Artificial intelligence: shaping the future of work with insights from firm-level evidence

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Key messages

- The existing literature on the impact of artificial intelligence (AI) on workers and labour is still very limited. Furthermore, the underlying causal mechanisms of how and why AI changes tasks and jobs remain unclear.
- Although AI implementations are likely to have a broader impact than foregoing technologies, AI-related empirical research is still relatively scarce. This is due, among other things, to the fact that AI is used in different forms in different companies and organisations, and the technological effects depend to a certain extent on the type and speed of the technology's adaptation.
- Yet, understanding the type of AI adoption and its complex impact on workplaces are of great importance to ensure both sustainable- and inclusive growth.
- Therefore, a key method to better understand the underlying relation between different types of AI adoption and its impact on workers and labour is by analysing AI-related practices and applications in workplaces among different firms and sectors. Such detailed firm level analysis can shed more light on identifying the role of AI in work environments.
- A multiple stakeholder approach is essential to uncover how the future of work will develop under the influence of AI.

Artificial Intelligence: its impact on work and individuals?

Artificial intelligence[1] (AI) has a significant potential to deeply transform our society, economy, and labour markets. Yet, little is known about the exact consequences of AI for the future of work and the workers itself. While previous estimates of automation risks of occupations tend to diverge from 9% (Arntz, Gregory, and Zierahn, 2016) to 47% (Frey and Osborne, 2017), a quantifiable impact of AI diffusion on workers and their jobs has thus far to be determined. With increasing job polarization and a rising fear of automation risks amongst workers (Frank, Autor, Bessen, Brynjolfsson, Cebrian, Deming, Feldman, Groh, Lobo, Moro, Wang, Youn, and Rahwan, 2019), research should aim to investigate how AI influences the future of work and the workers involved. Given the vast number of different types of AI-implementations in firms, it is essential to specifically understand the differential impact of AI diffusion on workers and their jobs on a firm-level. This

1. To-date, there exists a considerable amount of ambiguity surrounding what constitutes AI and different types of AI (i.e., weak vs strong). This policy brief, while approaching the topic in a broader perspective, is centered on the clarification of an AI of the German Bundestag (2019, p. 51): *"AI systems are human-designed intelligent systems consisting of hardware and/or software components that aim to solve complex problems and tasks in interaction with and for the digital or physical world. AI systems acquire, process, and analyze data and exhibit appropriate behavior to solve and fulfill the respective problems and tasks."*

research involving case studies and insider econometrics, which are based on empirical studies of workplaces, is currently scarce. With more firm-level evidence at hand, policy makers can create and foster policies that allow societies to reap the benefits of AI while simultaneously mitigating its potential risks.

The potential of AI in comparison to previous technologies

There is a broad variety of literature that captures the impact of technological innovation on job- and skills demand in the labour market. Most notably, previous literature suggests that technological innovations such as computerization, automation, and robotization tend to substitute those tasks within jobs that have a high level of "routineness," while complementing the tasks that are "non-routine" (Author, Levy, and Murnane, 2003; Acemoglu and Autor, 2011). Researchers have found that this trend favours both high- and low-skilled (non-routine) workers at the expense of medium-skilled (routine) workers, resulting in reducing the demand for medium-skilled jobs while enlarging the demand for low- and high-skilled jobs. This process eventually leading to job polarisation on the labour market (e.g., Goos and Manning, 2007; Acemoglu and Autor, 2011). The phenomenon of job polarization in labour markets is pervasive in advanced economies to slightly different extents across 16 Western European countries (Goos, Manning, and Salomons, 2014). While said literature suggests that technological change is mostly routine-biased and likely causes job polarization, artificial intelligence (AI), machine learning, and other smart technologies, part of the so-called "Fourth Industrial Revolution" (4IR) (Schwab, 2017), are mainly still left out of this existing research frontier.

