers increasingly working with each other (rising segregation). In particular, the highest earning workers at the largest firms have benefitted the most. These include CEOs and CFOs, but also a wider group of managers and technicians. In contrast, the earnings of the median employee in big firms have decreased by 7%, with even larger drops for the lowest paid workers.[15]

Greater globalisation allows successful entrepreneurs to grow their profits more rapidly, which can put further upward pressure on income inequality.[16] When economies of scale are present, the integration of global markets can result in an increasing concentration of the market power among few worldwide leaders. This phenomenon is very salient in the case of IT companies such as Alphabet or Amazon, but also in other sectors in which digital innovation is key, including pharmaceuticals or automobiles. Although sometimes rents from innovation are shared with the workers, the labour share has decreased more in countries with more digital innovation and innovative sectors with more market concentration.[17]

While higher innovation contributes to increasing top income shares, it also raises social mobility. Specifically, estimates based on US data imply that a 1% increase in the number of patents raises the top 1% income share by 0.2%.[18] However, when innovation occurs through entry of new firms, social mobility increases, allowing workers from diverse backgrounds (including those with low-income parents) to achieve high earnings.

In addition to rising inequality (widening cross-sectional distribution), digitalisation has also been related to an increase in earnings risk (larger volatility of shocks to earnings). As for the change in earnings risk across the income distribution, while digitalisation benefited high-skilled workers, their earnings also became more volatile. In particular, STEM majors (science, technology, engineering, mathematics) and other high-skilled workers tend to experience fast wage growth after graduation, but their wage return to ability decreases notably with age,[19] as these workers are more exposed to the introduction of newer technologies and constantly need to acquire new skills. Wages rise for workers who can learn how to use the new technologies, but decline for those who do not, as the demand for the original occupations falls. These factors account for a large part of the increase in persistent earnings risk in the US over the past couple of decades.[20]

[15] Song at al., 2019
[16] Jones and Kim, 2018
[17] Guellec and Paunov, 2017
[18] Aghion et al., 2019a
[19] Deming and Noray, 2020
[20] Carter Braxton, Herkenhoff, Rothbaum and Schmidt, 2021

2.4 Wealth inequality and other dimensions of inequality

Automation and digitalisation may also increase wealth inequality. Per se, the changes in earnings inequality and earnings risk likely do not explain much of the observed increase in wealth inequality.[21] However, automation increases the return to capital, which in turn leads to an increase in wealth inequality. Specifically, the rise in demand for capital relative to labour increases returns to wealth especially in the top segments of the wealth distribution.[22]

The lower costs of investing in financial markets have sparked an increase in stock market participation, with opposing effects on wealth inequality. The widespread availability of investment apps and the reduction of trading costs have increased the number of small investors that directly hold stocks, mutual funds, or ETFs. Since these are higher-return assets, the increase in participation by poorer households can narrow the gap in returns between the rich and the poor and so reduce wealth inequality. However, there is evidence that these retail investors make different investment choices. For instance, less wealthy investors are much more likely to buy stocks just because they are salient or show up in a top returns list (attention-induced trading), even if by doing so they consistently underperform the market.[23] Some low-wealth investors have also taken risky and highly levered positions in asset markets, including cryptocurrencies, and are particularly vulnerable to price corrections like those observed in early 2022. Lower costs of investing can also affect the aggregate evolution of the stock market and increase the value of information, which can in turn increase the wealth of more sophisticated investors.[24]

Digitalisation lowers the price of digital products and disproportionately benefits richer households. High-income households spend a higher fraction of their expenditures on digital products than low-income households. In the US data, the information and communication technology intensity of consumption among the top 10 percent of households by income is roughly 13% higher than for the lowest 10 percent. Consequently, lower prices of digital products benefit richer households more than poorer households.[25] Overall, the lower price of digital goods has contributed by 22.5% to the increase in US consumption inequality between 1960 and 2017.

[21] Hubmer, Krusell and Smith, 2020[22] Moll, Rachel and Restrepo, 2022
[22] Moll, Rachel and Restrepo, 2022
[23] Barber et al., 2022
[24] Mihet, 2020
[25] Arvai and Mann, 2022

The implications of digitalisation on gender inequality and gender wage gaps are complex. On the one hand, women are under-represented in the professions that benefit from automation (e.g., workers in IT sector or managers). On the other hand, digitalisation may result in more flexible jobs in which workers will not be expected to be on call for most of the day, which may in turn reduce the premium on flexibility and gender wage gaps.[26]

2.5 Policy implications

Unregulated adoption of automation and AI may lead to various social, economic, and political harms, such as damaging competition, consumer privacy and consumer choice; excessively automating work, fuelling inequality, pushing down wages, and failing to improve worker productivity.[27] Consequently, various policies are needed to address side effects of digitalisation.

Policies that foster competition and market contestability can raise productivity against the background of increased market concentration. Entry of competitors is not only key to reduce monopoly rents, but also to stimulate future technological progress. However, fostering competition in a world with fast-evolving technologies can be challenging for regulators, especially given that a coordinated cross-border regulation may be needed.