The possibilities of AI could be much broader and more profound than the effects of previous technologies, such as computerization and automation. In contrast to AI, previous technologies use explicit rules or manually written computer programs that are mostly designed to automate tasks. While these previous technologies have had a significant positive impact on productivity and labour (Autor, Levy, and Murnane, 2003; Acemoglu and Autor, 2011), their influence on codifiable knowledge is limited. AI is different from previous technological innovations because it does not only depend on instructions or rules provided by humans, but also consists of self-learning, i.e., it can automatically infer connections between inputs and outputs without the need for any manual rule-based design. Hence, AI provides novel opportunities to complement labour in tasks involving analytical reasoning such as medical diagnosis and forecasting while tending to substitute human skills in codifiable tasks in for instance speech- and imagine recognition (Brynolfsson, Mitchell, and Rock, 2018).

Several researchers even believe that AI has the potential to become a "general intelligence" that could outperform humans in any cognitive area in the future (Acemoglu and Restrepo, 2020, p1.). Although today AI is still far away from reaching its full potential, it can already perform a much wider range of different tasks than previous technologies. Therefore, AI entails a greater possibility to influence more jobs, sectors, and industries in the future than previous technologies (Brynolfsson, Mitchell, and Rock, 2018). In fact, there is a big discussion about whether and when AI might be able to outperform humans in every area of life, although there is no shared consensus on how an AI future should look like (Russell, 2020; WEF, 2021).

The following sections provide a brief state-of-the-art of what we know so far of the impact of AI on the labour market and in the workplace.

AI in the labour market: effects on workforce and labour

Whereas previous technologies often substituted mostly routine and low-skilled tasks, AI can, as previously described, potentially have a much larger effect on labour markets and workers by altering the task structure of jobs, replacing some tasks, and simultaneously generating often new ones that require a new kind of skills set (Autor et al., 2003; Autor and Dorn, 2013; Brynjolfsson and Mitchell, 2017; Acemoglu and Restrepo, 2018; Frank et al., 2019; Webb, 2019; Acemoglu et al., 2020; Acemoglu and Restrepo, 2020; Acemoglu, 2021; WEF, 2021; Xie et al., 2021). Empirical research has so far established that AI is likely to transform work and labour in multiple ways. In the following section the two most important areas of change are described in more detail. First, changes in what we actually do in our jobs; the specific tasks. Second, changes in how we work and what we need in order to do our jobs well; the skills requirements.

Complementing vs. substituting impact of AI on tasks

Acemoglu and Restrepo (2020) identify two general outcomes of AI: the "substituting"- and the "complementing" kind. The complementing force of AI leads to substantial productivity gains and enhances

human labour, such that it can lead to increasing employment in the long run.

Literature does suggest that complementing AI already exists (Autor, 2015; Acemoglu and Restrepo, 2018; Agrawal, Gons, and Goldfarb, 2019; Acemoglu and Restrepo, 2020; Autor, Salomons, and Seegmiller, 2021; WEF, 2021). For instance, AI does already enhance cognitive workers in their tasks such as oncologists using AI in their decisions of cancer detection (Susskind and Susskind, 2015). Besides complementing existing jobs, AI also has the possibility to create completely new occupations that do not yet exist, think of radiologists in the previous phase of technological innovation (Acemoglu and Restrepo, 2020; Autor et al., 2021). Furthermore, AI needs excessive training based on real-life data of good quality. This data often needs to be created first and therefore creates new job opportunities for AI- and other types of experts. Although some, yet little, complementary effects of AI have already been studied, the extent to which such AI diffusion could increase labour demand is empirically still scarce and less established.

In contrast to complementary AI, substituting AI is largely focussed on automating human labour. Therefore, such AI tends to decrease the demand for labour in automatable jobs, while its productivity growth cannot compensate for the loss in labour demand. As a result, this kind of AI is expected to increase inequality between workers in automatable- and non-automatable jobs (Acemoglu et al., 2020; Acemoglu and Restrepo, 2020; Acemoglu, 2021).

Researchers have investigated vacancy data of US firms and found that firms that adopt more AI hire fewer workers than firms that adopt less of it. This study concludes that the substituting force of AI is more pervasive than the complementary effect among most US firms - at least until now (Acemoglu, Autor, Hazell, and Restrepo, 2020). Other studies also find that currently many types of tasks can already be substituted by an AI; some examples are speech- and image-recognition, natural language processing and prediction tasks (Brynjolfsson et al., 2018).

It appears that both forces of AI can simultaneously occur in the labour market. This makes it challenging to assess the overall net impact of AI implementation to the future of work. A future with AI will greatly depend on the type of AI that is adopted and the nature of jobs and sectors in which these implementations occur. While some tasks within jobs might be suitable for AI-substitution or -complementation, others will likely not be (Brynolfsson and Mitchell, 2017). It will depend on us how we shape the future developments of the labour markets; either we use AI to make processes marginally more productive or we invest in innovations which are more focussed on complementing workers, and therefore increase employment opportunities (Acemoglu and Restrepo, 2020).

The requirement of a different skill set

Changes in tasks are strongly associated with changes in the skills demanded on-the-job. While AI has many capabilities, it cannot do everything (yet). Currently, tasks with higher levels of interpersonal- and social skills and physical activities, in which labour has a comparative advantage, are identified as key bottlenecks to the evolution of AI (Deming, 2017; Lane and Saint-Martin, 2021; Webb, 2019)

A recent OECD (2021) paper illustrates how important it is therefore for (future) workers to acquire such interpersonal and social skills. The OECD paper examines how skills demands, mentioned in AI-related online job postings in the US and UK, differ over time (Samek, Squicciarini and Cammeraat, 2021). The results show that AI exposure increases the demand for technical skills, e.g., Python, machine learning, data mining, natural language processing, and robotics. In addition to these technical AI-skills, a substantial number of socio-emotional skills also often seem to be found in the job postings. These socio-emotional skills are among others needed in education and business services to function in interdisciplinary teams, to communicate and/or present results, and to creatively solve problems. Hence, these results indicate that besides having just the technical skills to develop an AI, it becomes increasingly more important to be able to illustrate socio-emotional skills as well. This is to ensure that not only that all stakeholders understand the AI but also that it is deployed correctly (Samek, Squicciarini and Cammeraat, 2021).

To date, there is little empirical research that analyses the detailed skill requirement in respond to increasing AI exposure. It will be essential to further understand how AI changes the way we work with AI and consequently, what skills we need to do our job well.

AI in the workplace: effects on individuals

AI does not only affect the tasks and skills of workers, but it also changes the work environment, and the way workers perform and interact with each other. However, evidence on the influence of AI on the nature of work is still relatively scarce. Instead, several studies have investigated how other automating technologies have reshaped the work environment in the past decade. These studies show that rapid

advances in technology and automation reduce informal learning, motivation, and interdisciplinary cooperation among workers, and that they lead to rising levels of uncertainty, lower situation awareness, and distrust towards automation (Bakker and Demerouti, 2017; Bonekamp and Sure, 2015; Cascio and Montealegre, 2016; Ghislieri, Molino, and Cortese, 2018).

A small strand of literature which has investigated, but not yet empirically estimated, the impact of AI on employee well-being suggests that a well-designed and implemented AI could positively influence workers by fostering them to be more autonomous, flexible, and creative (Nazareno and Schiff, 2021). Several scholars expect AI to produce new efficiencies and enhance worker capacities. It is likely that AI can 'free-up' workers in a way such that they become more independent, strategic, inventive, and deep thinkers, who can do more unstructured work and address complex problems with increased cognitive skills (Johnson et al., 2020; Nazareno and Schiff, 2021; Pew Research Center, 2018). A study that evaluates the impact of AI on worker well-being by surveying 10.000 workers in Japan, already revealed that workers show a greater sense of job satisfaction and motivation as work gets more complex and challenging, especially when they succeed to tackle these novel situations (Yamamoto, 2018).