A stable and coherent regulatory framework may foster development and investment in digital technologies. As business models in digital services are typically characterized by a first-mover advantage and massive economies of scale, attracting new entrants is a prerequisite for the creation of high-value-added jobs in Europe. The EU Digital Services Act is an important step in this direction. It has the explicit aim of simplifying the “start-up and scale-up” of digital services in Europe. The foundation for this is legal certainty, which provides security of investment against regulatory risks, and a common regulation effective throughout the EU, as only then the size advantages of the common market are fully unleashed.[28]

Supporting the build-up and upgrade of worker skills is critical to optimise the positive impact of AI. For those who are currently employed, such policies might include individual learning accounts or vouchers and leave for training.[29] For the young and those who have been displaced, it is essential to

[26] Goldin, 2021
[27] Acemoglu, 2021b
[28] Information on the digital services act and the EU’s digital strategy is available at: https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age_en
[29] European Commission, 2019

promote well targeted vocational education.[30] Through these means, workers can make the most out of new technologies, but also other current trends, such as globalisation or the greening of the economy. A readily available workforce with up-to-date skills in developing and applying new technologies is also a key factor for global firms in choosing their location.

Public support in the form of unemployment insurance, other benefits, and public provision of services can help workers smooth the impact of technological changes. These systems may benefit in particular older workers that have become unemployed, who have a lot of job-specific skills and thus might benefit less from retraining and placement support programmes.[31]

A comprehensive public strategy targeted at the creation of "good jobs" can jointly improve productivity and equity. Increased education and a strong public support net might not be sufficient to address some of the inclusion challenges in the labour market driven by digitalisation and other structural trends. For instance, there might be an under-provision of "good jobs", defined as those that provide a middle-class living standard, sufficiently high benefits and security, and career prospects. Public intervention can boost the conditions of large segments of the labour market, and jointly improve productivity and equity. A strategy aimed at increasing the supply of "good jobs" can comprise: "i) active labour market policies linked to employers; ii) industrial and regional policies directly targeting the creation of good jobs; (iii) innovation policies that incentivize labour-friendly technologies; (iv) international economic policies that facilitate the maintenance of high domestic labour/social standard."[32]

Labour market policies such as minimum wages can help contain wage inequality in the presence of these structural developments; their impact on employment depends on the state of the labour market and other institutions. Evidence from France suggests that minimum wages, centralised wage negotiation and labour protecting legislation can break the link between increased automation and digitalisation and higher earnings inequality. However, these policies may have costs in terms of underemployment.[33] Evidence on the introduction of the minimum wage in Germany in 2015 estimates that the measure increased wages of low wage workers, without worsening their

[30] Cedefop, 2019
[31] Jung and Kuhn, 2018
[32] Rodrik and Stantcheva, 2021
[33] Cahuc, 2022

employment prospects, and prompted reallocation toward more productive firms.[34] These facts suggest that the effects of minimum wages depend on their specific level and the state of the labour market: While in stagnant markets minimum wages may lower employment, in booming labour markets they tend not to have adverse effects on employment and succeed in reducing inequality.

It has been argued that more radical policies, such as a stronger redistribution of wealth and even a universal basic income should be considered in the future if AI will substantially lower the marginal cost of labour. Somewhat speculatively, some observers raised the possibility that AI will reduce the marginal costs of labour toward zero.[35] This would imply that consumers would benefit from lower prices of many products, but also that owners of capital would earn higher returns while workers would lose. As a policy response, capital (and land, which has a fixed supply) might need to be taxed more strongly, so that wealth could be redistributed more equally. For example, all adults could receive an annual distribution of company shares, so that the benefits from higher equity prices could be spread more equally. This proposal is related to the idea of a universal basic income. Initial evidence on the effects of the provision of universal basic income in Finland suggests that there are limited adverse effects on employment; however, to assess the overall effects, other aspects would need considering; for instance, providing a universal basic income is a costly policy requiring a substantial increase in government revenues, including distortionary taxation.[36]

3. E-commerce and Fintech

3.1 The effect of digitalisation

Through technological developments in information collection, storage and exchange, digitalisation affects the interface of businesses with their customers, with significant effects on e-commerce and fintech. As large technology firms ("BigTech"[37]) and digital platforms are gaining market share in both

[34] Dustmann et al., 2022
[35] Altman, 2022
[36] Verho et al., 2022
[37] There is no commonly accepted definition of "BigTech". In this note, we use this term to refer to large, data-driven companies which dominate a market as technological leader and platform operator. Examples include online retailing, social networking, mobile devices and cloud computing. Currently, most BigTech companies focus on business with consumers (e.g., Amazon, Apple, Google, and Meta). An exception is Microsoft, which focuses on business customers as well.

financial and goods retailing, these two markets become increasingly interlinked. The three most prominent technological advancements driving both e-commerce and fintech are:

1) *Information collection*: efficient collection and storage of vast amounts of financial and non-financial data (e.g., the ratings of counterparties, customers, retailers, products, …)
2) *Information processing*: fast, real-time, automated processing, potentially by AI (e.g., calculating ratings in real time) and on third-party infrastructure (cloud)
3) *Information exchange*: simple, efficient, cost-free data exchange (e.g., provision of price or rating information, remote data storage and processing)

These technological advancements give rise to product innovation. New products driven by these developments are mostly digital goods (e.g., eBooks, tokens) and online services (e.g., online games and virtual reality, online banking, online pre-ordering). Furthermore, digitalisation renders tailoring some products (both financial and non-financial) to individual consumer preferences profitable. A feature of many (but not all) information goods is their non-rival character and near-zero cost of reproduction. In effect, the market for digital goods and services is characterised by considerable economies of scale. These enable market power, even if the fixed cost of product development was low.

More profound, however, might be the consequences of the digitalisation-enabled process innovations. Often, digital goods and services are nominally free of charge and provided in exchange for personal data. Digitalisation makes it possible to generate and process information in a fully automated manner, for example analysing data by AI. It allows for a fully automated data exchange, for example between market participants or members of the value chain.

The most prominent overarching process innovation is the evolution of platforms. Digitalisation facilitates the disintegration of the customer interface and the supply of the product or service. For example, the customer interface of a bank may be replaced by a (financial) platform. Likewise, the customer interface of a retailer (a traditional brick-and-mortar store or a stand-alone web-shop) might be substituted by a retail platform. Such platforms might integrate additional down-stream services from suppliers, such as delivery and customer service.

Another fundamental change is the broad-based inroad of large technology firms as cloud operators into industries with a significant digital goods or services component. For the final customer, the primary advantage of a cloud-service is the convenience of access – independent of location and software platform. It is, however, the suppliers of digital goods and services who drive the success of the cloud operators. They benefit from lower fixed costs, scalable capacity, and a software environment spanning all established operating systems and input devices. As this allows them to focus on their core competence, one can view the move to the cloud as an efficient reallocation of tasks. But this move has another, important effect. Large cloud operators gain deep insight in their cloud users' needs and business models, and can integrate that into their own service offerings, eventually even competing with their former clients. This can result in an increase in concentration and pricing power across different markets.

Network effects and efficiency gains are among the most salient economic implications of these process innovations for both e-commerce and fintech. Efficiency gains build on the ease of outsourcing distribution, IT, and potentially further functions such as accounting within a platform. This facilitates the emergence of highly specialised financial and non-financial sellers and service providers.

The network effects of platforms result from participation and information externalities. Participation externalities reflect that not only market depth, but also the range of offered (financial and non-financial) product varieties, i.e., market breadth, increases in the number of participants that a platform can attract. Information externalities reflect economies of scale and scope as well as the informational advantages from collecting and aggregating information from many participants, for example by member monitoring, by collecting their ratings, or by using this information, e.g., for cross-selling.

Network effects confer a sizeable advantage to early innovators. Additionally, high fixed costs, low variable costs, and economies of scale in, e.g., software, IT infrastructure (including cloud services) and data collection deter late entry to the platform business. This first-mover advantage leaves little room for adaptors to regain market share from early innovators.

Platforms reduce the entry costs and the fixed costs of suppliers. Platforms eliminate the need of operating a proprietary distribution network. In particular, the use of platforms reduces the cost of setting up a store (or bank), including the cost of advertising. This comes, however, with higher variable costs for suppliers in the form of platform fees or third-party delivery charges, especially if the platform has monopoly power.

Platforms thereby facilitate the entry of start-ups and specialists. In doing so, they aid product and service innovation and the fragmentation of value chains. Start-ups can bring their new products to the market (and test their economic viability) without building up a distribution network. Once set up, platforms scale at a low variable cost. Adding an additional product to a platform is therefore far cheaper than adding a product in a brick-and-mortar store, where it competes with other products for scarce floor and shelf space. Due to the lower cost on the platform, also specialised products and services with lower turnover can break even. Specialists can focus on small parts of the value chains, bring it to perfection, and sell only this product or service via a platform. This eliminates the fixed cost of an own distribution network and thus the pressure for vertical integration.

Platforms are natural monopolies. Competition among platforms is limited because of network effects and economies of scale. As platforms extract monopoly rents from the platform participants, most of the efficiency gains might accrue to the platform operator.[38]

The net effect of centralised marketplaces on competition is ambiguous. On the one hand, higher information transparency and reduced search cost increase the competition *within* a platform. This might, however, be counteracted by more prominent personalised pricing. On the other hand, network effects inhibit the competition *between* platforms, providing established platforms with sizable monopoly rents.

3.2 E-commerce

Digitalisation creates room for new products and services. This includes digital goods and services. The combination of online and offline features provides room for additional offline services, such as order compilation by the store or home delivery.

Automated information exchange and processing renders the mass customisation of products feasible. By automated order processing, more products can profitably be tailored to consumer specifications, ranging from simple personalisation to tailor-made products such as 3D-printed spare parts. The absence of a common, standard product widens the possibilities for price discrimination.

Custom-fit products and prices might complicate inflation measurement. More wide-spread price discrimination between households makes it harder to deduce a "representative" price for a given

[38] The EU digital markets act addresses the role of "gatekeeper" platforms.

product. This reduces price comparability across space and time and might thereby complicate inflation measurement.[39]