On the contrary, some studies argue that AI-driven changes in the workplace can lead to a deterioration of mental health and job satisfaction. As AI can accelerate the work pace and the number of tasks to accomplish, rising levels of stress, fear, exhaustion, and burnout could come as possible consequences (Johnson, Dey, Nguyen, Groth, Joyce, Tan, Glozier, and Harvey, 2020). In addition, AI implementation can and likely will increase control and surveillance over all aspects of work, and mainly, the workers. Such monitoring systems might have adverse effects on workers by reducing control over their job, and eventually, inducing a loss of meaning and lower job satisfaction (Moore, 2019; Nazareno and Schiff, 2021; Pew Research Center, 2018). Moreover, since AI could influence a broader set of the workforce in terms of task and skill disruption, it will require workers to be able to adapt and respond to future skills requirements. Such transformation may lead to higher levels of uncertainty and anxiety among workers and place a higher burden on the workforce to sustain their future employability (Bonekamp and Sure, 2015). During periods of technological change, as more jobs become cognitively complex and demanding, researchers observe that workers experience distress about job insecurity, being insufficiently trained, and the necessity for re-skilling or up-skilling to acquire AI-skills (Brougham and Haar, 2018; Nazareno and Schiff, 2021).

Overall, the research suggests that AI implementation posits both significant opportunities, and challenges for workers to adapt to the future workplace transitions and job landscape. Considering the mixed findings, it becomes safe to say that the outcome of AI adoption in the workplace is highly unpredictable, and therefore can be either detrimental or beneficial, depending strongly on how the AI is deployed, how the process is monitored, and which policies are in place to ensure sustainable employment. Yet, to date, there still exist scarce research to realize the way AI impacts worker well-being.

Research AI where it is being used: the need for more firm-level evidence

AI as a technology platform has the potential to reshape societies, and augment, replace, and transform most occupations in a way that has not yet been experienced before (Frank et al., 2019). Although, to what extent and how this transformation will occur remains unclear. Nevertheless, what is more critical is to realize that, albeit profound change is inevitable, AI-related practices will appear in different forms for each business and individuals in the labour market. Since each firm deploys different types of AI, depending upon their long-term goals, strategies and expectations, its underlying mechanisms are likely to create diverse outcomes for their work and workforce. With its distinct deployment and usage across various industries, the possible consequences of AI can therefore be better understood by analyzing firm specific, customized AI-practices. The existing AI research suffers from a lack of detailed firm level case studies and insights from insider econometrics that identify the causal impact of AI implementations.

The right question is not 'What will happen?' but 'What will we choose to do?'

To close this research gap, further research should be more tailored towards understanding the type of AI adoption and its diverse impact on work and workplaces. Such firm level analyses, supported by microeconomic evidence, can then shed more light on identifying how and to what extent various AI practices affect workers' tasks, skills, well-being, and mental- and physical health. Creating such evidence-based research and high-quality insights on practical implementations of AI and its effects is especially beneficial for policy

makers, i.e., governments, the corporate world, and social partners, when it comes to implementing sound and informed policies in terms of redesigning jobs and tasks as well as providing education and training opportunities to reskill affected workers. Therefore, a multi-stakeholder approach is needed to develop a human-centric AI which is 'innovative,' i.e., new and good, and has the greatest potential for a positive future of work to benefit our society to ensure sustainable employability and inclusive growth. In the end, as among others, Erik Brynjolfsson (2018) claims; the AI-related outcomes are shaped by the policies and actions we take ourselves.

> *AI and related technologies have already achieved superhuman performance in many areas, and there is little doubt that their capabilities will improve, probably very significantly, by 2030. … I think it is more likely than not that we will use this power to make the world a better place. For instance, we can virtually eliminate global poverty, massively reduce disease and provide better education to almost everyone on the planet. That said, AI and ML [machine learning] can also be used to increasingly concentrate wealth and power, leaving many people behind, and to create even more horrifying weapons. Neither outcome is inevitable, so the right question is not 'What will happen?' but 'What will we choose to do?' We need to work aggressively to make sure technology matches our values. This can and must be done at all levels, from government, to business, to academia, and to individual choices.* (Erik Brynjolfsson, as cited in Pew Research Center, 2018, pp. 4-5).

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