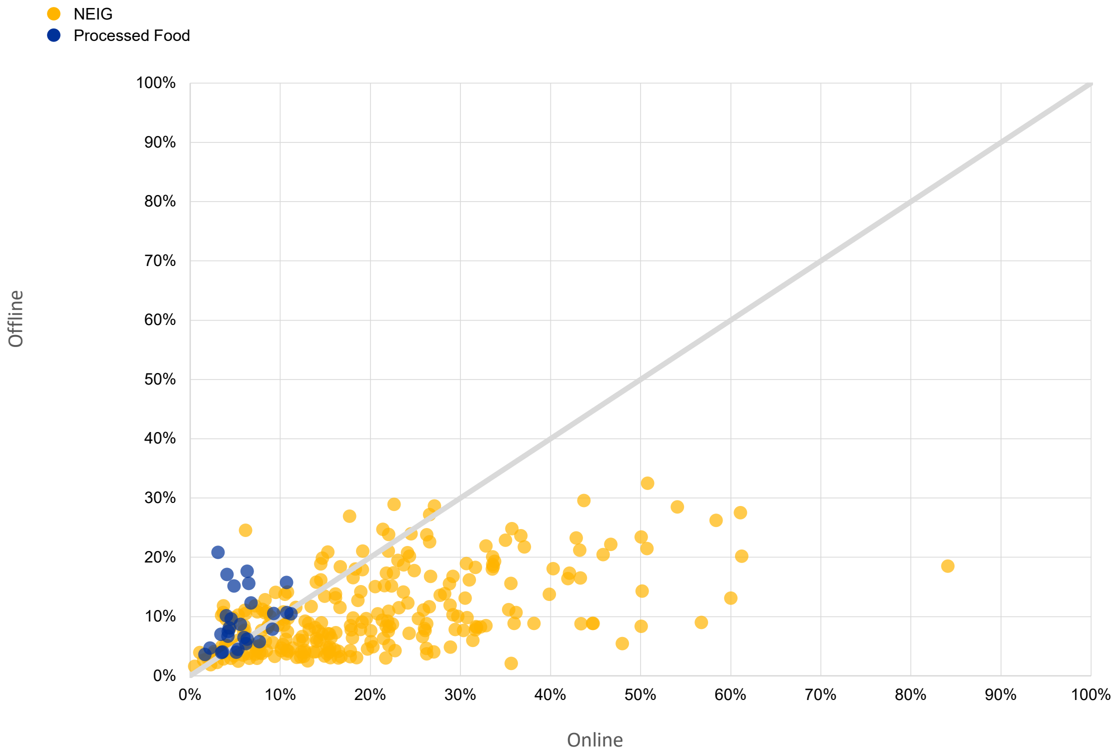
Except for durables and semi-durables, most online consumer markets in Europe are still developing. The diffusion of online retailing is high in consumer durables and semi-durables, emerging in typical supermarket goods, and low in many services. A long period of gradual adaption is likely. Digitalisation provides efficiency gains and affects competition in business to consumer (B2C) e-commerce. [40]

Digitalisation improves the efficiency of retailing. Online-only players face lower fixed costs by minimising their distribution network. Sufficiently large incumbent retailers can realise efficiency gains from digitalisation in their proprietary online stores. The efficiency gains among small B2C businesses stem primarily from the use of common third-party platforms, realising economies of scale in distribution. Finally, due to the more efficient information processing, the provision of additional services becomes profitable.[41]

Online price adjustment frictions seem lower, resulting in more frequent price changes. The prices of, for example, online non-energy industrial goods (NEIG) change more often, but by less, than offline prices.[42] There is, however, considerable heterogeneity of price flexibility across retailer types.[43] The lower cost of changing prices and the more uniform pricing online raise also the volatility of the size of price changes.[44] Via multi-channel retailers[45] and via direct online-offline competition this spills over to offline prices as well. Overall, there is evidence of a quicker pass-through of cost shocks.[46]

[39] The "posted price" might refer to a rarely ordered specification or the posted specification might change frequently. In this sense business-to-consumer might become similar to business-to-business price collection, which is often based on quotes for a given specification.
[40] The available data on online B2C e-commerce is limited to product category data underlying consumer price indices (CPI), transaction data in typical supermarket goods ("fast-moving consumer goods"), and web-scraped price quotes. Web-scraped data is more comprehensive in scope but lacks quantity information. CPI microdata spans the entire consumption basket but provides typically only pre-aggregated information.
[41] These new services often cross the online-offline divide. For example, the "click and collect" service has a different cost structure than the online-only business model, but replicates some of its convenience (e.g., "drive" format in France).
[42] See, e.g., Lünnemann and Wintr (2011) and Wieland (2022) for Germany. Web-scraped prices in Poland, for example, change more in online than in physical stores (Strasser et al., 2023).
[43] At multichannel retailers online and offline prices are equally flexible (Cavallo 2018, Bonomo et al. 2020). Prices at online retailers without an offline presence tend to be more flexible (Gorodnichenko et al. 2018, Hillen and Fedoseeva 2021).
[44] See, e.g., Gorodnichenko and Talavera (2017).
[45] See, for instance, Cavallo (2018) for multi-channel retailers.
[46] See, e.g., Cavallo (2018).

Figure 5: Frequency of changes in offline and online price in the German CPI



Sources: Wieland (2022) based on German CPI micro data.
Notes: Statistics are derived at the level of 288 online/offline products (COICOP 10-digit level) and aggregated to a given product category based on the corresponding 2015 expenditure share in the German CPI. The sample period covers 2015-2019.

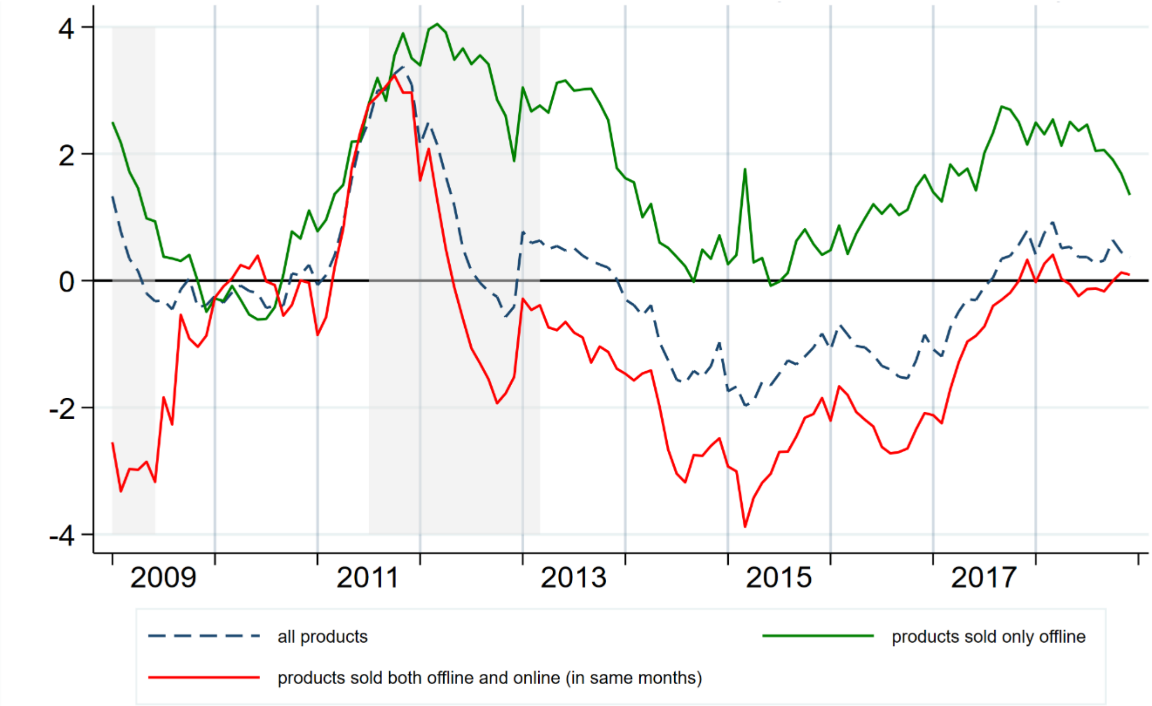
The ambiguous net effects of digitalisation on competition apply to retail e-commerce as well. This applies both to market power and to the role of platforms, with ex-ante uncertain net effects on pricing power and "real rigidities".

Online information[47] seems to increase price transparency. This, in turn, increases competition, both online and viz-a-viz offline incumbents. Online information alone can reduce both offline prices and within-chain price differences. Paired with online competition, this induces a spatially more uniform pricing offline.[48]

[47] For example, information on price, quality, and on the rating of product, retailer, and customer.
[48] Jo et al. (2019) provide evidence for a more spatially uniform pricing in Japan. For Israel, Ater and Rigbi (2023) show that in Israel the posting of price information online reduced within-chain price differences. Strasser and Wittekopf (2022) show that online and offline prices in France and the UK are highly synchronised, but nevertheless widely dispersed.

However, digitalisation also increases the possibilities for price discrimination. Full personalisation of prices is possible if the shopper has identified herself by logging into her account. Even without this, identifiers saved on the customer's computer, such as cookies, allow conditioning prices on past online activities. Less data-intensive, but also less targeted, is price discrimination based on, e.g., computer and software characteristics, IP address and time of shopping. There is some evidence of personalised pricing in US online supermarkets, i.e., that different individuals see different prices. In the same sector in Europe, we do not (yet?) see strong evidence on personalised pricing.[49]

Figure 6: Effect of online competition on inflation of supermarket goods in France (% p.a.)



Sources: Strasser and Wittekopf (2022) based on Kantar household panel.
Notes: Laspeyres y-o-y inflation rate based on offline prices and joint-basket weights. Standard barcodes only.

Network effects limit the competition *between platforms*. Once a market has consolidated, network effects pose a high entry barrier, and therefore limit competition among platforms. Established multi-product platforms are dominated by US companies (e.g., early innovators such as Amazon or eBay), with some attempts for differentiation by new entrants.[50]

[49] Aparicio et al. (2021) provide evidence for algorithmic pricing in the USA. For Europe, however, Strasser and Wittekopf (2022) report that in France and the UK price dispersion has been lower online than offline.
[50] Late entrants to the platform market ("adaptors") typically target a specific market segment (e.g., Etsy, manomano) to differentiate themselves from the general interest platforms by offering a more tailored search

However, the competition *between suppliers* increases. The reason is that the entry barriers *for suppliers* to the consumer mass market are lower on a platform. The high price transparency on platforms supports a stiff competition between suppliers on a given platform, across platforms, and viz-a-viz offline incumbents. In France, for example, as shown in Figure 6, products subject to online competition had lower inflation during 2009-2018.[51]

The attractiveness of cloud computing opens business-to-business (B2B) e-commerce to large technology companies.[52] B2B customers rely increasingly on information processing and computing services provided by BigTech companies, most notably cloud computing services. By tailoring services to B2B customers, large technology firms build industry know-how and customer relationships, which reduces their entry cost towards developing platforms targeted at corporate clients. This includes B2B marketplaces, potentially linked with a broad range of additional services (so-called "ecosystems") for B2B customers.

Lower price adjustment frictions seem likely in the B2B market as well. Digital markets B2B allow in principle for an automated price adjustment: Cost, utilisation, competitor, and demand information could be automatically collected and analysed. Based on this, updated prices could be communicated to customers in almost real time. Contracting habits in long-time B2B relationships, however, might suppress such flexible B2B pricing for the time being.[53] The automated exchange of information and automated contracting might aid, however, a further fragmentation of the value chain, and the entry of specialists.

B2B bidding platforms might speed up price adjustment after cost shocks. The increased competition on B2B platforms is likely to be analogous to retailing. There is some scope, however, for proprietary (downstream or upstream) bidding platforms of large incumbent B2B suppliers or customers, which would hinder the evolution of large third-party B2B platforms.

and assortment functionality to specific customer groups. Likewise, incumbents differentiate their online service levels (e.g., "delivery" vs. "click and collect") and with it their online pricing.

[51] But there is no visible effect in UK (Strasser and Wittekopf, 2022). This does not imply lower inflation overall, but rather that products subject to online competition are priced competitively, whereas the prices of other products not subject to online competition increase by more.

[52] There is no publicly available data on B2B e-commerce. It is a blind spot.

[53] There is no evidence that just-in-time production increased the frequency of price adjustment. It is therefore not obvious that a further digitalisation of supply chains would change this in a low inflation regime. It might well change, however, at higher inflation rates.

3.3 Fintech

Financial services are typically subject to significant informational frictions. For example, loan contracts are prone to adverse selection and moral hazard, and these risks lead to a higher cost of credit and lower lending volumes. To overcome these frictions, financial services are typically provided by intermediaries (such as banks) that specialise in screening and monitoring.

The information-sensitivity of many financial services suggests that the effects of digitalisation in the financial sector could be even more disruptive than in the case of e-commerce. In principle, the entire value-chain of the financial industry can be digitalised, from "production" to distribution. Moreover, the ability to bundle financial and non-financial services has the potential to create new interconnections between the financial sector and the real economy.

The proliferation of data favours a business model based on "hard" information (e.g., credit scores), which will diminish traditional relationship lending.[54] Innovation in data collection and processing has first-order implications for the provision of financial services. On the one hand, efficiency gains are likely to reduce information-related frictions and thus enable larger credit volumes at better terms. On the other hand, a financial system reliant on hard information is more cyclical due to absence of long-term relationships that facilitate the smoothing of credit terms over the cycle.[55] Moreover, hard information exhibits economies of scale, which induces consolidation and thus can increase systemic risk.[56]

Non-financial data can be used for credit-scoring and possibly reduce the need for collateral. Large technology firms collect vast amounts of personal data on their customers. For example, platform operators observe fluctuations in transaction volumes, response times, financial flows, payment delays, and so forth. While typically non-financial in nature, it has been shown that these data can be used for credit-scoring, and possibly substitute for collateral.[57] Accordingly, large technology firms have the informational capacity to engage in the provision of financial services. This is already a reality

[54] Relationship banking is often associated with "soft information" acquired by loan officers through personal contact with lenders. Unlike "hard information", it cannot be stored or transmitted easily. See Liberti and Petersen (2018).
[55] See Allen and Gale (1997), Bolton et al. (2016), Boot and Ratnovski (2016), Beck et al. (2018).
[56] Berger et al. (2005); Laeven et al. (2016).
[57] Berg et al. (2019); Frost et al. (2019); Gambacorta et al. (2020)

in China, especially in regions with a limited presence of banks.[58] Nevertheless, collateral might be increasingly scarce in a digital economy focused on intangibles like data and ideas. [59]

Innovations in computing and cryptography enable the decentralized settlement of financial transactions. While traditional financial services rely on intermediaries such as banks and exchanges for the certification of transactions, "decentralized finance" (or "DeFi") builds on decentralized record-keeping through distributed ledgers that are updated by means of a consensus protocol. The underlying technology forms the basis for crypto assets such as "Bitcoin", but more generally features potential applications in the areas of payments, securities settlement, trade finance, and others. While current market movements are mainly driven by the typical investor exuberance associated with financial innovation, DeFi applications have the potential to contribute intrinsic value by enabling new forms of financial contracting. Despite the goal of decentralization, some of these new markets are rather concentrated. For example, centralized exchanges for crypto assets have grown large as they benefit from pooling liquidity. Similarly, some consensus protocols concentrate power in a few large market participants. Moreover, full decentralization may fail because it is impossible to include all future contingencies into the design of DeFi protocols.[60] If these markets continue to grow, large players might become systemically relevant, and may have to be regulated in similar ways as traditional financial firms.[61]

Many banks pursue an integrated business model. Financial services were traditionally distributed through brick-and-mortar branches, which made banks the "first point of contact" and allowed them to complement traditional products such as loans and deposits with auxiliary services (payments, asset management, advisory). Such cross-selling has traditionally been a major profit source.

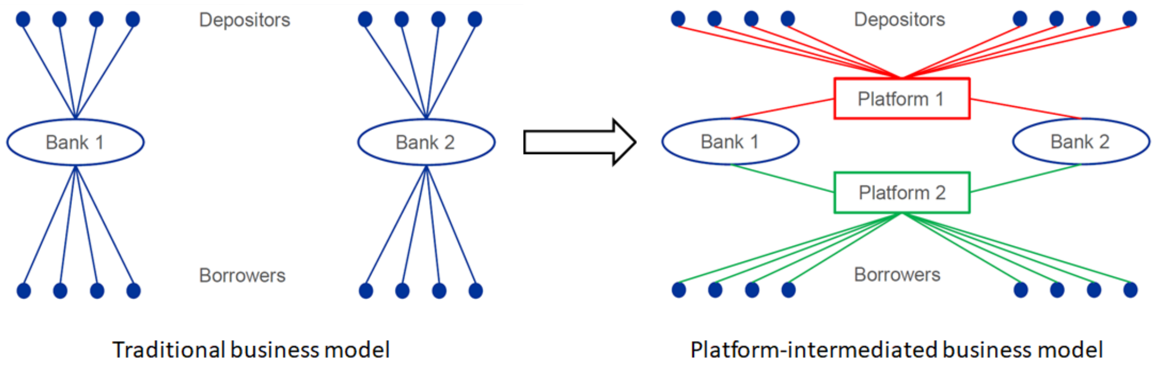
The secular shift towards online banking is a mixed blessing for banks. While it has lowered costs and increased customer convenience, low-cost digital distribution enables specialised financial services

[58] Hau et al. (2019). The basis for the expansion of technology companies into financial services is the access to large amounts of (consumer or business client) customer data. As European platforms are typically operating in niche markets, it is less likely that they will accumulate the critical mass of data to expand into financial services – unlike the large international technology companies.
[59] See Dell'Ariccia et al. (2021).
[60] See by W. Huang and A. Schrimpf "DeFi risks and the decentralisation illusion", BIS Quarterly December 2021.
[61] This includes anti-money laundering, taxation, disclosure (e.g., of reserve assets), transparency of operation, and the enforcement of standards to manage operational risk, volatility, and liquidity. Such regulation will be most effective if its implementation is coordinated internationally (Panetta 2022).

providers to bypass banks' distribution networks.[62] Moreover, large digital platforms are becoming increasingly interested in incorporating financial services into their "ecosystems".

Technology enables the bundling of financial and non-financial goods and services. This provides convenience to consumers and gives rise to significant synergies. The most salient examples in this direction come from Asia, where technology firms have successfully bundled retail payments with text messaging (WeChat), e-commerce (Alibaba), or ride-hailing (Go-Jek) services, and supplanted traditional financial intermediaries.

Figure 7: "Disintegration of business model of universal banks through platforms"



The business model of universal banks faces the risk of disintegration. Their large customer base and the underlying network externalities, and the access to vast data treasures could imply that BigTech will become the new "first point of contact" for financial services. Moreover, competition from specialised providers threatens banks' ability to engage in the cross-selling of auxiliary financial services. Jointly, platforms and specialist start-ups ("Fintech") have the potential to dismantle the integrated universal bank business model. Wherever they lose the customer interface, banks face the risk of becoming relegated to the role of a pure (upstream) supplier.

Banks are likely to retrench towards corporate banking. Business clients exhibit more diverse needs (structured products, tailored advice, etc.) and represent a less uniform customer group. Moreover, the current fragmentation of B2B e-commerce inhibits building sufficiently comprehensive datasets of corporate activity. For these reasons, banks may retain some of their edge relative to BigTech when dealing with corporate clients. However, the growing demand for cloud computing might change this.

[62] A case in point is the rise of "Rocket Mortgage" in the United States, an online non-bank mortgage provider that provides close to 10% of US residential mortgages.

If technology companies are successful in enriching their cloud operations with additional services (i.e., in establishing "B2B ecosystems"), banks may also face increased competition for this customer segment in the medium term.

3.4 Aggregate effects and policy implications

The longer-run net effect of (platform) concentration and efficiency gains on retail competition and consumer prices is ambiguous. It is to be seen to whom the efficiency gains of digitalisation will eventually accrue. Early, mostly US-based innovators have secured most of the general B2C platform market and are earning high monopoly rents. Due to network effects there appears to be less room for European late entrants.[63]

Online and offline inflation differentials are unlikely to be permanent. E-commerce affects primarily the level of prices. As markets mature, online and offline prices converge. Depending on the entry pricing, online inflation can run above or below offline inflation during the transition period,[64] and can be different between sectors.[65]

A heterogenous adoption of e-commerce might temporarily increase inflation heterogeneity. Due to different adoption rates across euro area countries and across household types, differences between online and offline inflation translate into inflation differences between households. This might imply that during the adoption period households that are more active online, e.g., richer or larger households, might face a somewhat lower inflation. [66]

[63] There is potentially room for European adaptors with specialised B2C platforms and for B2B platforms in cooperation with B2B suppliers and customers. At this point in time, however, European companies, such as the Swiss cloud provider "Tresoit", operate in niche markets.

[64] During the transition period online inflation can be lower (Goolsbee and Klenow 2018 for USA, Strasser and Wittekopf 2002 for UK) or higher (Strasser and Wittekopf 2022 for France).

[65] See, for instance, for Germany Wieland (2022).

[66] Strasser and Wittekopf (2022) report for the French and UK FMCG market in the year 2018 that younger, richer, and larger households shop relatively more online. For example, 44% in French and 31% of UK households with more than two members shopped online, but only 23% and 19%, respectively, of smaller households.

Online retail competition might induce a quicker offline price adjustment. As a result, prices might become more volatile in the short term.[67] On the upside, online prices might allow a timelier tracking of parts of consumer price inflation.[68]

Digitalisation may enhance the pass-through of monetary policy into prices. Higher price flexibility speeds up the pass-through of monetary policy to prices. This renders money more neutral and reduces the short-term real effects of monetary policy.

The rapid changes in the structure of the financial industry effected by digitalisation create risks for regulatory arbitrage. New technologies, business models and processes may not be covered by the existing regulatory framework. As banks face competition from specialised entrants and digital platforms, the regulatory toolkit requires updating. The existence of strong network effects in digital markets implies that change can be quite abrupt, which makes a forward-looking approach to regulation essential.

The proliferation of cryptocurrencies and new digital forms of money is a particular case in point. They largely operate outside the current regulatory perimeter and threaten to disrupt the status quo of the monetary system. Moreover, their popularity among unsophisticated investors gives rise to consumer protection concerns. For example, retail investors were lured into the cryptocurrency "Luna" with a 20% yield before its collapse in May 2022.[69] Proposals such as the "Markets in Crypto Assets" (MICA) regulation in the European Union are aiming at bringing these activities into the regulatory domain.

The use of new technologies also poses new risks. For example, the performance of credit scoring algorithms based on AI is untested in downturns. The absence of an underlying model implies that the resulting output is difficult to interpret and extrapolate to stressed scenarios, which complicates supervision and regulation. Moreover, new technologies may give rise to unintended consequences, such as an increase in discrimination of disadvantaged borrowers.[70]

[67] Gorodnichenko (2018) mentions higher volatility, similar to commodity prices.
[68] Webscraped prices allow nowcasting parts of the aggregate CPI (see, e.g., Cavallo 2013; Macias et al. 2023). In some cases, online inflation anticipates offline inflation (Cavallo and Rigobon 2016; Aparicio and Bertolotto 2020).
[69] See "$40bn crypto collapse turns South Korea against the 'Lunatic' leader", Financial Times, 24 May 2022.
[70] See Fuster et al. (2021).

The rapid rise of new business models and processes can create operational risks that may be hard to monitor and quantify. While cloud computing promises large efficiency gains, it also increases the scope for "cyber risk". Moreover, digital platforms and the cloud computing infrastructure may emerge as systemically important and require designation and supervision as such.

The fact that large technology companies venture into financial services creates stronger interlinkages between financial and non-financial activities. This could amplify the risk of moral hazard related to the explicit and implicit public guarantees which aim at safeguarding the financial sector. The original Libra proposal[71], for example, would have created a dominant issuer of private digital money from outside the financial sector. This would have called for the – potentially unwarranted, but clearly unprecedented – extension of the public safety net beyond the financial sector, created risks for public finances ("too big to bail"), and impaired competition in markets for non-financial product and services.

Increased coordination among national and cross-border regulatory authorities may become a necessity. While financial regulators are becoming concerned about the effects of BigTech's push into finance, policies aimed at addressing their dominance currently mainly lie in the field of competition policy. This suggests that only coordinated regulatory proposals may be successful in reaching public policy objectives. Moreover, the possibility of "races to the bottom" and global spillovers suggests a role for international coordination as well.

The financial system is likely to become more cyclical. As hard information becomes abundant, financial intermediaries lack incentives to engage in building on long-term lending relationships. This may give rise to a more market-based financial system, as opposed to the current, bank-centric system predominating across Europe. This trend is likely to override potentially countercyclical effects such as the reduced need of physical collateral (whose value fluctuates) in the presence of more precise data on borrower characteristics.

A more "digital" financial system will likely see a stronger pass-through of monetary policy. As banks' market power diminishes due to increased competition, loan and deposit rates will follow policy rates more closely. Recent developments in the US markets for mortgages and automobile loans, where

[71] The Libra proposal was renamed into "Diem" and ultimately discontinued in early 2022 due to increased regulatory scrutiny.

Fintech lenders have acquired significant market shares, are consistent with this view.[72] Similarly, the rise of non-bank payment providers in China led to significant growth of money market funds (remunerated at wholesale market rates) at the expense of traditional bank deposit accounts. Given the increased cyclicality indicated previously, a more direct pass-through may be welcome as a catalyst for more countercyclical monetary policy. [73]

4. Concluding remarks

Digital technologies open up great opportunities but also pose substantive challenges, and their ultimate effects will largely depend on the adoption of appropriate public policies at the national and international level. While the potential benefits of digitalisation for growth and consumer welfare may be often apparent, their drawbacks and challenges, and how to address them, may appear less obvious. History might be able to offer useful insights in that regard. As mentioned in the introduction, John Maynard Keynes (1930) had forecasted a secular decline in labour demand, which did not materialise. Acemoglu (2021) suggests several factors that may have helped to boost demand for human labour despite the ongoing technological change at the time. Specifically, he stresses the interplay between labour market institutions protecting workers and the emergence of technologies boosting human productivity, fostered by the broadly competitive environment after WWII and the government's role not only as a funding source, director, and coordinator of research efforts, but also as a major purchaser of new technologies. Based on this experience, he argues that government policy, funding and leadership are critical in shaping the future course of AI developments. At the same time, he highlights the need for international coordination, as individual countries adopting public policies will not be able to set the future direction of AI, when "hundreds of thousands of researchers in [...] other countries can still pursue surveillance and military applications of AI technology and eagerly continue the trend towards [labour-saving] automation."[74]

[72] See Fuster et al. (2019) and Yao (2022)
[73] While the increasing substitution of data for physical collateral could ameliorate a more direct pass-through, such effects are likely to be limited in advanced economies with well-functioning credit markets (see DeFiore et al., 2022).
[74] Acemoglu (2021c)

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